The Effects of Taiwan's State-Industrial Arrangements on International Competitiveness:

The Case of Notebook-Sized Computer and High-Definition Television Industry

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Abstract

This thesis aims at testing Hart's theoretical model -- the effects of state-societal arrangements on international competitiveness, by applying it to Taiwan's situation in the 1990s through two empirical studies, namely, the public-private collaboration in the innovation process of NPC and HDTV industries. It is argued that the authoritarian explanation of the developmental state does not accord with the transitions that have had happened in Taiwan in the relation between the state and industry concerning the issues of promoting technology development in the emerging industries. More international and technological considerations need to be incorporated into the developmentalist analysis. Moreover, the state alone is inefficient in moving industrial development without active participation from the industrial sector. Under circumstances of fierce international competition, rapid technological changes, and heavy physical and human investment for innovation, an innovative arrangement is called for in which the state actors and industry can cooperate and associate.

The research findings suggest that a new type of institutional arrangement has emerged in the innovation process through collaboration between the public and private sector in both NPC and HDTV industries which has had a substantial impact on international competitiveness. The NPC Alliance demonstrates an initial case of coupling the public sector research institute with the industrial sector in terms of R&D for a new industrial product, while HDTV consortia-complexes modelling the NPC example shows an extensive adaptation to bring this kind of institutional advantage for the revitalisation of declining consumer electronics industries. It arrives at the conclusion that Taiwan's state-industrial arrangement in the 1990 characterised as the institutionalised strategic partnership (ISP), a reciprocal institution based on industrial policy-driven cooperation with prudent definition by the state. ISP, a new form of industrial governance, combines state-defined policy and an implementation network of state-industrial cooperation which differs from the conception of one-sided interventionist governance and purely free market solutions.

The theoretical application of Hart's model to Taiwan's current situation is appropriate. Taiwan fits into his model in the position of the state-business coalition side which is assumed to be a more competitive arrangement than in the position of the state vertex. State-Societal arrangements have been an endogenous and institutional factor which forms a necessary part of the explanation and understanding of the promotion of international competitiveness. Institutional arrangements should be evolved to cope with changes in order to create institutional advantages rather than be subject to environmental constraints.

CONTENTS

List of Charts, Figures and Tables

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Declaration

The material contained in this thesis is the work solely of the author. None of the material has been submitted previously for a degree in this or any other university.

List of Abbreviations

CCL	The Computer and Communication Research Laboratories/ITRI, Taiwan
CEPD	Council for Economic Planning and Development, Taiwan
CIS	Chung-Shan Institute of Science and Technology, Taiwan
COC	General Chamber of Commerce, Taiwan
COLA	Council of Labour Affairs, Taiwan
DIT	Department of Industrial Technology/MOEA, Taiwan
DPP	Democratic Progressive Party, Taiwan
EC	European Community
EOI	Export-Oriented Industrialisation
ERSO	Electronics Research and Service Organisation/ITRI, Taiwan
FOI	National Federation of Industries, Taiwan
GDP	Gross Domestic Product
GI	Government-Industry
GNP	Gross National Product
HDTV	High-Definition Television
IDB	Industrial Development Bureau, Taiwan
IDF	Indigenous Defence Fighter
IDIC	Industrial Development and Investment Center/ MOEA, Taiwan
III	Institute for Information Industry, Taiwan
IP	Industrial Policy
IPR	Intellectual Property Right
ISI	Import-Substitution Industrialisation
ISP	Institutionalised Strategic Partnership
ITIS	Industrial Technology Information Service, Taiwan
ITRI	Industrial Technology Research Institute, Taiwan
KMT	Kuomintang, Nationalist Party, Taiwan
LCD	Liquid Crystal Displayer
MITI	Ministry of International Trade and Industry, Japan
MOEA	Ministry of Economic Affairs, Taiwan
MOND	Ministry of National Defence, Taiwan
MRL	Materials Research Laboratories/ITRI, Taiwan
NFL	National Federation of Labour, Taiwan
NIEs	Newly Industrialising Economies
NIP	Regulations Governing Encouragement of Development of New Industrial Products by Private Enterprises, Taiwan
NLSDC	The National Long-Term Science Development Council, Taiwan
NPC	Notebook-Sized Computer

NSC	National Science Council, Taiwan
NT$	New Taiwan Dollars
ODM	Own Design and Manufacturing
OEM	Original Equipment Manufacturing
PC	Personal Computer
QIO	Quasi-Internal Organisation
R&D	Research and Development
ROC	The Republic of China on Taiwan
SIP	Science-Based Industrial Park, Taiwan
SMEs	Small and Medium-Sized Enterprises
S&T	Science and Technology
STAG	Science and Technology Advisory Group, Taiwan
STP	Special Technology Project/MOEA, Taiwan
SUI	Statute for Upgrading Industries, Taiwan
TEAMA	The Taiwan Electric Appliance Manufacturers' Association
TEEMA	The Taiwan Electrical and Electronic Manufacturers' Association
TLP	Regulations Governing Assistance in the Development of Targeted Leading Products, Taiwan
UK	United Kingdom
US/USA	The United States of America

Technical Abbreviations in Chapter Six

AEA	American Electronic Association
ATTC	Advanced Television Testing Center, USA
ATV	Advanced TV
CCIR	International Radio Consultative Committee
DARPA	Defence Advanced Research Projects Agency, USA
DAT	Digital Audio Tape
DBS	Direct Broadcast Satellite
DSC	Digital Still Camera
DVB	Digital Video Broadcasting
DVD	Digital Video Disk
FCC	Federal Communications Commission, USA
HVC	The HiVision Promotion Center, Japan
ITV	Interactive TV
MAC	Multiple Analog Component
MPEG	The Motion Picture Expert Group
MPT	The Ministry of Post and Telecommunications, Japan
MUSE	Multiple Sub-Nyquist Encoding

NHK	Nippon Hoso Kyokai, Japan
NTSC	National Television Standard Committee
PAL	Phase Alternation by Line
PTV	Projection TV
Rx	Receiver
SECAM	Sequential Colour and Memory
STB	Set-Top Box
TAC	Taiwan Aerospace Corporation
VCD	Video CD
WS	Wide Screen
WTV	Wide-Screen TV

CHAPTER ONE

INTRODUCTION

1. RESEARCH MOTIVATION AND PROBLEM ANALYSIS

The economic development of Taiwan is the subject of debate between political scientists and economists. There is no doubt about the scale of Taiwan's economic achievements, but there is a dispute about how it achieved its considerable success. There were two important competing approaches in the political economy of development before 1980, namely the neo-classical and the dependency perspectives. The state-centred perspective has emerged as another rival explanation in the field of East Asian development since the early 1980s. All of them provide some relevant and valuable insights, but there are significant variations in each in terms of their theoretical implications.

The earlier neo-statist theory's applicability to the historical experience of East Asian development, however, was not seriously challenged before 1990. The changing international political economy and the change from an authoritarian regime towards a more democratic one in Taiwan, demands a revised theory. Taiwan is one of the leading newly industrialising economies (NIEs), and the next country in line to enter the club of OECD countries. If Taiwan hopes to improve its competitiveness further and get into the developed world earlier, it is necessary to consider the relevance for Taiwan of an analytical framework similar to that of the developed countries, rather than to use the theoretical framework generally provided for developing countries[1].

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[1] There are many studies concerned with how countries enhance their industrial competitiveness, but there is a difference between studies focusing on developed and developing countries (Lall, 1990). The main concerns of the studies of developed countries were on innovation, the function of labour and capital markets, the education system, the management system and the linkages between scientific and applied research. In contrast, those of developing countries were focused on the orientation of trade and industrial policies, in particular, the debate about export-oriented versus import-substituting strategies. 'The dominant set of explanations of their industrial performance concentrates on incentive rather than structure factors (ibid.:11).' The neglect of the structural factors that the latter studies focus on

There are many theoretical frameworks advanced to interpret the relationship between national structure and international competitiveness, but none of them provide a model for framing public-private sector interactions that ensure maximum effectiveness in realising even the single goal of international competitiveness. Most studies focus on the significant role of the state and do not answer the question about what type of relationship there should be between the public and private sectors in order to achieve international competitiveness. It is almost impossible to propose a general public-private relationship for developing a nation's competitiveness because of the different cultural, economic and social conditions of each country. Rather, public-private sector relationships should be flexible instead of precisely defined, according to the World Bank's collected volume -- International Competitiveness: Interaction of the Public and Private sectors (Haque, 1991). In this many authors agreed

> (a) that the private sector had an important and legitimate role to play in economic development in all economies;
> (b) that the public-private sector interactions are better articulated within a market-coordinated economy than one of central control and direction; and
> (c) that public-private sector relations evolve and vary over time rather than being subject to a once and for all definition as is usually the case in systemic definitions. (ibid.: 16)

1.1. Defining 'International Competitiveness' and 'Technology'

While using 'international competitiveness' as a framework to analyse national economic problems in relation to growth and as an indicator to judge the strength of a country's manufacturing export in international trade has come a popular realm of political economy. Krugman (1994) devalued the concept of competitiveness when applied to national economies and suggested that the obsession with competitiveness would mislead domestic policies and threaten the international economy. But he neglected the fact that competitiveness is rather endogenous than exogenous and that the concept of competitiveness is dependent on the comparability of different economies based on a set of indicators, not a single number to sum it all up.

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results in the chance to learn from the experience of developed countries in enhancing their industrial competitiveness being forfeited.

Some works on international competitiveness have connected its dynamics to internal determinants. For example, Hart's book -- Rival capitalists (1992), used state-societal arrangements as a framework to analyse competitiveness amongst main industrial countries; Porter's book -- The competitive advantage of nations (1990), used the diamond (the determinants of national competitive advantage including: 1. factor conditions 2. demand conditions 3. related and supporting industries 4. firm strategy, structure, and rivalry) plus the role of chance and government to illustrate the issues that will govern the future development of a nation's economy. If a firm or an industry within a nation wants to become a strong competitor, 'the home-based advantage must then become the level to enter foreign markets' (Porter, 1990:63). Accordingly, a nation's competitiveness is endogenous rather than exogenous.

Bradford argued that 'development proceeds from inside outward rather than from outside inward (1994:42).' He proposed a new paradigm of systemic competitiveness which is based on the interaction within a nation's economic system of its component systems, namely the financial, production, innovation and governance systems (ibid.). Velloso (1994) had the same concept, he defined international competitiveness from four internal bases -- technology, human capital, economic and institutional infrastructures, and interactions between various actors. National competitiveness is not simply an economic or market-driven phenomenon, a society-wide vision is required (Haque, 1991). Not only have scholars emphasised the importance of domestic determinants in competitiveness, but they also required a redefinition of the government- industry (GI) relationship and the role of the state. In this sense, the GI relationship as one of the important factors to enhance competitiveness is back on the policy agenda. The private sector is given a new meaning of acting as a partner with the government to work hand-in-hand on the efforts of creating competitiveness, and it also calls for integrating industrial organisations into the national policy-making process.

To define 'international competitiveness' in terms of manufactured products is not easy. It is because two basic elements of manufactured product -- price and quality -- are difficult to compare. Comparing the price between two products without regard to their quality is virtually meaningless, and quality is difficult to specify in terms of product differentiation. Unless your products are 'sellable', no one will buy them -- a business or marketing meaning of competitiveness. The global consumers care more about products' price and quality which meet their needs and taste than the origins of products. In a common marketing jargon, is the product value for money?

However, international competitiveness can not be defined in such a microeconomic way, it should be defined in macroeconomic terms, at least for use in this thesis. There is a misunderstanding of believing that nations compete with each other in a similar fashion to the way firms do. Firms and industries, rather than the countries, which compete in the international markets are the main operators of business activities (Krugman, 1994; Porter, 1990). When we talk about a firm's competitiveness that means its market position is sustainable and promotable. A nation can not be the competitor acting in the international market. It has to engage in business through its nation's firms or public enterprises. Thus, the meaning of competitiveness for a nation is to maintain and promote the market share of national industries in the domestic and international markets.

Basically speaking, world trade is somehow governed by the principles of survival of the fittest, but it is by no means a zero-sum game. The productivity of an industry rising in some countries, which implies their increasing competitiveness, is not necessarily at the expense of others. On the one hand, if they can improve their productivity to catch up with rivals, then they can sustain competitiveness; on the other hand, if they fail to do so, they can leave that industry to others. As far as a single country is concerned, if an industry within a country confronted fierce competition from foreign rivals, the government may help to strengthen its competitive advantages, or shift its resources to other industries where there are strong competitive advantages that can be created. When a country encounters decreased competitiveness in an industry, it might lead to an increasing competitiveness in some others if the resource can be efficiently used. The competitive advantages of firm/industry differ from firm/industry and from country to country (Porter, 1990). Therefore, there is no single country that can maintain strong competitiveness in all industries. 'A country does not need to be competitive in all industries to be competitive overall, but it does need to be competitive in a variety of industries (Hart, 1992:6).' In order to build some competitive industries, well-functioning GI interactions and well-focused policies are of paramount importance. Although some countries, notably the USA, do not operate their economies in this way. However, this point of view is held by many other countries.

The most frequently used single indicator of international competitiveness is trade balance, or trade surplus. However, trade balance and trade surplus sometimes indicate competitive strength, but it is not suitable to all cases. Taking Bolivia as an example (Hatsopoulos et al., 1990), its exports exceeded imports by more than 60%, and the trade surplus as a percentage of gross national product (GNP) was usually larger than that of Japan in most of years. It cannot demonstrate Bolivia's competitiveness because its per capita output of economy fell by 26%. Bolivia was forced to run large trade surpluses to pay back the large debts incurred from petrol-recycled money in earlier years. Thus, the proper test of competitiveness is not simply the ability of a country to balance its trade, but its ability to do so while achieving an acceptable rate of improvement in its standard of living which can keep pace with those of the other industrial countries (ibid.:110).

Porter defined international competitiveness by a nation's industry as 'possessing competitive advantage relative to the best worldwide competitors' (Porter, 1990:25). He argued that either '(1) the presence of substantial and sustained exports to a wide array of other nations and/or (2) significant outbound foreign investment based on skilled and assets created in the home country' (ibid.) as the best measures of international competitive advantage. Trade and foreign direct investment are two good indicators to present competitiveness, but the latter is more difficult to identify in terms of the home-based nation since increasing numbers of stateless firms and joint ventures operate internationally. There is no widely accepted criterion to assess a nation's competitiveness. One definition proposed by the USA President's Commission on Industrial Competitiveness seems to satisfy many experts: 'the degree to which a nation can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining or expanding the real income of its citizens'[2].

The word technology is defined in this thesis as 'the ability to carry out productive transformations', which are able to have the effect of 'translating materials, energy and information in one set of states into another more highly valued set of states' (Metcalfe, 1995:455). In this sense, the concept of technology is more concerned with knowledge than with the use of machines to accelerate productivity. It clearly involves the ability to think and the knowledge to improve productivity, although technology is more than thoughts. Some of the knowledge is embodied in machines, but most of it is not. The following paragraph is worth quoting at some length, since it illuminates the linkage between technology and structures which embrace knowledge:

> It (knowledge) is embodied elsewhere -- in the brains of people, in organisational structures and in behavioural patterns, which in turn are conditioned by the strategies of different social factors and their patterns of conflict and cooperation. ...technology changes cannot be separated from market structures, patterns of competition and social regulation, and from the quality of the educational system and of the labour force. ...It (technology change) is derived, to a large degree, by the fundamental requirements of competition. ...One cannot expect to understand the nature of international technology diffusion, and the chances of different actors to gain access to key technologies, if one doesn't analyse explicitly the driving forces behind global competition and the restructuring of productions and markets. (Ernst & O'Connor, 1989:20)

1.2. Changing Environmental Constraints

The role of the state is aggressive and crucial to economic development, and the paternalist industrial policy (IP) can be deemed to have been successful in the past. Two recent changes have weakened its autonomy in relation to IP in Taiwan. These are the

[2] Global competition: The new reality, Report of the President's Commission on Industrial Competitiveness, Vol. 2 (Washington, D.C.: U.S. Government Printing Office, 1985), P6. This quotation has been used by Hart, 1992:5; and Cohen & Zysman, 1987:60. Hatsopoulos et al. (1990) have similar views on defining competitiveness.

change in the political system towards a more democratic system of government, and the significantly increased power of the private sector over financial matters and in relation to investment decisions. This will introduce new uncertainties to Taiwan's industrial development. This is not to say that the Taiwanese state is on the decline, but rather there has to be a redefinition of the state. For future development, the state may need to exercise its role as a coordinator more strongly than as a director in industrial matters. The future arrangements for Taiwan's system of IP-making and its implementation have to adjust towards a system of state-industry cooperation.

The international environment and Taiwan's domestic environment have changed dramatically since the mid-eighties. In terms of the international environment, trade conflicts and international competitiveness have replaced the traditional military race as the main concern of international affairs in the post cold war era. The increasing and continuing globalization of industrial activities, markets and competition affect the international competitiveness of a country and also affect economic development at the state and local level.

Two serious changes that have affected the world economic system can be observed in the period of 1970-1990. Firstly, rapid and sustained growth in international trade in the past two decades has led to an increase in the internationalisation of the world economy and an enlarged world market. International trade today is no longer concentrated on an exchange between primary and manufactured products. In fact, countries, whether developed or developing, reveal a pattern of trade increasingly concentrated in broadly similar industrial products. With an increasing range and sophistication of industrial products exported from developing countries, this has created considerable tension in world markets as most developed countries have experienced a decline of their market shares. Empirical and theoretical evidence also suggests that a country's economic success and influence depends to a large extent on its ability to expand export earnings, thus the competition in world trade has intensified over the years. This, then, is the global environment in which nations, as well as private industrial sectors, need to create their competitiveness.

Secondly, the accelerated rate of development of technology fostered a strong tendency in the leading traders towards the creation of science-based industries, and an orientation towards high tech goods and the production of high value-added products. However, a country's technology capability system can no longer survive depending on private technology development alone. It should include the network of institutions and agents in the public and private sectors, that make effective use of existing technology, that introduce into the local economy better goods and services regardless of whether they are new by world standards, and that improve and develop technology appropriate to local needs (Haque, 1991:48). Under the circumstance of the urgency of continuous technological and product innovation to 'catch up' with international demand, it tends to bring the state back in and to lead to the adoption of an appropriate state policy for techno-industrial innovation. This political attempt concerning the state involved in these new high tech world markets and in the global race for innovation has increasingly required a state-led rapid shift of both capital and human resources from sector to sector, or within the same sector. While it can be argued that the importance of an overall national framework for technology development has been overemphasised, it is about time to give an equivalent weight to its counterpart -- the private industrial sector, because that national framework could never succeed while lacking responsive private participation. Accordingly, to maintain international competitiveness and to promote exports are goals highly relevant to many aspects of government/private sector interaction, especially in the tasks of developing and diffusing technology.

Trade and foreign investment are two major indicators of the degree of internationalisation of a country and its firms. The volume of world trade has expanded significantly since the 1960s as tariffs and quotas have been reduced through multilateral agreement. The share of the world market and the resistance to import penetration were evidence of competitiveness, in particular, in the 1960s. In the 1970s, internationalisation was marked by its emphasis on industrial expansion through foreign investment and competition between multinationals. The competitiveness of a country and its firms came to include the proportion of global sales accounted for by production abroad.

In the 1980s, a new pattern of industrial competitiveness emerged largely due to the influence of technology. The key to global competition was neither Fordist mass production of standardised products nor the concept of comparative advantage on collective factors such as resource endowment, labour and capital inputs, but the ability to innovate and to adapt and implement technologies. For the purposes of technological sophistication, maximum flexibility, commercialised products, extensive supplier network, and most important, global competition, firms interact on a global scale of external alliances, for instance, joint ventures, subcontracting, licensing and inter-firm agreements. 'Firms have gone beyond their traditional practices of exporting to foreign countries and building foreign facilities to establishing intricate international networks of research, production and information. These flexible webs of interaction exist alongside trade and foreign investment as evidence of the increasing globalization of industrial activities, but have proven far more difficult to measure' (OECD, 1992:11).

The consequence of the internationalisation of industrial activities is the decline in the power of states to control economic events. Nations are more anxious to promote their competitiveness in an international setting of fierce competition, by the method of intervening in markets, negotiating with rivals, and making special arrangements for government and societal actors to co-operate. They can't easily control production which is aimed at a global market, in particular those production activities located outside their frontiers. 'They find they cannot direct; they can only bargain' (Stopford & Strange, 1991:14).

Stopford and Strange argued that traditional government-government diplomacy has been replaced by a new form of triangular diplomacy -- government-government, government-company, and company-company relations, in a changing international political economy. They not only point out that states are losing the power to pursue independent policies and they have to learn the new game of triangular bargaining, but also that technology and the structure of international finance have become the primary driving forces for change (ibid.). That is not to say that the economic functions of the state for competitiveness are less important in the international environment. Conversely, 'global competition is much more than rivalry among firms, for it involves the "structural competitiveness" of states within the world system' (ibid.:63). The capacity of the state to produce internal wealth and to create exports to finance purchases of needed goods and service has the effect of easing the pressures for social and political change.

In terms of Taiwan's domestic environment, rapid economic growth has evolved from the results of economic liberalisation and political democratisation in the post-Chiang-Ching-Kuo era. This is not only a phenomenon that has happened in Taiwan, but all over the Third World[3]. The state faces problems arising not only from demand for more public services and more opportunities for participation in the decision making of public policy, but also of growing economic power in the private business sector, which is weakening the previously dominant and pervasive role of the Taiwanese state in industrial development. It seems that two advantageous structural factors are on the decline. These are the highly pervasive presence of an authoritarian political regime and the strong system of capable economic bureaucracy. Now, the state is not the only player on the stage. Challenges have arisen from social classes, which were treated and exploited as defaulters by the 'strong and effective state'.

Taiwan has experienced unprecedented internal changes since the termination of martial law in 1987: the expansion of parliamentary legitimacy, the challenge from the

[3] A survey of the relationship between democracy and economic development in cross-national perspective concludes that 'the greater the increases in gross domestic product (GDP) per capita between the early 1960s and the early 1980s, the greater the positive shifts on the democracy scale' (Moore, 1995:17), but not the other way round. This trend has been described as 'the third wave' by Huntington (1992) and 'the political economy of authoritarian withdrawals' by Haggard and Kaufmen (1995).

opposition, and the rising influence of the private sector. Taiwanese society has no prior democratic experience, moreover, prior to 1987 the Kuomintang (KMT) state was characterised by the strong presence of the military in both the party and state power structure and by its institutionalised intervention in civilian affairs through martial law. Politically, to respond to the potential military assault of Communist China and to maintain political and social stability, the KMT state not only restricted human rights and civil rights, but also controlled the unions and the whole society through the reform and expansion of the party, the military, the government and the intelligence system. Economically, in the period of import substitution, there was intervention and severe regulation of interest rates, prices, trade, foreign exchange and finance. While the degree of state intervention into every aspect of civilian activities had been reduced to a lower level, up to the eve of the termination of martial law there was no fundamental change in the nature of state intervention.

If the Taiwanese government continues to follow the old tactic of state-led industrial development, it can be presumed that Taiwanese competitiveness will decline soon. In an era where that ideology is playing a lesser part in political life and where economic pressure for the opening of markets to international competition is increasing, the KMT's ability to reserve economic rewards for political supporters is being reduced (Ferdinand, 1994). The state must adjust its role in a fast-changing world. A conventional one-party authoritarian regime cannot deal with these new domestic and international transmutations and a new form of state-societal arrangements is required. The issue of finding compatible state-societal arrangements for industrial development is fundamentally different from changing the pattern of IP. It is an issue involving both economic and political considerations, and the interaction between actors which is more complex than ever before.

There is a trend in Taiwan to economise its previous state-driven industrial development towards a system of public-private cooperation in order to cope with changing environmental constraints. Taiwan has long been known to have a high degree of government intervention in its economy and a paternalistic IP of promoting industrial competitiveness. It demonstrates that the Taiwanese state has no choice but to adapt itself to the consequences of economic globalization and political democratisation. No matter what kind of economy there will be in the future, it should be more like the open economies of the industrialised countries than it was. The role the state plays as the engine of growth that will get Taiwan into next century is highly contested.

To sum up, there is a need for a new model, instead of the state-centred model, to capture the complexity of the changes that have taken place in Taiwan. As far as competitiveness is concerned, the core of the new model should be the development of technology and the adjustment of the relationship between the state and industry.

1.3. Objectives

Proposals will be made for a new state-industrial arrangement in Taiwan which could help to ensure international competitiveness in a changing international and domestic climate. Basically speaking, this thesis is designed as a theory-testing one. To search for such a model, the situation in Taiwan will be examined according to a well-developed theoretical background--that of J.A. Hart's model: the effect of state-societal arrangements on international competitiveness. In his model, three variables are introduced, namely, international structure, state structure, and social structure, of which he uses state-societal arrangements (through their impact on the speed of diffusion of new technology) to explain different types of influence on competitiveness among the main capitalist countries. Although the framework of analysis is derived from Hart's model, emphasis is placed on state-industrial arrangements, in particular on the interaction between the government and industry. This is mainly to reflect the fact that labour is still too weak to affect national policy in Taiwan.

IP, focused on the development of technology, will be the main concern in analysis of the interplay between the state and industry. How a national IP will be affected under the pressure of competition and structural adjustment, and what kind of relationship will be formed between the government and industry under the changing environmental constraints are two main questions, which will be examined through the perspective of IP.

Hart's model provides a new tool for examining a country's competitiveness through arrangements among three domestic actors (the state, labour, and business). This model is the most appropriate for the analysis of those capitalist countries with industrial capacity to compete within the world economy whatever inherent domestic structures they might employ. Those without industrial competitiveness or outside the world economy are excluded from this model. While other approaches to the political economy of development in developing countries (especially, NIEs) are significant variations in each. Hart's model, however, could provide an approach to remedy the shortcomings of these theoretical perspectives. It could be argued that none of the neo-classical, dependency, and state-centred (neo-statist) perspectives is fully adequate by itself to elucidate what has occurred in East Asia, but all accommodate some relevant and valuable insights. Because of their bias to different concerns, for instance, the neo-classical perspective stressed market mechanisms and limited state, the dependency on international linkage, and the statist focused on state interventions and IP, it is very difficult for any of them to confer a comprehensive explanation in the contemporary situation. Nations like Taiwan and Korea have increased their industrial competitiveness since the late 1970s, however, their state-societal arrangements for international competitiveness are still under-explored. It is thus worthwhile to restore the balance and to apply this model to the case of NIEs.

Besides, it would also be valuable for NIEs to find a superior system for themselves and by its application to learn the merits of a competitive model and to avoid the shortcomings of their predecessors. In this way, countries late to industrialisation will be able to take advantage of their predecessors' technical and developmental experiences. There will be an analysis of how Taiwan has evolved its arrangements for industrial development and whether these arrangements are competitive in practice and theory.

The objectives of this thesis are threefold: (1) to justify the theoretical application of state-societal arrangements in explaining the case of Taiwan; (2) to suggest an appropriate state-industrial arrangements which will enable Taiwan to transfer from its state-led one and remain competitive; (3) to interpret the impact of the political/economic environment on the evolution of institutional arrangements.

2. METHODOLOGY

2.1. Assumptions

This thesis is not a theory-building one, but a theory-testing one. Accordingly, the research method will follow the theory-then-research school, rather than research-then-theory school. The principles of theory-then-research are, firstly, that the establishment of scientific knowledge depends mainly on the development of a theory, and that research testing the theory can justify or not its validity; secondly, the main function of the process of scientific research is theory-testing in which a hypothesis is deduced from theory, not theory-building in which theory is established by inductive logic.

The rationale of the research design proceeds from three associated assumptions:

(1) The model created by Hart which was designed to analyse the five largest industrialised countries is applicable to the case of Taiwan.

(2) The new state-societal arrangements will be formed under changing environmental factors. Because of the previous strong role performed by the state, the new state-societal arrangements could be either the Japanese type of strong state and business but weak labour or the type of strong state and labour but weak business. It is impossible for Taiwan to be the Germany type of strong business and labour but weak state in near future, unless there is a major political change. It is also difficult for any country to be the type of strong state and labour but weak business because how can a

country with weak business compete internationally?

(3) Changes in domestic politico-economic conditions and increasing international competition influence not only the economic functions of the state in gaining international competitiveness and its role on IP per se, but also the reshaping of GI relations towards a new institutional arrangement.

2.2. Research Methods

This study employed made use of a hybrid design comprised of library data, public source information (press releases, government publications, local newspaper announcements, association publications), observations, archival materials, and field interviews with policy insiders and participants in the sample industries.

Collecting these empirical research materials was not easy, in particular, for those from government resources. Secondary sources, such as books, journals and periodicals, are abundant. There is also no lack of English versions of secondary research materials from Taiwan, since many academics educated at postgraduate level abroad, mostly in the USA, have published their works in English. Those secondary materials have provided general background knowledge for this study.

The collection of government materials was more difficult in the beginning when I tried to obtain materials for selecting industries for study[4]. The notion of free information was not yet well-developed in Taiwan. Getting inside information depends very much on intimate relationships. In 1995, I was also frustrated by many officials at different government levels when I needed to arrange formal interviews. Finally, I overcame the situation by building and tracing some personal connections in 1996.

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[4] In 1995, I had several informal interviews with technocrats in charge of the administration of specific industries within the different divisions of IDB. The coverage of industries included, computer, semiconductor, steel, auto, ship-building, consumer electronics, textile, machinery and petrochemistry industries. The materials they supplied were too general and I felt there were barriers between them and me. I could not get further industrial information about the details of policies. Many officials at MOEA's branches refused to give interviews by saying that they were too busy to do so. One even said, 'there are so many postgraduates wanting to arrange interviews, how can we have time to cope with all of you?' Since they did not know me, they did not want to damage their careers by releasing important information or stating something 'wrongly'.

Two turning points made the collection of information and the arrangement of interviews easier. The first is that I have three friends working at the central government[5]. They all made efforts to provide the information needed for my research. Some materials are characterised as involving sensitive issues, classified and circulated among certain 'competent authorities' only, which I would never have obtained without their assistance. I had arranged some interviews with the higher officials at the Department of Industrial Technology (DIT) and the Industrial Development Bureau (IDB) through a friend at the Executive Yuan by only making a few phone calls, while I had made so many visits and calls but failed.

The second is that I participated in a government-held intensive course concerning the operation and management of high technology industry, on 18/03/96-28/03/96[6], which eased the pain of arranging interviews at the Industrial Technology Research Institute (ITRI) and the private sector. Some interviewees, with professional backgrounds of technology or high technology industries, were lecturers holding seminars in the course. Nine interviewees were from the course and some other interviews were arranged with their assistance. This course provided a stairway to enter the circles of Taiwan's high technology industries, besides, it extended my analysis to the management perspective where I had only limited background knowledge.

Research materials are classified as secondary and empirical in the bibliography in which the latter will be precisely defined. Empirical materials include public publications, documents for internal circulation (including classified materials), and opinions drawn from elite interviews. The range of public publications is from government branches to ITRI and associations. Internal documents, mostly from

[5] One is an alumnus of University of Warwick, and we knew each other in 1993. The other is a colleague of mine when we campaigned for Dr. Ding at the 1989 legislator general election. Another is also an alumnus of University of Warwick, and we knew each other at National Taiwan University.

[6] The course was provided by the government (the National Youth Commission in association with the Graduate Institute of Technology and Innovation Management of National Cheng-Chi University) in order to cultivate managerial human resources for the future needs of high technology industries and the participants are those who have a master or higher degree.

government, will be listed in the bibliography, but classified materials have been selectively excluded because this might cause unnecessary trouble for the providers. These internal documents serve as the very foundation of empirical evidence in relation to policy. For instance, three research papers for 'internal use only' from foreign actors (ADL, 1989; Dynatech, 1992; Dataquest, 1992) were the basis for the strategic planning of high-definition television (HDTV) policy.

Field interviews have occupied an essential place in empirical investigations. The practical content of policy implementation could not be understood from official publications and internal documents alone. Those interviewees supplied personal insights and inside information which sometimes told a different story from that of government propaganda. Thirty-two interviews were carried out in 1996, and most interviewees have had direct involvement in the field of the two case studies, while some others were involved in general IP (See Appendix).

Some interviewees had a conservative attitude towards releasing information (but they still provided valuable information) and asked that their information should be treated confidentially in case some developing countries might imitate Taiwan's institutional arrangements and become future rivals, or in case of other international 'concerns'. But some have other thoughts, as Interview No. 6 stated, 'don't worry about the imitation by other countries, Taiwan's system is quite unique, unless they have as supportive a government as Taiwan which is willing to invest in industrial technology.' This concurs with my view, and many academic works (see chapter 3) which indicate that state-industrial arrangements are embedded in a national setting. Since every nation has a different culture, society and state, the institution can not be transplanted from one country to another one. To the fear of international criticism on 'unfair government measures', the answer, based on academic intuition, is that if Taiwan did not violate international regulations, it need not worry about the exploration of the detailed operation of its institutional innovation. If Taiwan did disobey 'the rules of the game', sanctions are inevitable. The nature of academic examination is to find the reality, unlike that of the press which is to dig for scandal, so it is the duty of the academic to disclose the facts rather than to undercover 'unfairness'. However, in order to respect the wishes of some interviewees, I shall not refer to their names on citing their opinions.

Concerning Chinese ideographs in this study, they have been used so as to avoid the confusion of many romanisation systems actually in use for transliterating from Chinese. There are, at least, four systems (Wade-Giles, Yale, Pinyin 拼音, and Kuo-yu-chu-in-fa 國語注音法), and all led to different English spellings. Thus, Chinese ideographs are appended to those names that have not an official standard translation in Taiwan, in particular, for those policies and documents that I have translated. It is sometimes difficult for me to understand what the romanised spelling refers to, let alone for international readers. Chinese ideograph could be meaningless to those who could not read it, so do romanisation forms. However, it would be easier for non-Chinese readers to trace the origin of documents or certain terms by showing the actual Chinese characters. In addition, translations are made to those Chinese titles. Those documents listed in the bibliography with both English and Chinese characters are available in a Chinese version only.

Many financial figures, mainly in New Taiwan dollars (NT$) and US dollars (US$) are used in this study without converting to the value of one currency. In the research time span from 1990-96, it was about NT$24-27 against US$1, but mostly stabilised at 25:1. Tables, figures, and charts used in this thesis are numbered in order of their appearance in each chapter.

2.3. Selection of Sample Industries

To decide objectives for empirical study is not just a question of combining the knowledge of existing literature and personal knowledge, it sometimes calls for the researcher to pay special attention to the linkage between theories and practice. In other words, in selecting a sampling mechanism to conduct empirical study, generally speaking, one must think about its application, or relationship, to the realm of theory.

Thus a bad sampling procedure would lead to either a blurring of the theory to be tested/built, or superficiality. Moreover, the need for empirical study to test J.A. Hart's model lies at the heart of this thesis. This model cannot be discussed and tested without offering appropriate empirical evidence. For the sake of successfully testing the fit of Taiwan with this model, sampling industries for empirical study must be done very carefully. Linking the theory and the empirical study will be the central concern in selecting sample industries.

Because the main concern of this thesis is Taiwanese state-industrial arrangements and international competitiveness, the criteria for the selection of sample industries in this study are twofold: one concerns the academic development of GI relations and the other relates to competitiveness among Taiwan's various industries with special reference to industrial innovation. Most empirical studies of Taiwan's industries were conducted at a national level (undertaken by economists) or at the firm level (by business studies specialists). The first is too general and the second, too specific. Therefore, a sectoral investigation has been chosen as the empirical target, but even so, to analyse industries under a national structure is inescapable. This is mainly because industrial activities operate in a domestic environment which is created, regulated and maintained by the national government, and more importantly, GI relations are about the 'politics of reciprocal arrangements', in which relations are shaped by the government and the private sector. In addition, only very few of Taiwan's empirical industrial studies took international constraints into account which might result in a failure to cope with the ever-changing world market. As far as the development of industrial technology is concerned, only those industries with promising markets and with technology which requires further innovation will be taken as empirical cases. The so-called sunset and mature industries are excluded from the investigation.

The development of GI relations has shifted its emphasis from the national level to sectoral studies (Wilks & Wright, 1987). That is not to say that the states have to be excluded from analysis, but rather that the private sector should increase its relative importance in the analysis of GI relations. This rejection of a state-centred explanation in GI relations reflects at least two important facts. First, the relative decline of state autonomy to deal with industrial activities is evidenced, such as investment decision and financial matters, which have been highly internationalised (Strange, 1988). In particular, globalized production for world markets is far more than states can control. That is not to say that the state has lost its role, rather, the state must transfer its role from one of controller to one of bargainer. It still has the authority to define the boundary of the national market in a new era of international political economy. Moreover, the concept of GI relations in a national economy without a special focus on the variation between sectors makes it hard to generalise about the existence of particular kinds of sectoral GI interaction. It is rather as the 'macro explanation of state-economy relations', sheds light on culture, social structure and institution (Gamble, 1995:526). Due to the differentiation of forms of production from industry to industry, which may affect the formation of distinctive patterns of GI relations, it is necessary to conduct research on a sectoral, sub-sectoral level, see for example, many articles in Wilks & Wright (1987); Grant (1989a); Genther (1990). Some even advocate that GI relations should not only be understood at the meso level, but also at the micro level. Cawson et al.(1990) argued that the firm is more suitable to be the unit of analysis than the industry in the study of the European electronics industry. Furthermore, to measure competitiveness based on the data of a special industry is much easier to interpret than on that tested on the economy as a whole (Hart, 1992:7).

However, macro GI relations should not be ignored in the sense that a general IP influencing fundamental environmental factors which create a favourable context for industrial success cannot be observed just from sectoral studies. A comparative study of six different industries in the UK, the USA and Canada concluded that:

> First, any account of industry adjustment which fails to take account of both national policy paths and sectoral influences is going to be inadequate. Future research should be focus on the complex interaction between the two patterns, rather than assigning a priority to either national or sectoral influences ..... Second, the differences between the historical experiences, inherited institutional

arrangements, technologies, and markets of sectors remain so significant that government must retain a capability to understand such differences, and to develop policies tailored to sectoral needs (Grant, 1989a:269).

Second, a general assumption that the degree of political attention is similar for different industries is inappropriate in contemporary GI relations. Some are always more equal than others. Certain industrial sectors which have distinctive economic characteristics have attracted governmental concern. The economic importance of an industry to a nation is an important factor which shapes GI relations. A sectoral study based on the Japanese auto industry demonstrated that the Japanese government was more responsive to the auto industry's needs because of its central role to the Japanese economy, leading not only to more interactions and negotiation between government and auto business, but also to shelter it from liberalisation for as long as possible (Genther, 1990). The pictures of GI relation in sectors in structural decline and rising high-tech industries are different. An analysis which simply focuses on the management of industrial crises may lead to a distorted understanding of the pattern of GI relations (Grant et al., 1987). In general, state interventions, --or in other words -- political attentions, tend to be in favour of 'promising' industries in the 1990s. Those advantageous sectors accept more government assistance and have easy access to the process of policy-making, thus their GI relations are different from those of the Cinderella sectors. Besides, different state strategies are appropriate for different sectors, because 'industry structure as well as the source of competitive advantage are different (Porter, 1990:67)'. Thus, 'economic centrality' is an essential determinant to frame GI relations (Grant, 1989a).

The increasing competition of international trade raises the question of whether there is a way to foster a nation's competitiveness in industrial products through a certain type of GI relationship. It is often argued that Japan's GI relations provide evidence which demonstrates that a more effective IP can help to restructure industry and the economy. The Japanese government's ability to intervene in the private sector and the willingness of industry to accept such 'administrative guidance[7]' seem two essential determinants for its economic performance. The Japanese case suggests that well-functioning GI interactions could lead to the growth of international competitiveness. If so, GI relations become one of the factors which help to form a national advantage in global competition causing IP to be more effective and industry more competitive.

The competitiveness of an industry is also a very important determinant of GI relations. The stronger the competitiveness of an industry, the weaker the ability of the state to dominate GI relations. The ability of an industry to resist government intervention increases as it becomes more competitive. In general, the state will protect infant industries in their early stages of development based on the doctrine of economic nationalism and the purposes of state-building. Meanwhile, the private sector is also willing to 'accept' this paternalist kind of protection to restrict foreign competition. The goals of both sides are similar, since the state wants to promote economic growth, and the industry wants to increase productivity and market share. Under this condition of mutual understanding, GI relations are more likely to tend towards the state-led style. The situation will change in association with increasing sectoral competitiveness, which means that the development of 'self-governing capability' lets the industry develop and implement sector-generated solutions, instead of government-designed solutions (Grant,1989a:258-70). The views on goals might diverge and the ability of the private sector to resist undesirable policies increase, leading to a changing pattern of interactions between government and industry. Two possible general directions of interaction may develop: one is that cooperative relations may be formed through negotiation between two sides, the other is that adversarial relations may appear because of disagreements on future goals. In this sense, GI relations will be affected by

[7] Administrative guidance (gyosei shido) is defined as 'an administrator's action, without any coercive legal effect, which encourage related parties to act in a specify way in order to realise some administrative aim (Wakiyama, 1987:211)' in Japan. These informal guidelines provide a fast IP instrument to solve short-term, low-key problems in specific industries. According to Okimoto (1989:93-5), administrative guidelines have often been argued as a tool of IP for sunset and declining industries or as trade-related agreements among domestic companies, but have served relatively infrequently as a versatile tool for high technology.

sectoral competitiveness; in turn, sectoral competitiveness will also be affected by GI relations. A dynamic analysis of this changing relationship is necessary.

Accordingly, GI relations are not static but alter through time (Genther, 1990; Kuo, 1995), from sector to sector and from country to country (Grant, 1989a; Hart,1992). However, the effect of GI relations on international competitiveness cannot be simply understood in terms of the role of the state or political institutions, such as Japanese Ministry of International Trade and Industry (MITI) and Taiwan's IDB, as mediated through industry policy. GI relations are not controllable just by the state or the private sector. It is a complex phenomenon with many actors involved in shaping relations including agencies, domestic and international firms, foreign government, international organisations and individuals. In all this, the state remains as an important unit of analysis, especially given that the authoritarian Taiwanese state is undergoing a process of transition and is still involved in industrial activities, but the private sector and the international factors have to be incorporated into the account because of their undeniable importance in shaping GI relations.

In this study, the development of Taiwan's notebook-sized computer (NPC) and HDTV have been selected as the empirical cases. Both are electronic-related industries which has emerged as the most important single industry since 1980s. Because of their economic centrality and increasing competitiveness in international markets, the relationship between government and industry is worthy of examination.

Manufacturing industries have long been the heart of Taiwan's economy. Their share of GDP increased from 22% in 1965 to 34% in 1990. The average annual growth rate (in % of GDP) was 14.6% in 1965-80 and 7.7% in 1980-90 (TSDB, 1993:309, 311).

The importance of the electronics industry to Taiwan's economy has increased in accordance with its industrial structure shifting from light, labour-intensive industry towards capital- and technological-intensive industry since the 1980s. Taiwan's highly successful export-oriented industries underwent a gradual transformation in the 1970s, a period of heavy industrialisation. The textile industry continued to play an important role, but other main exports declined, such as the products of agricultural processing which have been replaced by rising industries, for instance, petrochemicals, iron and steel, electronic goods. Electrical and electronics industries were characterised by relatively low technology and labour-intensiveness at that time. In early 1980s, textiles and garments were the largest single industry. After a decade of the state's efforts to reallocate sources into the development of technology-intensive industries, the proportion of the export value of these industries has increased substantially and become the largest industry. In 1990 alone, heavy, chemical and technology-intensive products accounted for 54% of the nation's total exports, while another 40% represented the output of the electronic (including information) and machinery industries.

In 1995, Taiwan became the largest producer of NPC. This leads to the question of whether the government's programme on the development of NPC in 1990 had the effect of promoting technology and competitiveness. This programme was the first case of a special effort to incorporate public research institutions and individual firms to conduct research and development (R&D) together. How the public research institute, represented as the surrogate of state intervention in the field of innovation, ran this earmarked collaboration and solved the conflicts between government and firms, and between firms provides an experimental model to build public-private cooperation in technological development.

In the case of collaboration to develop HDTV the government realised the importance of HDTV development to integrate different industries into a 'future' industry. The government was afraid of losing future markets to rivals. Thus, cooperation between the government and different industries and firms is going on in order to make Taiwan's HDTV R&D commercialised. Like the development of NPC, the potential market of HDTV is promising, but it is more difficult than NPC because its technology involves many industries, such as electronic, information technology and telecommunications.

In the case of collaboration to develop NPC, Taiwan has become a strong rival in the international market and it is possible that its HDTV programme will follow suit. Through a cooperative approach to develop and diffuse technology in strategic sectors, the flexibility of smaller firms, the strengths of larger firms and the R&D capacity of public institutions are brought together. The pace of innovation has increased by such alliances. It is still too early to say that the Taiwanese state is the main actor in the process of collaborative innovation before taking industry's response into account. However, it is safe to argue that the private sector cannot produce technological innovation in such a short time without governmental efforts to promote and link it. In this sense, the GI relations in the case of collaboration to develop technology is more cooperative than adversarial.

3. THE ORGANISATION OF THESIS

This thesis is divided into seven chapters. This chapter identifies the problems confronted in Taiwan's economic development. Under the changing environmental constraints, the pattern of industrial development should be adjusted to a more effective and efficient arrangement. The second part of chapter one concerns methodology deployed in this study, including the objectives of the thesis, three associated assumptions, precise definition of research materials, and the selection criteria for sectoral investigations.

Chapter two reviews the literature in relation to the East Asian developmentalism, in particular, referring to the case of Taiwan. It clarifies the vulnerability of neo-statist theories on interpreting the current situation of Taiwan's development. A new interpretation of theoretical developments, focused on state-industrial arrangements, is presented to remedy the universal application of an authoritarian perspective. A pragmatic approach have been taken to the analysis of the interface between the state and industry, as well as international factors which might seriously affect national policy towards industrial development.

Chapter three provides an analytical framework and theoretical perspective derived from the work of J.A. Hart. However, the related terms and definitions have been justified and modified to cope with the needs of this research. It highlights the relations between international competitiveness, technology innovation, and GI arrangements. The two relevant theoretical perspectives which are discussed, statism and corporatism, can each provide part of the explanation of GI relationship in Taiwan, but it is argued, according to the findings of this study, that the institutionalised strategic partnership (ISP) is more capable of explaining the current GI relationships.

Chapter four describes the innovation system in Taiwan with special emphasis on those IPs supporting industrial upgrading. It demonstrates that the Taiwan government was the biggest institutional actor in the field of innovative activities which could be observed from the enforcement of laws and regulations, the creation of public research institutes, and pervasive policies for supporting industrial upgrading.

Chapter five deals with the NPC Alliance which is the generation of a public-private cooperation in developing a product. Through the collaborative efforts of two sectors, NPC was created in a very short time which finally led Taiwan to become the largest NPC producer in the world. It is argued that the case of NPC Alliance built a model of tightly merging industry with the public research institutes that integrated technology innovation, technology diffusion and product creation. And these generic state-industrial arrangements have been institutionalised in the sense that most GI cooperation on technology development has followed suit.

Chapter six unveils the state-industrial arrangements of HDTV development in Taiwan, which basically modelled the case of NPC Alliance but extended it to a sector-wide application in order to create more commercial products at the same time. This is also an initial case that the government intended to develop/revive a new/old industry through public-private cooperation. The state-industrial arrangements has penetrated deeply into the area of emerging industry. The degree of state intervention has increased because of the strategic importance of this sector.

Chapter seven concludes that the three initial assumptions have been proved to be correct. The newly emerging state-industrial arrangements in Taiwan can be characterised as 'institutionalised strategic partnerships'. Taiwan fits into Hart's model in the position of the state-business coalition side which is assumed to be a more competitive arrangement than in the position of the state vertex. State-Societal arrangements have been an endogenous and institutional factor which forms a necessary part of the explanation and understanding of the promotion of international competitiveness. It also suggests that a revision of East Asian developmentalist theories is desirable in which technological and international factors should be incorporated in the analysis.

CHAPTER TWO

LITERATURE REVIEW

1. DEPENDENCY PERSPECTIVE

The main arguments of dependency theory are based on the rejection of a universal Western-based model of development and the development experience of Latin America, inspired from long standing analyses of imperialism and neo-imperialism and from structural theories about the effects of ineqalitarian or dependency relations in the international system. Dependency theory suggests that the structure of an international regime constrains the developmental opportunities for less-developed countries, and attempts to analyse economic development from the view of the interplay between internal and external structures. The world has been divided into two parts by dependency theorists, a core of industrialised nations in Western Europe and North America, and a periphery in Asia, Africa and Latin America. In this Marxist tradition of analysis, the periphery is represented as the producer of raw material and the consumer of industrial commodities; moreover, the international division of labour exploits the periphery by multinationals from the core through either the colonial administration method of direct extraction of resources, or the neo-colonialist method of unequal terms of trade.

However, in response to the dynamic development of NIEs, a revised theory has evolved as the concept of 'dependent development ' by Cardoso and Faletto (1979). They argue that even some of the peripheral countries will gradually achieve industrialisation as, for example, the case of Brazil, Korea and Taiwan. This is not to say that these countries will become core countries. The economic growth of these NIEs still relies on markets, capital, technology and operation from core countries on the one hand, and on the other hand these NIEs exploit less developed countries in the same way as they have been exploited. In this sense, according to I. Wallerstein's theory of the modern world system, NIEs are at best in the position of a 'semi-periphery' in which the core states tend to specialise in manufacturing, the periphery is relegated to the production of raw materials, and the semiperiphery is somewhere in between (quoted from Gilpin, 1987:67-72).

In the 1980s, the dependencista literature has shown that an active state is one of the keys to the movement from a situation of classic dependence to one of dependent development (Evans et al., 1985). Evans takes the argument further to demonstrate that there is clearly a 'triple alliance' (1987) behind dependent capitalist development, which is constituted by authoritarian state, transnationals and local private capitalists. The difference between Latin American and the East Asian NIEs is that the Asian states are the dominant partners in a triple alliance, which has contradicted the dependent development's view that foreign firms are the dominant and constraining partner. The effort of the dependency theorists to extend its theoretical application to East Asian NIEs was unsuccessful. First, the dependency theory (or an historic-structural analysis of the political economy of Third World capitalist development) assumes that the structure of the global economy conditions economic growth, class relations, and political forms which tends to 'ignore how domestic political forces constrain economic policy and shape state responses to the external environment' (Haggard, 1990:21). Indeed, the unsupervised state administration of Korea and Taiwan is highly related to the success of economic development (Johnson, 1987). Second, the critique of a triple alliance is based on the argument that triple alliances can be observed all over the world (include the developed world), in which it is unclear who is dominant among the state, local businessmen and transnationals. Thus, a triple alliance is not an unique feature for economic development. As Schive (1990) argued foreign direct investment did facilitate Taiwan's economic development, but it was not the main cause of its economic development. Moreover, 'the countries which grew more rapidly used foreign capital relatively less intensively than those that grew less rapidly' (Parry, 1988:127).

Dependence on foreign direct investment in East Asian NIEs has been relatively low (Haggard & Cheng, 1987), and the relationship between foreign capital inflows and growth is at best tenuous (Parry, 1988). Furthermore, the demand for foreign capital is decided by a country's domestic policies, not by special foreign investment 'incentives', which is behind the concerns of dependency.

2. THE NEO-CLASSICAL PERSPECTIVE

The economic development of Taiwan, and of other Asian NIEs, have been cited as evidence to support neo-classical theories. The neo-classical perspective seems to be the mainstream interpretation of the successful development of East Asian NIEs in the 1970s and the early 1980s, before the emergence of the statist or interventionist perspective. This perspective, including the neoliberal interpretation as a subset, emphasised the liberalised market, in particular the free trade regime and minimum state intervention, as the main cause of East Asian miraculous development.

According to the neo-classical explanation, import-substitution industrialisation (ISI) is the proper strategy for Taiwan and Korea to protect their infant industries in the early process of industrialisation, and export-oriented industrialisation (EOI) can be deemed the 'engine' factor of successful take-off growth in the late process of industrialisation. The notion of 'government failure' in the neo-classical tradition suggests that trade-related and market-oriented strategies are the main cause of increasing East Asian NIEs' comparative advantage. Thus, operating under the assumption that 'market failure' is rare and exceptional, Lal argued (1983) that any attempt by the government to intervene in the market would retard economic development. The state in economic development should operate within carefully prescribed limits in terms of the neo-classical perspective, thus:

1. The state should primarily rely on market-based, private-sector-driven initiatives in the mobilisation and allocation of resource to growth-promoting activities.
2. The state should intervene only in cases of clearly established 'market failure' (i.e. In cases where private sector operations do not correspond to societal interests).
3. Even in cases of proven market failure, appropriate policy responses should be parametric measures (such as lump-sum taxes and subsidies) as well as incentives that establish a private

market (such as a venture capital market)

4. The state should provide 'pure public goods' (law and order, national defence, public infrastructure) including the proper assignment and enforcement of property rights
5. The state should provide a stable and predictable macroeconomic environment through appropriate condition of fiscal, monetary and exchange rate policies
6. The state should adopt a free trade (or almost free trade) regime as a core component of a neutral policy regime (Chowdhury & Islam, 1993:46).

Therefore, the dynamic economic growth of East Asian NIEs relied on the private sector and free trade so that these economies have been able to minimise government failure so common in the Third World countries. But it is an overstatement that East Asian economic success depends on market mechanisms alone (Haggard,1990; Wade, 1990). There are two questions that challenged neo-classical political economy in terms of the contribution of international trade and the minimal role of the state in East Asian economic development.

First, free trade might be a fashionable rhetoric rather than a reality, or at least, the success of EOI could be limited to a particular period of time in an international setting of favouring free trade. Taiwan's economic take-off of export expansion has benefitted from its own strategy of EOI in accordance with the neo-classical explanation, which is also a widely accepted conception by neo-statists. More importantly, it benefitted from the guardianship of the liberal trading order by the US -- the biggest market for Taiwan. This factor implies that Taiwan had a relatively easy and privileged access to the most prosperous markets at a time of international economic expansion. Because of the slow growth of most industrial countries and the massive US trade deficit in the late 1980s, the favourable condition for exporting to those countries has disappeared. Moreover, the US has transformed the advocacy of a liberal trade regime into a relatively protectionist and defensive one. The ratification of the 1988 trade act gives the US Trade Representative the right of being the 'judge and jury' in section 301 so as to force its trading rivals to comply with what the US required, which has been termed as 'aggressive unilateralism' by Bhagwati (1990). In addition, regionalised trade blocs also constrained opportunities for 'trading free'. This being so, the replication of export-oriented growth is more difficult than it was two or three decades ago, the developing countries will only find difficulties if they try to imitate the outward-looking pathway of NIEs in a neo-protectionism era. Free trade as the engine of growth could be a short-term explanation confined to 1950-1985 but not a universal explanation. Therefore, the neo-classical view of free trade in relation to economic development fails to take the changing world trade climate into account.

Moreover, the notion of free trade is only valid in the sense of a general freedom from state intervention. In neo-classical analysis it is absolutely right to say that trade is the economic pulse of most outward-looking economies, but it may be wrong to say that the economic growth of East Asian NIEs can be attributed to free trade. The relationship between state intervention and success in international trade is more complex than the neo-classical explanation suggests. If we take government intervention in import controls and export incentives into account, Taiwan was not by any means a free trade regime (Wade, 1990, 1991; Gunnarsson, 1993). So an invisible hand is rarely the answer to the economic growth of NIEs.

Second, minimal government intervention as one of the essential components of economic success in the East Asian NIEs has now been challenged by developmental statist views. In particular, neo-classical considerations based on the absence of government intervention in promoting economic growth arrive at the conclusion that 'the industrial policy was either of negligible importance in understanding growth in the Asian Newly Industrialising countries, or that growth would have been faster without industrial policy' (Nolan, 1993:72). The statist argument, that the East Asian states traditionally exercised a wide range of IP instruments and different patterns of state intervention, is far removed from the position of the liberal market-oriented economy in the form of neo-classical analysis.

Three features characterise Taiwan's IP (Liu, 1993). These are a high level of state intervention in the operation of the private sector, discretionary manipulation of assistance to targeted industries, and influence on the investment pattern. These have had the effect of accelerating Taiwan's industrial development and promoting international competitiveness. The state serves as regulator, protector, subsidiser, controller, and entrepreneur which corrects market failures and accelerates industrial performance. The state formulates and pursues IP according to a conception of the national interest, rather than the demands or interests of the private sector. The state as an IP actor has had an independent effect on industrial dynamics. This well-directed state action, utilising the capacity of the bureaucracy provides an institutional framework of state-driven industrial development.

Some authors, for example Wade (1990), suggest that the Taiwanese state tries to lead or to govern, not to follow or to replace, the market, which is inconsistent with the neo-classical account. He argues against the neo-classical explanation in terms of self-regulating markets, of a free trade regime, and of neglecting the state autonomy over the economy development for creating advantages (Wade, 1988, 1990:chapter 3, 1992b; White & Wade, 1988). Moreover, the neo-classical explanation obviously does not specify the institutional sources of policymaking, and inadequately evaluates direct government interventions on individual industries within NIEs (Ting, 1992). Many factors, other than trade-related issues, which had deeply been influenced by the state are deliberately ignored in the case of Taiwan's development by neo-classical economists, for example, the role of economic bureaucracy (Ho,1987; Johnson, 1987; Wade, 1990), financial system and investment funds (Chiu, 1992; Shea & Yang, 1994), technological development (O.C.C. Lin, 1992; Liu, 1992; Simon, 1992), the exploitation of the labour force (Deyo, 1987), and nationalised enterprises.

3. THE NEO-STATIST PERSPECTIVE

Since the early 1980s, there has been a political, economic and sociological academic movement to 'bring the state back in' (Evans et al., 1985). In response to a lack of political institutional analysis in the political economy of East Asian development by 'international system-centred' dependency theory and a 'laissez faire' neo-classical approach, new theories have been developed. These focus mainly based on the analysis of public policy and the role of the state to embody a new perspective on East Asian development process. There has been a paradigm switch in the 'western social sciences' in the 1970s. As Skocpol (1985) argued, the society-centred work which treated the state as a dependent variable should be substituted by theories which treat it as an independent variable. Her arguments also demonstrated that not only does the scope for autonomous state action vary but so does the capacity and readiness of state bureaucrats to follow an independent strategy relative to non-state actors (1985:14-9).

Many researchers who are interested in the issue of Taiwan's development, argued that Taiwan, with a capable economic bureaucracy and state autonomy free from social class, is not guided by free-market principles. Contrary to neo-classical misconceptions the state intervenes strongly in the process of economic development (Aberbach et al., 1994; Amsden, 1985; Clark, 1987; Cumings, 1984; Deyo, 1987; Gold, 1986; Haggard, 1988 & 1990; Hughes, 1988; Ranis, 1992; Rueschemeyer & Evans, 1985; Tien, 1989; Wade, 1990; Whitely, 1991; Winckler & Greenhalgh, 1988; Woronoff, 1992). This new trend of explaining the state as an engine of growth has emerged from the work on Japanese development by Johnson (1982), as well as the Korean case by Amsden (1989) and the Taiwanese case by Wade (1990). These cases have emphasised that East Asian 'developmental states' are very important to guide and promote economic development. Synthetically speaking, there are three main associational arguments in relation to the role of the state in promoting growth in the neo-statist literature, namely policy activism, strong capacity and relative autonomy.

3.1. The Policy Activism of National Governments

The state actively initiated policies in economic issues relative to three fields, which are very essential to industrial development, namely, finance, trade and nationalised enterprises. The most visible state action is the employment of people to produce goods and services; the least visible is the regulation of behaviour in the private sector (Lane, 1993). Taiwan's trade and financial policies, as instruments of public regulation, play a great role in industrial development. These are often neglected by the neoclassicalists who pay attention to resource allocation and resource redistribution.

In terms of Taiwan's financial system, it was characterised by public-ownership and tightly controlled by the state before the opening up of private banking operations in 1990. There is no doubt that Taiwan's financial system is rigid. This arises from following factors: (1) the state can control the financial ability of firms and can require the compliance of firms in other matters through credit allocation; (2) the state's financial control is not based on political authority, but on its economic power to provide loans and funds through associated institutions, such as the Ministry of Finance and the Central Bank; (3) financial control has a direct effect on individual firms rather than specific sectors (Lee & Lee, 1992:117-8). Moreover, the state not only used concessionary credit for export production, but also listed priority industries for bank lending (Wade, 1990:167). However, Pack (1992) argued that the growth of the private industrial investment was based on the high savings rate rather than on government intervention in the capital market. He agreed that the sectoral structure of investment was affected by financial policy, but disagreed that Taiwan's rigid financial system had a strong relationship to economic development. This view is in contrast to Wade's (1990) suggestion that tightened financial control facilitated the government in implementing an IP in order to modify a market-determined allocation of investment in line with government preferences which would finally contribute to economic development.

In terms of trade policy, the influence of public regulations in imports and exports, which affected the production and trade structure significantly, demonstrated the policy activism of the government. Taiwan's trade policy in the past was characterised by its protectionism. Taiwan had a fairly high level of protection in place for the domestic market and a relatively weak industrial sector at least until the mid 1980s when trade liberalisation was enforced. The state has used special administrative means to achieve the protection of the domestic market through restrictive import controls, and the acceleration of manufacturing exports by giving rebates or exemptions to those import items that went into exports. In order to control imports, some imports were prohibited and others were controlled by licence (Riedel, 1992; Wade, 1992b). To accelerate manufacturing exports the government employed the duty rebate scheme (Wade, 1991), which is designed to allow export sales to be distinguished from domestic sales, with rebate or exemption from tariffs and other charges allowed for imports that go into exports. The adjustment of non-tariff barriers is also an administrative means to control trade. The purpose of tariffs is relatively oriented to raising revenue, but non-tariff barriers are relatively oriented to industrial promotion and protection. Taiwan's non-tariff barriers are lower for the imports of strategic industries and industrial inputs in comparison to the imports of output which goes to domestic consumption.

The state provides public regulations of imports and exports for the industrial sector to follow, so as to control the direction of production. While this is not a direct intervention in the production process, it does affect the direction of production. Such regulations allowed the state to target winners, and to limit losers. Needless to say, the state's regulation affected, if not the growth rate of short-term productivity, the long-term developmental direction of selected industry. Some writers have deemed Taiwan a free trade regime because they have not taken the public regulation of trade into account.

In terms of the policy of the state to develop nationalised enterprises, the entrepreneurial role of the state is most clearly evidenced when it assumes the direction of public industrial enterprises. The Taiwanese state built nationalised enterprises for two purposes: to act as an entrepreneur and to influence the private industrial sector. The KMT state set up the public industrial sector also for political reasons. The state sector served as the mainlanders' economic preserve, to counter and control a private sector, which for the most part was dominated by local Taiwanese. As Denis Simon notes in his analysis of Taiwan in the 1970s: 'Most local businessmen claim that state control is politically motivated -- that is, since the government lacks a widespread economic base, the state has strategically chosen to remain active in key industries where it can exert more influence over the economy in general, and the private sector in particular' (Quoted from Bello & Rosenfeld, 1990:253).

The need to control prices of specific industrial goods, especially those of supplied raw materials from the nationalised enterprises, led to further state intervention in the private sector. This situation became more concrete after the expansion of public enterprises in the 1970s, and after the first oil crisis. The public enterprises were concentrated mostly in upstream sectors, so it was very easy to gain control over the downstream private sector. Moreover, private productive capital depends heavily on the upstream public sector, for example, the state has indirect leverage on synthetic fibres and textiles (the largest private industrial groups before mid-80s) through the Chinese Petroleum Corporation. Besides, the KMT state has control not only over the domestic private sector through public enterprises, but also over the industries which would expect to be dominated by multinationals (Wade, 1990:273). Moreover, many firms are not calculated in the group of public enterprises, because the state only owned part of the company. In fact, the state shares over 50% or more in many firms. The wholly or partly party-owned enterprises in manufacturing (textile, paper and printing, cement, and fibre and glass) and the service sector (television and radio network, Central Daily News/CDN, insurance, and Central Investment and Trust corporation) adds to the weight of the state sector. The image of economic liberalisation and privatisation is obtained because the state may reduce its share in an important firm by transferring the ownership to a party-owned company.

Concentrated government control in the context of relatively dispersed private ownership and in the prices of supplied materials, creates a situation whereby private enterprises depend more heavily on the public sector than the other way around. Heavy private sector reliance on government inputs makes it easy for the state to manipulate the direction of industrial development. Therefore, the policies of a large share of public and semi-public enterprises in Taiwan's industrialisation increased the autonomy of the state in relation to private industrial development. This is also important evidence for the interventionist nature of Taiwan's IP.

3.2. Strong State Capacity as the Dynamics of National Policy

National policies lead the state to play the role of trade regulator, financial controller, and entrepreneur in the process of Taiwan's economic development. However, Taiwan's economic development could not have reached its current level without a strong state capacity to implement its policies. For the purpose of rapid industrialisation the state must have the power to direct some resources to the high priority sector and to require this sector to meet performance goals. In the neo-statist theories, the state capacity to implement policies effectively through a centralised bureaucracy is one of the important components of a miracle. Neo-statist theories emphasised the positive role of government in which the well-educated bureaucrats and efficient agents injected influence into economic development. Under this conception, Taiwan's case has been described as 'the reciprocal interaction between the structure of the state apparatus and the process of economic growth' by Amsden (1985:101). Wade argued (1990:195-227), the 'organisational advantages' of economic bureaucracy were essential determinants leading to the successful government of the market. Johnson (1987) argued, the 'capitalist developmental state' that includes an elite bureaucracy and an authoritarian regime, adopted the 'market-conforming' intervention to promote economic growth. This is in contrast to the rule of the liberal market.

The weight of the strong state-bureaucratic capacity is parallel with the degree of state intervention in East Asian developmental states. In the accounts of neo-statism (or new political economy of development), state intervention has been deemed as a necessary 'sin' to implement national policies. This new way of thought, based on the experience of Japan and East Asian NIEs and the comparative industrial decline of the US and the UK in the 1980s, argued 'that it was incorrect to think of government intervention always as a market distortion' (Jones & Kirby, 1991:4). The judgement of whether a policy is a success or a failure is made by the outcomes of the policy not by the policy-making process. The outcomes of the policy depend very much on successful policy implementation. According to Lane's conception of implementation (1993:91-2), the public sector (including three independent actors--policy formator, implementor and initiator) is the most important actor in policy implementation to control three dependent variables (policy, outcome and time). Therefore, state intervention in the process of policy implementation is one necessary 'sin' in order to achieve a policy goal on the one hand; intermediary institutions to put state intervention into action is another condition to implement a successful policy on the other hand.

A simple definition could be given to the neo-statist notion of IP: 'A strategic IP is a policy in which a government sets out a target for the selective future-oriented industries to promote their international competitiveness and to make substantial contributions to economic growth, and to some extent, state intervention should assist the implementation of this market-oriented goal'[8]. In this definition, the state underpins IP through exercising intervention not only by targeting a market-oriented goal and selecting future-oriented industries, but also by creating competitive advantage. Thus, the distinctive feature of state intervention is strategic and the meaning of 'strategic' in IP embraces three characteristics, namely, selectivity, targeting and creation. Moreover, the distinctive feature of institutional advantages are creatable. Some institutions can be created by the centralised government according to the needs of development in order to provide the capacity to tackle special industrial problems. A central planning agent is the basic example of this. The creation of special institutions for targeting industries in Taiwan is unique, for instance, III for the information technology industry and a supra-agent office for the promotion of HDTV. While ITRI supports the technical needs of various industries and the commercialisation of industrial technology, Industrial Technology Information Service (ITIS) makes the technological outcomes of ITRI

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[8] This definition is derived from my M.A. thesis with a little amendment. For a full length of discusion of IP please refers to Liu, 1993:9-21.

available to the industrial sector.

3.3. Relative Autonomy as the Institutional Foundation

The institutional foundation of effective intervention is possible in the sense that the centralised bureaucracy makes national policies enforceable without the influence of major social interests. Because relative autonomy leads the state to become the main actor in economic development, these social interests, such as landlords, industrial capitalists, labour and politicians are less able to exercise their influence over national policies. It is believed that the relative autonomy of the state is crucial in accounting for policy reform in the past experience of Taiwan (Chang, 1989; Chowdhury & Islam, 1993; Evans, 1987; Haggard, 1988, 1990; Johnson, 1987; Wade, 1988, 1990; Weiss & Hobson, 1995). Without state autonomy free from the demands of particular interest groups, the pursuit of major policies such as land reform, shifting to the EOI, lowering of real wages, raising of interest rates, devaluation, and lifting of subsidies and protection, would have been impossible.

The power of landlords of being a political and economic actor has been reduced through land reform which has two effects on economic development: one is the distribution of assets in land resulting in a broadly equalising effect on income distribution (Haggard, 1990); the other is to build political support in the countryside (Wade, 1990). The worker's concern is with raising wages and benefits, which could undermine the profit of the company. KMT government intervened to control labour organisations through the party mechanism in order to eliminate unionism and labour activism (Deyo, 1987). Politicians in general in economic activities are characterised as protecting local, narrow, factional and short-term interests which is often at the cost of national, long-term interests. However, the Executive Yuan held a relatively autonomous authority over the Legislative Yuan in economic policy-making before 1988 (Liu, 1993:46-9). That is to say, the politician had very limited ability to change economic policy. Capitalists are characterised as profit-seeking, monopoly-renting and protection-searching from government to avoid internal and external competition. The autonomy of KMT state was strong in relation to capitalists before 1988, only those capitalist with cooperative, clientelist attitude would find it possible to get access to the policy-making process as an economic reward (ibid.:49-57). Therefore, the relatively autonomous state can make policy choices according to the national interest overriding societal interests.

Several interpretations of the origin of 'relative autonomy' have been advanced by neo-statist writers. Johnson (1987) regards Taiwan as the 'most explicitly authoritarian country' (in comparison to Japan and Korea) which makes it a participant and often the determining influence in most business decisions. In answering questions about conflict between the market and the authoritarian state, he takes the argument further as 'the soft authoritarianism-capitalism nexus' to illustrate the relation between political arrangements and economic performance[9]. Wade argues that the characteristics of the Taiwanese state are not only authoritarian but also corporatist. The following paragraph appropriately describes the situation of the relative autonomy of KMT state before 1990.

> 'Taiwan's economic bureaucracy fits into a wider set of political arrangements of an "authoritarian-corporatist" kind. The rules for selecting the rulers give little scope for the expression of popular preferences, and specially, do not allow competition between political parties (prior to 1987). Interest groups are not voluntary associations, but are chartered or even created by the government. They function more as dependent auxiliaries of government than as autonomous aggregators of members' interests. This type of political system enables the political leaders to articulate a public philosophy and broker political demands within the framework of that philosophy. In particular, it enables them to exercise much influence over public investment decisions and policy choice (Wade, 1990:228).'

Haggard (1990) agrees about the links between authoritarian rules and economic performance, but he has concerns about the functions of institutions to solve the problems of collective-action and to reconcile individual and collective rationality. The 'dominant-party regime', in which a monopoly of legitimate authority makes the state

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[9] Johnson argues that the coexistence of authoritarianism and capitalism in the political economy of capitalism in ways unprecedented in the West, and the outcome of this nexus is greater economic performance and less political participation. For detailed analysis of the issues of the state associated with financial control, labour relations, autonomy, administrative guidance, industrial conglomerates and foreign capital, see Johnson, 1987.

independent of societal forces, enables the KMT state to manipulate political and economic reforms gradually without reflecting the pressing needed to forge political relations with the private sector (Haggard & Kaufman, 1995).

4. CRITICISM OF NEO-STATIST THEORIES

According to a report of the World Bank's (1993) -- The East Asian Miracle, most of East Asia's extraordinary growth is due to superior accumulation and allocation of physical and human capital. It reaches two conclusions. Firstly, rapid growth in each economy took place primarily because of the application of a set of common, market-friendly economic policies, which got the fundamentals right. Fundamental policies referred to several broad policy areas, such as, ensuring low inflation and competitive exchange rates, building human capital, creating effective and secure financial systems, limiting price distortions, absorbing foreign technology, and limiting the bias against agriculture. Secondly, the institutional basis of the economy functioned well, selective interventions were possible which contributed to growth. Interventionist policies referred to as creating institutional mechanisms to promote growth and to implement fundamental policies, for instance, export push, bureaucratic capacity, and arguably as this report denoted, promoting specific industries, and repressing interest rates and directing credit. This report tries to understand how government policies, both fundamental and interventionist, may have contributed to faster accumulation, more efficient allocation, and higher productivity growth. It has sought to reconcile the debate between neo-classical and statist views on the issues of East Asia's miraculous economic growth.

To explain East Asia's outstanding growth as a result of reconciliation between fundamental and interventionist policy is plausible. But, the 'getting the fundamentals right' policy is the first prerequisite for development. The lack of such a policy easily leads to failure in economic development. It is extremely important to get the whole economy into a sound orbit of development, and we may suppose that the East Asian economies could not be in the position in which they are today, without a fundamental policy. However, it still leaves something to be criticised. First, if the fundamental policy was the basic element of economic growth, it could explain any case of growth, rather than being the specific causation of East Asian 'miracles'. A miracle means something with extraordinary features. 'Getting the fundamentals right' may be a prerequisite, but while this is a necessary condition for industrial success it is not a sufficient one.

Second, it is generally accepted that state intervention is characteristic of high growth rate economies, particularly the cases of Taiwan and Korea. However, there is a methodological difficulty since the growth of these economies cannot be observed in the absence of the interventionist policy. Nevertheless, a high degree of state intervention in the detailed operation of the private sector is unique in Korea and Taiwan, and cannot be observed anywhere else. At risk of overstatement, the suggestion is then, that the interventionist view is more persuasive than the fundamentals' view in terms of the specific causation of their success. In addition, it is an essential feature of the export drive and import protection which operates in East Asian countries. Historically, the special circumstances of the process of industrialisation in Taiwan make it very plausible and persuasive to theorise its developmental model as a state-driven one. However, that the policy concerning 'fundamentals' had undoubted effects on rapid industrialisation should not be ignored.

Neo-statist theories of the advocacy of the state to intervene and work through rather than to replace the market are more plausible than the neo-classical theories and traditional Anglo-American economic thought. The combination of policy activism, the strong capacity and the relative autonomy of the state have contributed to produce the institutional pattern of East Asian capitalism. In the neo-statist perspective, this explains the integral dynamics of rapid growth. A central idea that emerges from these studies, including the World Bank's report, is the significant role played by the state. Taiwanese state-led economic/industrial strategy has been deemed to be the main reason for its successful economic development, in both fundamentalist and interventionist policies. Concerning international competitiveness, most studies have focused on the response of the state in promoting the national interest and in implementing interventionist IP. The studies tend to the view that the state and state-society relations as invariant through time, across society, and across the industrial sectors. They fail to explain the complex interplay between the state and society under the changing structural constraints. Fewer studies have been conducted about other societal actors which may play an equally important role in affecting national policies and in creating their own interests. Therefore, there is a need to explore the interaction between the state, organised interests, and social classes in conjunction with international competitiveness.

The neo-statist perspective tries to use the idea of 'authoritarian regime' to explain the origin of relative autonomy. Thus, under the umbrella of authoritarian rule, the state, using its strong capacity, acts in the interests of national economy, rather than that of the private capitalist. This suggests that the private sector is subordinated to the national structure. However, there are many interests within the private sector. The neo-statists only tell the story of picking up the 'winners', but fail to tell the other side of the story--how to comfort 'losers'. Moreover, it is also in doubt whether 'the interest and orientation of firms are necessarily convergent with the interests and orientations of states (Weiss & Hobson, 1995)' in the neo-statist assumption. Since the attention of capitalists follows profit maximisation, it might conflict with the goal of the state. It is right to say that the structure and the operations of the state affect firms' willingness to undertake long-term investments and their dependence on state agencies in making decisions (Cawson et al., 1987; Grant et al., 1987; Okimoto, 1989; Zysman, 1983). It is debatable, as neo-statists suggest, that the authoritarian use of power can lead to the compliance of industries without carefully examining the GI linkage. Without voluntary cooperation of the industry any IP will find difficulty in the process of policy-making and implementation. There must be channels to solve the problem when divergence occurred, which is ignored by neo-statist theories.

The statist theories did not provide a clear picture of the interplay between government and industry. Even some writers, for example, Wade (1990) and Haggard (1990), have emphasised the importance of the links between the state structure, institutions and industry, but there is not sufficient empirical evidence to support either Wade's authoritarian-corporatism or Haggard's coalitional approach. Moreover, most of the neo-statist descriptions of Taiwan's GI relations are too general, not to mention their very weak empirical background. In particular, GI relations have changed over time and different industries will form different relations with the government according to their economic centralities and the strength of competitiveness. Some sectors might match the authoritarian-corporatist description or coalitional analysis, but others might not. A research finding based on Taiwan's automobile industry suggests that the state capacity and government relation with the auto industry may not be constant across industry, and the developmental strategy at macro level may be in conflict with that at sectoral level (Arnold, 1989). Another research study conducted by Kuo (1995) on textiles, plywood and the electronic industry in Taiwan also demonstrated the same finding; besides, various type of GI relations can be traced in different time spans[10]. This reveals that neo-statist theories not only failed to provide empirical justification for an authoritarian analysis, but also they were too general to reflect sectoral reality.

It is inappropriate to view development as a top-down process through which the state has been able to affect big business, guide investment, and promote exports, in particular, the firms reacting passively to state intervention. The private sector may have an influential capacity to resist state intervention.

[10] According to Kuo (1995), there are three main types of GI relations, namely clientelism, Laissez-faire and state corporatism. GI relations in the textile industry presented as clientelism in the 50s, state corporatism in the 60s & 70s and laissez-faire in the 80s; in the electronics industry, laissez-faire with mild clientelism in the 50s, and state corporatism in the 60s-80s; in the plywood industry, basically, Laissez-faire.

5. NEW AGENDAS ON THE DEVELOPMENT OF NEO-STATIST THEORIES

Beginning around 1990, the neo-statist concerns have shifted from a previous focus on state autonomy and institutional arrangements for intervention in relation to economic development towards new agendas: institutional links between the state and the private sector (Chu, 1989, 1994; Chowdhury & Islam, 1993; Fields, 1995; Kang, 1995; Kong, 1995; Weiss, 1994; Weiss & Hobson, 1995:161-91). This is to overcome the inappropriate interpretation, or missing linkage, about the relationships between the state and industry. It rejects the authoritarian concept that the state power is exclusive-despotic-coercive. Rather, this new trend of research has placed a lens on the view that 'cooperation between state and industrial/economic elites is constitutive of state power (Weiss, 1994:28)'. To cope with changing environmental constraints which have inevitable impacts on Taiwan's industrial development, neo-statist theories have to be revitalised and to dance to the tune of the new political-economic situation. Otherwise, they will soon become a historic explanation of East Asian development.

The political economy of developmental transition is a complex issue involving the explanation of national and international aspects of state autonomy decline. States are an integral part of the international political economy, in which they tend to influence one another. Taiwan has actively sought to incorporate and integrate itself into the global capitalist system economically, politically and militarily. For this purpose, the state has had to undergo political democratisation and economic liberalisation and this has led to the changes in relative autonomy. 'The state is no longer in a position of "commanding heights" relative to society; its autonomy and strength have declined. The state is being transformed by society (Chan, 1990:148)'. As Ross (1990) argues the pattern of capitalism has been transformed from monopoly capitalism to global capitalism. While the state was relatively autonomous from the immediate enterprise-based interests and political power of capital in the form of monopoly capitalism, this autonomy has now declined and global capitalism has taken over. 'When fundamental aspects of the strategic relations of capitalism change, class-to-state relation change also' (ibid.:211). There is a research trend to explore the disaggregated state structure, in particular, relative to the effectiveness of state actions and the nature of state-industry relations.

C.H. Lee (1992) argues that close cooperation between government and big business in the policy-making process converts the state into a 'quasi-internal organisation' (QIO), the most important element of the East Asian state. QIO operates in two forms, one as an 'internal capital market' the state acts as a QIO through its financial control and regulation to exercise discretion in channelling credit to various sectors and industries, and the other as a 'network' state in which key representatives of the state and the private sector form a subtle network of long-term ties to exchange views and opinions on the future economic goals. When the state is organised in the form of QIO, the state would provide financial incentives and subsidies to targeted industries and those clients would meet state-imposed performance standards. Thus, QIO based on the use of performance targets allows the state to monitor economic development. The QIO explanation seems a very useful generalisation to describe East Asian government-business cooperation. Repeatedly, state interest may not prevail over private interest even in the case of a QIO. It is also difficult for the state to pick winners in the 1990s. An inappropriate selection of an industry/firm for the injection of financial resources may lead to 'organisational failure' (Chowdhury & Islam, 1993:54-5), as in the case of the 1997-98 financial crisis in South Korea which was partly caused by the high concentration of bank lending to large industrial groups.

In Kong's argument, the state's success in establishing and securing societal compliance with national economic priorities has been transformed from authoritarian autonomy to 'consensual development' (1995). The case of Korea is characterised by three principal institutional pillars of consensual development. These are government-business partnerships, exclusion of labour influence over economic decision-making, and emergence of a dominant political party with close business and bureaucratic connections (ibid.:635). The consideration of consensual development, despite democratisation and economic liberalisation, still calls for a continuing role for the developmental state and against the emergence of an economic free for all in Korea. Consensual development initiates an alternative means of viewing government-business relationships as a close partnership and tries to generalise an East Asian type of advanced capitalist state, that interventionist practices are consistent with the economic context of the 1990s. However, it is worth noting that political corruption is not taken into account in this model. The bribery scandals exposed in Japan, Korea and Taiwan suggest a deeply rooted problem. If the excellence of consensual development is to build economic performance, the weakness must be that it is based on a dark consensus between government and business which is beyond public scrutiny.

Some argued that the character of GI relationship, which was indeed highly interdependent, was to strengthen state autonomy rather than to weaken it. In the 'governed interdependence' thesis, proposed by Weiss (1994; see also Weiss & Hobson, 1995; Weiss & Mathews, 1994), competitive collaboration under state sponsorship was the very nature of the GI relationship in terms of governed interdependence in which 'business compliance is not something spontaneously or voluntarily given, (but that) quite a good deal of public effort has gone into inducing it (Weiss and Hobson, 1995:178)'. It concurs with the research findings of this study that policy instruments have served as the leverage for the private commitment to accommodate IP. Collective benefits for all in a specific industry as the main motivation for business community to cooperate with the state is evidenced in the case studies. It implies that, unlike a cultural explanation, based on voluntaristic norms or a strong/authoritarian state interpretation based on power, business collaborates with the government in a state-defined area simply because it is advantageous. Thus, by the forms of governed interdependence, or closely collaborative GI relationships between bureaucratic and business elites, the East Asian states are not so much losing their autonomy in economic dominance as transforming them.

In sum, the rising interest of GI relationships concerning economic growth in East Asian literature has been in remedying the bias of state-centred interventionism. As many neo-statist theories have come to adopt a more pragmatic approach towards the interactions between the public and private sector, it provides a better understanding of the ways in which the state can derive knowledge in relation to industry, market and technology via GI interchange. However, international and technological factors which are essential to economic growth, are still not the main considerations of neo-statist theories. The changes in international political economy have affected national policy to a very strong extent while the increasing pace of technological changes has influenced the competitiveness of industry as well as of the nation. It is necessary for the neo-statist to incorporate both factors into the development of theory since the old pattern of authoritarian approach will never fully explain the current and future situation of developmental states. In addition, the 'miracle' would have faded out if miraculous states failed to keep their footsteps abreast of international and technological changes.

CHAPTER THREE

THEORETICAL FRAMEWORK AND JUSTIFICATION

> **Technological innovation was central in determining which firms and countries should come out on top of international competition. State-societal arrangements played a key role in the creation and diffusion of the necessary technologies and therefore had a major effect on international competitiveness. (Hart, 1992:20)**

1. HART'S MODEL AS THE ANALYTICAL FRAMEWORK

Using Hart's model to be the analytical framework is basically based on two reasons. Firstly, Taiwan should be put into an analysis context for industrialised countries instead of that generally provided for developing countries since its international competitiveness has greatly improved towards the end of century. Secondly, 'the state-societal approach is the most general approach and the one that best fits the data at hand' (ibid.:287), and this, Hart explains as the advantage of the state-societal arrangements approach based on the vulnerabilities of alternative approaches in explaining the changes in competitiveness of objective countries (ibid.:27-35 & 285-7)[11]. Besides, the concept of this approach is simple and clear, and not premised upon complicated assumptions and theoretical constraints. Any country, or industry, with competitive strength can be tested and then the pattern of state-societal arrangements can be figured out and its impacts on international competitiveness assessed.

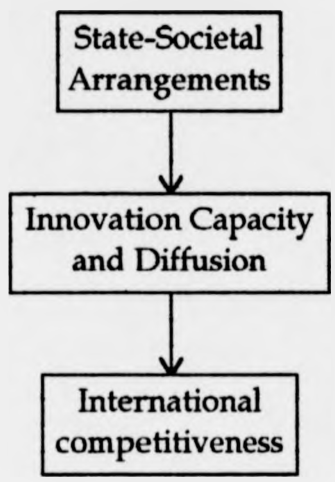
1.1. The Impacts of State-Societal Arrangements on International Competitiveness

The main argument of Hart's theory maintains that state-societal arrangements are the key to explaining recent changes in international competitiveness because state-societal

[11] The main rejections of other approaches by Hart can be roughly summarised: Macroeconomic approach faces the problems of fitting data, same as others; the Marxist variant of coalitional approach (and pluralist) focuses exclusively on classes (interest groups) as social actors; culturalist explanations are historically naive with a bias to culture and ideology; the statist explanations are empirically incapable to provide evidence on a comparative base, such as that Germany with a relatively weak state than France has better competitiveness; corporatist explanation is subsumed within state-societal arrangements approach, but not all countries can be characterised as corporatist.

arrangements can accelerate (or impede) the development and diffusion of technological innovations. The diagram (Figure 3.1) below explicitly illustrates his theory in outline and suggests cause-and-effect relationships between state-societal arrangements, innovation capacity and diffusion, and international competitiveness.

Figure 3.1 The Impact of State-Societal Arrangements on International Competitiveness



'State-societal arrangements are defined as the manner in which state and civil societies are organized and institutionally linked. The state consists of a set of institutions mostly associated with the government but also including tripartite (government-business-labor) boards and commissions, state-owned business enterprises, and other parastatal organisations. Civil society is the domestic social environment in which the state operates. In contemporary advanced industrial countries, two groups in civil society, business and organized labour, are of primary importance, especially when considering competitiveness in manufacturing industry'.

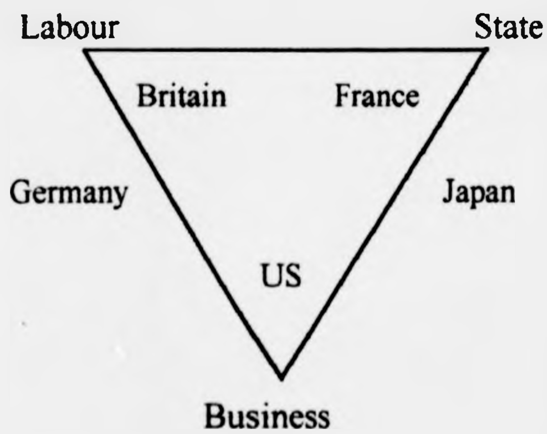
Source: Hart, 1992:2.

This theory is strongly supported by convincing empirical evidence in the comparability of France, Germany, Japan, Britain, and USA from a historical angle. However, the validity of this model on theoretical grounds is not comprehensively justified. It does advance good criteria to measure competitiveness (ibid.:7-20) and interpretations of the effect of technological diffusion in competitiveness in specific industries (ibid.:20-7), but it leaves many aspects not well-justified that are essential to build a theory/model, such as the origins of competitiveness, the role of technology as well as the state in promoting competitiveness. To redress the theoretical weaknesses of this model, the rest of this chapter attempts to strengthen the definition of relative terms and the justification of the linkage between institutional arrangements, technological innovation, and industrial competitiveness. In the final section of this chapter the two theoretical perspectives, statist and corporatist, have been discussed because of their high relevance to the issue of GI relationship in a domestic setting. It is argued that 'institutionalised strategic partnership' is a more insightful explanation of the institutional evolution which has happened in Taiwan.

1.2. The Typology of State-societal Arrangements

The variations in state-societal arrangements are the best explanation for divergence in international competitiveness, Hart concluded (ibid.:280-292). Through examining the impact of differences in state-societal arrangements on the creation and diffusion of new technologies, the performance of three industries (steel, autos and semiconductors) in five countries was found to depend on the ability to adopt new technology rapidly. Sectoral state-societal arrangements in one nation tend to be similar whereas national state-societal arrangements in different countries are represented in a quite different way which Figure 3.2 illuminates.

Figure 3.2 State-Societal Arrangements in the Five Countries



Source: Hart, 1992:281.

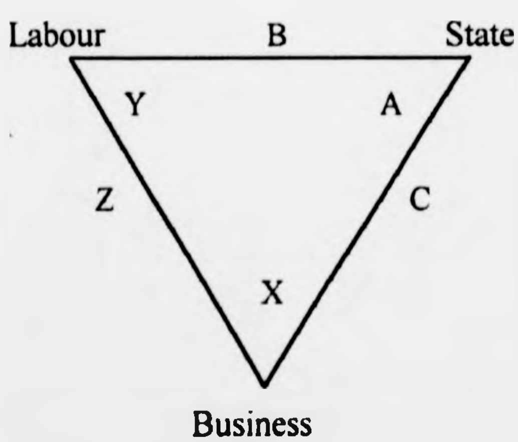
'The five countries are placed on the faces or vertices of a triangle that represents the influence of the government, business, and labor in state-societal arrangements. A country on the labor vertex has strong labor, weak government, and weak business. A country on the business vertex has strong business, weak labor, and weak government. A country between the labor and business vertices has strong labor and business and weak government. Each country has a distinctive pattern. This is, Japan has a pattern of high influence for the state and business but low influence for labor; Germany has a pattern of high influence of business and labor but low influence for the state'.

According to his research findings, state-societal arrangements with only one major dominant social actor in the realm of IP, on the corner of state-business-labour triangle (France, USA, Britain) tended to decrease international competitiveness relatively, and arrangements with two, on the side linking the state and business (Japan) or linking business and labour (Germany), to increase competitiveness. It suggests that a two actor coalition seems to be more conducive to the diffusion of new technologies than one actor dominance and that a one actor dominant country shall move from corner position to an adjacent side of two actor coalition (ibid.:290-2).

1.3. Fitting Taiwan into Hart's Model: Some Adjustments

Accordingly, six patterns of state-societal arrangements can be found in this state-business-labour triangle (Figure 3.3). From Taiwan's past experience in the process of industrialisation before 1985 when it was an authoritarian state, the state performed as a dominant actor, this placed Taiwan on the position A - 'state corner'. For Taiwan now there is a strong possibility that the state-societal arrangement can be in position A, B or C and a weak possibility that it can be in position X, Y or Z because 'it is easier to move from a corner to an adjacent side or from a side to an adjacent corner than to a nonadjacent position' (ibid.:290).

Figure 3.3 The Possible Positions of State-Societal Arrangements for Taiwan



Position A: French pattern,
State dominance
Position B: Strong state and labour
Position C: Japanese pattern,
Strong state and business
Position X: USA pattern,
Business dominance
Position Y: British pattern,
Labour dominance
Position Z: German pattern,
Strong business and labour

Position A: The KMT state remains the dominant actor in industrial matters and the industrial sector is compliant. If this happened, Taiwan would be in the same position as France whose competitive strength is not as good as those of the Japanese and German patterns. However, a state-dominated system without the commitments of business will lead to improved competitiveness is doubtful given that fast technological changes have increased fierce competition in a globalised market.

Position B: Taiwan moves from state vertex towards the state-labour side. Taiwan should avoid this position since there is no case of a country with weak business which has become an international competitor in contemporary history. Besides, the rising power of societal actors are to be seen after 1985 but in unequal terms where business has gained more influence in national policy because of the increasing competitiveness of certain sectors, while labour, strong at a time when radical labour movements did improve their rights, lost influence at the end of 1980s after a large amount of investment moved to foreign countries that affected domestic employment in Taiwan.

Position C: Taiwan could possibly become like the Japanese pattern of strong business and strong state which has been perceived as an effective and efficient institutional arrangement. This is the best position among possible choices that Taiwan can expect. There is also a trend that Taiwan is moving from state-driven economic management towards state-industrial interactions. However, it is still necessary to examine the degree of interactions and the evolution of institutional changes before confirming Taiwan's current pattern of state-societal arrangements.

Position X, Y and Z: To move into the position X, Y, or Z is unlikely to happen in the near future, unless there is a major political change, such as being united with Mainland China. However, some sectoral transformation towards a business-dominated system may occur if competitiveness in some industries becomes sustainable by sector-generated solutions instead of state-designed solutions.

This explains the title of the thesis using 'state-industrial' arrangements rather than state-societal arrangements and for that reason labour has been left out of the analysis. The evidence that labour is not an active player in national policy will be given at the end of this chapter.

Another adjustment is on the selection of sample industries. Three industries, the steel, automobile and semiconductor industries, have been used as empirical investigations by Hart. However, these three industries would not actually reflect the current situation of state-industrial arrangements in Taiwan. The competitive strength of steel and auto industry can not rival those of the industrialised countries, whose applications to Hart's model would confront difficulty in explaining the situation.

The steel industry in Taiwan is structurally dominated by a state enterprise (China

Steel) which provides private steel manufacturers with necessary technical assistance. The steel industry, including a large-scale integrated steel mill produced flat steels and tubes by China Steel and several private mini mills produced specialty steels and alloys, not intended for export but to supply domestic demands. China Steel's products exported to Japan, counted as the second largest steel import of Japan. Taiwan depended more on imports from Japan of higher-quality specialty steels (Wade, 1990:99-100). The value of imports is higher than the exports under the classification of basic metals & articles thereof in every single year in 1986-94 (TSDB, 1995:213, 224). This reveals that the competitiveness of Taiwan's steel industry is not among top international competitors. Besides, a large public enterprise, as an upstream manufacturer, has dominated the development of the whole industry, which suggests that Taiwan's steel industry is in position A (state corner).

Taiwan's auto industry has never been a world competitor, and its auto IP has been cited as the unsuccessful case of state intervention (Arnold, 1989), in particular, in comparison with its Korean counterpart (Chu, 1994). In the 1970s, the auto IP was no more than trade protection when most attention and resources were assigned to other industries (e.g. steel, plastics, petrochemicals and electronics). The domestic auto market was highly penetrated by foreign auto makers after reducing tariffs for auto imports and terminating the import ban of Japanese cars. In the 1980s, a government-led plan to build a big auto plant - a joint venture between a large foreign car maker and two state enterprises (China Steel and Taiwan machinery), failed after negotiation with General Motor, Nissan, Toyota and Ford because of harsh requirements imposed by the government, for instance, 45% ceiling for foreign equity, 50% export ratio, 90% domestic content and national control. Ironically, six domestic private producers were not invited, even consulted, to join this plan that implied another state attempt to control an industry. In the 1990s, policy direction shifted towards the reduction of the degree of dependence on Japan in critical components by technical upgrading, and to be part of the offshore sourcing strategy of large foreign producers aimed at the prospective China market. It aimed at building Taiwan into a base for parts and components, rather than by establishing a competitive export-oriented industry for industry-end products (vehicles). According to Chu's (1994:165) analysis, economic bureaucrats have failed to overcome the conflict between short-term business strategies and long-term state industrial goals in the auto industry through the years. Any government attempt to establish vertical integration in this industry failed. The inefficiency of institutional arrangements of the auto sector makes it difficult to fit in Hart's model.

Taiwan's semiconductor industry, the world's fourth largest producer, can be a good example of sectoral investigation in Hart's model. It demonstrates how Taiwan created its world-competitive semiconductor industry by an institutional arrangement mainly handled by the public sector (Hong, 1995; Mathews, 1995; Meaney, 1994). Leadership for the industry was vested in the public research institute and those spin-off ventures with larger public investment, from different stages of development rather than shared with existing large private companies (probably, there were none who could undertake technology transfer). The industrial sector would not have invested in its own R&D in the 1970s and 1980s. However, the situation changed in the 1990s since the industry showed signs of getting ahead of the public laboratory in developing more advanced technologies while the state launched the submicron project hoping to maintain its leading role in cooperation with the industry. It could be argued that state-societal arrangements in the semiconductor industry are in position A in its early stage of development, and in position C after 1990. The reason for abandoning this industry as a case was in relation to the intention of the originality of the thesis in the sense that there were many ongoing research projects and much existing literature in different disciplines concerning Taiwan's semiconductor development when this industry was reviewed[12].

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[12] In the process of collecting materials and selecting sample industries, some persons concerned have stated that they have been recently interviewed or requested for materials by scholars from US, Australia, South Korea, and Taiwan, who were conducting research about the development of the semiconductor industry in Taiwan (& Korea). Besides,

The technology diffusion process of NPC and HDTV industry exhibits the rise of new industries in Taiwan's high-tech industrialisation which accommodates the description of Hart's theory. The state-societal arrangements in these two sectors have conditioned the diffusion and application of new technologies that eventually leads to increase sectoral competitiveness. The evolution of institutional arrangements can be traced by observing from the formation and implementation of both cases which shows two types of innovative institutions for public-private cooperation. The NPC Alliance provides an initial case for product creation, while the HDTV consortia-complex an inaugural case for upgrading the industry as a whole. Subsequently, both patterns have been extensively employed in the technology diffusion of other industries. The current development of state-industrial arrangements would be best understood by using the NPC and HDTV industries rather than by using the steel, auto and semiconductor industries.

1.4. Assessment Criteria of International Competitiveness

One can design one's own criteria or choose from existing frameworks, only if these are in sympathy with the research topic and its needs. The main concern of this research is with the interaction between government and industry/society in relation to the diffusion of technology. The focus is more on national actors, institutions and IP than on international competitiveness. However, to evaluate the success of an IP and to judge the applicability of GI relationship we still need a set of indicators as a criterion to illustrate the competitive strength.

Because this study aims at testing Hart's model on international competitiveness and state-societal arrangements, the tools to assess international competitiveness are derived from his criteria. The assessed criteria on international competitiveness, for both nation-wide and industry-specific levels, required in this thesis rely on statistical

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three ongoing Ph.D. dissertations, either in politics, economics or bisiness studies, in Taiwan and the US, as far as I know, also targeted this industry. All this made the interest in the semiconductor industry shift to the HDTV industry.

evidence.

The time span of this study focuses on the 1990s. The NPC Alliance was enforced in 1990-91, and the HDTV consortia were operated between 1991 and 1996. Moreover, there was no major change in the relations between the state and societal actors before 1990. In order to observe the nation-wide trend of increasing productivity in Taiwan, data is provided at five year intervals since 1955 but in every single year after 1985 for a decade. For those indicators in comparison with major industrialised countries, data is given mainly to reflect the general trend of growth in the 1980s and the early 1990s. Data for sectoral growth in the NPC and HDTV industries, concentrated on global market shares in the 1990s, is given principally to examine the subsequence of the NPC Alliance and the HDTV consortia and to contrast with those before the operation of public-private cooperation.

'A country that experiences growth in productivity, world export shares, and real wages is clearly more competitive than one experiencing declining productivity, world export shares, and real wages (Hart, 1992:8)'. For the evidence of national competitiveness in terms of trade, productivity, real wages at a nation-wide level, data shows that Taiwan is actually increasing its competitiveness. Table 3.4 indicates that Taiwan's growth on these terms in comparison with its past performances while Table 3.5 demonstrates these terms in comparison with those of other countries.

Taiwan's competitiveness at nation-wide level has increased faster than those of industrialised countries which implies that it is catching up with top international competitors. In Hart's theory, it is because state-societal arrangements accelerate, not impede, the development and diffusion of technological innovations. If Taiwan kept on narrowing the gap of competitiveness with higher income countries, it would let Taiwan promote its status to that of the industrialised countries in the early 21st century.

Table 3.4 Taiwan's Economic Indicators

	Real incomes		Manufacturing production		Trade	
Year	GNP annual growth rate (%)	Per capita GNP (US$)	Annual growth rate (%)	Indices (1991=100)	Trade balance (US$million)	Foreign reserves (US$million)
1955	8.1	203	10.6	1.67	-57	-
1960	6.4	154	14.2	2.82	-78	-
1965	11.0	217	16.6	5.40	-59	245
1970	11.3	389	22.2	13.77	-94	540
1975	4.4	964	8.0	25.06	205	1,074
1980	7.1	2,344	6.2	49.68	-253	2,205
1985	5.6	3,297	2.5	68.14	10,776	22,556
1986	12.6	3,993	15.3	78.56	15,673	46,310
1987	12.3	5,294	11.1	87.27	14,440	76,748
1988	8.3	6,379	3.6	90.42	18,019	73,897
1989	8.0	7,626	3.6	93.71	16,895	73,224
1990	5.5	8,111	-0.7	93.02	11,188	72,441
1991	7.6	8,928	7.5	100.00	17,261	82,405
1992	6.2	10,470	4.0	103.95	12,756	82,306
1993	6.0	10,852	2.3	106.38	13,891	83,573
1994	6.1	11,604	5.9	112.60	16,437	92,454

Source: TSDB, 1995:4, 27, 32, 84 & 191.

Table 3.5 The Comparison of Taiwan's Economic Indicators with Major Industrialised Countries

	Taiwan	S. Korea	Japan	Germany	France	UK	USA
1993 per capita GNP (US$)	10,852	7,461	34,475	21,008	18,752	16,396	18,537
†Big Mac indicator (minutes)*	22	30	9	20	24	23	12
1993 indices of industrial production (1980=100)	211	366	135	115	111	120	132
Average 1980-92 manufacturing growth rate (%)	7.2	11.9	5.8	1.6	0.9	-	-
Exports of goods & services (as % of GDP)	44.3	29.4	9.4	31.9	21.9	25.0	10.4
Average 1980-92 export growth rate (%)	11.0	11.9	4.6	4.6	5.2	3.5	3.8
1992 terms of trade (1987=100)	109	106	109	99	101	104	104
Foreign reserves (US$bn)*	86.1	36.5	221.1	78.0	28.9	39.1	55.1

Source: TSDB, 1995:304-5, 308-10 & 314-5. *Economist,11/10/97:171-2.

† Big Mac index provides a guide to the purchasing power of different countries which shows working time required to buy a Big Mac. Data based on 2nd quarter, 1997.

Another economy-wide indicator to measure the strength of competitiveness by Hart is the decreasing price elasticities of imports[13]. Generally, consumers in Taiwan are willing to pay for luxury imported goods (because of recently increasing incomes) and low-end standardisation products from developing countries (because of decreasing quality differentials). This is more like the situation in Japan. It is hard to say that the economy as a whole is characterised by low price elasticities of imports. Consumers would pay a premium for import autos, but not for imported computers. As for the electronics products, consumers bought local-made products which included domestic and international brands. However, there is difficulty in applying price elasticities of imports in the domestic manufacturing of foreign direct investment.

Assessment criteria for industry-specific competitiveness, as defined by Hart (ibid.:12-20), are global production shares, sectoral employment, profitability, and the frequency of industry crisis. The quantitative evidence of global market shares in two empirical cases will be provided in the relevant chapters. Profitability of firms is much more difficult to assess than that of industry as a whole (ibid.:17), so industry-specific profitability will be discussed in the empirical chapters. Industrial crisis in both empirical cases seems not to have happened from 1990 up to 1997 except many financial collapses of NPC producers which did not seriously damage this industry. The two sectoral investigations of emerging industries in this study show that they are less likely to have negative development, but other industries, mainly labour-intensive ones, confront different kinds of crises. In these two cases, Industry-wide crisis can not be sensed which might be partly the consequence of continuing growing demand in international markets and partly the consequence of rising competitiveness in Taiwan's products. If there is any crisis, it is limited in scope. In particular, the industrial crisis of

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[13] According to the explanation of price elasticity of demand, 'if a change in price results in a more than proportionate change in quantity supplied then supply is price-elastic; if a change in price produces a less than proportionate change in quantity supplied, then supply is price-inelastic' (Pass & Lowes, 1993:417). When this term is applied to price elasticity of imports, 'low price elasticities of imports will indicate quality differentials between domestic products and imports' (Hart, 1992:7). In this sense, consumers in Japan and Germany have low price elasticities of imports, and consumers in the USA have higher price elasticities of imports while consumers in Britain and France have behaved more like those in the USA (ibid.:11-2).

Taiwanese small and medium-sized enterprises (SMEs) would hardly have had a serious impact on the industry as a whole. According to Hart (ibid.:19), the low frequency of industrial crises is also an indicator of industry-wide competitiveness. In this respect, Taiwan could be seen as competitive.

Using sectoral employment as one of the criteria for assessing competitiveness is arguably valid since increasing competitiveness of industries may be via automation and technological application but not necessarily by employment growth in some sectors, in particular, technology-led ones. The employment of the manufacturing sector, as the percentage of Taiwan's employment decreased from 33.7% (2501/7428 thousand persons) in 1985 to 27.8% (2485/8939 thousand persons) in 1994, however, the labour productivity increased, in the same period, by 172% in manufacturing sector, and by 222% in electrical and electronic sector (TSDB, 1995:20 & 24). This reveals that the decreasing employment in one sector may not necessarily lead to the decline of sectoral competitiveness.

2. THE CONCEPTS OF "INTERNATIONAL COMPETITIVENESS"

The increasing economic integration in the world market and production has been referred to as globalization, which also brings about its own consequences for the competitiveness of countries. The trend of economic globalization is a complex issue, which can be observed from increasing economic interdependence and globalization of markets in the form of a rapid acceleration of trade and investment flows, the creation and diffusion of new technologies, the explosive growth of capital markets and financial market integration, and the conduct of business operations on a global basis.

'Global is clearly used as opposed to local and its use reveals local concerns' (Humbert, 1993:3). To make a firm profitable, to support local industry, and to ensure a nation's competitiveness one is required to think globally and to act locally. In other words, the consideration of a government policy or a corporate strategy should be concentrated on internal factors as well as on external factors. The trend of economic globalization will be critical - not only the response of private enterprises, as well as policy-maker; 'failure to react will bring about permanent changes in "comparative advantage" for individual countries in an international economy, and result in a major set-back to further economic development' (San, 1991:57).

The world economy is experiencing a process of global restructuring that not only affects domestic policy (Keohane & Milner, 1996) but also redefines GI relationships, and the role of the state, while furthering the asymmetrical interdependency of economic functions across national boundaries. Governments have become more involved in the field of industrial and trade issues, assuming larger responsibilities with regard to creating or supporting competitive advantages for domestic industries through innovation policies. Under fierce competition, the government is actively attempting to build competitiveness and the firms are responsively seeking state assistance.

Competitive advantage in itself is not comparable, it only demonstrates its meaning in comparison with that of other countries, industries, firms, or over time. A country's 'ability to compete in world markets, essentially depends on the resources, markets, institutional mechanisms and incentives available to its firms to organise the production of different kinds of value adding activities in that country; and the efficiency at which this task is undertaken' (Dunning, 1990:28). According to Dunning (ibid.:28), competitive advantage can be classified into static and dynamic competitive advantage. The former refers to the capability and willingness of countries -- or rather firms and industries in countries -- to allocate resources to the right sectors and to utilise them in the most cost effective way. Dynamic competitive advantage embraces the extent to which a country can sustain or advance its living standards by upgrading the quality of its resources, by innovating new products and production methods and by a better organisation of its existing resources and markets.

Even if we can realise the importance of government actions which have had a decisive impact on the competitiveness of the economy, it is still difficult to identify the responsibility for the competitive advantages of nations. Dunning argues that 'governments, acting on behalf of the societies they represent, are becoming an increasingly important conditioner of the level and direction of international business activity' (1990:36).

Generally speaking, firms are frail in certain aspects that affect their production, such as that they only have limited control of economic structural and political environments, and that the behaviour of workers and IPs of government are sometimes beyond their control. Some firms or industrial organisations may have the ability to influence policy, but most of them have not. Nonetheless, the ability of national firms to influence policies differs from country to country due to cultural differences and the tradition of government-business relations.

The Asian ethos towards government intervention is more positive than the western liberal one. Government intervention has always been deemed as 'a necessary sin' in East Asia (Liu, 1993). The state acts in making industrial choices according to its own interest or a preference that is separate and distinct from the interests of any particular societal group. The tradition of the Confucianist culture and strong nationalism made it possible to view the state as a mobilizer for economic development that was accepted as a common good beneficial to all members of society (Lee & Lee, 1992). The East Asian states, such as Japan, Taiwan, Korea, and Singapore, play the role for the visible hand by supplementing market forces. Nonetheless, most countries, either Asian, American or European, have adopted a more pragmatic attitude towards state intervention in terms of international trade and strategic industries, which is mainly a response to fierce international competition.

In explaining industrial success in international markets, the classical economist David Ricardo proposed the notion of 'comparative advantage', recognising that market forces will allocate a nation's resources to those industries where they are relatively most productive. However, although comparative advantage based on the factors of production has intuitive appeal, national differences in factor costs have certainly played a role in determining trade patterns in many industries. This view has often informed the state's role in competitiveness, because it has been argued that the state can alter factor advantage, either overall or in specific sectors through various forms of intervention (Porter, 1990; Zysman & Tyson, 1983).

Competition in the post-war trading system was initially envisaged as competition among firms with the state establishing the rules and the enforcement process. The traditional concepts of free markets, the invisible hand, and the limited state as the framework for domestic competition has now been challenged by developmentalist countries that have found a positive role for the visible hand of the state. It can create comparative advantage and promote mobility of capital and labour in exploiting this advantage. Managing global competition requires the state to play a role in mediating decisions about who should give up what, and also to monitor compliance. Nowadays, nations, like firms, compete with each other for resources and markets, and especially for those which influence their future competitiveness. It is a age that might embarrass Adam Smith, who was in favour of a limited government, a laissez-faire economy, and self-interested individuals. It seems that the mercantilist idea of favouring state intervention in order to maximise national wealth and power through the expansion of foreign trade has been revitalised in the contemporary world.

The experience of economic development in East Asia is a revised theory of comparative advantage in which competitive challenge focuses on opportunity as well as resources. A country can mobilise whatever limited resources it has, and seize opportunities, instead of focusing on 'static' mobility and the possibility of declining long-term costs based on the learning curve as well as economies of scale. It is a theory that focuses on the opportunities for change over time -- a dynamic theory of comparative advantage which supplements the static traditional Western one. The continued industrial restructuring in East Asia is a case in which 'state policies' combine with 'corporate strategies' to ensure rapid adjustment for targeted industries in order to gain timely competitive advantage, not only for the nation but also for the company itself.

Countries with more competitive policies and competitive arrangements are likely to have a higher performance than others. IPs based on mobilising the resources of a nation to create competitive advantage in growth industries and industries in which technological change is rapid yields a higher growth over the medium term than a strategy which accepts advantage as 'given'. It also reveals that a policy that promotes mobility and/or limits the rigidities associated with entitlement allows a country to capitalise more rapidly on the advantages it creates. Therefore, those countries where the state does not play an active role in guiding the private sector are increasingly challenged by those with more competitive policies based, in part, on collaboration between the state and firms.

Furthermore, the East Asian policy-makers sought to maximise growth by specialising in those sectors where a competitive advantage could be established by organisational/institutional superiority. 'Organisation, a non-marketable input and the intermediate variable between the cost of resources and the value of output, can be the basis of competitive advantage, at least in certain sectors' (Best, 1989). If competitive advantage based upon institutional linkage, or organisational superiority, has been established, it would be difficult and take a period of time for competitors to match even if they have better endowments.

A state's governance structure is constituted by institutions linking the state and societal actors. Institutions are the underlying determinant of the long-run performance of economies (North, 1990:107). Between the state and industrial sector, there are many organisations functioning as mediators in relation to policy formation and implementation.

3. THE ROLE OF TECHNOLOGY IN ECONOMIC DEVELOPMENT

3.1. Technology and Competitiveness

Currently global restructuring is defined as a techno-economic process in which new technologies are at the core of the current process of economic restructuring, and the most immediate impact on productivity has been in manufacturing (Henderson & Castells, 1987:5). The worldwide race to capture the lead in strategic technology has been characterised as the 'technology war' (Brandin & Harrison, 1987). Economic/industrial issues must focus on technology not only because it affects the standard of living and a nation's wealth, but also because technology is the key to the future. The technology war differs from the traditional conflict which is more sophisticated than the competition found in most of the existing political and economic systems. Nations, that prevail in this war, 'will control the resources of the world; they will control their *Lebensraum*; they will be the next global powers' (ibid.:v). 'The consequences of losing the war are the loss of national wealth, prosperity, leadership, employment, national security, and freedom' (ibid.:4). The competition between states for markets is becoming a competition for leadership in the knowledge structure. Strange argued that the competition is for a place at the 'leading edge' of advanced technology, which is the means which both leads to military superiority and to economic prosperity (1988:136). Moreover, technological changes in the knowledge structure have had an impact on both the production and financial structure (ibid.:133-5). Accordingly, international competitiveness is based on a technology /information-rich foundation rather than on a capital/resource-rich foundation.

The failure of structural adjustment in the industrial sectors will lead to a decline in industrial growth. Zysman (1983) suggested that three components -- the financial system, the state structure and economic conditions -- represent an enabling condition for a particular pattern of industrial adjustment. However, followed by fierce global competition and a shortened product life cycle, technological changes have become another important component highly relevant to industrial adjustment. Technology may not be the only element of restructuring industry, but it has at least equivalent effects on industrial reconstruction as factors such as financial system, state structure and economic conditions do, in relation to industrial competitiveness (Bradford, 1994; Dahlman, 1994; Haque, 1991; Hart, 1992; Porter, 1990). A nation can obtain increasing marginal productivity from the external effects of the accumulation of knowledge -- the use of existing knowledge and the acquisition of new knowledge, which eventually contributes to trade and growth (Sodersten, 1993). Moreover, technological change is also one of the sources of new investment which is the main engine of economic growth. Because of that a rush of investment in the high technology sectors stimulates the economy out of recession and invigorates markets (Castells, 1987).

Furthermore, new technologies contribute to a qualitative increase in productivity in manufacturing, as well as in agriculture and services. The increase of productivity in manufacturing takes two forms. One is by moving production towards higher productivity sectors, for instance, from agriculture to manufacturing or from light and labour-intensive manufacturing to capital- or technology-intensive production. Another is by adopting increasingly efficient production processes, for example, using machines to replace labour or automation. Accordingly, technology is one of the key factors of the process of economic/industrial restructuring and has a decisive effect on the making of our future world.

As technology increases in importance in relation to economic performance, many efforts have been made to enhance both the nation's and individual firms' competitiveness in this technology war. 'There clearly is a new spirit of what might be called 'technonationalism' in the air, combining a strong belief that the technological capabilities of a nation's firms are a key resources of their competitive prowess, with a belief that these capabilities are in a sense national, and can be built by national action' (Nelson & Rosenberg, 1993:3). There is no strong empirical evidence to say that national economies are broadly advantaged if their firms are especially strong in high tech and disadvantaged if they are not (Nelson, 1993:517). However, there is also no one who will take the risk of suggesting that economic growth is irrelevant to technological improvement[14].

Traditional economic remedies cannot in themselves reverse the deterioration of a nation's position in the international economy. The major reason for the decline in

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[14] Many authors have the same view that Technological innovation has characterised economic development and industrial change, for instance, Castells, 1987; Cohen & Zysman, 1991; Coombs et al., 1987 & Verspagen, 1994.

competitiveness lies in an erosion of manufacturing skills and capacities (Cohen & Zysman, 1987:8). In the case of American manufacturing industry, the difficulty of promoting competitiveness 'lies not in machines and technology, but in organisations and the use of people in production, in the strategies for automation and the goals we attempt to achieve with production innovation' (Cohen & Zysman, 1991:265).

Production innovation rather than technological innovation, is the most important element linking manufacturing output and consumption. Japan did not invent colour television, video recorder and semiconductors, but their market share of those products is in an unbeatable position in world market. Japanese producers developed designs and manufacturing systems that created a decisive competitive advantage. Technology in itself is an essential base to create new products, but it is not necessary to sustain and expand market shares. The rate of technology diffusion has become so fast, therefore that no one can secure a position of technological monopoly any longer. For the purpose of developing a technological advantage and differentiated products to sustain market superiority, the cost input into the R&D activities is tremendous. A competitor, either a firm or a state, must be able to sell simultaneously to the entire world in order to pay for the heavy technological investment. Without continuous innovation, any product and patent will soon become obsolete because of increasingly shorter product life cycles. Production innovation demands value-added designs in order to become competitive in manufacturing. It is not an overstatement to argue, firstly, that technology lacking the ability to transfer from an original design to a commercially viable and value-added design is in vain; secondly, technology without the ability to integrate itself into a production system is of little or no value.

Technological advantage will soon be eroded by a production disadvantage. By capturing the profit on an innovation through volume sales of a product, a firm/industry can repay its R&D costs and invest in R&D for a next-generation product. A firm with a strong market position can buy a portfolio of technologies at a relatively lower price than that needed to create technology by invention. It is because a firm will capture the technology rents through volume sales and compensate the cost of buying technology.

Technology matters for manufacturing. Technological progress implies new and better quality products and more efficient production processes. Technological innovation embraces product innovation and process innovation (Stoneman, 1995:3). The former relates to the generation, introduction and diffusion of a new products, and the latter to a new production process. Both kind of innovations imply 'a short hand for doing something new' (ibid.). Thus, technology is central to an economy's capacity to grow and compete internationally. The linkages between technology and manufacturing, which are the organisation of production and the commercialisation of technology, are not less important. International competitiveness is based on how effectively a firm/industry/country develops and diffuses technology and production know-how. The value of technology in terms of manufacturing is how effectively producers use those technologies, not the technology itself.

3.2. Government's Role in Technology Development

There are many arguments against government-led R&D measures, but more which advocate that government has a proper role to play in this new wave of global techno-economic restructuring. Some have argued that inappropriate policy measures implemented by the government may result in the misallocation of R&D resources because of information barriers (Dasgupta & Stiglitz, 1980), and in subsidising second-best projects under the pressure of interest groups (Nelson & Eads, 1971). Some simply argue that government intervention may hamper rather than facilitate the necessary adjustment of industry. It is true that government intervention in private R&D activity is sometimes wasteful and misdirected, but it is also true that collaborative innovation between the government and industry may lead to a certain pace of technological progress (Weiss & Mathews, 1994). To avoid misdirection of government intervention, the management of innovation activities should be organised appropriately (Metcalfe, 1995) and communicated mutually between the public and private sector.

Government intervention in private sector R&D unavoidably causes administration costs and negative externalities, but this does not imply government intervention is unnecessary (J. Wang, 1991). Governments have to intervene financially to help firms avoid technological and market risks, because of the accelerating pace of technological change, and because of the broader technical capabilities firms must possess (Galbraith, 1969). Some empirical evidence from advanced countries also shows good examples of government intervention. In many countries, simply helping an important industry has been accepted as an economic function of the state (Nelson & Rosenberg, 1993). Japan has a good record of this and is good at building new industry. It has promoted ties between MITI and industry, and a large proportion of research funding of private enterprises comes from MITI (Johnson, 1982; Okimoto, 1989). The US industry has benefited from some high technology through government-developed military and space programmes. The EC also has some technological programmes subsidised by the Community (Sharp, 1989).

Innovation is a process of socio-economic transformation. Technological R&D is only a part of the larger innovation picture. Traditionally, public laboratories and universities are the two major institutions funded by government. Increasingly, public money flows to help the development of industrial technologies that are in civilian use. Most cases of government support in industrial R&D are limited to projects of governmental targeted industry. The state is expected to play an outstanding role in introducing tech-industrial innovation, according to Hilpert:

> (1) Organizing academic research so that its structure and its techno-scientific progress serves the need of innovation, (2) organizing markets for new science-products that are appropriate in size to encourage the creation of new and innovative industries, and (3) to create circumstances that are appropriate for general innovative potential of the nation's industries and to provide the incentives for them to engage in the fields that are regarded as being likely to be profitable. (Hilpert, 1991:3-4)

Because of this new role of the state and erosion of corporatist policy-making in national innovation system, it is argued by Hilpert (1991) and Naschold (1991) that a redefinition of the role of the interest group and of the relationship between politics and socio-economic development is necessary. It is undeniable that the role of the state plays in the innovation process become highly important for the understanding of socio-economic development in modern capitalist societies. However, it is still open to question, as Hilpert (1991) stated whether the state should take an active and leading role itself rather than intermediary organisations.

Increasing support for government intervention in promoting technological industries occurs because the market cannot be relied upon to allocate resources to R&D. There is a dispute over the cost of this involvement and the possible benefits that may arise. The cost of technological development is huge, and the outcome of R&D is an uncertainty. Some large firms do sustain high level of R&D, but it would cut their costs down and increase competitiveness if they had received government assistance. The state may financially support technological development in the name of national interest. But the notion of national interest in technological development is hard to define. Using public money to engage in defence and space programmes, as the USA government does, can be classified as, in the national interest, and part of the R&D results will contribute to the upgrading of industrial technology in the sectors such as communication and new material. In the case of supporting consumer goods (PC, HDTV, sport equipment and so on), it is doubted that public money is spent directly in the 'national interest'. Then the fruit of R&D will benefit only on the minority of certain firms and industries, this will be criticised in terms of social justice to the majority of civil tax-payers.

It is difficult to say that government or industry have a leading role in the process of technological innovation, because GI relations vary from sector/country to sector/country and so this requires more empirical sectoral comparisons and individual country studies. In some countries, notably Japan, this relationship has been close and harmonious and has helped in securing competitive strength on tech-industrial innovation (Okimoto, 1989). In terms of the improvement of productivity and the commercialisation of technology, the industrial sector is always the one which knows the market and product creation better than the government. In other words, in manufacturing at least, the efforts of government may support, but cannot be a substitute for the technological efforts of firms (Nelson & Rosenberg, 1993). It is difficult to define concretely whether the state or industry has the active, leading role in GI relations on tech-industrial innovation. Rather, there is a possibility of GI cooperation where industries themselves are more cognisant of the social costs and benefits of their own actions. Collaborative innovation between both sides creates a new form of government intervention which may lead to rapid commercialisation of targeted products.

There are other structures involved in innovation within a nation, in which the state does have a major role to play in constructing national technological capability (Hilpert, 1991; Nelson & Rosenberg, 1993). That is the educational system including schooling, training and retraining, which affects not only the quality of human resources required for innovation from skilled-labour to engineer, but also the attitudes of workers towards technical advance and the work ethic. Other factors, such as industrial relations, financial institutions, environmental issues, also influence national innovation systems. All these call for the state to synthesise them and for an IP to implement innovation. These factors are not in the parameters of discussion in this study which is confined to public-private cooperation in terms of technology innovation and diffusion and subsequent influence on competitiveness.

3.3. Technology Development in Taiwan

The influence of technological spread through a process of productive decentralisation reaches many peripheral countries. The NIEs are major beneficiaries of the required technological capacity after competing in the world economy for about two decades, mainly on the basis of lower production costs in traditional manufacturing. Those countries are now concentrating on more sophisticated and hi-tech production activities. In the case of Korea and Taiwan their technological sophistication in certain sectors could even rival some Western countries.

Now that Taiwan has made the transition from a developing country to an NIE, its industrial strategy should be correspondingly adjusted in order to cope with the new conditions of trade competition. Taiwan faces trade competition not only from the developed countries but also from the developing countries. Those developed countries compete with Taiwan in the field of technology-intensive products, not only in their markets and Taiwan's market, but also in the markets of other developing countries. Many rapidly developing countries compete with Taiwan in the field of labour-intensive products, especially in the markets of the developed countries and the NIEs, because these countries have greater purchasing power.

Taiwan's competitive advantage is subject to change. From past developmental experience, it would appear that competitive advantage in manufacturing has broadened and exports have become somewhat more diversified. This no doubt lessens the pain of structural adjustment which accompanies changes in competitive advantage. 'As Taiwan comes to resemble more closely the economies of higher-income developed countries, it may find changes in comparative advantage more difficult to absorb' (Riedel, 1992:275).

Taiwan used to be a producer of low quality products in 1960s and 1970s, and since the wage level was relatively low at that time, the price could compete in the world market. However, Taiwan no longer enjoys a low wage rate. This kind of low technology industry has become a 'sunset' industry. Some industries have promoted their level of technology through the transfer of technology from foreign companies, and can still survive in the world market. Since Taiwan has lost its competitive advantage in low-cost, labour-intensive products, those labour-intensive industries for which no technology is available to increase productivity and upgrade production should be abandoned, and technology-intensive industries should be developed to supplant them (Yu, 1990).

How to raise the level of technology is of paramount importance. Technological progress depends not only on the introduction of foreign technology but also on the development of indigenous R&D. For developing countries, the introduction of foreign technology is the most important step in raising the level of technology, and Taiwan has taken advantage of this. For the developed countries, since there are limited opportunities for them to obtain technology from other countries, the development of R&D must be strengthened. As for the NIEs, the introduction of foreign technology and the enhancement of investment in R&D are both of importance to increasing competitiveness.

It needs to be noted that Taiwan's industrial structure is dominated by SMEs[15]. However, SMEs have very limited financial capacity to conduct R&D, particularly since the minimum scale of efficiency in high technology industries has increased rapidly[16] and entry barriers exist. Because of the size constraints of SMEs, they are reluctant to invest in R&D. Consequently, sluggish R&D investment by the private sector is one of factors leading to slow structural transformation.

Available evidence shows that the Taiwan's research intensity (R&D expenditure as a percentage of GNP) is much lower than those in advanced countries (TSDB, 1993:108; 1995:109). Even in comparison with Taiwan's powerful trade rival, Korea, Taiwan's research intensity is lower than that of Korea. Korea's industrial structure is dominated by fewer very large companies such as Hyundai, Samsung and Goldstar. So they have more capability to put into catch-up cooperative research. This is not to say that the large firms have more advantages than SMEs[17]. But rather, the SMEs in Taiwan need a big push from outside the industry community. Therefore, for the purposes of narrowing the technology gap between Taiwan and advanced countries and remaining competitive in the global market, government should prepare to adopt a strategic, long-term approach to innovation policy.

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[15] SMEs accounted for 95% of all firms and employed about 70% of the industrial workers in 1982. If we take the manufacturing industry as an example, this contributed 36% of GDP in 1986, and nearly 50% of the manufacturing output was produced by SMEs. The value of SME exports reached 61% of total export value while 94% of export value came from the manufacturing industry as a whole (Chiu, 1992:156). The role of SMEs in Taiwan and their importance to economic development has been widely recognised and documented since the 1980s, see for examples, W. Lin (1992); N. Wang (1992); Wu & Chou (1988).

[16] For example, minimum progress in integrated circuit, DRAM, fax modem, and liquid crystal display, can improve product design and reduce production cost substantially.

[17] In the last few decades, the attitude toward SMEs has changing because of the need for efficiency and flexibility of response to the ever-changing world market. In Japan, the macroeconomic development policies of the early years favoured large industries. Korea's 'bigger is better' policy was less successful in promoting external trade than Taiwan's 'small is beautiful' philosophy. And both Japan and Korea realised that heavy industries could not be operated efficiently without the development of the domestic parts and components industries. Therefore, SME policies and programmes were introduced to counter balance a previous bias in favour of large enterprises. (W. Lin, 1992)

4. GOVERNMENT-INDUSTRY RELATIONSHIP IN TAIWAN

The increasing competition in international trade raises the question about whether there is a way to create a nation's competitiveness in industrial products through a certain type of GI relation. It is always argued that Japan's GI relations provide evidence to demonstrate a more effective IP to restructure industry and economy than others. If so, GI relations become one of elements for creating the national advantages in global competition leading to IP more effective and industry more competitive.

'Picking winners' to create the competitive advantage of industry in Taiwan's industrialisation is evident (Liu, 1993; Wade, 1991). The state is deeply involved in the investment decisions of the private sector and has intervened with subsidies or protective trade measures to create favoured conditions for the strategic industries. 'Companies compete in the new international economy, but many of them are no longer creators of disinterested market forces; they are the agents of government policies for national economic development' (Cohen & Zysman, 1990:63). It is doubted that an interventionist state can get Taiwan into 21st century without jeopardising its economic growth. The state should function more as a catalyst and facilitator of private sector development, rather than a leading actor in economic development. Institution building to complement market development, to diffuse and promote innovation throughout society, and to accelerate human capital investment, ought to supersede old interventionist measures, such as protection of domestic markets from foreign competition, operation of public enterprises, and controls on the financial system. It is presumed that the role of the Taiwanese state is characterised fundamentally as indirect, interactive, and associative in the future, which is different from an interventionist, paternalist, and authoritarian role in the past.

Recent experiences of economic development in Taiwan show that the public and private sector do not operate as adversaries. Much attention has been devoted to defining the respective roles of the two sectors and establishing practices and institutions to harmonise their interactions. However, conflicts still arise from both sides. While governments often feel that their policies and reforms aimed at developing internationally competitive industries are frustrated by a lack of private support, the private sector tends to deem those policies and reforms either as inadequate or as a disturbance of their own strategies. There is a fundamental conflict in the pursuance of goals between government and industry. While the state needs to sustain a high rate of economic growth and to improve its people's living standard, the firms hope to maximise their profit. Government tries to use private industry as an instrument for economic growth, a public goal; industries give cheerful applause to incentives and financial assistance, but they dislike those regulations imposed on their development and any notion that government should act as a director involved in their detailed operations.

Generally speaking, government adopts a long-term perspective on industrial development and wishes to expand the share of certain world markets in particular industries. In contrast the private sector focuses on short-term profits and is reluctant to invest in those sectors which returns are uncertain or highly risky in the developing countries. Taiwanese firms face more difficulties in developing a longer-term operation because of the constraint of relatively small firm size, unlike Japanese firms which can deploy a strategy, say, a plan for one decade, so as to capture future markets through the effective deployment of conglomerate resources. Thus, the new state-industrial arrangements have formed to constitute the innovative collaborations for industries to upgrade technology.

In Taiwan, policy makers, as well as academics, paid too little attention to domestic interactions between government and industries affecting the nation's industrial competitiveness, not to mention how international political economy affected such interaction the other way round.

4.1. The State and the Private Sector in Economic Growth

It is not easy to understand GI relations without a clear picture of the evolution of the balance between the public and private sector involving their interactions on the process of growth or industrialisation. Economic policies for growth, whether the economy is one of the industrialised, developing or Eastern European countries, are characterised by two main tendencies after the end of the World War II. These two tendencies are the emergence of an interventionist state on the one hand and state disengagement in favour of a liberal market system on the other, both of which have deeply influenced attitudes towards the role of the state and the private sector in the growth and development process.

The preference for the interventionist state predominated until the late 1970s or the early 1980s. During this period, the role of the state was as a builder, investor, regulator, entrepreneur and provider of welfare. In the industrialised economies, the state's role expanded greatly in terms of direct or indirect intervention through increased government spending, nationalisation, regulation and so on. The trend was even more marked in developing countries as, following independence, everything had to be constructed or reconstructed. Due to the inability of governments to redirect domestic economies back onto the path of growth in some industrialised economies and international organisations dealing with the difficult task of correcting trade, monetary and fiscal disequilibria in some developing countries, the 1980s saw a shift to more liberal policy approaches. Liberalising economic environment, privatising nationalised enterprises and reregulating economic activities were the main structural adjustment programmes. This approach implies a radically different interpretation of the respective role of the public and the private sectors.

The ongoing change in favour of the transfer of responsibility in economic development to the private sector demonstrates that the allocative efficiency of the market and the productive efficiency of private management is regarded as significant, at least, that view has taken hold.

4.2. State Theory-- a Missing Linkage with Society

A rise of state theory has been a central feature of a number of studies from all social science disciplines in the 1970s (Skocpol, 1985). In trying to answer third world development problems, however, both modernisation and dependency theories failed to explain the role the state played in the development process. The theoretical focus was not 'state-centred', but 'society-centred' in the case of modernisation theory and 'international system-centred' in the case of dependency theory (Kim, 1987). In this sense, current state theories, focusing mainly on the role of the state and public policy in the development process, do offer substantial literature and arguments to shed light on this matter (Dunleavy & O'Leary, 1987; Jessop, 1990a).

The state, defined to include executive, legislative and judicial branches of the state apparatus, and not simply 'government', has a pervasive role in most economic systems, whether capitalist or socialist. In the past two decades, we have witnessed a growing demand to 'bring the state back in' as a key explanatory variable in social analysis. Skocpol (1985) argued that there has been a paradigm switch in the 'Western social sciences' in the 1970s: from society-centred work which treated the state as a dependent variable to theories which treat it as an independent variable.

It is a general concept recognised by the statists that the role of the state, as an actor and as a force, has an independent effect in social dynamics. Moreover, 'the state, conceived as an organisation claiming control over territories and people, may formulate and pursue goals that are not simply reflective of the demands or interests of social groups, classes or society' (ibid.:9,20-1). In addition, Skocpol suggests that the overall configuration of the state 'unintentionally influences the formation of groups and the political capacities, ideas, and demands of various sectors of society' (ibid.:21).

The state has powers of autonomous action which have been ignored by most 'society-centred' theories. However, although there are arguments about their contents, all 'state-centred' theories, no matter under which classifications, emphasise different factors but all agree that the state is a force in its own right and not just a reflection of civil society. As the state theorists 'bring the state back in' to its proper central place in explaining social change and practice, it is necessary to develop a grounded understandings of the causal relations with respect to social structures and other group actors in the modern world.

The state may be viewed as a set of organisations through which bureaucracy may be able to formulate and implement IP. The state as an actor makes strategic choices according to national interest. The content and process of state strategies can be understood in terms of state system: the state strategies could have been developed within that system and/or at a distance from that system; and they could have been concerned to maintain and/or change it. In this sense the current strategic choice of the state is in part the emergence of the interaction between its past patterns of strategic choice and the strategies adopted for other actors in society.

In explaining social change and public policy, it seems that other societal actors are presented as passive in statist analysis. It is mainly because the statists one-sidedly emphasised the importance of the state as a crucial causal factor (Jessop, 1990b), to some extent ignoring the possible reactions which may arise from the private side. However, 'the state is constituted by society, and society in turn is shaped by the state (Held et al., 1983:ix)'. Thus, there are many different forms of the state and each individual state has a different mix of institutions and relations within it. In rejecting the 'state-centred' approach, 'the state system should be analysed through its compenetration and articulation with the rest of society, and neither should be privileged as an automatic starting point for explanation' (Jessop, 1990b:53).

As state power has grown in different policy realms, it reveals that different departments in charge of various affairs have also expanded, which leads to a more complex intra-governmental conflict for resources and a blurring of government as a distinctive identity. It is thus that departmentalism is reinforced and state power is fragmented among different branches and policy networks. Moreover, the state depends increasingly on the cooperation of other social forces to secure success for its interventions so that state power is increasingly interlinked with external forces (Offe, 1985). Accordingly, state autonomy over public policy is therefore disrupted by forces other than the state itself.

Furthermore, 'social-political forms of governing are forms in which public or private sectors do not act separately but in conjunctions, together, in combination, that is to say in 'co'arrangements' (Kooiman, 1993: 2). The increasing interactions, or to a strong extent, cooperations between government and industry/business in the eighties, are due to fierce international competition on trade and technological development. The need of the private and public sector to channel or even to exploit mutual interdependencies by means of cooperation is motivated by two accounts, financial-economic and managerial-strategic (cf Kouwenhoven, 1993). In the financial-economic accounts, contrary to the limited financial capacity of government and its budget deficit, the private sector shows a financial surplus. And the expectation of commercial returns and the prospects of diversifying investment risks are the main determinants to form a public-private partnership in some joint projects. In managerial-strategic accounts, to bring about a more businesslike effective and efficient functions for government and to get a better understanding of administrative operations and be able to anticipate policy making for the private sector, a mutual reappreciation by government and industry has led to a convergence on public policy. Under these conditions, public-private partnership based on 'mutual interdependencies by means of cooperation' has emerged as a new type of GI relation in the 1990s.

The state theorists stress the significant role played by the state and most of them failed to explain the respective role of industry which might be an important factor contributing to a nation's competitiveness. The potential vulnerability of the state theory is that it left unanswered what the ideal type of state-industry relations ought to be. Even when some of the theorists provide specific views on the relationship between industry/capital and the state, for example, Jessop's clientelism & parliamentarism, however, the perspective still cannot meet the theoretical requirements of this thesis. State theorists analyse the GI relationship from the angle of state system and may neglect the influence of the private sector through informal channels. It would be wrong to argue that the state is always relatively more autonomous than the private sector, in particular in the account of economic/capital issues.

4.3. Corporatism

It is necessary to discuss corporatism for two reasons. First, there should be a position for a corporatist state in Hart's triangular model given that this model is conceived similarly to corporatism by its nature. Although there is no match of nations presented as corporatist arrangements in his analysis, there is a question about the position of corporatist states, such as Austria and Sweden. The policies of a corporatist state are seen as the result of tripartite arrangements, then they will be at the central point of his model. Or, they will be in the state corner position as the undeniable corporatist characteristic of a high degree of centralisation in the process of collective bargaining. Besides, changes in competitiveness are not explained by the analysis in the literature of corporatism (Hart, 1992:33) and 'in no time period did corporatism have a significant impact on economic growth' (Crepaz, 1992:161). The intention is neither to give a concrete answer to the position of a corporatist state in Hart's model, nor to assess the international competitiveness of corporatist states, rather to examine interest intermediation in Taiwan.

The second reason concerning the description of Taiwan is based on the experience before 1990 as a corporatist state, by some writers. Wade's authoritarian corporatism in Taiwan argued that 'only those economic interest groups sanctioned by the state get access to the state', but 'the government has only weakly developed a policy network linking the central economic bureaus with the private sector, relying more on public enterprises and other public agencies' (1990:294-6). It implied that interest groups were lacking a framework for bargaining with the state on strategic issues (even though not totally impossible). Haggard & Cheng (1987:101) pointed out that the nature of corporatism is state-controlled rather than societal in Taiwan, and that the channels for corporatist arrangements do exist in Taiwan. According to Winckler (1992:41-2), incorporation is the state strategy which draws corporatist associations under state control 'to prevent anyone from organising social forces to challenge Nationalist rules' under hard authoritarian regimes. However, the functions of corporatism might change from corporatist control towards corporatist consultation which could tackle difficult social issues under 'democratic corporatism' (ibid.:42-3). Taiwan's political system is essentially corporatist in which 'group autonomy is held suspect as the party-state seeks to utilize civil groups for political mobilization and as auxiliary instruments for policy implementation' (Tien,1992:7).

The term corporatism has been used loosely and not been precisely defined in the area of theoretical applications when the historical case of Taiwan is referred to, let alone the different concerns between the above arguments. However, most corporatist explanations of Taiwan's political economy highlights the 'macro' corporatist means of state control over sanctioned organisations which is a feature of state corporatism. A distinction between state and societal corporatism was made by Schmitter (1979:20-2, 67) in which state corporatism is characterised as authoritarian and anti-liberal, and the interest groups were created by the state. According to the description of Schmitter,

> 'State corporatism tends to be associated with political systems in which territorial subunits are tightly subordinated to central bureaucratic power; elections are nonexistent or plebiscitary; party systems are dominated or monopolized by a weak single party; executive authorities are ideologically exclusive and more narrowly recruited and are such that political subcultures based on class, ethnicity, language, or regionalism are repressed (1979:22).'

This is very similar to the concept of statist political structure where civil society is brought under the leadership and guidance of the political structure. Even though Taiwan could be described as state corporatist in the past (but writers on this issue did not specify), it is highly questionable whether the theoretical application of state corporatism in Taiwan after 1990 is appropriate because democratisation might break state-corporatist arrangements. The discussion of corporatism thereafter is connected to the modern usage rather than state/authoritarian corporatism to reflect the environmental transition in Taiwan.

This will help us to understand the relationship between the Taiwanese state and societal interests and the degree of civil participation in relation to intermediary organisations.

Corporatism is one of the conventional analyses of government-industrial relations. The modern usage of corporatism stresses the role of interest organisations which are at intermediary position between the state and the society. The particular value of corporatism is in explaining a form of economic management in relation to the economy and issues of production. The definition of corporatism in this thesis follows that of Cawson,

> 'Corporatism is a specific socio-political process in which organisations representing monopolistic functional interests engage in political exchange with state agencies over public policy outputs which involves those organisations in a role which combines interest representation and policy implementation through delegated self-enforcement (Cawson, 1986:38).'

In his concept, the state is at the heart of corporatism, because 'the state is the arena in which the process of corporatist politics takes place'; and 'policy becomes a series of bargains between state agencies and organised interests' (ibid.:36 & 67). Accordingly, reciprocity of the relationship between the state and interest association in terms of the fusion of intervention, interest representation and policy implementation, can be found within a relatively closed corporatist bargaining process.

Even though corporatism is arguably in decline (Gobeyn, 1995:431), in particular, in explaining macro-political forms of bargaining, it provides some valuable insights to interpret how corporatist countries lowered inflation and solved political and economic crises in conjunction with the demands of labour in the 1970s and 1980s (Crepaz, 1992:161) and macro-political bargaining arrangements do manage, in periods of economic crisis, to restructure the productive side of the economy (Taylor, 1995). However, corporatism is a set of concepts originally developed to interpret reciprocal relationships between the state and interest organisations from the division of labour in society in the post-war European countries. According to Grant (1985:25), 'it offers the possibility of transforming the process of economic management into a non-zero-sum game, so that everyone is better off than they would be in the absence of corporatist arrangements'. In this sense corporatism might be a useful analytical tool to examine the situation in Taiwan where the polity is being transformed from an authoritarian towards a more democratic one. If the situation matches Cawson's definition, it can be said that corporatist arrangements do open more opportunities for societal participation in policy and show the willingness of the state to share its power with monopolistic functional interests; if not, then, what would it be?

Corporatist arrangements may be seen as an intermediate mechanism by which state intervention has become involved in the process of bargaining. The attributes of corporatism vary with the degree of state intervention[18]. The degree of state intervention in a state corporatist country is higher than that in a societal corporatist country; the degree of societal partnership in a state corporatist country is lower than that in a societal corporatist country. For an authoritarian regime transforming towards full democracy, which is simply defined as representing opinion through voluntary pressure groups and open election, it is presumed that the degree of state intervention in interest intermediation is decreased. In Taiwan's case, given that it is almost impossible for the state to change its nature over night, then corporatism is an appropriate mechanism by which to reduce the degree of authoritarian intervention and to promote social partnership. That is to say, statist control over intermediary organisations, to ensure the compliance of the private sector and policy implementation should move towards societal corporatist agreement to incorporate social participation in the policy process.

4.3.1. Weak labour in Taiwan

One of the reasons leading to Taiwan not having been referred to as a strong example of a societal corporatist country is the weak bargaining nature of Taiwanese labour to represent its own interests through the corporatist system. Although bipartite corporatism is possible, in particular at meso level, this should exclude the bargaining agreement between union and business associations (Cawson, 1986:76, 82).

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[18] This idea is derived from the work of Cawson (1985:225) in which he attempted to couple corporatism and state theory by using the degree of autonomy of the state as an underlying variable in the form of a continuum:
Strong state → State corporatism → Societal corporatism → Weak state. The countries with strong state autonomy (eg. France and Japan) tend to be at the left side and those with weak state autonomy (the UK and USA) on the right side.

Labour never actively played an essential role in Taiwan's politics. The activities of the unions were tightly controlled by KMT representatives through the party mechanism. Neither of the mainstream of ruling and opposition parties have paid serious attention to the labour issue. Even labour movements which occurred after political liberalisation during the late 1980s, were mild in an international perspective (unlike those of South Korea in the 1980s and Britain in the 1970s) and constrained in scope. In the 1990s, social/labour movement leaders are concerned more about the ideological issue over Taiwan's future in relation to Mainland China than the welfare of the working class. Labour has become 'quite demanding' compared with earlier times, but 'not yet developed into a mature class' because the state is not willing to grant autonomy to union organisation by legislation (Hsiao, 1992:165-6).

According to the analysis of Wang (1993:120), labour movements did not promote labour's influence over national policy but strengthened the allied relationship between the state and the capitalists to depress the collective actions of labour. As a bizarre result, labour movements, intended to strengthen their class interests through collective actions, made the working class lose some of the interests that it had (ibid.:119). An article - 'The Angers of Capitalists' (Economic Daily News: 04/01/89) jointly published by eight heavyweight capitalists, claimed that the origins of the deterioration of the domestic investment environment were 'radical' environmental and labour movements and condemned the government for its impotence in 'regulating' these social movements. Formosa Plastics, the largest manufacturing group, announced its termination of domestic investment (and went overseas), and this gained a great deal of support from the industrial sector. Subsequently, the state increased the level of its intervention in managing social movements. It could be said that the basic rights of labour have been nominally recognised, but the means to realise their rights has been strictly limited, such as strike and demonstration. The voice of an investment strike is apparently louder than that of a labour strike.

After 1989, labour movements lost influence over the political economy and the ability of labour mobilisation decreased (Wang, 1993:216). Active labour leaders attempted to gain political influence on labour policy through legislator elections, but the results were frustrated in 1990 and 1992 elections. Thus labour in Taiwan did not acquire a significant degree of political power, nor did it challenge the system of political economy. However, it did affect the state which divided labour affairs from the Ministry of the Interior, as a quasi-ministerial level organ in 1987.

Inside the state apparatus, labour authority – the Council of Labour Affairs (COLA) supervising the welfare of workers, was never a powerful government branch to influence national policy. As the statement of ex-chairman[19] of the COLA on answering why he resigned as a chair of COLA and intended to join the 1997 election of Taipei County Magistrate that is abnormal because the political level of a COLA chair, a cabinet position is deemed much higher than that of a county magistrate:

> It has to be admitted that COLA is a relatively weak organ in the Executive Yuan. Usually, the COLA-led labour policy has been rejected in the meeting of Executive Yuan by the Ministry of Economic Affairs (MOEA), the Council for Economic Planning and Development (CEPD), the Ministry of Finance, and the Directorate General of Budget, Accounting & Statistics, even sometimes by the Environmental Protection Administration, because of the conflicting situation of the departments. COLA chair's attitude should be very resolute, otherwise, the labour policy is very difficult to move. Promoting the welfare of labour as far as COLA is concerned, is very important to get the support of other ministries. If you could not obtain support, the policy would only be frustrated. But you have more space, resources and administrative discretion when you are a mayor or magistrate. The policy at local government level might be easier to promote than at central government level. (Business Weekly, 28/04/97:48)

The introduction of foreign workers also weakened the bargaining power of local labour. Not only is the pay of foreign workers low, but also they make fewer demands because if they are fired by a contracted employer, they will lose their work permits and be repatriated immediately. In 1989, foreign workers were only permitted for public construction projects. This was the first time that foreign workers were introduced into Taiwan, but they were already working in manufacturing illegally. However, the introduction of foreign workers, mainly from Thailand, the Philippines, and Malaysia, has

[19] Mr. Hsieh, Shen-Shan, a politician with blue-collared background and once head of the National Federation of Labour, has been deemed to be the heaviest weight labour spokesman. Before being invited to be COLA chair in 1994, he was a very senior legislator representing the working class in the Legislative Yuan. He got this cabinet position as a deal to give up his intention of participating in the election for vice chair of the Legislative Yuan. This might be because of his strong labour linkage the KMT preferred that he did not chair the Legislative Yuan. During the period of being COLA chair, the promotion of labour affairs has been handicapped. He failed in the 1997 election.

been extensively employed in many industries, primarily labour-intensive ones, and the quotas have been increased rapidly. In 1995, there are about 200,000 foreign workers in Taiwan and 70,000-80,000 more are awaiting approval[20] (Free China Review, Aug. 1995:39). Importing foreign workers has had a serious impact on industrial relations for local labour, in particular, for low-skilled labour who actively supported labour movements. It also indicates that COLA failed to defend the interest of local workers.

4.3.2. Peak associations and the party-state in Taiwan

State corporatism at macro level is the characteristic of authoritarian rule by KMT state in relation to peak associations. It is argued that the state corporatism at macro level, in general, is bipartite rather than tripartite, and party-led rather than state-led. The situation has not changed fundamentally, so far.

Unlike the chairs of both the General Chamber of Commerce (COC, for business), and National Federation of Industries (FOI, for manufacturing), who are selected members of the Central Standing Committee -- the most powerful organ of the KMT, the leader of National Federation of Labour (NFL) is not always admitted to this body[21]. The decision of the Central Standing Committee (held on Wednesday) directs the meeting of the Executive Yuan (held on Thursday), where state policies are made. 'Also, economic officials were not entrusted with the power to dispense economic privileges. Instead, they had to consult with the party leadership for politically sensitive economic decisions (Chu,1992:133).'

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[20] From the same source (pp38-40), a statement by Mr. H.S. Chan (Vice Chairman of COLA): 'It's especially difficult to determine how large a supply of foreign labour Taiwan needs. There is, of course, a huge demand for foreign labour because it's relatively cheap. But COLA has to protect local workers... But we worry that admitting more might delay the closure of those labour-intensive industries that have already lost competitiveness in the global market, thereby hindering our overall industrial development... But remember, we've introduced a large number of foreign workers in just the past five years. This is unprecedented in Southeast Asia - and in most places around the world.... It is amazing that we could hire so many foreign workers. Of course, it's going to have some impacts on our economy and society.'

[21] The most influential organ of the KMT is the 31-member Central Standing Committee which meets every Wednesday to deliberate and approve important policies for the government, and to nominate people for important party and government positions (1993 ROC Yearbook:135-6). Half of its members is selected by party chairman, and another half is elected between the members of Central Committee. Two leaders of capitalist organisations (FOI & COC) are always members while leader of the unions has to take part in an election and, most of the time is unsuccessful.

It is safe to say that business and industry have more influence on economic policy through corporatist measures, at least in terms of a macro environment favouring business, than labour in the KMT one party-dominated Taiwan. Nonetheless, this does not necessarily mean that FOI and COC are in a position of 'insider groups' (Grant, 1989b:20). The KMT state incorporated the leaders of national business associations into its power centre for two main reasons. Firstly, it needs the views and opinions of business circles to reflect the demands of the private sector in order to make manageable policies. They can make suggestions, not manipulations, at the meetings of Central Standing Committee since there are another 29 members from powerful party staffs to important state technocrats. Secondly, it also needs control of associations at all levels and sectors through its major party members because, politically speaking, the government shall not intervene in the operation of associations except by laws but the party can. Observing from recent leaders of FOI and COC, they were KMT party-spirited capitalists who closely matched the direction of government policy and kept good relationships with the highest level of KMT[22].

Bipartite corporatism rather than tripartite corporatism is more suitable to describe state corporatism in Taiwan. Although COC and FOI are two functional associations, which are normally integrated into one in some other countries, they both represent capitalist interests in contrast to trade union from the labour class. Thus, COC and FOI are counted as the same functionally corporatist association for capitalist interests to negotiate with the state. In respect of interest intermediation, it is still corporatist in nature, even corporatist agreement principally happens inside party mechanism rather than between associations and state agencies. Basically, corporatist consultation can be found in Taiwan, but to what extent associations can affect macroeconomic policy requires more investigation.

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22 There is no way to rule out whether the KMT gave special assistance via party mechanism to the chairs of associations when they campaigned for their leaderships in FOI and COC. The staffs interviewed in both organisations refused to answer politically sensitive questions of this kind.

However, the characteristics of government-sanctioned groups and of compulsory membership are very state-corporatist in Taiwan. The establishment of NFL, FOI and COC, and all their local counterparts, is according to respective Organisation Laws. Under the principle of 'every firm/local organisation must affiliate to an association/national counterpart' (業必歸會), the private sector has no choice but to join a related organisation[23]. This strengthened corporatist control through different level of associations. The functions of these economic organisations have been stipulated by law, the government lists the functions that organisations shall perform and those activities unlisted are prohibited. In the case of the Industrial Organisation Law, many functions of association are designed to assist the government to promote IP and none allows FOI to act as pressure group. Under this constraint, economic organisations tend to cooperate with the state rather than act against it (Interview No.4 & 12). It is argued that industrial associations in Taiwan function on behalf of the government more as a means of collecting information, propagating IP, and implementing export promotion measures, than playing a role in policy formation, and shaping industrial development strategy.

Under the structural weakness of organisations, liberal corporatism at macro level is less clear because corporatist agreement is based on legal coercion rather than on voluntary agreement. Policy formation is the area that was performed by the state apparently, and policy implementation is the area where peak organisations had to exercise some control over the behaviour of their members, and some sanctions backed up by state authority (Coleman, 1985:107). However, the administrative capacity of corporatist bodies, as well as state authority, to regulate those members who disobeyed corporatist agreement is doubted in the 1990s, for instance, on the issue of destination constraint for outward investment.

Taiwan's situation at macro level in the 1990s matches more of the characteristics of state corporatism than those of liberal corporatism. However, if the general conception of

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[23] Taking manufacturing firms as an example, whenever and wherever more than five manufacturers of the same field exist in a district, they must form a local industrial association; industrial associations of the same trade in Taiwan must jointly form a Taiwan regional association. There are 132 regional associations which come under the umbrella of FOI.

corporatism is a method of policy-making by incorporating corporatist association into the process (let alone policy implementation), then Taiwan is hardly a corporatist system.

4.3.3. Meso corporatism in the electronics industry?

Meso corporatism is much more flexible in explaining sectoral interest intermediation than the 'system-steering' concerns of macro-corporatism (Cawson, 1985:11). The interest intermediation in Taiwan's electronics sector is similar to macro corporatism in terms of labour which is excluded from corporatist arrangements. There is no such evidence in the two case studies suggesting that the special sectoral interest association affects the decision in conjunction with selecting winners at the KMT centre. Rather, consultation from international sources is much more significant than within a meso corporatist system.

However, cooperative measures in terms of policy implementation is not corporatist even though sectoral association is highly involved in the process (see chapter 5 & 6). The policy implementation between the ITRI, association and the association's members was based on contracts rather than a corporatist agreement. The association plays a very important role in relation to administrative assistance to the NPC Alliance and HDTV consortia-complexes. But it can not be seen as meso corporatism because association's involvement in the process of policy implementation is rather on administrative support than on interest intermediation and collective bargaining. Given a closer look at the firm's level, the individual firm, representing itself, had contract relations with ITRI which was not monopolised by functional association collectively. It could be argued that the meso corporatist characteristics of interest representation and policy implementation in the NPC and HDTV cases is implicit; but, in practice, contract relations underlie the cooperation between different parties, a characteristic other than meso corporatism.

Neither state corporatism, macro corporatism nor meso corporatism provide a comprehensive explanation of Taiwan's GI relationships in the 1990s. In particular, the absence of labour at every level is the major obstacle to the application of corporatist theories. The corporatist perspective does provide some useful insights in explaining some phenomena in Taiwan, in particular, state corporatism and macro corporatism. But liberal/societal corporatism has not been developed in Taiwan because of the association's structural weakness of authoritarian inheritance in which political exchange with the state is less possible; meso corporatism can not be used to interpret the situation in Taiwan's electronics sector. Although interest intermediation is a good starting point to examine the interaction between the state and interest associations, the application of corporatist theories to Taiwan will not reflect the current situation which occurred in the 1990s in relation to GI corporation for technology innovation.

4.4. Institutionalised Strategic Partnership (ISP) as an Ideal Type

None of these traditional approaches alone can fully interpret the current GI relationship in Taiwan. Statist and corporatist theories both provide insights to interpret partly the GI relationships in Taiwan. They do not pay special attention to the examination of GI relationships in the process of technology diffusion. They also neglect, how a country, by institutional arrangements, actively responds to the competitive requirements of the global economy. Thus, a new theoretical pattern of GI relationship should be developed to explain the current GI cooperation that has happened in Taiwan's electronics sector and other high-tech sectors.

The empirical findings in chapter 4-6 arrived at a suggestion that Taiwan's state-industrial arrangements can be characterised as an institutionalised strategic partnership (ISP). ISP, defined as an institutional arrangement of mixing the state-designed policy and GI cooperative policy implementation, has proved to be an effective method of promoting competitiveness. It differs from neo-statist theory, in which the state authoritatively distributes resources to the industrial sector by imposing performance criteria on them; from corporatist theory in which the outputs of policy formation and policy implementation are through corporatist exchange with the state. Neither the statist autonomous concept nor the corporatist societal partnership give a fair account in relation to technological and international factors that have influenced the changes of political economy and GI relationships substantially. In fact, under the ISP, the state assigned resources to a particular sector in the hope of stimulating more private investment and the accommodative efforts of firms; the policy-making process was hardly penetrated by the industrial sector and unions, rather by foreign advisors and international consultancies; business associations played the role of administrative assistance to project implementation instead of pressing for more benefits. The private sector is given a new meaning in the notion of ISP, unlike that defined in the developmentalist explanation which was seen to be a docile and unresisting subordinate. It is now performing as a partner with the state to act hand-in-hand on the efforts of innovation and diffusion.

It seems that the government, in this wave of technology-led structure adjustment, can accelerate and assist industrial development, especially in the situation of Taiwan where public research institutes are the major dynamic for innovation. Even though the government plays a dominant role in the technology development process, the fact that private firms share the efforts of technology development as well as risks, is also important. The industry is the end user of technology, a fact that the state can not substitute. IPs are very essential for the success of industrial development, an institutional mechanism that can effectively enforce IPs is of paramount importance, however.

ISP, seen as a form of effective GI relationship in accelerating the pace of technology diffusion by linking the public research institute and the industry, has a decisive influence on the creation of both new products and the new sector. This, in the long run, contributes to the increasingly competitive advantages of some industries. Through ISP, the flexibility of smaller firms on the production of components, the strength of large firms on product designs (in particular, HDTV complex), and the R&D capacity of ITRI are brought together. Three different stages in the process of technology development, namely, technology innovation, technology diffusion and the commercialisation of technology, are integrated into one stage by this new institutional arrangement. Thus, it has shortened the time for technology development and the time for the product to reach the market. This has led to an increase in profit and competitiveness.

An ISP identifies the essence of state-industrial arrangements in technology diffusion in the 1990s in Taiwan. It embraces three elements, as shown by the individual meanings of the words: 'institutionalised' stands for IP-driven institutionalisation; 'strategic' for selective intervention; and 'partnership' for reciprocity between the state and industry.

IP is the basic element underlying the whole picture of ISP. Two different kinds of IP constitute the institution for the effective operation of GI cooperation in relation to technology innovation and product creation. A technological IP, Special Technology Project, is the main determinant to bring about the consequence of linking the public research institute and private firms while other supporting IPs contribute to strengthen the R&D in the private sector. The evolution of the Special Technology Project and its relation to the NPC and HDTV cases will be discussed in chapters five and six (in particular, in the section 3.2. of chapter six). The general IPs supporting technology development will be explained in full in the second section of the next chapter.

The word 'strategic' denotes selective intervention of the state in technology development. State intervention concentrates on the emerging industries which are perceived and planned as the future industries for Taiwan by the government. Selective characteristics of state intervention will be disclosed in the first part of chapter four which shows a economic-biased national innovation system, and in the section 3.1.1. of chapter six which relates to the choice of HDTV as a winner. The rapid rise of high tech sectors is the result of functional and selective intervention.

The state-industrial partnership represents a reciprocal and cooperative relation in which the willingness of the state to invest in key technology and the accommodation of the industrial sector to technology development are the bases on which to consolidate ISP. Even though policy making is hardly penetrated by the industrial sector, this partnership is built upon the fact that the firms can get more benefits by joining government projects than by keeping outside the institutional arrangement. There is no coercion in this partnership, but institutional 'sweeteners'.

The conception of ISP and its three elementary characteristics will be comprehensively elaborated with supporting empirical evidence in the final chapter. It is argued that, first, ISP is the main factor leading to effective GI interaction and conducive policy implementation; second, ISP will become a viable model for the development of high-tech industries and a very common scenario for the foreseeable future.

CHAPTER FOUR

NATIONAL INNOVATION SYSTEM AND INDUSTRIAL POLICIES SUPPORTING TECHNOLOGY DEVELOPMENT IN TAIWAN

The globalization of industrial activities and the increasing number of strategic alliances between different country-originated firms seems to blur the boundaries of so-called national innovation systems. The process of innovation is characterised as transnational and global rather than national. Many big corporations are loosening their ties to their home country and starting to spread innovative activities and to 'source' from different national innovation systems. That is not to say that to study a national innovation system of supporting industrial technology development is less important. As many authors suggest, the strength of the national innovation system based on different degrees of cultural homogeneity and of political centrality is a good indicator to explain why different countries have different economic performances, see for example, Hart (1992), Nelson (1993) and Patel & Pavitt (1994). Moreover, national production systems (e.g. the supply system of Computer components in Taiwan) and geographical technological areas (e.g. the overall manufacturing ability in East Asian region in consumer electronics) have formed an industrial cluster to strengthen technological specialisation (Porter, 1990). This kind of national or geographical network in technology and production implies that marrying with a strong and big foreign firm is not the only way to conduct R&D. Innovative activities under a national framework still play an important role in directing and supporting processes of innovation and learning (Lundvall, 1992). Besides, the small size of Taiwanese firms constrains their opportunities to form strategic alliances with foreign firms, but does serve as the main motivation to create group cooperation in technological R&D.

It is increasingly assumed that innovation is a key element in national economic growth and national government should play a proper role in innovation policy. More and more attention has been devoted to understanding organisations and agencies operating at national, or even international level, and the interaction between the public and the private sector. 'The assignment of proper roles for, respectively, government and the private sector in enhancing technological capabilities should build upon a better understanding of national system of innovation (Lundvall, 1992:5).'

Innovation involves much more than R&D activities. A national innovation system does not confine its range either to innovative capability in relation to economic performance, such as the behaviour of firms at the forefront of technology, or to institutions influencing national technological capabilities. According to Nelson (1993:4), 'the concept is a set of institutions whose interactions determine the innovative performance of national firms.' The meaning of 'system' is 'a set of institutional actors that, together, plays the major role in influencing innovative performance (ibid.)', not simply the actors doing R&D. In the language of Lundvall, there are two definitions of a national innovation system in the narrow and the broad sense.

> The narrow definition would include organisations and institutions involved in searching and exploring - such as R&D departments, technological institutes and universities. The broad definition which follows from the theoretical perspective presented above includes all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring - the production system, the marketing system and the system of finance present themselves as sub-systems in which learning takes place (Lundvall, 1992:12).

National innovative capabilities are based upon a set of institutions in which R&D activities are conducted through interactions between institutional actors. Both Lundvall and Nelson agree that a definition of a national innovation system should be open and flexible. And the argument of Lundvall concerning the need to incorporate some of the most important sub-systems (production, marketing and finance sub-system) in the national innovation system is very useful to the argument of this thesis, in particular, since some strategically specific industries might form a closed sub-system.

The evidence in the empirical chapters reveals that exclusive R&D sub-systems have been formed by strategic industries and the public research institutes within a national innovation system.

The first part of this chapter will introduce the national innovation system in Taiwan which includes the trend in government participation in R&D, the administrative system governing technological development, and the functions of public and semi-public organisations related to industrial innovation. The second part emphasises industrial and technological policies and laws and regulations deployed to enhance technological capabilities. This is a basic element underlying ISP which has been operated under and facilitated by these policy measures.

1. NATIONAL INNOVATION SYSTEM

1.1. The Trend in R&D Activities

It can be observed from the process of economic development that the weight of the government in R&D has been incrementally increased along with its shift from agricultural production, to light and labour-intensive production in the 1960s and 1970s, and to capital- and knowledge-intensive production in the 1980s and 1990s. In the past, Taiwan depended on its cheap labour to explore its competitive advantage rather than on R&D. However, R&D has become the engine to expedite economic growth.

There were no so-called industrial R&D policies in the early stage of economic development. The level of industrial technology required by light and labour-intensive industries was comparatively very low and this could not motivate the state to invest in R&D. Rather, Taiwan depended on transfer of technological, marketing and managerial know-how through the investment of transnational corporations. The first three four-year economic development plans (1953-1956, 1957-1960, and 1961-1964) did not contain any industrial R&D activities. Even in the Fourth four-year economic development plan (1965-1968), the emergence of R&D activities were rather on agricultural than industrial R&D. Before the implementation of the 1965-1968 plan. Taiwan could have been called preindustrial, since the share of the agricultural sector in GDP was bigger than that of the manufacturing sector.

In 1966 (See Table 4.1), the share of both sectors in GDP was the same at the percentage of 22.5. After 1966, the manufacturing sector increased its importance rapidly and reached a peak of 47.1% share of GDP in 1986, while the agricultural sector decreased to less than 5% in 1988. In response to the increasing economic centrality of the manufacturing sector, the fifth four-year economic development plan (1969-1972) included some measures for the development of industrial R&D activities. These measures were (1) raising capital for industrial and applied science research; (2) bolstering research facilities and fostering personnel; (3) improving the utilisation of research resources; (4) encouraging R&D directed towards new production technologies and new products; (5) establishment of the Hsinchu science-based Industrial Park; (6) encouraging industry to establish specialised research and testing organisations to improve production technology and develop new products. It indicated that the government had realised the importance of technological development to the future of the industrial sector. However, the effect of these measures was limited because the technological infrastructure in Taiwan was very fragile and could not be improved in a short period of time. For example, the Hsinchu science-based Industrial Park was put into operation in 1981, a decade after the fifth plan; most of the public or semi-public industrial R&D organisations were mainly established in the 1980s. This plan could be deemed rather as a plan to strengthen the foundation of technological development than to improve technological capacities in practice. There is no evidence to show that the goals of improving production technology and developing new products were attained.

Table 4.1 Gross Domestic Product by Industry

Period	Agriculture	Manufacturing	Industry Construction	Electricity, Gas & Water	Service
1952	32.2	12.9	3.9	0.9	48.1
1955	29.1	15.6	4.8	1.0	47.7
1960	28.5	19.1	3.9	1.7	44.6
1965	23.6	22.3	4.0	2.1	46.2
1966	22.5	22.5	4.0	2.1	46.9
1967	24.6	25.0	4.2	2.0	46.4
1968	19.0	26.5	4.3	2.1	46.5
1969	15.9	29.1	4.2	2.3	47.3
1970	15.5	29.2	3.9	2.4	47.7
1971	13.1	31.5	3.9	2.3	48.0
1972	12.2	34.3	4.0	2.2	46.2
1973	12.1	36.8	4.0	1.9	44.1
1974	12.4	32.8	4.5	2.2	46.9
1975	12.7	30.9	5.3	2.6	47.4
1976	11.4	33.8	5.7	2.4	45.5
1977	10.6	34.2	6.1	2.5	45.4
1978	9.4	35.6	6.1	2.5	45.4
1979	8.6	35.9	6.2	2.3	46.1
1980	7.7	36.0	6.3	2.5	46.6
1981	7.3	35.6	5.7	3.4	47.2
1982	7.7	35.2	5.0	3.3	48.0
1983	7.3	35.9	4.6	3.7	47.7
1984	6.3	37.5	4.3	3.8	47.5
1985	5.8	37.6	4.1	4.0	47.9
1986	5.6	39.4	3.8	3.5	47.3
1987	5.3	38.9	3.9	3.4	48.0
1988	5.0	37.2	4.2	3.0	50.1
1989	4.9	34.6	4.5	2.9	52.8
1990	4.2	33.3	4.7	2.8	54.6
1991	3.8	33.3	4.7	2.7	55.1
1992	3.6	31.7	5.0	2.7	56.5
1993	3.7	30.5	5.3	2.7	57.3
1994	3.6	29.0	5.3	2.7	59.1

Source: TSDB, 1995:42. Total=100%

The subsequent six-year plan (1973-1978) had a major emphasis on industrial R&D aimed at upgrading industrial standards and improving industrial structures. The measures adopted in this plan followed those of the previous plan and continued to carry out those unfinished plan goals. By 1978, the manufacturing sector accounted for

35.6% of GDP and industrial products composed 89.2% of total export value. These figures did not mean that the level of technology had been upgraded by technology-related measures. In the 1970s, Textile, Garments and Footwear industries continued to play an important role, but some new industries increased their shares in exports to replace the declining agricultural sector. The rising industries, such as petrochemicals, iron and steel, electronic and electric goods, were characterised by relatively low technology and labour-intensiveness then[24]. At best, the 1970s could be seemed as a preparatory decade to step into the 'real' high technology era in Taiwan.

It can be argued that a well-functioning administrative framework of industrial technology was not established until the formation of the Science and Technology Advisory Group (STAG) under the Executive Yuan in 1979 and the respective counterparts under many ministries. The establishment of STAG represented a new era in that industrial technology development became a regular administrative task, rather than an addition to the national economic development plan. It denotes that technological administration increased its significance in national development, and more importantly, that government had shifted its resources from other policy areas to the development of industrial technology.

Unlike the development of industrial and applied technology, the development of basic science and technology (S&T) occurred much earlier. The earliest government office charged specifically with planning basic science research and science education was the National Long-term Science Development Council (NLSDC,國家長期發展科學委員會), which was founded in 1959. Its main functions were limited to the promotion of

[24] According to Hobday (1994b), the rising importance of the electronic and the electric industry in Taiwan was mainly due to large foreign buyers from United States and Japan. He proposed a simple market-technology model to explain how the East Asian dragons overcame the initial difficulties of market and technological entry. The foreign buyers wanted to access cheap labour through licensing agreements, subcontracting arrangements, joint ventures and OEM (original equipment manufacturing). The foreign firms not only bought finished goods for export, but they would often supply technical specification, training, and advice on production and management. Through international linkage, domestic firms learned assembly skills and basic production capabilities to produce mature products. He argued that Taiwan's technological evolution in electronics industry was firstly by assembling simple consumer electronics in the 1960s mainly from OEM, then by a more advanced technological method of ODM (own design and manufacturing) in the 1980s, finally by building competitive R&D capabilities in the 1990s.

academic research by conducting long-term scientific research, by reviewing and allocating funds for scientific research, and by deciding who should be sent abroad to continue their studies. The National Long-term Plan for Science Development (國家長期發展科學計畫綱領, 1959-1968) was aimed at magnifying the foundation of scientific development. At that time, there were very few technological programmes controlled by competent authorities. They were presented as individual programmes without relevant consultation about what they developed with other agencies. The similar research topic might be done under two different departments and this led to a waste of government resources owing to a lack of a national review body on technological programmes.

In 1967, NLSDC had been reorganised into a National Science Council (NSC). In 1969, NSC was further reorganised and became an official member of the Executive Yuan. Today, NSC is the highest government organ responsible for the development of basic science and applied research. Between 1969-1980, there was a National Twelve-year Plan for Science Development which focused not only on magnifying the foundation of scientific development but also on strengthening and promoting academic research, and on fostering technical R&D to cope with the needs of national development.

The task of promoting technological development was launched in 1959 in the era of NLSDC, but the overall policy, to plan and promote national S&T development, started at the First National S&T Conference in 1978 (ROC 1994 S&T Yearbook, 1995:11). The National S&T Conference, organised by NSC, became a regular conference held at a four to five year interval in 1982, 1986, 1991 and 1996. The participants included scientists, engineers, business leaders and government administrators, and those who deliberated on the direction and strategies of S&T development.

Table 4.2 National S&T Conferences and Plans, 1978-96

	Policy	Goals	Focal Technology
1978	Program for S&T development, 1979	-Promote economic development -Raise the quality of life of the people -Establish self-sufficient defence capability	-Energy -Material -Information -Automation
1982	Program for S&T development, 1982 revised. Coordinated with 1982-85 4-year economic development plan	-Promote economic development -Raise the quality of life of the people -Establish self-sufficient defence capability	Aiding another four -Bio-tech -Food tech -Hepatitis control -Electro-optics
1986	Ten-year long-term plan for national S&T development, 1986-1995	-Raise the level of S&T -Promote economic development through industrial R&D -Raise the quality of life of the people -Establish self-sufficient defence capability	Aiding another four -Oceanography -Synchrotron radiation -Green tech -Disease & disaster prevention
1991	Extend 10-year plan to 12-year long-term plan, 1991-2002. A new 6-year mid-term S&T plan which integrated into 6-year National Development Plan	-Develop industrial tech -Improve scientific R&D environment -Raise basic research standards -Coordinate overall S&T development -Integrate technology into society	10 'star' industries selected by CEPD: telecommunication, information, semiconductors, aerospace, advanced materials, consumer-electronics, specilaty chemicals & pharmaceutical products, medical & health care, pollution control, automation & precision machinery.
1996	Continuing and amended 1991-2002 Plan	-The strategic planning and efficient employment of technological resources -The establishment of high-tech innovation system -Technology-driven state modernisation	10 emerging industries

Source: ROC Yearbook, 1993 CH20. ROC S&T Yearbook, 1994 CH1. NSC, 1993; Sep. 1996.

Table 4.2 shows government efforts on the planning and promotion of the overall S&T development through national S&T conferences and various programmes. The S&T Development Programmes, followed the conclusions of National S&T Conference and the suggestions of STAG, provided the guidelines for national development. These programmes became the legal base of the government in establishing technological agencies in various administrative branches, in setting up more than twenty five new laboratories and R&D institutions in different fields, and in ratifying laws and regulations in relation to technological development. The infrastructure of technological development has been improved gradually by resource inputs of manpower and budget which eventually contributed the strength of overall national technological capability.

The distinctive role of the government in creating a 'dynamic technological environment', in which technological administration is well-established at different levels of government; laws and regulations governing technological development are updated to the changing needs of the private sector, and research institutes are established to cope with the timely necessity of industrial upgrading, can be identified in Taiwan after 1980 (Table 4.3). The successful implementation of the S&T Development Program made certain both the maintenance and the renewal of the learning process inside the public sector. This implies that resources inside the public sector must be channelled continuously to S&T.

Table 4.3 ROC S&T Chronology since 1978

Year	Main Events	Agencies Established & Law	R&D Institutes Established
1978	● First National S&T Conference		
1979	● S&T Development Program	● STAG ● Office of S&T Advisors (Ministry of National Defence) ● Office of S&T Advisors (Ministry of Education) ● Institute for Information Industry	
1980	● First STAG Board Meeting (once a year)	● Office of S&T Advisors (MOEA) ● SIP	
1981	● First 5-year Plan (Academia Sinica)		● Institute of Bio-medical Science (Academia Sinica) ● Electronic Research & Service Organisation (ITRI) ● Institute of Harbour & Marine Tech
1982	● Second National S&T Conference ● S&T Development Program (revised)	● NSC Reorganised	● Institute of Atomic & Molecular Science (Academia Sinica) ● Institute of Molecular Biology (Academia Sinica) ● Materials Research Lab. (ITRI) ● Mechanical Industry Research Lab. (ITRI)

1983	• Technical Manpower Cultivation & Recruiting Program	• Regulations for Encouraging the Development of New Industrial Products by Private Enterprises	• Institute of Aeronautics & Aerospace (NCKU) • Institute of Applied Mechanics (NTU) • Micro-Electronics & Information S&T Research Center (NCTU)
1984	• Defence S&T Development Program		• Development Center for Biology
1985			• Materials Science Center (NTHU) • Synchrotron Radiation Research Center • Center for Measurement Standards (ITRI)
1986	• Second 5-year Plan (Academia Sinica) • 10-year S&T Development Program (1986-1995) • Third National S&T Conference		
1987		• Office of S&T Advisors (Ministry of Transportation & Communication) • Environmental Protection Administration	
1988	• 4-year S&T Mid-term Plan		• Sub-Micron Device Research Lab. (NSC) • National Lab. Animal Research Center (NSC) • National Center for Earthquake Engineering Research (NSC) • National Plant Genetic Resources Center
1990		• Statute for Upgrading Industries	• The Preparatory Office of National Space Lab. (NSC) • National Super Computer Center (NSC) • Electro-Optic Research Lab. (ITRI) • CCL (ITRI)
1991	• 4th National S&T Conference	• Program for the Development of Critical Components and Products • TLP • Space Program Office	• Wafer Design and Manufacture Center
1992	• 12-year Long-term S&T Development Program • 6-year Medium S&T Development Program		• National Institute of Health
1993		• Office of S&T Advisors reorganised into DIT (MOEA)	

1994		• Development Fund for Military and Civilian Common Technology	
1995		• Statute for Upgrading Industries (amended)	
1996	• 5th National S&T Conference		• Humanities and Social Science Research Center
1997		• Civilian STP • The Bill for S&T Basic Law	

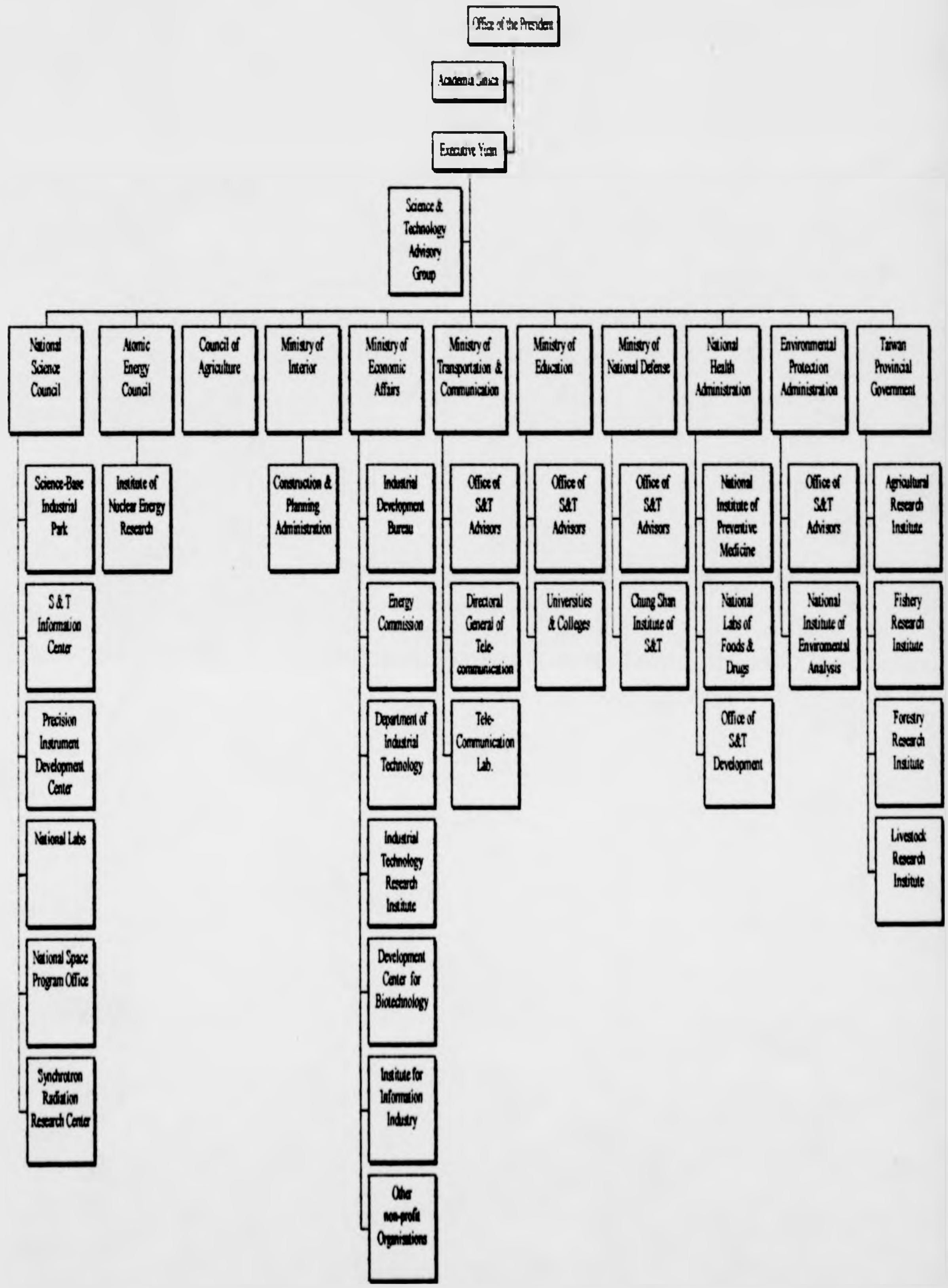
The government recognised that high-tech and high-value-added manufacturing industry would be the backbone of Taiwan's growth-oriented export trade as well as a driving force for future economic breakthroughs. Many efforts have been made to emphasise and to promote manufacturing prowess and to ride with the tide of progress in technology. The government is expecting, through the strategy of picking up winners to create new 'cash cow' sectors that can transform 'industrial Taiwan' with a sound infrastructure of manufacturing industry into a 'S&T island'.

1.2. Taiwan S&T Development Framework

Figure 4.4 shows the national framework of S&T development. There are many government agencies involved in S&T development. Not all agencies are directly deploying resources aimed at industrial upgrading, but this does affect the progress in improving a sound S&T infrastructure for future development. Taiwan's overall technology development proceeds in accordance with the guidelines of the S&T Development Program carried out through a division of responsibilities.

These agencies and their subordinate organisations constitute the national web for technological development. Each ministry has its own unit responsible for promoting R&D and an office of advisors. Among them the Ministry of Economic Affairs (MOEA) is the authority responsible for the advancement of industry-related technology and in a relatively important position in the national innovation system. The following analysis will show the significance of the MOEA and the preference of industrial technology in Taiwan's national innovation system.

Figure 4.4 The S&T Development Framework of Taiwanese Government



1.2.1. *Academia Sinica*

The Academia Sinica, the highest academic research institution in Taiwan, is under the supervision of the President and responsible for scientific research and the guidance, coordination, and encouragement of academic research. It aims at promoting the level of basic and natural science, rather than those of economic-related and strategy-considered applied research. There is no direct connection between the basic science work of Academia Sinica and the innovative and commercial nature of industrial research. The expenditure of Academia Sinica was substantially less than that of MOEA, which accounted for industrial R&D expenditure alone. In comparing the R&D budget of Academia Sinica and of MOEA, the former's budget was only 36.8%, 29.0%, 25.7% and 21.5% of the latter's in 1985, 1990, 1995 and 1997 respectively; the former has its budget enlarged at 3.4 times and the latter nearly 6 times in 1985-97 (Table 4.5). This not only implicitly reflects the consequence of increasing international competition and the national fear of losing competitive advantages, but also explicitly implies that the government has shifted more resources to industrial R&D than to basic scientific research.

1.2.2. *National Science Council (NSC) and Science and Technology Advisory Group (STAG)*

NSC serves as the Executive Branch's agency specifically responsible for S&T. Its principal duties are the planning and promotion of the overall development of S&T in the entire nation and assisting academic research and developing Science-based Industrial Parks[25]. The organisational goal is to assist the nation in its modernisation and development through raising the level of S&T.

STAG is an intra-Executive Yuan office whose task is to hasten the

[25]It is rather unusual for NSC to operate a science-based industrial park since it is a science administrative organisation aimed at promoting academic research. But it is politically and economically desirable because science-based industrial park is the base for high-tech manufacturing in Taiwan.

implementation of the 1979 S&T Development Program. STAG is made up of two main bodies to tackle different missions: a body of advisors constituted by twelve internationally outstanding foreign and two Chinese advisors to provide recommendations for S&T policy-making, taking a global view, to provide recommendations to promote the R&D activity of the private sector and to enhance the across-the board effects, and to assess national S&T development projects; and a body of the STAG office to coordinate R&D of applied technology through the integration of industries and research institutes at the inter-ministerial level, to review budgets on national S&T development projects, and to conduct other matters concerning S&T assigned by the Premier.

Table 4.5 ROC Government S&T Expenditures, 1985-97

Unit: NT$ thousand

Year	*Academia Sinica	Ministry of National Defence	Ministry of Economic Affairs	National Science Council	Atomic Energy Council	Others	Total
1985	1,114,934	8,930,387	3,027,650	2,862,292	1,517,289	78,106	13,954,661
1986	1,172,834	12,667,400	4,087,592 (35.0)	3,654,843	1,572,170	364,007	22,518,846 (61.3)
1987	1,041,179	13,078,870	4,504,700 (10.2)	3,550,477	1,616,295	444,034	24,235,555 (7.6)
1988	1,269,933	13,085,250	5,128,835 (13.8)	4,735,362	1,649,272	657,471	26,526,123 (9.4)
1989	1,435,704	16,952,350	5,472,674 (6.7)	4,713,381	1,600,453	2,095,612	32,270,174 (21.6)
1990	2,223,788	18,157,630	7,659,593 (39.9)	6,623,998	1,651,696	2,912,874	39,229,579 (21.5)
1991	2,605,127	18,215,260	9,294,582 (21.3)	8,585,310	1,796,154	3,742,798	44,239,231 (12.7)
1992	2,864,935	11,913,850	12,623,360 (35.8)	9,652,949	2,125,176	3,668,044	42,848,314 (-3.2)
1993	2,910,533	9,248,090	13,042,004 (3.3)	11,632,919	2,211,004	2,887,447	41,931,997 (-2.2)
1994	2,995,799	7,962,340	12,899,178 (-2.1)	11,725,813	2,231,487	3,130,746	40,945,363 (-2.4)
1995	3,306,022	7,083,093	12,843,873 (-0.4)	12,287,926	2,319,544	2,745,860	40,586,318 (-0.9)
1996	3,762,222	7,897,652	16,915,358 (31.7)	13,595,766	2,728,842	2,919,575	45,191,797 (11.3)
1997	3,830,001	7,600,356	17,819,563 (5.3)	13,807,025	2,422,994	4,316,339	49,796,305 (10.1)

Source: STAG

* Academia Sinica is not a branch of central government

( ) = Annual growth rate, %

It seems that the administrative coverage of STAG overlaps the functions of NSC.

But it does not in three aspects. First, the STAG responds directly to the premier and has support from the highest authority. It has the privilege of reviewing the proposed budgets of departments and of deciding the distribution of resources to avoid overlapping projects before these are ratified by the Legislative Yuan owing to its upper ministerial position. It has to be noted that STAG serves as the Executive's assistant office in S&T matters whose main function is coordinating inter- and intra-departmental affairs, rather than implementing policy directly. NSC and relevant departments are the respective agencies for implementing the projects and policies of their concerns. Besides, 'if necessary, STAG will make macro-adjustment on S&T budgets between ministries' (Interview No. 29).

Second, STAG itself is a mission-oriented organisation affiliated to the Secretary-general Office of the Executive Yuan in terms of budget and employee under 'the guideline for the STAG of the Executive Yuan (行政院科技顧問組辦事要點)', not an individual organisation settled by national organisational law. This does not affect its responsibility for supra-agency affairs, but it does affect its administrative capacity in terms of efficient manpower[26]. The STAG, as a main macro-controlled monitor on S&T affairs, is to concert efforts of ministries under the guidelines of 1979 S&T Development Program, while the NSC, as an implementation ministry, is to promote national S&T development and support academic research.

Third, the NSC has been given the duty of approving, controlling, and evaluating all essential government-funded S&T projects so as to improve promotional efforts for S&T development carried out by each government agency and to strengthen their coordination. That is not to say that other ministry's projects are at the mercy of the NSC. If the NSC, at the same hierarchical level as another ministry, tries to disapprove of the other's plan, inter-departmental conflicts may arise. In fact, the S&T

[26] In response to the small staff team, there are some mission-oriented ad hoc Committees, also known as Technical Review Boards made up of advisors and experts from related industries and institutes, to plan and promote specific strategies on the development of high-tech industries. This makes many temporary functioning projects viable without expanding STAG itself, for example, many industry-specific review boards and conferences, and some nation-wide plans, such as government office-automation and National Information Infrastructure.

Development Program has precisely assigned different tasks to related agencies. The Executive Yuan formulates policy and directs other ministries to plan and implement (Science and Technology Development Program, 1982:3). The NSC is there to communicate and coordinate research plans so as to avoid overlap and to ensure efficient deployment of resources.

Even though the NSC is the competent authority in charge of national S&T development, its weight in the national innovation system is no more important than that of MOEA in terms of its annual budget to develop technology. The NSC has increased its S&T budget by 4.8 times, from NT$2,862 million in 1987 to NT$13,807 million in 1997, while MOEA budget has increased 5.9 times, from NT$3,027 million to NT$17,819 million in the same period (Table 4.5). The MOEA's technological expenditure is comparatively higher than the NSC's in every single year. In 1997 alone, the S&T expenditure of central government distributed 45.61% to the MOEA and 35.55% to the NSC[27].

Moreover, the disbursement of NSC inclined towards technological development rather than basic research. Among the total proposed budget (NT$16,919 million) of NSC in 1997, basic research shared 30.1% (NT$5,100 million), applied research 13.2% (NT$2,226 million), technological development 24.9% (NT$4,219 million), and technological assistance 31.8% (NT$5,373 million). Under the category of technological assistance, the NSC offers financial support in applying for patents, copyrights, or other intellectual property rights for any relevant research results. It also assists in carrying out any transfers of technology to industry. More importantly, if the potential exists for new technologies or new products but the investment risk is too great, the NSC will commission research institutes or private industry to continue the project under the innovative technology development program. This demonstrates that

[27] The research expenditure of the Ministry of National Defence and Academia Sinica are excluded from central government expenditure on S&T development, the former has been counted as Defence expenditure and the latter's expenditure comes from the President Hall. The figures in 1997 are based on NSC's 1997 plan. The NSC 1997 budget proposal has been cut from NT$16,919 million down to NT$13,807 million by the Legislature Yuan.

there is a substantial proportion of NSC money spent on non-basic research.

1.2.3. The Ministry of National Defence (MOND) and the Chung-Shan Institute of Science and Technology (CIS)

MOND is responsible for the development of military technology. It was the largest recipient of the R&D budget at the time when Taiwan could not get necessary weapons from the advanced countries, in particular, the US government, due to its ambiguous political identity in world politics. Thus, Taiwan had to develop its own weapons, such as Skybow missile and Indigenous Defence Fighter (IDF), to replace obsolete ones. Before 1992 when Taiwan finally made agreements for sales on F-16 and Mirage 2000 fighters with both US and French government[28], the military R&D body, CIS, had received a larger budget more than those of MOEA, NSC and Academia Sinica put together. After Taiwan was able to purchase F-16, Mirage 2000, and other desired arms, many of the R&D projects developing at CIS ceased or diminished their scope, for instance, the Taiwan-made IDF aircraft reduced its proposed production from 300 to 120[29].

The expenditure for military R&D reached its peak at NT$18.2 billion in 1991, was halved at NT$9.2 billion in 1993 and dropped nearly 60% to NT$7.6 billion in 1997. Meanwhile, the R&D expenditure of MOEA increased steadily. MOEA's

[28] The 1979 Taiwan Relations Act, a replacement of previous US-ROC Mutual Defence Treaty after Washington built its diplomatic relationship with Peking, was not only intended to reassure the Taiwanese and deter China from any attempt to use force against Taiwan, but also to provide Taiwan with arms of a defensive character. The 1982 US-China Joint Communique constrained the US arms sales to Taiwan in qualitative and quantitative terms and intended gradually to reduce its sales of arms to Taiwan. This reflected the US view of China as a strategic partner and balanced the threat of the former Soviet Union in the 1980s. Arms sales declined from around US$830 million in 1979 to around US$670 million in 1990 gradually (Klintworth, 1995:66). In 1992, the Bush Administration in its final stage at White House agreed to sell 150 F-16 fighter aircraft and related parts and weapons to Taiwan in a deal worth US$5.8 billion based on reasons to redress balance in Taiwan straits (China got sophisticated Su-27 from Russia) and that China never gives up the idea of reunification by using force. In fact, the US changed its attitude to selling F-16 to Taiwan only after Taiwan had signed a procurement agreement on 150 Mirage 2000-5 aircraft and warships with France. The US feared that it might lose this big business to France and announced that it had lifted the ban on selling F-16 to Taiwan. Taiwan soon announced that it would sign a contract with US and reduce the procurement number of Mirage 2000-5 down to only 60 on the grounds that Taiwan's Air Force was used to US aircraft and logistic systems. This shows that Taiwan leans heavily on the US and can't afford to lose this 'big brother'.

[29] Taiwan wanted to buy US advanced fighter jets and missiles since 1979, but the US government didn't approve those deals until 1992. Therefore, Taiwan has no other choice but to develop its own IDF and missile in the 1980s. That's why the MOND had the largest expenditure on S&T. Once more advanced weapons could be imported from foreign countries, there is no need to support so much military R&D.

expenditure was only one third of MOND's in 1980s and it was half in 1991. It has dramatically exceeded MOND's since 1992, and is about 2.3 times of MOND's in 1997. It shows a substantial shift of R&D resources from the field of defence to that of industry in the 1990s. Taiwan could not have reached its current level of technological capacity if it had continued spending R&D resources on arms, not on industrial R&D.

The use of the manpower and facilities of the CIS to assist the development of industrial technology is an ongoing effort of government. Its aim is to accelerate the pace of industrial upgrading and to transform the functions of CIS. Since the budget of CIS has been reduced to a large extent, its primary task will be to find ways of maintaining its operations in order to avoid the waste of hard-won researchers and heavy investment in facilities[30].

CIS is open to public access instead of being a closed military research institute. Four special research parks affiliated to the CIS (see Table 4.15) designed by the government in 1995 under a plan to develop military and civilian common technology and to accept research projects on new technology and new products from private enterprise and government agencies. The MOEA entrusted the CIS with special technology projects amounting to NT$800 million in 1995, and it is estimated that there will be a further NT$6 billion from MOEA's special technology projects up to the year 2000. Besides, CIS is also entrusted with research projects from private enterprise and its research outcomes are transferable to the respective enterprises. An Industrial Cooperation Group of the CIS serves as a means of exchanging the views of the CIS and the entrepreneurial insights of industries so as to prevent overlapping investment and keep the CIS up-to-date on current economic trends and needs.

The MOEA, in association with the CIS, is engaged in promoting investment and

[30] National defence industries were hardly developed in Taiwan before 1979 because the national defence and the military-hardware needs were primarily supplied by the US. The CIS was established in 1968. It employs over 6,300 scientists and more than 8,500 technicians and has four research departments, six R&D production centres, and planning task force for specific projects such as Skybow missile and IDF. The capacity of CIS is much stronger than that of the ITRI in a single term of the number of employees (about 14:6).

establishing spin-off companies so as to accelerate the development of related industry by selecting related technologies and researchers from the CIS and the private sector. The Aero Industry Development Center of the CIS was reorganised into Taiwan Aerospace Co., a subordinate of MOEA, in July 1997.

1.2.4. MOEA -- DIT, IDB, and ITRI

The Department of Industrial Technology (DIT) was reorganised from MOEA's Office of S&T advisors in 1993. It is an internal department of MOEA dealing with the task of promoting industrial technology through the enforcement of 'MOEA's special project for the research and development of industrial technology' (經濟部產業科技發展專案計畫; thereafter special technology project--STP 科技專案). STP is a government-funded effort on industrial technology R&D with a special focus on the field of a high technical level, confined as applied research development, key technology development and key component development. STP started in 1977 as a national effort to promote industrial technology, but has been greatly increased its weight and budget since late 1980s. To hasten industrial upgrading, the government has targeted ten emerging industries, eight key technologies and sixty-nine key parts and products in the 1990s.

MOEA hopes to promote industrial technical development and strengthen industrial competitiveness which would eventually contribute to assist stable economic growth and to advance living quality. The characters of STP on developing specific techniques and products are based on market niches, technology-intensiveness, practical technology, or generic and experimental technology. As the budget of STP is from MOEA, the aims of these projects are expected to improve the economic performance of the industrial sector. Therefore, STPs are highly product-oriented and market-oriented.

Table 4.6 MOEA's Special Technology Projects -- Inputs, 1991-96

	Budget [NT$ Billion]	Project [Number]	Manpower [Person]
1991	79.5	48	3741
1992	108.4 (36.3)	56	4104 (9.7)
1993	113.6 (4.8)	58	4310 (5.0)
1994	108.1 (-4.9)	63	4549 (5.5)
1995	116.5 (7.8)	71	4751 (4.4)
1996	131.2 (12.6)	76	5169 (8.8)

Source: DIT, 1996c: 14 & 15. ()= Annual growth rate, %.

Table 4.7 1993 STP Expenditure Allocation by Project Classification

	NT $ thousand	Percentage
Electronics & Information	5,127,621	45.14
Machineries & Automation	1,818,335	16.01
Materials & Process	915,579	8.06
Food & Medicine	1,011,762	8.91
Environment & Resources	505,096	4.45
General	1,979,858	17.43
Total	11,358,251	100.00

Source: DIT, 1993: Figure 4.

Table 4.8 1995 STP Expenditure Allocation and Manpower Input by Institute

	NT $ million	Percentage	Manpower
DIT	197.5	1.70	84
ITRI	7410.3	63.63	2980
CIS	1019.2	8.75	413
China Textile Institute	298.1	2.56	119
Development Center for Biotechnology	631.4	5.42	260
Automotive Research Testing Center	228.2	1.96	66
Metal Industries Development Center	529.1	4.54	170
Food Industry R&D Institute	311.5	2.67	116
Institute for Information Industry	818.5	7.03	429
Others	202.7	1.74	114
Total	11,646.5	100.00	4751

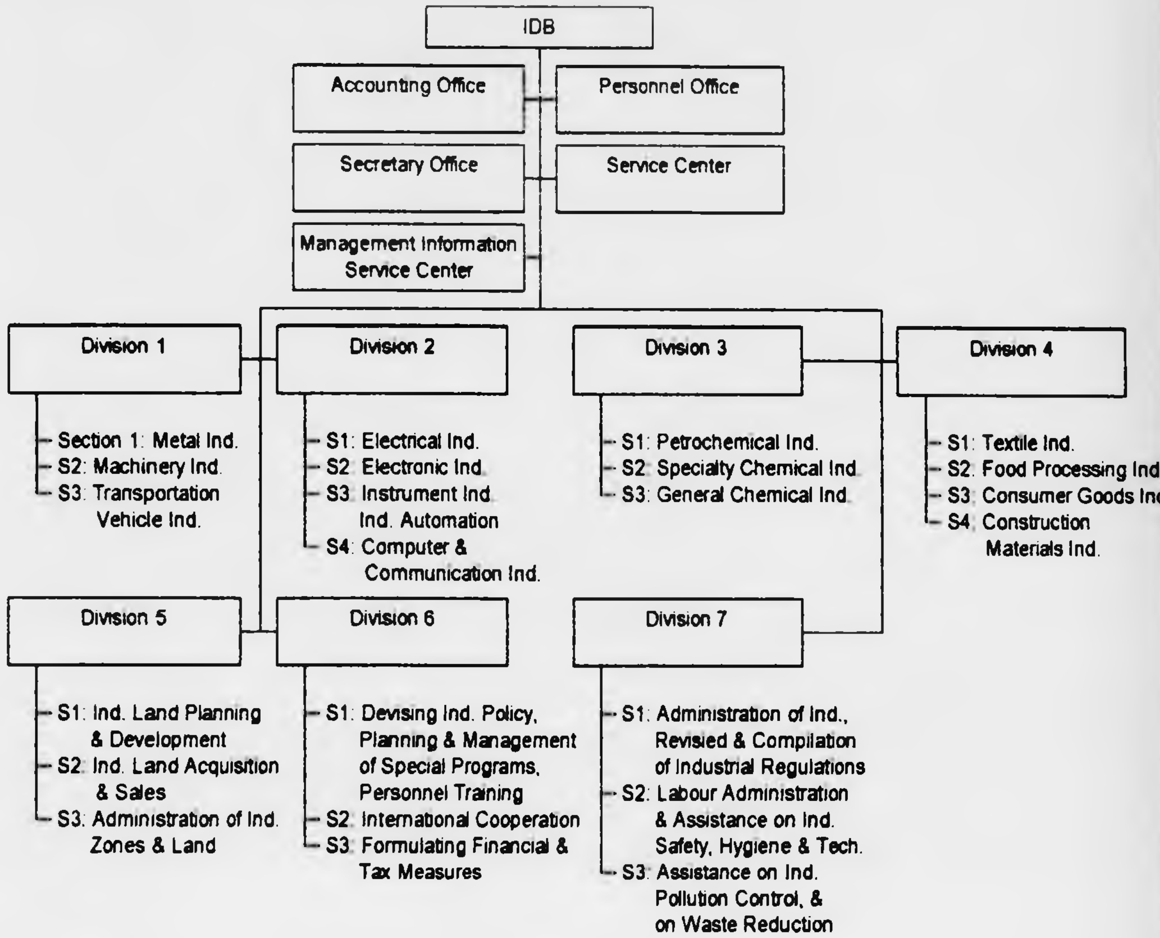
Source: DIT, 1996c:40.

In 1990s, STPs are characterised as increasing resources inputs, heavy investment on electronics-related technologies, with ITRI as the largest STP recipient. Table 4.6 shows a major growth of STP resources in terms of budget, project, and manpower between 1991-96. In 1993, electronics and information industry shared 45% of total STP expenditure due to their economic centrality in exports (Table 4.7). ITRI, the biggest public research institute for industrial technology with the most of its internal research organs connected to emerging industries, had been entrusted with 63.63% of total STP budget in 1995 amongst more than ten MOEA's research affiliates (Table 4.8). It reveals that STPs are for 'winners'.

DIT itself is not a research organisation, which is responsible for formatting industrial technology policy and for planning STPs. The industrial technology policy is in accordance with the IP from the IDB (Interview No.6). This is to say, IDB decides the developmental strategy of a specific industry, while the DIT's STP concentrates on the technological development of the future needs of a specific industry.

The IDB was established in February, 1970, as the most important agency in charge of industrial affairs. The formation and implementation of IPs are the main functions of IDB. In a nominal sense, IDB followed CEPD's (Council for Economic Planning and Development) guideline for the initiation of detailed sectoral and general IPs, and its proposed IPs have to be evaluated by CEPD. CEPD is an advisory body to the Executive Yuan without administrative authority of its own, whose major work consists of reviewing economy-related policy proposals or investigating policy issues generated in other ministries or in the Executive itself. IPs suggested by CEPD are readily approved by the Executive because most CEPD councillors are cabinet members. However, in a realistic term IP is formatted by IDB technocrats, those who have direct contact with industrial sectors. Hence, IDB technocrats have a better understanding of the problems faced by a specific industry in IP formation than if the IP is designed by politicians or the CEPD staffs, who lack the contact experience with individual firms or industries. Close linkage between IDB technocrats and the industrial sector reduces the problem of poor quality information required in IP-making and contributes to the effectiveness of IP implementation. This explains the outstanding performance of Taiwan's IP compared with those of other developing countries.

Chart 4.9 IDB Organisational Chart



All sectoral detailed IPs and problem-solving IPs are formulated within IDB's functional divisions directly. The organisational chart (4.9) of IDB demonstrates the different divisions that are in control of distinct industrial tasks. Division 1-4 undertake the administration of specific industries and their relatively sectoral IPs, while Division 5-7 tackle general IPs in relation to industrial development. Three internal offices maintain the management of logistical matters. The Information Service Center provides all information in relation to industrial affairs including regulations, standards, incentives, measures and funds; Service Center accepts all applications for assistance, incentives, advice, loans and funds.

IDB has a strong administrative capacity to put policies into action. The coverage of its functions varies from trade protection to financial incentives. Its capacity, generally speaking, includes setting up lists of tariffs and imports control, to issue import licences, to encourage domestic purchasing agreements, to operate the duty draw-back schemes, to approve applications for loans from various special loan scheme and for loan guarantees, to list those firms qualifying for fiscal incentives, to target industries for R&D support, and most importantly, to identify industries and firms to be targeted (Liu, 1993:Chapter 3 & 5). It also helps to establish orderly export marketing agreements in industries and overseas price negotiations in sensitive sectors like petrochemicals (Wade, 1990:202).

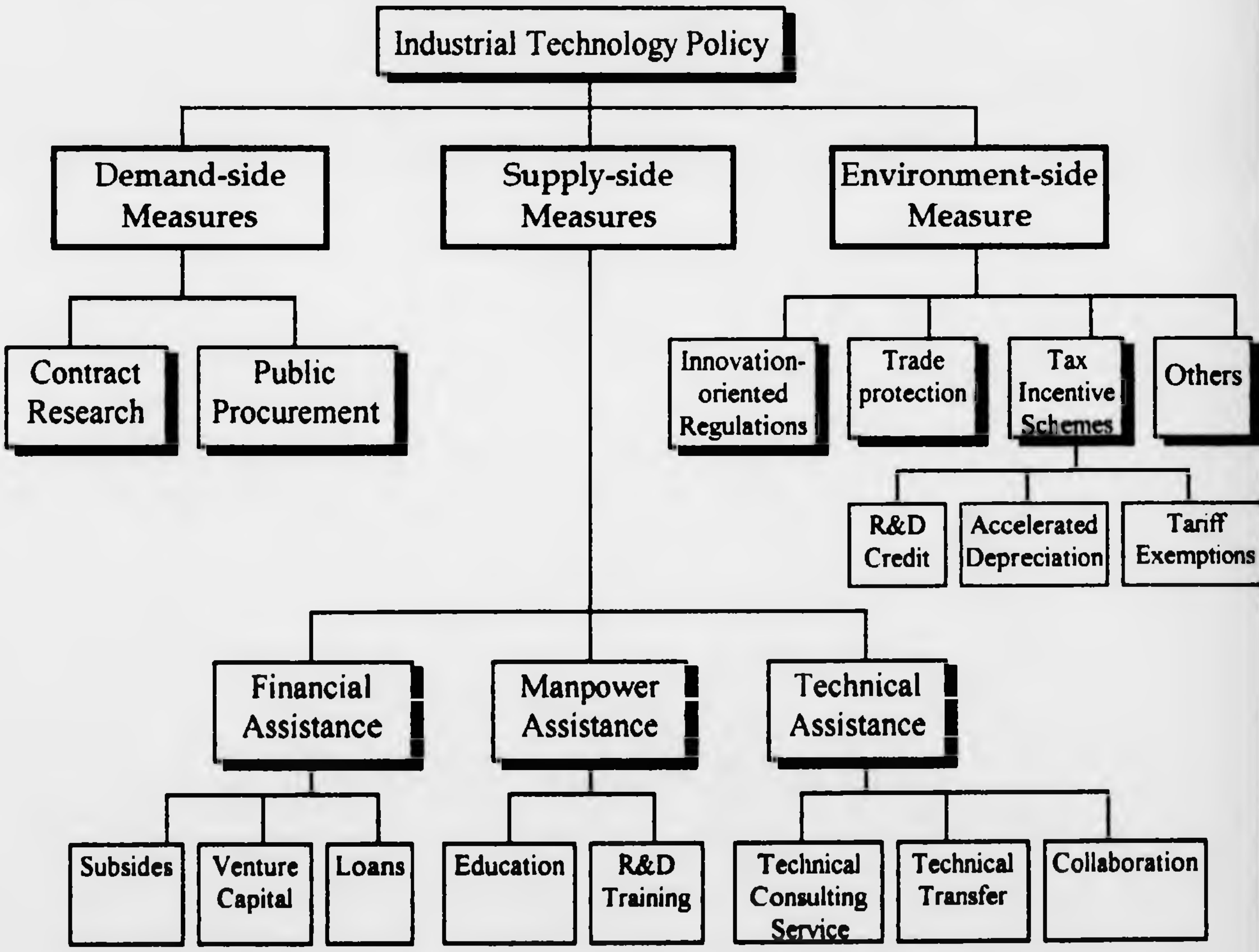
The organisational advantages of IDB can be understood from two perspectives. First, IDB has the responsibility for trade policy and the authority to redistribute financial incentives. This gives IDB more power than it would have if trade policy and the authority for giving financial incentives were the duties of other agencies. Basically, the Board of Foreign Trade is an administrative department, which cannot initiate any trade policy by itself, in particular, the measures of trade protection, but it has to follow instructions from IDB on industry-related matters. Besides, IDB, as the competent authority on the operation of funds and the distribution of financial incentives, led it to shift resources between sectors with less inter-departmental friction in the process of IP implementation and planning. IDB's strengthened functions covering the field of trade and finance, which are generally divided horizontally within the same hierarchy, makes for a better integration of various functioning policies into IP.

Second, IDB plays the roles of policy-initiator, policy-maker and policy-implementor which are different functions normally performed by vertical divisions within the same hierarchy. In the theory of public policy, the actors which decide on policy are generally different from those who are responsible for policy implementation. IDB is an exceptional case of one body playing three independent roles. Therefore, the coherence of industrial policy in the different stages of the policy process can be moderated (policy itself, policy outcome and planned schedule) by IDB entirely. Under these circumstances of converging vertical and horizontal functions, the organisational advantages of IDB serve as the principal impetus in supporting Taiwan's continuing industrial development.

2. STATE POLICIES SUPPORTING INDUSTRIAL TECHNOLOGY DEVELOPMENT

'Industrial technology policy is essentially a fusion of technology policy and industrial policy implemented by a government in order to assist, instigate, direct, or even restrain industrial technology activities (Wang & Tsai, 1995:69).' It aims at achieving the nation's short-term and long-term economic goals through the encouragement of R&D investment in a set of promotion measures and the creation of an environment conducive to innovation.

Figure 4.10 Taiwan's Industrial Technology Promotion Instruments

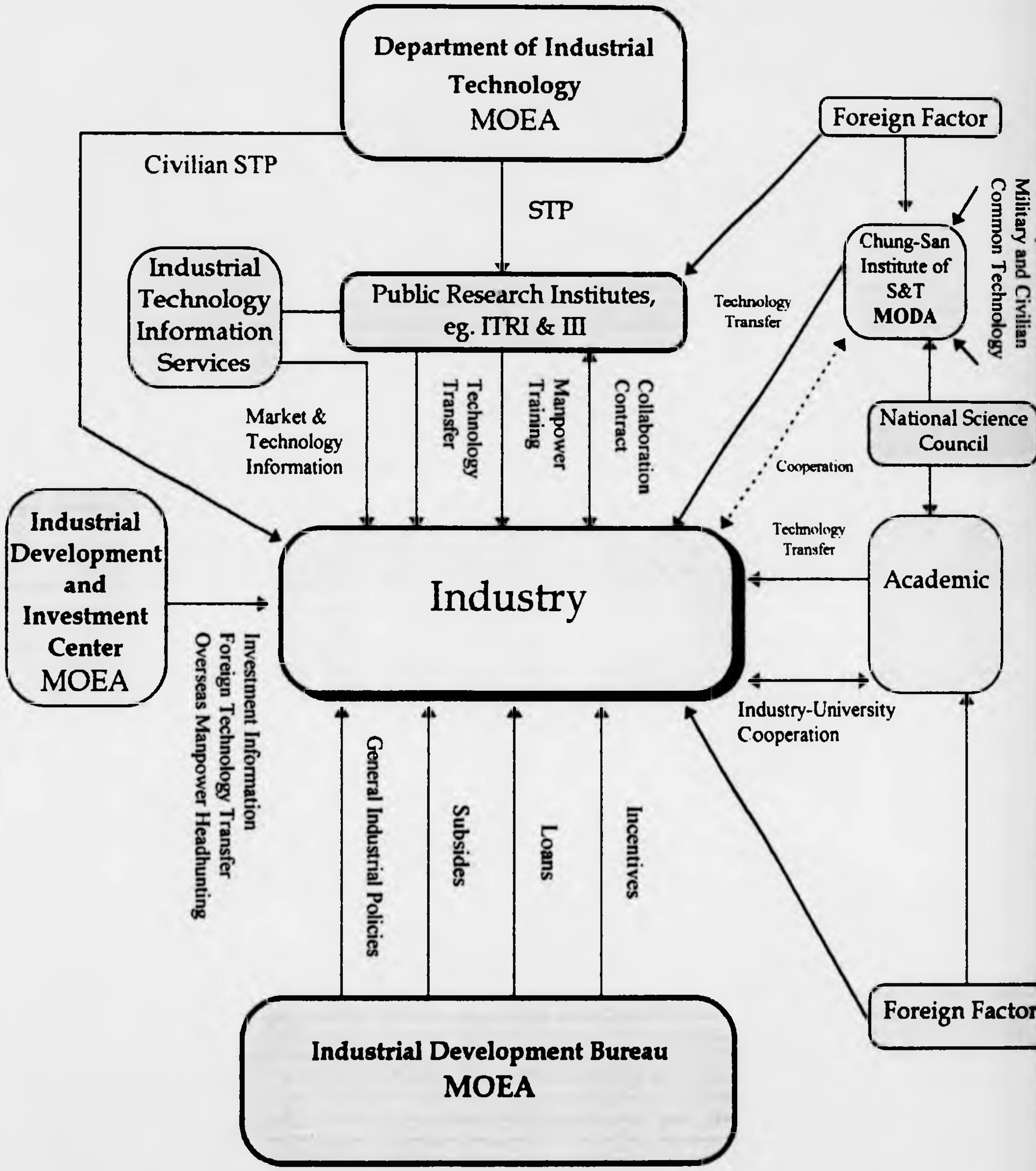


IDB and DIT are two government branches charged with industrial technology policy. The main tasks of IDB are in sectoral IP, general IP for encouraging investment and the policy concerning the innovative activities, while the DIT concentrates on the planning and the implementation of technology IP presented as STP.

Figure 4.10 gives an overview of Taiwan's industrial technology promotion system in which industrial technology policy is divided into three different kinds of measures, namely, the demand-side, the supply-side, and the environment-side measures[31]. In the category of demand-side measures, the government plays the role of the market so as to provoke private R&D efforts. These measures enable the government to provide a stable market demand as a lure to guide the direction of technological development by contract research and government procurement programmes. In the category of supply-side measures, financial, manpower and technical assistance are provided by the public branches to lessen the burden of the private sector so that government directly intervenes in technology supply to corroborate those developed technologies as state wishes. In the category of environment-side measures, a favourable infrastructure for technological development and sound economic climate are deployed in order to attract more investment into technology-based production. Under this industrial technology promotion system, there are many government agencies involved in promoting industrial technology policies. Figure 4.11 demonstrates an outline of the interactions between public agencies and the industry in which public resources to assist technology development are deployed by state actors. The following discussion stresses the operation and related law of each measure and the institutions in charge of these policy instruments.

[31] This classification of technology policy measures are originally derived by Wang & Tsai (1995) from R. Rothwell & W. Zegveld (1981) Industrial Innovation and Public Policy, London: Frances Pinter. But this is not the only classification of technology policy, for example, Mowery (1995) has three categories for the practice of the technology policy: supply policies, adoption policy, and competition policy. The reason to use Rothwell & Zegveld's classification is because it is easier to identify and appropriate for Taiwan's environment than others. It is also easier to add some new sub-categories to the framework, such as government-firm venture capital and innovation-oriented regulations.

Figure 4.11 The Main Interactions between Government Agencies and the Industry in Relation to Technology Development in Taiwan



2.1. Demand-Side Measures

2.1.1. Contract research

Contract research is funded by many public sources, for example, NSC, state enterprises, MOEA, and several government institutions. There are opportunities for the private sector to enlarge technological research, but it is difficult to get a complete picture of contract research at present. A major reform of STP, which was solely assigned to the public research institutes, incorporating the private sector into the contract research started from 1997 would be a significant landmark of contract research as a demand-side measure. This new source of contract research from the DIT, also known as Civilian STP (民間科專), is important not only because of the huge amount of allocated expenditure in the contract, but also because the developer of technology will become the user of technology. It is a big improvement in STP in two senses: first, it saves the time taken to transfer technology from the public research institute after it has been developed; second, it shortens the period from technological development to the commercialisation of a product.

2.1.2. Public procurement

Public procurement policy is a very effective way of enhancing long-term competitiveness for certain industries, for example, the US defence industry. At present in Taiwan, laws or regulations in relation to public procurement include the 'Administrative Law of Public Enterprises', and laws defining procedures for the purchase of military equipment, and methods by which public enterprises may apply for imports. However, the enforcement of 'local content requirement' in the public sector is intended to support the industry.

2.2. Supply-Side Measures

2.2.1. Financial assistance

In order to promote industrial development actively and to accelerate industrial upgrading, the government provides financial facilities in terms of low interest loans to various special projects, or joint ventures, and to subsidise R&D expenses. The financial source of loans, subsidies, and venture capital are from the Development Fund which should be appropriated from the National Treasury. The use of this fund is for the following purposes:

1. To participate in the investment in important enterprises or plans relating to industrial upgrading or improvement of industrial structure which are beyond the capacity or financial ability of private investors;
2. To provide financial facilities to important enterprises or plans which are relating to industrial upgrading or improvement of industrial structure but with insufficient capital;
3. To provide loans in line with the government industrial policy for assisting the sound development of industries;
4. To set aside an appropriate percentage of the fund in support of the plans relating to providing necessary assistance to the development of medium and/or small enterprises;
5. To take coordinative actions in the furtherance of the plans initiated by competent authorities concerned for acquiring of advanced technologies from abroad, promotion of R&D, training of personnel, pollution control, acceleration of improvement of industrial structure and/or betterment of economic development, and
6. Other purposes as specifically approved by the Executive Yuan.

(IDIC, Jun. 1995: Statute for Upgrading Industries, Article 21)

A. <u>loans</u>

Many loans use the special fund appropriated from the Economic Development Fund controlled by the Executive Yuan and the available funds of participating banks (see Table 4.12). Private companies eligible for loan No.1-4 & 8 can apply directly to participating banks. Applications for loan No.5-7 must be approved by the IDB. Those applying for loan No.9 must submit their investment plans to IDB for review and comment, and transmit them to CEPD for approval. Among them, loan No.7 is exclusively for technology intensive industries and major exporting industries. The largest total amount of loan available to private enterprises is the US$10 billion for loan No.8. For the purpose of positive and effective use of the foreign exchange reserves, government may provide outward investment projects, public infrastructure investment, and the investment projects in the ten major newly emerging industries and/or in the establishment of in-country capability of the eight major fields of technology.

Table 4.12 Favourable Financing Facilities

No.	Name of the Loan	Object of Loan	Total Amount of Loan
1	Loan for purchase of local-made automated machinery and equipment (購置國產自動化機械設備優惠貸款)	General production enterprise, warehousing business	NT$10 billion
2	Loan for purchase of imported automated machinery equipment (購置進口自動化機械設備優惠貸款)	General production enterprise, warehousing business	NT$20 billion
3	Loan to SMEs for purchase of local-made automated machinery and equipment (中小企業購置國產自動化機械設備優惠貸款)	Manufacturing enterprises and processing enterprises conforming to the qualification standards of SMEs	NT$5 billion
4	Loan for assisting the upgrading of SMEs (輔導中小企業升級貸款)	Same as above	NT$15 billion
5	Loan to private enterprises purchasing pollution control equipment (民營事業污染防治設備貸款)	Private factories purchasing pollution control equipment	NT$10 billion
6	Loan provided by ROC-US Fund to Medium/small Industries for Purchase of Pollution Control Equipment (中美基金中小型工業購置污染防治設備貸款)	SMEs purchasing pollution control equipment	NT$0.06 billion
7	US dollar Loan (六億美元外匯貸款)	Technology intensive industries, major exporting industries	US$0.6 billion
8	CBC's foreign currency Accommodation Facilities (央行外幣資金轉融通)	* Public/private enterprises making outward investment * Public infrastructure investments under 6-year National Reconstruction Project * 10 major new industries * Investment in 8 major critical technology fields * Major investment projects approved by government	US$10 billion
9	Medium/long term loans provided by CEPD (經建會中長期資金貸款)	* Government major construction projects * Any private investment project in a total amount over NT$200 million	NT$100 billion

Source: IDB, May, 1995:27-30.

Yang (1990) used a questionnaire to conduct a survey on the effect of preferential policy to firms in the 1980s. This showed that one third of the total loans from government were used to fund strategic industries[32]. However, Taiwan government's preferential policy of low interest loans in the 1980s did not reduce the interest burden, or increase the fixed capital formation, nor did it improve the operation performance of

[32] The coverage of this survey included one fund, about NT$70 billion, managed by the Bank of Communications and the other about NT$28 billion issued by Medium Business Bank in 1982-89. Those loans are similar to loan No. 1-5 at present in terms of the object of loans, but the amount of loans available is relatively smaller than those of present loans if we take loan No. 6-9 into account.

the firms[33].

B. <u>subsidies</u>

There are two 'subsidy' policy measures provided for the purpose of encouraging private enterprise to engage in the R&D of new and leading industrial products (see Table 4.13 for details). One is 'Regulations governing encouragement of development of new industrial products by private enterprises' (NIP,鼓助民間事業開發工業新產品辦法), promulgated by the MOEA in December 1984; the other is 'Regulations governing assistance in the development of targeted leading products' (TLP,主導性新產品開發輔導辦法), promulgated by the MOEA in June 1991.

NIP should be classified as an interest-free loan measure rather than as a subsidy measure in the sense that firms are obliged to pay back the loan. However, the fact that a firm does not need to amortise any loan or pay the interest on the loan during the period of developing a new product makes it different from other loan measures. Besides, it can be seen as a supplementary measure to TLP. Thus, it has been classified under 'subsidy' here.

TLP is a combination of subsidy measures and repayment-deferred interest-free loan measures. It has been deemed to be one of the main industrial technology policy measures in an effort to promote new emerging industries defined by government. 107 plans have been approved among 195 applications for TLP from July 1991 to June 1994, and about NT$2.16 billion have been granted from the Financing Fund to approved cases. It is estimated that this NT$2.16 billion government input has stimulated private investment in relevant products and technologies to about NT$17.62 billion (NT$6.82 billion on R&D expenditure and NT$10.8 billion on production investment) (IDB, Dec. 1994:56-7).

[33] Yang (1990) did not analyse the factors leading to the negative performance of loan measures, but it was mainly a reflection of his survey, a questionnaire replied by surveyed firms. The result of this survey was valuable for the government in reforming its preferential loan policy, however, the result of the survey is not applicable to the loan scheme in the 1990s because loan programmes and the amount of loan have increased substantially, in particular, in the high technology field.

Table 4.13 Subsidy Policy Measure: NIP & TLP

	NIP	TLP
Scope of application	(1) critical technology in industrial development; (2) Available, and prototype of the new product can be developed in a short period of time. (3) the new product has a great adaptability and market potential and can trigger the development of other relevant industries.	(1) 10 emerging industries, (2) the critical technology relating to the new product must be above the technology level currently available in ROC; (3) the new product has a great adaptability and market potential and can trigger the development of other relevant industries.
Condition of application	(1) limited to national private companies including manufacturing and technical business; (2) having a sound financial and economic ability and outstanding business performance; (3) having a R&D department in ROC and actual R&D development achievements and capable of implementing the proposed development plan and commercialising the new products to be developed; (4) In case the applicant is composed of two or more manufacturers, at least one of them shall meet the conditions.	
Sources of Fund	(1) Counterpart Fund: 'Industrial New Products R&D Program Account' specifically established by the Development Fund of the Executive Yuan; (2) Donation and contribution by individuals and the relevant organisations; (3) amortised counterpart fund and technical royalties received.	(1) Counterpart Fund: 'Industrial New Products R&D Program Account' specifically established by the Development Fund of the Executive Yuan; (2) Financing Fund: 'Targeted Leading Products R&D Program Account' from MOEA's STP.
Operation of Fund	The Counterpart Fund to be appropriated upon request of private enterprises are classified into: the counterpart fund for development expenses and counterpart fund for loan interest expenses.	50% of the development expenditure of approved plan will be subsidised by Financing Fund, while the other 50% may be loaned by a Counterpart Fund in accordance with the NIP (no more than 50%).
IPR	Patent right(s) derived in the course of new product development is (are) jointly owned by the developing manufacture(s) and the government pro rata to their respective contribution to the development fund. However, patent right may be vested in the developing manufactures with the approval of the Executive Yuan in the near future.	
Obligation	Amortisation of the Counterpart Fund: The user of the Counterpart Fund shall repay the fund in installation in 2-5 years from the day one year after the selling of the product. Royalty fee: Firms shall pay the NIP account the royalty fee at the rate of 1-3% (subject to the decision of New Product Review Board, in most cases 1%) from the selling day of the product for no more than 3 years by utilising the Counterpart Fund. There is no need to repay the 'subsidy' Financing Fund of TLP.	
Competent Authority	IDB (implementation agency) New Product Review Board in charge of the approval of applications (established by MOEA, with representatives from STAG, CEPD, NSC, MOEA, IDB, III, ITRI & relevant specialists)	IDB (implementation agency) New Product Review Board screening committee to evaluate plans and firm's technical capability (established by IDB, with representatives from government agencies, scholars and experts)

Source: IDB (May, 1995); IDIC (Mar. 1995); MOEA (Feb. 1995).

IDB's efforts to create new industries are much greater than its efforts on the technology upgrading of traditional industries in terms of financial input. Taking 1994 as an example, TLP's expenditure (NT$8.9 billion) was 7.8 times of that of 'Assistance Plan on the Upgrading of Industrial Technology for Traditional Industries (協助國內傳統工業技術升級計畫)' (NT$1.13 billion), let alone NIP's expenditure. The recipients of TLP is limited to those ten 'star' and high-tech industries, this shows that government efforts on upgrading the technology of traditional industries, which are several times than ten 'star' industries in number, are less positive in comparison.

C. venture capital

Venture capital is provided by the government in order to stimulate investment in high-tech-based enterprises through a special fund totalling NT$200 billion. This has been contributed: 40% by the Development Fund of the Executive Yuan and 60% by the Communication (Chiao Tung, 交通) Bank. This 'participation in investment' policy measure allows government to take part in the investment projects launched by newly created advanced-technology-based enterprises or the investment projects launched by existing enterprises for acquiring advanced technology.

Any newly created high-tech enterprise which needs to increase capital for acquiring new technology, to invest in R&D for new products, or to expand production capability, and with a project amounting to more than NT$2 billion, may submit its investment plan to the competent authority (normally, manufacturing enterprises to IDB). The competent authority must forward the application to the CEPD for final review, if the technical and economic evaluation of the investment plan reveals positive cost effectiveness. The government accepts the recommendation of the CEPD for participation in the investment project. The government investment in any individual project has been limited to an amount up to 40% of that particular project.

The government has invested in many new high-tech firms, notably in the semiconductor industry, by using this venture capital. Besides, KMT has also concentrated on investing in new technology-based firms by using its party-owned capital to form joint ventures.

2.2.2. *Manpower assistance*

The shortage of R&D manpower is a major obstacle to Taiwan's enterprises engaging in R&D activities. The government tries to enhance R&D manpower through university education, but the result is not very encouraging. The annual rate of increase in graduates in science and engineering from 1981 to 1993 was Ph.D. twenty times (24 to 481), master of science, six times (1,050 to 6,081), and bachelor of science, twice (11,342 to 20,856) (1994 ROC S&T Yearbook: Table 4-1-2). The postgraduate level shows a substantial increase compared with the undergraduate level. This does not mean that a quantitative increase in education leads to a qualitative improvement in research ability, because Taiwan's educational system focuses on cultivating teachers and professors rather than on qualified researchers. It is necessary to adjust the education system to reflect industrial demands, for example, encouraging cooperative research between universities, R&D institutes and industries, cultivating researchers in coordinated educational planning.

The COLA and the IDB are cooperating to meet the requirements of industrial development by combining institutions of higher learning with research organisations to promote aggressively the cultivation of the professionally trained technical personnel required by manufacturing industry through on-the-job training (IDB, 1992:23). This kind of training is vocational in orientation and can promote labour's skill but it does little to strengthen R&D ability. Training courses provided by non-profit organisations is another channel by which to improve the quality of the researcher. ITRI is one example that provides this kind of service to train researchers and technicians through courses, seminars and conferences, in the same way as Science-based Industrial Park (SIP) Administration[34]. The effect of those training and seminars is hard to measure in

[34] For statistics in this matter refers to Industrial Brief (Sep. 1995) & ITIS (1996).

qualitative terms in relation to R&D, but it has spread knowledge and technological know-how within the industrial sector.

The most effective method of strengthening R&D manpower is by providing incentives to recruit overseas Chinese S&T manpower, for example from those who went to the US to get a higher degree and never came back to work in Taiwan. These researchers also bring new knowledge, technological know-how and valuable experience. Most scientists and engineers who have returned are employed at universities and research institutes. Some have invested in their own high-tech business at HsinChu SIP. It could be argued that Taiwan would be unable to build its semiconductor industry without the return of experienced researchers from abroad. The team of researchers at ITRI's Electronics Research and Service Organisation (/the Computer and Communication Research Laboratories--CCL), the technology development and diffusion Center for semiconductors (/computer and communication), was mainly from RCA (/AT&T) in the 1970s and 1980s (/1980s and 1990s).

The recruitment of overseas Chinese researchers is very important to the supply of R&D manpower at present time, and also to the continuing efforts of government to introduce more outstanding researchers in the future. But to cultivate indigenous qualified researchers through the educational system and national training is no less important than that in the long term. An ideal national innovation system should be built upon educating its own researchers instead of borrowing 'foreign' talents, even if these technicians are somehow 'local'.

The Industrial Development and Investment Center (IDIC) of MOEA is the authority to promote the recruitment of high-tech specialists (Interview No.21). The Technology Transfer Service Center, a division of IDIC, built a network system with updated information on technologies and specialists, in which domestic-side data listed the demand of technologies and specialists, and overseas-side data the supply. Besides, the firm can get salary subsidies for headhunted specialists from IDIC for up to two approved cases per firm in which the government pays up to US$80,000 in each case in a three year span, but the firm has to pay at least an equal amount to the specialist.

2.2.3. *Technical assistance*

In the past Taiwan's industries did not pay enough attention to R&D, and therefore neither the accumulation of technological know-how nor the development of high value-added technology and products were within their reach. Abundant capital has been accumulated, but niches for investment cannot be found, nor can the technical problems which have arisen in the process of investment be solved.

Three types of government policy measures can be justified as technical assistance to help the private sector in Taiwan. The first is the provision of technical consulting services to local firms in relation to the operation of manufacturing industry in areas, such as financial matters, management issues, market intelligence, products information, and technological know-hows. The second is the transfer of technology from state-sponsored research institutes to the industrial sectors. The third is the emerging trend of the formation of government-led/financed research consortia between state-sponsored research institutes and private firms.

A. technical consulting service and information service

IDIC is the major agency which provides industrial investment information, including domestic and overseas investment. The Technology Transfer Service Center established in 1989 under the IDIC provides general consultation on technology transfer.

Industrial Technology Information Service (ITIS) is a plan created by the DIT so as to provide the industrial sector with the relevant industrial information and intelligence. The main tasks of ITIS are collecting and analysing industrial information through around 200 experienced industrial analysts in diverse industries. It aims to cultivate a group of outstanding specialists in industrial information as a think tank and data bank providing updated and correct industrial information and worldwide intelligence in relation to industry as a whole, particular products, firms within industries, markets, and technology trends (ITIS, 1996). Those industrial analysts are affiliated with the respective research institutions, such as the Institute for Information Industry (III) and ITRI, to some extent, they also help to format industry-specific policies.

Besides technology and management services from many governmental consulting institutions, the government also subsidised 60% of the total consulting expenses of the firms, up to a total of NT$1 million, to other sources. According to Yang's survey (1990), those firms which took advantage of technological and management guidance had better performance than those did not, no matter whether the guidance was from the government or other institutions.

B. technology transfer

Taiwan's industrial firms have benefited in terms of technology transfer through the state policies of developing industrial technology from public research institutes. This also includes technical innovation in the improvement of manufacturing process and the provision of key components in many industries. There are more than 25 state-owned and state-sponsored non-profit research institutes under the MOEA's supervision, which are the powerhouse for industrial innovation.

The expenditure of these research institutes is mostly from the government. It means that private firms can get their necessary technical assistance without paying a large amount in royalties. These research institutes also accept research contracts for certain technologies either in the improvement of the production process or in the creation of a new technical know-how, entrusted by private firms. Private firms can obtain from the IDIC and respective research institutes information about these technologies which have/had been developed. If there is no such indigenous technology to match the demand of the private sector, the information on foreign technology is provided by IDIC. IDIC takes a leading role in assisting local firms to search for foreign technologies through MOEA's 63 international offices.

The government is also involved in the activity of marrying local firms with international firms in terms of technology transfer. Taiwan is an odd case in forming strategic alliances with multinationals by the government rather than by private firms. During February of 1993 to June of 1995, MOEA worked actively to sign Letters of Intent for the formation of strategic alliances with multinationals, striving for prominent enterprises from throughout the world to invest in Taiwan, engage in technical cooperation/technology transfer, and set up Asia-Pacific Regional Operations Centres in Taiwan. There are a total of 25 firms which have signed agreements with MOEA among which 11 firms are among those ranking in the top 100 firms in the world (Taiwan Industrial Panorama, July 1995). The commitment of MOEA to these strategic partners is that IDIC serves as a coordinator and service window and provides much assistance and many services. The situation is the same for those public research institutes , for instance, ITRI was also buying from or co-operating with foreign firms to get technologies for the industry.

The provision of technology transfer from public-funded programmes and foreign sources, and the provision of information on new technologies, their access and applications, can be called 'diffusion-oriented' industrial technology policy. The performance of government in this respect is appreciable as the evidences in the empirical chapters, but it also reflects the limited structure and resources of Taiwan's manufacturing sector.

C. collaborative R&D

A new form of technical assistance has been introduced since 1990, that is a research consortium established by the private firm(s) and a state-sponsored research institute. Generally speaking, the research ability of state-sponsored institutes is much higher than that of private enterprise in terms of budget and research manpower, but the ability of firms in product design and commercialisation is better than that of the research institute. The combination of both public and private resources, in theory, will increase the strength of R&D, but it is subject to the management of the R&D project.

The first case of collaborative research was formed under the agreement between CCL/ITRI, the Taiwan's Electrical and Electronic Manufacturers' Association (TEEMA) and private firms on developing NPC in 1990. The effect of this research consortium was very positive in terms of upgrading the technological ability of Taiwan's computer industry as a whole. So, many R&D collaborations followed the collaborative model of NPC afterwards.

The state-sponsored institute played a very important role in such consortia. And private firms benefitted not only by the upgrading of their technology but also by the development of research manpower of their own through R&D collaboration. Also, business interest organisation was involved in the formation and operation of the processes of R&D consortia. Two case studies of R&D collaboration will be examined in the following chapters.

2.3. Environment-Side Measure

The aim of environment-side measures are to try to create an enabling environment to engage in R&D investment and to provide tax incentives to stimulate technological upgrading. There are other policy measures conducive to innovation by environment, such as, trade protection and intellectual property protection.

2.3.1. Innovation-oriented regulation

There are many government regulations which might affect the shape and direction of technological innovation, such as the acquisition of industrial land, safety and pollution regulations. Trade policy and competition policy affect not only market structure and conduct, but also the competitive performance of a firm's innovation activities (Mowery, 1995:539).

In recent years, Taiwan's trade policy has been liberalised from its old tactic of import control and export subsidy. The tariff for the importing of material, equipment and related items aimed to upgrade the level of technology and to the production of high-tech industry is much lower than the average. For machinery and equipment imported for self use by corporations, the payment of import duty may be deferred for five years.

The enforcement of the Fair Trade Law in 1991 ensures fair competition and maintains order in trade and protects the interests and welfare of the consumer. This has the effect of encouraging firms to engage in R&D investment under a fair and competitive environment. Besides, the legislation and amendment of laws concerning intellectual property rights can also be incentives for firms to invest in R&D activities, because the protection of royalties and patents is very important to ensure appropriate rewards for innovation activities for investors. Once the fruits of R&D can be protected and product piracy can be halted and punished, the willingness of firms to invest in R&D will be more highly motivated[35].

According to the spirit of the Fair Trade Law, cartel activities of enterprises are forbidden. However, if situations and the cartel activities are beneficial to the economy as a whole as well as to public interests, the government will permit certain kind of cartel activities. In relation to this study, jointly conducting R&D on products in order to upgrade technology, improve quality, reduce production cost, or increase efficiency, has been legalised. For the sake of promoting international competitiveness, the state has not only excluded joint R&D activities from cartel activities, but also this is the field that has been promoted by the state particularly.

The world trade rules also affect the amount of industrial subsidy to domestic

[35] The legislation (the cable TV law, the industrial design protection law, the Integrated Circuit Layout protection law, and the trade secret protection law) and revision (the patent law, the copyright law, and trade mark law) of several laws concerning intellectual property rights in Taiwan were mainly a response to the economic pressure of the United States and that Taiwan expected support from the US in joining GATT (General Agreement on Tariffs and Trade). Thus, Taiwan's IPR Laws achieved neither a 'high standard' nor 'low standard', but no standard at all (Kao, 1995: Chapter 6). However, they did contribute towards keeping a fair market order and advancing innovation.

industry in a form of R&D assistance. Trade-related subsidies were an agenda item in the Uruguay Round negotiations. As the result of negotiations, subsidies had been classified into prohibited, actionable and non-actionable categories in which subsidies for industrial R&D were in the non-actionable category (Groome, 1995:200-5). The agreement of subsidy under the World Trade Organisation follows the 1992 Brussels agreement, but with a precise definition and a percentage limitation. The subsidies to industrial R&D should not be in excess of 75%, and the subsidies to the precompetitive stage of production should not be in excess of 50% (BOFT, 1996).

Taiwan tries not to violate these international regulations. In response to the new regulation on subsidy under the World Trade Organisation, the subsidy to the R&D of new leading products is 50% and another 50% is given as loan in Taiwan, as discussed in 2.2.1. There is no subsidy to the pre-competitive R&D of new product, but 50% R&D cost is obtainable in a form of loan. In addition, the state has been actively organising product development consortia, a method that has not yet been regulated by international agreement.

2.3.2. Tax deduction schemes

In order to create a conducive investment environment and to further industrial upgrading, the government promulgated the 'Statute for Upgrading Industries' (SUI) by presidential decree at the end of 1990 and amended it in 1995 to cope with the changing needs. Table 4.14 lists the summaries of incentives under SUI.

Table 4.14 The Policy Measures of Financial Incentives in Taiwan

(1) Incentives for Automation
(a) Purchase of automated production technology and equipment qualify for tax credits relative to the cost according to the following rates: automated production technology 10%; domestically produced equipment 20%; imported equipment 12%. (b) Investment plans involving the purchase of automated machinery and equipment qualify for low-interest loans: the interest rate on loans for domestically produced equipment is 1% higher than the Center Bank's rediscount rate; the rate on loans for imported equipment is 2.155% lower than Chiao Tung Bank's basic interest rate.

(2) R&D Incentives	
	(a) Any outlays a company makes for purposes of new-product R&D, or improvement of production technology, improvement of service technology or upgrading production processes, may credit five to twenty percent against the amount of profit-seeking enterprise income tax payable for the current year (b) Service life of instruments and equipment for exclusive use in R&D purposes and/or inspection of pilot products may be accelerated by two years. (c) Privately-owned companies engaged in R&D of new industrial products may apply for matching funds to cover basic R&D expenses. New leading products may be eligible for further financial assistance. (d) In order to assist the R&D of products manufactured by traditional industries or the design of new production technology, companies can apply for professional consultation assistance or interest free loans covering R&D costs.
(3) Incentives for Purchasing New Equipment	
	Manufacturing machinery and equipment and research, experiment and quality inspection apparatus and equipment which are not manufactured locally and are imported, with the approval of MOEA, by manufacturers and technical service enterprises conforming to the regulations governing administration of factories for the purposes of development of new products, improvement of product quality, enhancement of productivity, saving of energy resources, promotion of waste reclamation, or improvement of manufacturing process shall be exempted from import duties.
(4)Incentives for Personnel Training	
	A company which undertakes personnel training which is provided either by the company itself or by an outside agency and is relevant to the company's activities, may credit 15% against the amount of profit-seeking enterprise income tax payable for the current year.
(5) Incentives for Establishing International Brands	
	A company promoting its name brands or symbol of service on the international markets, may credit 10% against the amount of profit-seeking enterprise income tax payable for the current year; however companies which use the Mark of Excellence for Taiwan-Made Products with the authority of MOEA may credit up to 15%.
(6) Incentives for Important Enterprises	
	(a) Investors making investments in important technology-based enterprise, important invested enterprises and venture capital investment enterprises, may credit up to 20% of price paid for acquisition of their respective capital investment against the amount of profit-seeking enterprise income tax or the consolidated income tax payable for the current year. (b) An important technology-based enterprise or an important investment enterprise conforming to the requirements set forth in the proceeding Article may, within 2 years from the beginning date of payment of the capital contributions by its shareholders, select, with the approval of its shareholders meeting, for application of the investment incentive in the form either of the exemption from profit-seeking enterprise income tax or of the shareholders investment credit against payable income tax.
(7) Anti-Pollution Incentives	
	(a) manufacturers are eligible for a company-tax credit of 20% for expenditure on locally-made environmental protection equipment, and 10% for imported equipment. (b) Exemption from import duty is available for equipment designed specially for prevention and control of air, noise, or water pollution, vibration control, environmental monitoring, or waste processing (including components). (c) Low-interest loans are available for anti-pollution investment plans as well as anti-pollution construction projects, related equipment production and waste treatment investment plans.
(8) Energy Conservation Incentives	
	(a) 5-20% of any expenditure on energy conservation technology for facilities may be credited against profit-seeking enterprise income tax. (b) Energy conservation projects qualify for low interest loans. (c) Service life of devices and systems that reduce energy conservation or serve as effective substitutes for energy may accelerate depreciation by 2 years.

(9) Recycling Incentives
5-20% of any expenditure on recycling technology or facilities may be credited against profit-seeking enterprise income tax.
(10) Incentives for Recycling of Water Used for Industrial Purposes
5-20% of any expenditure on technology or facilities for the recycling of water used for industrial purposes may be credited against profit-seeking enterprise income tax.
(11) Incentive for Personal Creation and Invention
ROC citizen's creation or invention provides or sells to the use of domestic firms whose gains are exempted from income tax.
(12) Merger Incentives
With the approval of MOEA, companies that merge to rationalise operations are entitled to the following incentives: (a) The normal stamp tax and deed tax incurred as a result of the merger will not apply. (b) Land-value increment tax incurred due to transfer of land titles can be charged to the merger and paid by that company at the time the land is further transferred. (c) Where the land, plant building, machinery and equipment previously used directly by an enterprise are sold, the proceeds realised from such sale and subsequently used for payment in whole for machinery, equipment, land, or factories needed for a merger plan involving said company shall be exempt from stamp tax and deed tax. (d) Where a company sells factory and land that was directly used by that company, and buys land to build a factory in an industrial zone or on the land zone by the government as industrial, if the purchase price of the original land after deducting land-value increment tax, the company can apply for return of the increment tax to cover the shortfall on the new land. The sum returned may not exceed the tax figure that the company paid on the sale of its land.

The investment incentive and assistance measures being provided and implemented by the government in accordance with the SUI and relative laws and regulations are indiscriminately applicable to any domestic and foreign manufacturer/firm making investment in Taiwan. SUI is almost the most important policy measure to remove investment obstacles by improving the investment environment and encouraging the willingness of investors, and to accelerate the upgrading of technical levels of domestic industries as well as to enhance the competitiveness of local industries in international markets.

However, the effect of these measures is hard to assess in the sense that no tool is executed alone because when a firm is eligible to apply for tax deduction schemes, it is also eligible for loans and other incentives. Thus the substantial growth of a firm's R&D investment can not be attributed to a single factor. There are many other factors (demand-side, supply-side, and infrastructural) which support successful innovation, and policy measures may have only a marginal impact on rising private investment in R&D. According to the results of some empirical investigations, there is a positive relationship between government R&D promotion schemes and the increase of private R&D expenditures[36]. Moreover, the effects of money-term incentives (R&D tax credits, other tax incentives and low/non-interest loans) is greater than those of non-money-term incentives (patent & intellectual property rights protection, technical & information assistance from public research institutes)[37].

2.3.3. Privileged park for emerging industries

The establishment of SIP is aimed at introducing high-tech industries and technological human resources, to promote the innovation of domestic industrial technology, and to promote the development of high-tech industries. The industries at SIP are characterised as high-value added, high productivity, high capital-intensive and high technology-oriented.

The Hsinchu SIP was established by NSC in 1980. This is the earliest Silicon Valley-type industrial park in Asia. In the same way Taiwan's export processing zones are also the first in Asia (the earliest export processing zones founded at Kaohsiung, Nantze and Taichung in 1966). The SIP administration is a public undertaking under the supervision of NSC. The SIP was home to over 179 private scientific and technical companies in 1994. These enjoy certain tax advantages, access to funding for innovative R&D programmes, and advanced training courses for employees. The SIP combined with ITRI and two leading technological Universities (National Chiao Tung University and National Tsing Hua University) to form an 'extraterritorial' high-tech area which received more governmental concern than any other industrial site. The intention is to promote close cooperation between high-tech industries, Universities and ITRI.

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[36] According to the survey of Wang & Tsai (1994) concerning the effect of promotion tools on private R&D investment in Taiwan's electrical industry, the investment tax credit is the most influential, the Tariff exemption the next, and accelerated depreciation the last. The larger the firm, the less sensitive to the change of government promotion tools; the smaller the firm, the more dependent on these tools. Further evidence provided by Wang & Chen (1995) concerning the effectiveness of R&D tax credit in the manufacturing sector shows that the effects of tax credit on research efficiency and economic benefits is positive.

[37] In this regard, Wang & Chen (1995) admitted that some firms may have a selfish attitude in responding to questionnaires which calculate that the more R&D tax credits the government will provide, the more benefits they can obtain, if they exaggerate the effects of R&D tax credit.

The average R&D expenditure as a percentage of sales at SIP was 5%, which is relatively higher than 1.5% of non-SIP companies. However, it does not take government assistance into account. In order to encourage companies to invest in R&D, there were 319 assistance cases up to 1993 with a total amount of NT$4.9 billions and 43 cases with a total amount of NT$1.02 billions in 1994 under 'Rules governing SIP assistance plan for innovation of technological R&D' (科學工業園區創新技術研究發展計畫獎助實施要點). Besides, there is a total budget of NT$45 billions for the period of July 1992 - June 1997 to assist the R&D investment in Key components and products. All the assistance is given to high-tech companies at SIP. It is another example of subsidies provided by the government and NSC's budget for industrial development.

According to a survey by the SIP Administration, more than half of the manufacturing techniques for the main products were created by companies themselves (Industrial Brief, Sep. 1995:65). Technological indigenisation can be deemed as one of the consequences of SIP. The turnover of SIP was increased by 37.81% from NT$1289 billions in 1993 to NT$1778 billions in 1994, which surpassed the total turnover of the export processing zones. Moreover, the per head turnover reached NT$5.3 millions, twice of that of the export processing zones (Industrial Brief, Jan. 1996:78).

Encouraged by the economic performance of high-tech firms in the SIP, the government is keen on establishing 20 to 30 intelligent industrial parks (智慧型工業園區) on the island in 1996-2005 (Table 4.15). Likewise, the government will organise joint venture corporations between the public and private sector for development and investment. Besides, a modern telecommunication link will be established to connect the new industrial park with the traditional ones (MOEA, May 1995:4).

Table 4.15 New Intelligent Industrial Parks in Taiwan *

Name	Time Table	Situation	Type
Hsinchu SIP (新竹科學工業園區)	Jan. 1993- Dec. 1997	The third term expansion is developing.	GD
Maoli SIP (苗栗科學工業園區)	On Planning	Location has decided. In the process of obtaining industrial land	GD
Tainan SIP (台南科學工業園區)	On Planning	Location has decided. In the process of obtaining industrial land	GD
Tainan TIP (台南科技工業區)	Aug. 1995- June 2001	In the process of construction	GP/ID
Yunlin TIP (雲林科技工業區)	Aug. 1995- May 2000	In the process of selecting companies	GP/ID
Hsinchu TIP (新竹科技工業區)	On Planning	In the process of evaluating	GP/ID
Nankang SWIP (南港軟體工業園區)	Dec. 1995- Dec. 1997	In the process of construction	GP/ID
Taichung SWIP (台中軟體工業園區)	On Planning	In the process of changing urban planning on the use of this SWIP	GP/ID
South SWIP (南部軟體工業園區)	On Planning	In the process of evaluating	GP/ID
Taichung AIP (台中航太工業園區)	Jan. 1997- Dec. 1999	In the process of planning report and evaluating environmental impacts	GP/ID
South AIP (南部航太工業園區)	On Planning	In the process of evaluating	GP/ID
Hsinchu BIP (新竹生物科技園區)	On Planning	A special area located inside HsinChu SIP with a budget of NT$8.39 billions	GP/ID
Taichung NIP (台中創業園區)	On Planning	A special area located inside Taichung industrial zone.	GP/ID
**Chingshan RP (青山研究園區) Lungyuan RP (龍園研究園區) Lungmen RP (龍門研究園區)	Coordinating with the MOND	Located inside CIS, the main R&D institute of the national defence. C.S. RP on chemical & material research; L.Y. RP on information & telecommunication research; L.M. RP on precise machinery & quality control.	GD
**Taichung RP (台中研究園區)	Coordinating with the MOND	Located inside C.C.K. (清泉崗) Military Airport. On Aerospace research	GD

Sources: 'How to build Taiwan into an Asia-Pacific Manufacturing Centre' -- Conference paper, Taipei: June 6th, 1995 (CEPD, Jun. 1995).

* TIP=Technology-based Industrial Park　　RP=R&D Park
SIP=Science-based Industrial Park　　GD=Development by government
SWIP=Software-based Industrial Park　　GP=Planning by government
NIP=New-enterprise Industrial Park　　ID=Development by industries
AIP=Aerospace Industrial Park　　BIP=Bio-tech Industrial Park

**There are two main budgets for the operation of four Research Parks: one is from STP with a mount of NT$68 billions up to year 2000; the other is the 'Development Fund for Military and Civilian Common Technology (軍民通用技術發展基金)' of CIS.

3. CONCLUSION

The overall picture of Taiwan's national innovation system will be addressed in this short summary in terms of three dimensions: technological capability, economic-oriented innovative performance, and institutions.

The efforts of government in trying to strengthen Taiwan's overall technological capability through S&T conferences and plans have achieved considerable progress in many aspects. The focus here is on the factors influencing national technological capabilities rather than on the performance of the industrial sector or institutions conducting the most advanced scientific research. Firstly, the government has created many technology-related agencies and public-owned research institutes in the past twenty years. These constitute a very sound national framework for the development of S&T. Secondly, the R&D expenditure in Taiwan has increased substantially which implies a shift of the industrial foundation from a labour-intensive one towards a more technology-oriented one. Besides, the government S&T expenditure share of total national expenditure dropped from around 60% to less than 50% reflected an increasing weight of private investment on S&T. Thirdly, the growth of research outputs in quantitative terms also demonstrates that national technological capabilities have been strengthened[38].

More and more concern for a national innovation system is tied to economic-oriented innovative performance. It is necessary to discuss the issue since the broad concept of competitiveness is highly relevant to economic-oriented innovative performance. First of all, the sharp decrease in R&D expenditure on national defence in the early 1990s and the steady increase in industrial R&D expenditure since mid-eighties has led Taiwan into a new era of high technology industrialisation[39]. Besides,

[38] For data about the indicators of technological capacities refers to 1994 ROC S&T Yearbook in chapter 2 & 3. The exports of technology-intensive products have increased by 4.4 times in a decade, NT$284 billion in 1984 and NT$1255 billion in 1993, while those as % of total export products has increased from 23.6% in 1984 to 55.7% in 1993 (ibid.:36).

[39] In most of the countries among high-income and newly industrialised countries, military R&D shares the largest part of government funding to R&D. The USA has the largest portion of R&D on military projects, it did help its aircraft and electronic industries to dominate the world market in the 1960s; Britain has the second highest part of R&D on military projects, but most of the companies having defence R&D contracts have shown little ability to penetrate the commercial market, as well as the case of France. 'Civilian commercial spillover seldom has been the central objective of military R&D (Nelson, 1993:512)'. Two reasons might lead to that Taiwanese government would rather invest in civilian R&D than in defence R&D. One is that Taiwan can obtain advanced weapon in the 1990s; the other is that the commercial returns of developing industrial technology is more promising than that of defence technology, not to mention that Taiwan-developed defence technology is not among the best in the world which makes it hard to be commercialised.

R&D budget for MOEA is much more than that of NSC and other government branches. This bias reveals Taiwan's innovation system is economic development-led rather than scientific discovery and invention-led. Moreover, industrial technology is the core concern of R&D activities (Table 4.16).

The state's efforts to promote industrial technology can be captured by the operation of IPs through supply-, demand-, and environment-side measures. The government-sponsored research institutes, which share a very high proportion of R&D budget in the public sector, have been an important source of new designs later taken over by manufacturing firms in Taiwan. For example, the creation of the semiconductor industry followed this type in the 1980s. Furthermore, the high-tech industries which have been developed/developing in Taiwan are aimed at the international market rather than the domestic market. The source of competitiveness of high-tech industries comes from constant innovative activities, and this is the area which the government makes every effort to improve.

The institutional prospects of Taiwan's national innovation system are threefold. At the central government level, the administrative system governing the development of S&T is well-organised and the responsibilities for diverse agencies are clearly defined. This is one of the preconditions of running a national innovation system in relation to planning and managing S&T-concerned affairs. In legal terms, the institutions have been built upon the 'S&T Development Program' through which many tasks have been done, such as the creation of new agencies, the establishment of research institutes and laboratories, the ratification of relevant laws and regulations, and the direction of national S&T development. Under Taiwan's innovation system, sub-systems exist made up of specific functions. Financial institutions with the goal of fostering industrial innovation are for the easy access by the industrial sector. Incentives, technical services and the provision of information under MOEA are also institutionalised and available to the industrial sector. Thus, the government is the largest institutional actor in Taiwan's innovation system.

Table 4.16 National R&D Expenditures, 1982-94

Unit: NT$ million
( ): %

Year	By Government vs. Private sector (=100%)			By Industry, Academic & Research Institutions (=100%)			By Type of Research (=100%)			By Field of Research (=100%)		
	Govern-ment	Private	For-eign	Indus-try	R&D Inst.	Univer-sity	Basic	Appli-ed	Experi-mental	Engineer-ing	Nature, Medic & Agri.	Huma &Soc Sci
1982	9,813 (58.2)	6,984 (41.4)	67 (0.4)	8,057 (47.8)	5,660 (33.6)	3,147 (18.7)	1,742 (10.3)	9,741 (57.8)	5,381 (31.9)	10,399 (61.7)	6,465 (38.4)	–
1983	11,756 (61.2)	7,418 (38.6)	26 (0.1)	9,553 (49.8)	5,805 (3.2)	3,842 (20.0)	2,324 (12.1)	5,342 (27.8)	11,535 (60.1)	11,987 (62.4)	7,213 (37.3)	–
1984	14,197 (63.3)	8,041 (35.8)	205 (0.9)	10,971 (48.9)	7,325 (32.6)	10,149 (18.5)	3,173 (14.1)	7,232 (32.2)	12,040 (53.6)	14,870 (66.3)	7,017 (19.3)	557 (2.5)
1985	16,141 (63.6)	8,978 (35.4)	278 (1.1)	12,715 (50.1)	8,401 (33.1)	4,282 (16.9)	3,672 (14.5)	8,368 (32.9)	13,357 (52.6)	17,947 (70.7)	5,070 (26.9)	597 (2.4)
1986	17,253 (60.1)	11,301 (39.4)	148 (0.5)	15,921 (55.5)	8,356 (29.1)	4,424 (15.4)	3,809 (13.3)	11,747 (40.9)	13,146 (45.8)	19,759 (68.8)	8,344 (29.1)	600 (2.1)
1987	18,701 (50.8)	17,868 (48.6)	211 (0.6)	21,763 (59.2)	9,844 (26.8)	5,173 (14.1)	3,819 (10.4)	12,170 (33.1)	20,791 (56.5)	28,617 (77.8)	7,864 (21.4)	300 (0.8)
1988	24,793 (56.5)	18,922 (43.2)	124 (0.3)	20,948 (47.8)	15,627 (35.6)	7,265 (16.6)	5,413 (12.3)	20,971 (47.4)	17,635 (40.2)	30,895 (70.5)	11,241 (25.6)	1,702 (3.9)
1989	26,127 (47.7)	28,393 (51.8)	269 (0.5)	30,695 (56.0)	15,827 (28.9)	8,267 (15.1)	5,777 (10.5)	19,823 (36.2)	29,189 (53.3)	42,535 (77.6)	10,965 (20.1)	1,289 (2.4)
1990	32,772 (45.8)	38,659 (54.0)	117 (0.2)	42,240 (59.0)	19,830 (27.8)	9,478 (13.2)	7,100 (9.9)	25,665 (35.9)	38,783 (54.2)	56,116 (78.4)	14,054 (19.7)	1,378 (1.9)
1991	42,574 (52.0)	37,977 (46.4)	1,241 (1.5)	43,836 (53.6)	25,280 (30.9)	12,649 (15.5)	9,390 (11.5)	32,983 (40.3)	38,392 (48.2)	64,420 (78.8)	15,240 (18.6)	2,105 (2.6)
1992	49,509 (52.2)	44,803 (47.3)	516 (0.5)	49,825 (52.6)	31,316 (33.0)	13,687 (14.4)	11,811 (12.5)	34,511 (36.4)	48,506 (51.1)	70,641 (74.5)	21,348 (22.5)	2,839 (3.0)
1993	51,292 (49.5)	52,219 (50.4)	106 (0.1)	58,968 (56.9)	29,697 (28.7)	14,952 (14.4)	14,193 (13.7)	37,143 (35.8)	52,281 (50.5)	75,867 (73.2)	23,772 (22.9)	3,978 (3.9)
1994	55,286 (48.2)	59,235 (51.6)	161 (0.1)	65,921 (57.5)	31,448 (27.4)	17,313 (15.1)	17,138 (14.9)	40,384 (35.2)	57,160 (49.8)	83,018 (72.4)	26,816 (23.4)	4,848 (4.2)

Note: 1. R&D expenditures for national defence are not included.
2. Government R&D expenditures includes that of public enterprises.
Source: Data for 1982-1992 from TSDB, 1995: Table 6.1, 6.2, 6.3 and 6.4.
Data for 1993-1994 from 1994 ROC S&T Yearbook: 19 & 24.

There is no standard to judge a national innovation system. One system concentrates on scientific R&D and another on commercial technology, so it is difficult to compare the performance of two systems. A system might perform very well in the short term, but it is not guaranteed in the long term, and vice versa. The national innovation system in Taiwan, it could be argued, is excellent in term of its supporting policies for the development of industrial technology and the environment created by government in favouring of economic-oriented innovation. But there is not much evidence to argue that it is also good at basic science.

CHAPTER FIVE

CASE STUDY: NOTEBOOK-SIZED COMPUTER RESEARCH CONSORTIUM

> **'Fundamentally, the effective of operation of an evolutionary innovation system depends on the effective coupling between firms with other knowledge-based institutions to jointly enhance processes of learning and creativity (Metcalfe, 1995:497).' 'While every nation pays lip service to this goal (strong links between research institutions and industry), in reality the connections are often distant (Porter, 1990:632).'**

The electronics industry is one of the largest industries in the world economy today. As the service industries have become more dominant economic activities than manufacturing industries in most mature economies, the importance of the electronics industry as an 'engine of growth' is increasing in the eyes of industrial economists and policy-makers in the light of its contribution to production and trade. In particular, information technology is central to the process of industrial transformation in the sense that the promotion of electronics capacities through computer power is the modern way to improve productivity and competitiveness.

The integration of different fields of technology into electronics-based industries reveals 'the interdependence of systems of products' (Cawson et al., 1995:29-33). Technological development in information technology makes it possible to integrate more functions into home automation and electronic products. The high volume data storage capacity and high speed of semiconductors leads to a continuous upgrading of the functions of computer and a rapid expansion of multimedia. The trend of digitisation in electronics-related technology links one technology to another and is blurring the boundaries between industries. It can be predicted that visual products, audio products, home automation, information technology, and communication will become one unit due to their increasing compatibility.

In this case study, the development of Notebook-sized PC (NPC) in 1990 in Taiwan will be examined in terms of a collaborative R&D consortium. This NPC R&D consortium is of paramount importance for three reasons. Firstly, this was an unprecedented experience of large-scale collaboration between a government-sponsored research institute, intermediary association and individual firms in relation to the rapid commercialisation of industrial technology. It became a model of technology diffusion and application and a very effective way to create a new industrial product. Thereafter, many R&D consortia have been formed by the same method. Secondly, in the light of creating a new product for Taiwan's computer industry the NPC consortium is an economic success. There was no such product before this NPC consortium, but Taiwan became the number three NPC manufacturer in 1993, the number two in 1994, and the number one in 1996. This product even made Taiwan's computer industry grow in the 1992-3 worldwide recession of production in information technology. Thirdly, the time span of developing a new product is astoundingly short because of the effect of collective action. The NPC consortium took four months (from July to October 1990) to create a prototype NPC as a result of the efficiency of R&D teams and the strong commitment of firms in the R&D stage. The timely effect of the very short period of R&D meant that Taiwan's NPC product was able to capture the demand of the world market--only a few months behind Japan's Toshiba.

Previous studies on the NPC consortium were biased towards the management perspective of strategic alliances (S. Wang, 1991; D. Lee, 1992), and neglected the role of government in the promotion of the development of NPC. To understand the internal management of a R&D consortium is one thing, to analyse the successful factors in relation to government support leading to the rapid commercialisation of an industrial product is quite another. Many government efforts to promote the development of NPC are keys to the success of the NPC consortium. Moreover, the role of the ITRI as a public sector research institute in developing the economy-related technology deserves more attention. In the case of NPC R&D consortium, there was no direct government intervention, but ITRI, acted as a quasi government agent to navigate and assist the application of industrial technology. It thus could be seen as a policy instrument for the fulfillment of upgrading industrial competitiveness. Attention must also be given to the role played by the intermediary organisation bridging the R&D institute and the individual firm. Without the coordination of business associations, the implementation of a large scale R&D consortium with 46 participating firms would not be manageable by ITRI alone.

1. GOVERNMENT PROJECT SUPPORTING THE DEVELOPMENT OF COMPUTER TECHNOLOGY

The computer industry expanded rapidly in Taiwan in the 1980s. However, computer products were low value-added and the technology was relatively basic. The upgrading of computer technology in terms of manufacturing was necessary to ensure high value-added and high intensive technology. The structure of the local industry was based on SMEs. Both the technology and R&D capabilities were insufficient. In particular, investment in long term R&D was subject to lack of skill and capital. The development of computer products always lagged behind that of foreign companies. Therefore, Taiwanese businesses were always controlled by foreign companies and local companies were asked to pay technological royalties or licence fees. Thus, competitiveness was lowered.

In order to reduce manufacturing costs and raise quality, a four year Special Technology Project (STP)-- the Development of Packaging Technology for Computer Products (Packaging STP), was introduced by the MOEA in July 1990. Packaging technology was aimed at developing the critical technology for precision mechanical processing and electro-mechanical integration which could be used in the process of high-intensive physical design and mechanism structures for the miniaturisation of electric and computer products. The total budget was nearly NT$500 million in a four year span. With reference to the development of NPC, the first year plan with a budget of NT$116 million emphasised the technology for the application to manufacturing of 'light, thin, short, and small' electrical products[40]. Three main programmes and eight sub-programmes were developed in order to solve the problems in the pre-competitive and mass production stage. In terms of physical design, the designer applied a computerised analysis instrument to assist the design of electrical board and systematic structures so as to prove their testability and ability to produce a satisfactory product. This approach matches the demands of high tech production and shortens the time of development. In terms of manufacturing, the plan was intended to enhance product quality and to reduce the cost of mass production. The core of Packaging STP was, to a certain extent, to develop the technology needed for miniaturisation in the first year (Interview No.30).

However, the coverage of high-intensive physical design and the technology of manufacturing engineering relative to packaging technology involved many specific fields such as modules analysis, physics, chemistry, material, engineering, electrics, and automated control, which were far more complex than the private sector can tackle because the R&D teams in the private sector were relatively small. Therefore, the use of government power of planning and financing an STP to develop an overall packaging technology as a contribution to the electrical and computer industries, was expected and effected.

ITRI is the institute for implementing the Packaging STP. The CCL of ITRI is the leading R&D unit conducting R&D in conjunction with the coordination of the Electronics Research and Service Organisation (ERSO) and the Materials Research Laboratories (MRL).

The total manpower and capital input in this STP was 76 persons and NT$116

[40] The discussion of the 4-year computer packaging technology STP is stressed on the first year plan because that the NPC consortium derived its technological application mainly from the result of the first year of this project.

million in 1990. The research team is larger than that of any private enterprise in Taiwan. Some local companies (Acer and Mitac) had larger research teams than those of SMEs, however, they were 'big' in Taiwan but not by international standards or in comparison with those of ITRI. In addition, researchers were from different backgrounds of technology, for example, ERSO, CCL and MRL, so that the coverage of R&D ability was also stronger than that of the private sector. The large amount of government investment also exceeded the ability of any local companies. The financial input of Packaging STP from the government in 1990 alone was twice the fund of the NPC Alliance paid by 46 private participating firms.

Nonetheless, the significance of Packaging STP as a government contribution was not so much the vast manpower and capital investment, but rather the fruits of its R&D which were directly applied to the development of NPC and eventually applied to the computer industry. If the resource inputs did not lead to promising technological outputs, all investment would be in vain. According to Mr. Chen (Interview No.6), a technology advisor to DIT, it is not necessary for every government technological project to lead to a commercially viable product because the success of a technological project can not be judged in market terms alone. In Taiwan, however, six or seven out of ten cases could be deemed successful in government STPs. In his view, it is very unusual to have such a high rate of success since the R&D investment can be repaid if one in ten cases were successfully commercialised.

As far as the DIT/MOEA is concerned, the review criteria of technology development plan is the combination of industrial policy and industrial demands in future 2-4 years which emphasises a market-oriented project leading to the development of technology or a product with a potential market niche. Accordingly, Packaging STP is a success.

2. THE FORMATION OF NPC ALLIANCE

2.1. The Notebook-Sized Computer

The portable PC used today includes lap-top PC, Notebook PC and palm-top PC. In the 1990s, NPC is the main portable PC in the market with functions almost equivalent to the desk-top PC and in size the same as a note book or A4 size paper. After the successful development of NPC technology, the lap-top PC has gradually decreased market share because of its larger size and relatively heavier weight than NPC. The palm-top PC also finds it difficult to compete with the NPC because its functions are too simple and basic, in particular, the size of keyboard is not very user-friendly. Some even think the electronic diary can be deemed as a portable PC, however, it does not embody the basic functions of a PC. The emerging product in the portable PC family after 1995 is the sub-notebook PC. Its functions are equivalent to NPC, but the size and weight are reduced to a substantial degree, and most important, the keyboard is about the same size as that of NPC. There is no precise definition about the size and weight or even the functions which should be included in the portable PC, but normally the weight of a lap-top PC is more than 10 kgs, the weight of a NPC is less than 5 kgs, and the weight of a sub-notebook PC is between 2-3 kgs[41].

Before 1990, there was no so-called NPC on the international market, but some portable PCs were in the market. At that time, the portable PC was defined as easy to carry for uses other than those available on a fixed desk PC, and it was mainly referred to as the lap-top PC. The life of the lap-top PC on the market is about one year. It was soon replaced by the NPC. In the 1989, the ITRI successfully developed the technology of the lap-top PC which was under a NT$7 million contract with Tatung[42]. However, no

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[41] Following the progress in the technology of miniaturisation, the weight of latest model of NPC is less than 3 kgs, Sub-notebook PC between 1.5-2 kgs in 1997. The market for Hand-held (palm-top) PC, weighed less than 1 kg, also increased to the amount of 80-110 thousand sets in 1997 due to the development of a mini-edition of Windows by Microsoft (CDN, 21/04/97).

[42] This NT$7 million contract was signed between ITRI and Tatung in 1989. The arrangement of this contract is not a coordination of R&D activities between two parties, it is as the old pattern that the private company entrusted ITRI to develop the technology desired. In this lap-top development case, ITRI successfully developed a product and which was

other company wished to accept the transfer of lap-top PC technology because the market for this product was ambiguous. The domestic companies would not take this risk and accept a soon-to-be-outdated technology, and still observed the market trends.

2.2. A Birth of NPC Alliance

While most firms hesitated whether to choose a lap-top PC or NPC to develop, some domestic companies (Acer, Twinhead, Cha-cha) had started the R&D for NPC because of the trend to miniaturise the size and to reduce the weight of the portable PC, but progress was limited. Meanwhile, ITRI decided to advance its lap-top PC technology to NPC technology because the technology needed would be developed by Packaging STP. ITRI's position as a public-sector research organisation, allowed it to apply to the IDB for R&D finance to conduct the development of NPC. However, the IDB denied this kind of product-oriented R&D because government funding is assigned to the development of frontier and basic technology. The IDB also recognised the potential market of NPC and the importance of rapid commercialisation of NPC to match the demand of market, so it advised ITRI to search the private sector for support for the further development of NPC technology.

Besides, Taiwan's industrial policy makers were keen to see new and smaller computer firms benefiting from the market niche created by the NPC, so it led to an open-to-all policy for the private sector to join the NPC Alliance. The rationale behind IDB's preference for an open-to-all policy rather than a large/competitive-firm-only policy is threefold. Firstly, the investment of NPC R&D was huge and not every firm could afford it. If the government does not give the smaller firms a chance to join NPC R&D consortium, they would never have shared a piece of the NPC cake due to high R&D entry barriers in both financial and technological terms. Secondly, the government would like to see more domestic firms accepting NPC technology rather than only a few large firms under the consideration of technology diffusion. Obviously, the effects of

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shown at the 1989 Hanover computer exhibition.

transplanting technology into the majority of industry is preferable to its monopolisation by some large firms. Thirdly, ITRI had failed to attract large firms to the consortium. In the initial stage of planning an ITRI-firms cooperative project, the CCL/ITRI intended to look for 5-8 larger companies to invest NT$3-5 million each to cover an estimated budget of NT$30 million. However, the larger firms deemed NT$5 million too much since the development of a successful NPC is still an uncertainty.

That is not to say that SMEs would be more competitive than large firms in the eyes of IDB. The innovatory performance in industry judged by the size of firm is highly sectorally influenced, but SMEs can play an important role in the emergence of new technology-based sectors of industry (Rothwell & Dodgson, 1994)[43]. In addition, the flexibility of SMEs in relation to export and manufacturing was one of important factors underlying Taiwan's economic growth. Given that SMEs still shared more than half of total exports, the government expects that the flexible operation of SMEs can catch the fast-changing market requirements since the principle of fast follower is the strategy for Taiwan's products survival in the high-tech industry.

One thing that has to be noted here is that the ITRI is a subordinate of the MOEA, in particular, the main financial resource is from the government budget. Any projects of the ITRI should be agreed with the MOEA, and this is also true in the case of the NPC Alliance. Thus, the guidance and advice from the IDB/MOEA should strongly influence the direction of ITRI's project. Even the NPC Alliance is a contract between ITRI, the Taiwan Electric Appliance Manufacturers' Association (TEAMA) and firms, IDB remains the ultimate monitoring body.

The Japanese Toshiba was the first NPC on the market in February, 1990. The appearance of Toshiba's NPC has accelerated the decline of the lap-top PC and started the battle for the market of the NPC. It is certain that the NPC will become the main

[43] According to Rothwell & Dodgson (1994), small firm advantages are mainly behavioural (little bureaucracy, effective communication, fast marketing reaction, and fast learning capability), while those of large firms are mainly material (high market power, high technical manpower, finance, and ability to cope with government regulations and to defend patents).

product for portable PCs. The idea of developing a uniform NPC was advanced by the office of planning/ITRI ten days after Toshiba launched its NPC on the market, but ITRI still awaited the response of the private sector. Some firms feared that the NPC might become tomorrow's lap-top PC and the palm-top PC would be the leading product. However, many firms showed their interest in joining the alliance because CCL has a technological team with experience in design and development of the lap-top PC and a logistic team supporting market information and the movement of related technology. Moreover, a new STP with a year budget of NT$116 million concerning the packaging technology for electrical and computer products would be launched in July, 1990.

In the computer industry, the quality of the progress of developing a NPC differs between firms in terms of their technological capability, financial ability and market awareness. Some bigger firms have invested in the development of NPC, most firms have entry barriers in the technology.

In general, the development of NPC in the private sector is not promising. Three factors explain the difficulties faced by the Taiwanese computer industry at that time (S. Wang, 1991:40). First, the technology related to the development of a NPC is a highly intensive construction which involved not only the idea of 'how to put so many tiny things into a limited space', but also the interior design for the efficient functioning of a PC and the reshaping of many components. Second, no technicians in the private sector were familiar with NPC technology, not to mention not having experience of constructing and designing a NPC. Last but not least, there is no product standard to follow. This is the biggest problem confronted by the computer manufacturing sector. Many components (liquid crystal displayer/LCD, hard disk, keyboard, etc.) available in the market do not fit in with NPC product design, so firms might develop their own components. Because of different standards between firms' products, they have to enlarge their orders for safe storage. No intra-industrial division of labour means that one firm which wishes to develop a NPC must take responsibility for many tasks which are supposed to be done by many other component suppliers. This is in contrast to the case of desk-top PC where a centre-satellite supply system has been well-developed. All these had led to an expensive investment and a slower development of the product.

The CCL proposed a plan for 'the uniform set' so as to use a uniform NPC to reduce investment risk, to promote an intra-industrial division of labour, and to produce a standard NPC in the computer industry. This proposal with the assistance of TEAMA was announced in May 1990. It hoped to recruit 15-35 firms to join the NPC Alliance with each firm contributing NT$1.2 million. This immediately met with an enthusiastic response from the private sector. In the beginning, the CCL planned to develop a 286 NPC and gave training courses on the construction and interior design to participating firms. When the number of participating firms reached 30, it was decided that an extra prototype model should be given to each firm. Finally, there were a total of 42 firms joining the NPC Alliance by 27th of June, 1997. Meanwhile, the ITRI and the TEAMA gave a name to this uniform set as 'Teamate'[44]. The funds raised by the Teamate project exceeded ITRI's expectation. It was a total fund of NT$50.4 million equivalent to about US$2 million. This extra budget made the CCL decide to upgrade Teamate from 286SX to 386SX while the 286 model was still the dominant PC in the market. Even if this decision did not make the development of Teamate a step ahead of other competitors, at least it led Teamate to be a very competitive product.

The contract of NPC Alliance was signed in July 1990 with 42 participating firms. However, there were some firms that hoped to join the alliance after the alliance started work. Eventually, there was a total of 46 participating firms in the NPC Alliance in which four late comers should pay an extra 50% joining fee.

The participating firms can benefit from the Teamate project in several ways.

[44] Teamate (茶友) in Chinese means 'a friend for tea (time)'. The name of Teamate reflects its connection to TEAMA and its market segment aiming at second set of PC for using outside business environment. NPC has been defined as a second set of PC for user in its earlier concept of marketing, which is the same idea as the second car for leisure purpose in a family, but the share of NPC on the PC market has increased in a way that it can not be seen as a secondary product on the PC market.

They receive a technical report at each development stage; access to production models created by the alliance; motherboard designs; samples of mass production modules; participation in training courses; and a Teamate. In addition, IDB required that each firm should organise a 'learning by doing' team in order to cultivate some experts in the industry in case the project failed to create a commercially viable product, at least the aim of technology diffusion could be realised through a learning process. This made NPC technology diffused through learning by doing teams organised by the private sector, which has had an effect on the cultivation of experts.

2.3. The Complex Background of Participating Firms

In the beginning, ITRI intended to recruit intra-industrial companies, those who had at least the basic production line, and researchers and engineers to make further advances[45]. However, ITRI could not reject any domestic firm that wished to join the alliance under the guidance of IDB's open-to-all policy. The qualification for joining the NPC Alliance was loosely related to membership of TEAMA, but eight firms in the NPC Alliance were not members of TEAMA. Most firms were in the information industry, some were not. All firms joined the alliance with a common objective of expecting the transfer of NPC manufacturing technology, in particular, those that were PC producers.

However, the companies of peripherals (modem, mouse, etc.) and the suppliers of components (power adopter, keyboard, plastic case) are expecting to have easy access to the large number of business orders created by a new product. Other firms which are not in the PC industry, such as home electronics, communication, terminals and even textiles, might seek an entry opportunity into NPC manufacturing. Strangely, trade companies without any previous manufacturing experience also joined the alliance in

[45] According to Mr. Lo (Interview No.25), who is the General Director of the Office of Planning at ITRI and was as researcher/technical division's vice director of CCL in charge of the operation of the NPC Alliance, one of the aims of NPC Alliance is to diffuse technology in the industry so that ITRI expected participants themselves embodied basic technological capability to join the Alliance for 'learning by doing', not for the final product and the production module.

the sense that they hoped to seize the opportunities of export in the future, anticipating that if they could learn the design of NPC, they would find a manufacturer to do the OEM. Even new firms, created just before the formation of the alliance, simply wanted to share this big cake. Because of the complex background of the participating firms and their differences in motivation and engineering capability, the organisation and management task was very difficult.

2.4. The Taiwan Electric Appliance Manufacturers' Association (TEAMA)

TEAMA was renamed as the Taiwan Electrical and Electronic Manufacturers' Association (TEEMA) in October 1993. TEAMA and TEEMA refer to the same organisation. The name of TEAMA is used in this chapter because the NPC Alliance was run mainly in 1990, but TEEMA replaces TEAMA in the next chapter concerning the development of the television industry when the time span crosses the year 1993.

TEEMA is the largest association among 135 associations for manufacturing industry in Taiwan which are registered under the Ministry of Interior. It has about 4500 member companies, 85% of which are SMEs, defined as an enterprise having a paid-in capital of less than NT$60 million, and only 15% are large enterprises. The total number of employees under TEEMA's member companies was around 460 thousand in 1995, which was about 19% of total employment (2,485 thousand) in manufacturing sector in 1994 (TSDB, 1995:19).

The role played by TEEMA can be divided into two kinds, as a service provider to the industry and as an intermediary institute between the industry and government. In terms of its service provider role, TEEMA provides many services to the member companies, such as trade-related services (export promotion and exhibition), investment services, industry services, information services, legal services, and training services. In terms of its role as an intermediary institute, TEEMA is the bridge between the industry and government in relation to the fulfillment of policy requirements and the reflection of members' opinions. In this two-way communication, TEEMA works as a coordinator to relay government policies, regulations and administration instructions on the one hand, and to collect members' opinions on certain issues, protect members' rights and proposes plans to competent authorities. This is important as a means of promoting mutual understanding. Eleven functional committees, eleven product committees and eighty-six product groups were established in the TEEMA to ensure well-functioning intra-industrial communication in terms of market, product, and technology information.

A function that TEEMA has never actively performed is as a pressure group against government. The business associations in Taiwan act more as subordinates to support the implementation of government policies than as pressure groups to strive for their own interests. As Mr. Chen, the director of TEEMA's business department, states the relation between government and business associations is very harmonious in Taiwan, and TEEMA corresponds to government policies most of the time (Interview No.7). He stresses that the majority of domestic firms are not big enough to act as a pressure group, given that SMEs constitute 85% of TEEMA's membership[46].

To form the R&D consortia under the plan of TEEMA is an unusual function for business associations, which is generally unfamiliar to its foreign counterparts. The detailed operation of R&D consortia and the role of TEEMA will be explored in this and the next chapter. Due to the very successful development experience of the NPC Alliance, many TEEMA-led industry-wide R&D consortia were operating between 1990-95, as shown on Table 5.1.

The members of TEAMA hold a certain degree of collective bargaining power to gain government financial subsidies in terms of cooperation R&D (J.C. Wang, 1991:14). This is a consequence of the fact that the electrical and electronic industry is more research-intensive than most of the other industries in Taiwan. Under the condition of a

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[46] In answering the question that the export of TEEMA's members is in a leading position compared to other manufacturing associations so TEEMA should have a great bargaining power with government, Mr. Chen did not give a direct answer. But he gave me a very thoughtful smile when I asked whether many sweets came from the government.

short product life cycle and the severe international competition in this industry, domestic firms have formed more R&D collaboration to obtain new technologies and maintain their competitive advantage in the world market.

Table 5.1 Technology Collaboration Organised by TEAMA, 1990-95

1	Integrated service digital network PABX
2	Synchronous optical network
3	Notebook PC
4	Laser facsimile
5	G4 ISDN computer facsimile
6	X window terminal
7	Palmtop PC
8	Integrated service digital network customer premises equipment (ISDN CPE)
9	Digital tape recorder
10	Small size satellite telecommunications ground station
11	Encoded multi-task telephone
12	Network gate information system
13	Advanced television (ATV)
14	Liquid crystal projection television (PTV)
15	Wide screen 36 inch monitor (16:9)
16	Ethernet network multi-port bridge fiber optic cable digital interface technology
17	IC card
18	PowerPC alliance
19	Interactive TV/Set-Top Box (ITV/STB)
20	Digital Video Disc (DVD)
21	Personal Accessory Communication System

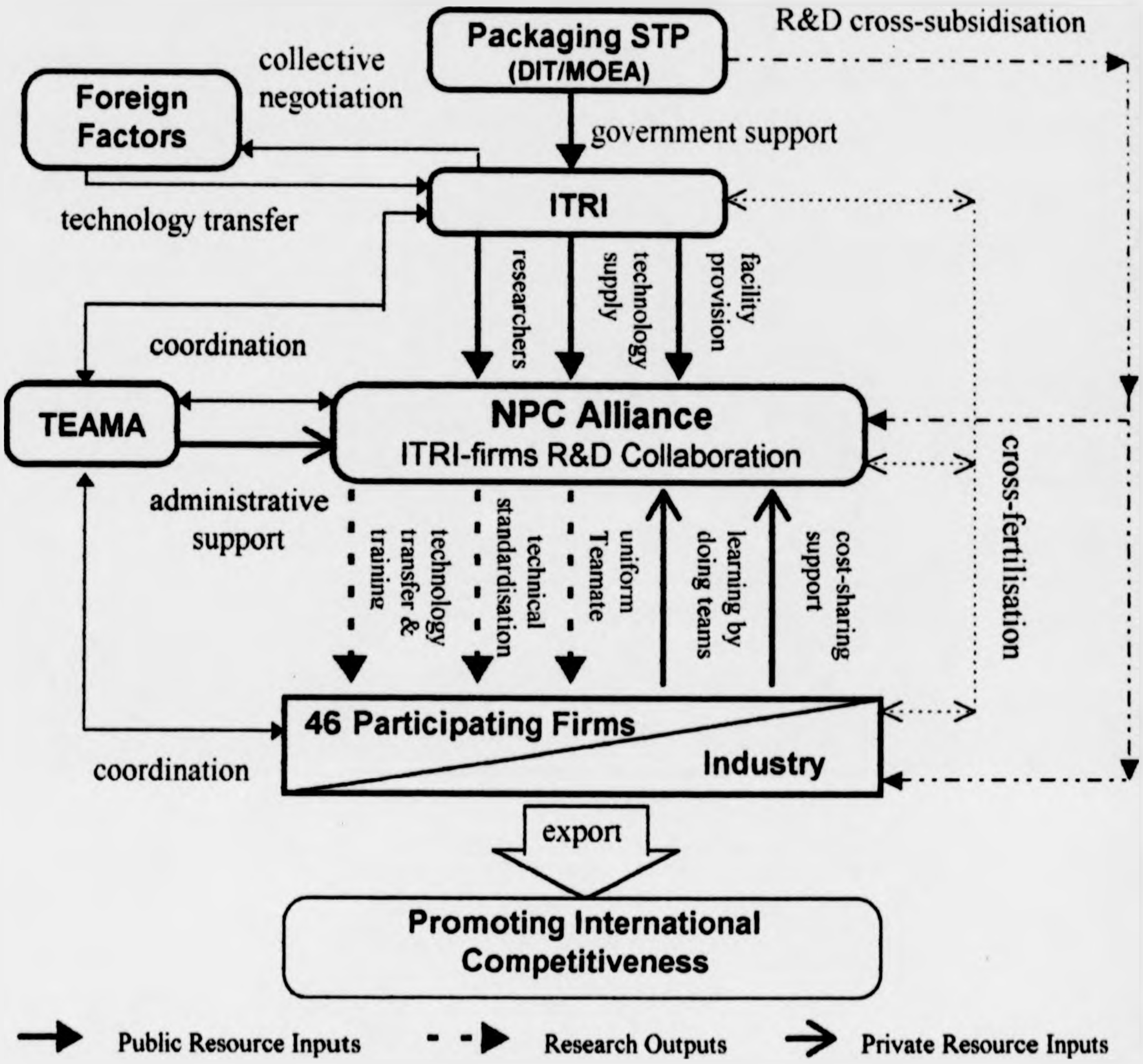
However, the argument here is that this is more as a reflection of the economic centrality of TEAMA's members than simply as a effect of autonomous coalitional politics. Economic bureaucrats are still the steering force in the policy reform, although some associations, or larger enterprises gradually increased their influence in policy decisions, which they did not during the authoritarian years (Chu, 1994:147). In recent years, the shift of R&D resources from the military sector to the economic sector, in which electric and electronics shared the largest part (See Chapter 4), reveals the changing priority of state concerns and the rising importance of hi-tech industry. But it is not perceived as a major policy concession to the private sector. Moreover, the very nature of state-sanctioned business associations prevented them from becoming an institutional base for autonomous collective actions. This structural characteristic of business associations inherited from past authoritarian rule made the private interests depend on the state for economic resources. It is inappropriate in the sense that textile-related associations successfully influenced the state policy preference, when the textile and garment industry received more incentives, subsidies and protections in the 1970s. However, the 'work-out' of textile and garment industry to overseas countries and the deprivation of previous privileged economic resources in the 1980s and 1990s was not caused by the declining ability of the associations to strive for their interests, nor by the increasing influence of other sectoral associations, rather by the changing nature of industrial structure. State priority is given to the technology-based sector which has a heavy weight in the national economy.

3. THE IMPLEMENTATION OF THE TEAMATE PROJECT

Figure 5.2 demonstrates the major interactions between actors in the Teamate project. The resource inputs of the public and private sector into the Teamate project are identified, and the outputs of research collaboration also produce as the expectations of project. Invisible effects of the project, such as R&D cross-subsidisation and cross-fertilisation are disclosed. These elements which constitute a successful process for new product creation in a cooperative technological project will be analysed in the rest of chapter.

In order to promote the Teamate project, a tripartite contract was signed by CCL/ITRI, TEAMA, and individual firms in July 1990. The total payment from firms was divided into three parts according to the contract. 50% of budget was assigned to CCL for the cost of R&D; 45% to 'the NPC Joint Development Committee'; and 5% to TEAMA for the administrative costs. 'The NPC Joint Development Committee' has four divisions, a R&D Division for product development, a Product Planning Division for suggestions about product design and standards, a Promotion Division which is in charge of media-related tasks, a Production and Marketing Division which is in charge of issues relevant to the post-R&D stage. The committee men and the directors of divisions were represented from the staffs of CCL, TEAMA, and firms.

Figure 5.2 The Interaction of Teamate Project



3.1. Product Planning Division

The final decision on the systematic standard of Teamate was made about a month after the contract was signed after many long and intensive meetings between the three parts. The efficiency of the Product Planning Division in setting out the product standards in a short time was motivated by the hope that the Teamate project could produce a prototype in time for COMDEX, a computer exhibition held in early November, 1990 in the United States. The 386DX NPC the size of A4 paper, height 5.4 cm, and weight 5 kgs with key components and interior design was technically standardised. Soon after this, the R&D Division started its tasks.

3.2. R&D Division

Among the four divisions, the R&D Division was most important to the success of NPC Alliance. For the purpose of the division of labour and of accelerating product development, the R&D Division was further divided into six Technical Functioning Groups, namely, the Motherboard Technical Group, the Mechanism and Keyboard Technical Group, the Power Supply/Battery Technical Group, the External Procurement Group, the Integration Test Group, and the Electromagnetic Group. The operation of these Technical Functioning Groups was organised by the technical leaders of CCL with the participation of the firms' engineers.

The main task of these groups was the transfer of laboratory technology to a state suitable for manufacturing. In the process of development of certain components, many international (mostly, Japanese) and domestic firms wished to make a free offer of modified or specially designed components to accommodate the needs of Teamate. Some suppliers were also the participating firms in the NPC Committee, which led to an accusation of monopoly. All component suppliers calculated that once their parts or components became the standard of Teamate, the rewards would be considerable. However, ITRI had abundant choices from which to select the most suitable component without paying a high cost in the development process. It also shortened the development process in such a way that many components could be developed by the suppliers.

The hard-working researchers and engineers in the Technical Functioning Groups were also very important in meeting the target of creating the prototype NPC by early November 1990. Between the final decision of a standard in the middle of August and the USA COMDEX in early November, there were only two and half months left to produce sample NPCs (1-2 samples to each member). Because the Teamate project was the first case of a R&D consortium in Taiwan which had attracted national concern about its results, CCL, TEAMA, participating companies, and component suppliers were enthusiastic about the progress of the Teamate[47]. Because of the pressure of time, some teams and supplier factories had to work exceptional hours (Interview No.25 & 30).

The experience of developing a lap-top PC at CCL and the supportive technology developed in the Packaging STP were the main factors leading to the rapid commercialisation of a NPC. The technological capability of CCL in the field of miniaturisation was in a leading position at a time when most domestic firms in the computer industry manufactured only less sophisticated products, such as keyboard, mouse, monitor, and diskette. The timing of Packaging STP added to ITRI was able to meet the need of the Teamate project in view of the fact that the core technology in packaging a miniaturised PC could be funded by government instead of using the resource of NPC Alliance. It has to be noted that this STP was aimed at developing the technology of high intensive packaging, not at directly developing the NPC product, but the application of the packaging technology had a substantial influence on the design of the NPC (Interview No.30).

However, the ideas and suggestions of firms' engineers were equally crucial to the extent that they provided practical manufacturing experience to overcome problems not envisaged by laboratory-based researchers in relation to mass production. Consequently, the integration of theoretical techniques and practical skill in the process of R&D created two advantageous elements. One was to offset the time gap between the transfer of technology and its transformation into a suitable state for manufacturing; the other was to build a model that firms could put into assembly line immediately. Both had a significant impact on matching the demand of the market, in particular, to the fast-changing market of a high tech industry.

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[47] The topic of a strategic alliance was very new to the society at that time, in particular, a very large-scale indigenous public-private R&D consortium, which can be observed from the frequent news concerning the development of the NPC Alliance in the local media (Table 5.7).

3.3. Production and Marketing Division

When the prototype Teamate was exhibited at COMDEX, the response of the market was very positive. The market potential of Teamate was recognised which led to eagerness on the part of participating firms that CCL should provide the final production module and pass the test under the regulations of the US Federal Communication Committee in order to manufacture products as soon as possible. Many interviewees hold the view that the achievement of NPC Alliance has been very successful in terms of product development so far. It is primarily as the result of the fact that the basic goal of the R&D consortium was clear and that every member was urgently asked to cooperate. However, soon after the sample model was developed, the motivation to cooperate for a common goal was eroded by the conflicts of the market potential for each firm. The situation between firms changed from 'we are all in the same boat' to 'on the same bed but with different dreams'. Gradually, the NPC Alliance broke up, and cooperation turned into competition.

The CCL kept on modifying and testing the functions of Teamate to make sure its final model could be mass produced after COMDEX. The output of the first experimental production was 1,200 Teamate NPCs which would be exhibited at CEBIT, a computer show in Hanover, Germany. In February 1991, the 1,200 Teamates became the focus at the CEBIT. The total of orders received from international buyers was twice that expected. However, the price of NPC in the international market dropped by twenty percent because the Taiwanese firms were competing with each other in terms of price rather than of quality[48].

The failure of the Production and Marketing Division to reach an effective agreement on the price led to a price war. Every firm hoped to expand its market share,

[48] The functions and design of Taiwanese NPCs in the CEBIT were the same at that time, the only difference was their appearances and marks because that their origin came from the same resource--Teamate. Taiwanese firms with the same product could not diversify market, but to fall into a 'bloody price battle' (Economic Daily News, 05/04/91). The international price for a NPC dropped from US$2,000 to 1,600 in few days during the CEBIT which was caused by the entry of Taiwan's Teamate.

but buyers knew that there was no difference in quality as the consequence of collective development. Fierce price competition was unavoidable. It showed the disarray of the management of the NPC Alliance. There was no way to regulate firms' marketing behaviour. Even ITRI and TEAMA could not help to solve the marketing disorders. 'CCL/ITRI, as a technology provider, would not involve any marketing issue', Mr. Lo admitted that 'it is better to let businessmen solve their problems in a business way' (Interview No.25). The government was also unwilling to intervene in such an issue because there were too many interests involved (Interview No.13).

There was a 'common price' agreed between firms in early September, 1990 after one month's negotiation, but it was soon broken when the products were marketed. The idea of collective production and marketing was advanced by TEAMA. It not only collected the related market information of international enterprises, but also invited the marketing directors of participating firms to form a coordination association in order to build a consensus on price and to discuss the issue of market division through product differentiation. However, in terms of marketing, the price coordination was destroyed by firms' 'profit first' expectation. In terms of product differentiation, most firms' technological capability was too unsophisticated to modify and add functions to upgrade their products. Thus, product convergence was high and all they could do was to make the appearance of products attractive and smart. Mr. Chen of TEAMA commented it as 'the selfishness of firms has spoiled the high-profit honeymoon period for a new product'(Interview No.7).

3.4. The End of NPC Alliance

The CCL had completed the task of creating a commercially viable NPC model by April 1991. According to the tripartite contract, CCL should prepare the transfer of technology and training courses to participants. As defined in the contract, CCL left the NPC Alliance and the diversification of NPC was the task of private firms.

The running of the NPC Joint Development Committee should have lasted for another three years in contractual terms, but no member paid attention to the function of the NPC Committee in practice. This was principally due to a lack of a common goal to keep the Committee in energetic operation. No decision of the NPC Committee could authorise or regulate members' behaviours. Besides, individual firms were too busy on the matters of production and marketing for themselves. Meanwhile, the activities of developing a second-generation NPC Alliance was started in February 1991. Members and non-members of the NPC Alliance were anxious about the new alliance instead of keeping an eye on the 'old' alliance. The NPC Alliance came to an end after CEBIT.

4. THE AFTERMATH OF THE NPC ALLIANCE

The evaluation of the NPC Alliance, in particular, its impact on international competitiveness, is extremely difficult for two reasons. Firstly, to judge a R&D consortium based on a short term perspective is inappropriate since most R&D investment can not boost commercial returns immediately. In 1991 and 1992, the criticism of NPC Alliance was very serious, for instance, distrust and quarrels between members, key components shortage, price competition and high product convergence (Table 5.7). However, it did create a champion product for Taiwan's export manufacturing in a longer term. Secondly, the effects of NPC Alliance on the corporate strategy and on the industrial policy are likewise difficult to assess. In theory, the aim of a strategic alliance is to create a win-win or all-wins for members of the alliance. However, in a micro view, Taiwan's NPC Alliance resulted in many bankruptcies of member firms, a most-of-them-lost lesson. There are less than ten survivors among forty-six members. In a macro view, this Alliance not only made the information industry as a whole more competitive, but it also discovered a more efficient way for technology diffusion.

4.1. International Reflection

Very little attention has been paid to the reactions of the international actors (foreign governments and enterprises) towards the NPC Alliance. The reflections about the NPC

Alliance of international actors were much stronger after the successful creation of a commercial NPC than in the development process.

4.1.1. In the process of development

Before the commencement of the NPC Alliance, Taiwan was an important supply source of less sophisticated parts and components, and an original equipment manufacturer of desk-top PCs. So, the NPC Alliance did not attract too much concern from large international PC companies. Meanwhile, international companies were developing their own NPC. The efforts of Taiwan's NPC Alliance might have been deemed as an effort of trying to enlarge the industrial base of PC manufacturing, but not as a challenge, or even a threat, in the eyes of international PC companies.

During the development process, some international companies kept an eye on the potential markets for high level key components, such as the key IC, the high power battery, and the LCD, if the Teamate could be accomplished. For example, Intel and Motorola offered a specially designed IC to fit in with Teamate, and Hitachi supplied a notebook-sized LCD. For other components, such as the motherboard, the case, the keyboard, and the IC card, Taiwan had the strength in design and manufacturing. In order to acquire foreign components, ITRI represented the NPC Alliance in negotiations with foreign suppliers, instead of each individual firm having to purchase their own requirements. Collective bargaining made the negotiation easier and the cost cheaper[49]. During this period, international enterprises were interested in the business opportunities which might originate from the NPC Alliance. They did not realise that this Alliance would lead to the generation of a strong competitor in the field.

[49] This method not only reduced the cost of obtaining key components, but also made the foreign firms willing to provide special service to cope with the standard of Teamate which they would otherwise to do, if the buyer only purchased a limited amount. Whatever the demands of alliance members in the foreign components, ITRI represented as a collective negotiator. It might be the desired components for Teamate in the pre-competitive developing process or the future needs of common components in the manufacturing stage.

4.1.2. After the birth of Teamate

The exhibition of a Teamate in COMDEX (US, November 1990) revealed the successful development of a Taiwanese NPC using its own technological capability. International actors were shocked by the fact that Taiwan had generated a prototype NPC through a public-private consortium in only four months. Moreover, the NPC price dramatically dropped on the international market after the appearance of the final Teamate in CEBIT (Germany, April 1991). The entry of Teamate into the international market had a serious impact on international companies. On the one hand, they were frightened, witnessing the cannibal marketing behaviours of NPC Alliance's members which led to the price slide of 20% in few days and of 35% in six months. On the other hand, international companies who had developed NPCs were annoyed about the shortening of the market skimming period, abnormal for high tech products. For those who were developing or planning to develop, they feared that further investment in NPC development might be wasted or the return might take a longer time.

Foreign firms and governments were also very curious about the formation and the operation of NPC Alliance[50]. The firms saw it as a good example of a strategic alliance to strengthen R&D, and foreign governments showed their interest in imitating a public-private R&D consortium to promote competitiveness. This is the case for international actors from developing countries, principally, from Southeast Asia. However, foreign actors, from the United States and Japan whose technological capabilities were ahead of those of Taiwan were more concerned about whether the government had a deeper and more direct involvement than simply the detailed operation of the Alliance in technology development.

[50] According to the interviewees, the overseas visitors from all over the world (including media correspondents, enterprise representatives, and government officers) hoped to get information about the NPC Alliance from IDB, ITRI, TEEMA, and firms. However, the visitors from different fields had different concerns. The media simply took this event as a story worth reporting; enterprises and governments were interested about how and what to form and run this alliance. From the statements of interviewees, their attitudes towards the overseas visitors were very conservative in the sense that they did not hope to cause any negative impression which might harm the future development of industry, in particular, the new form of 'public-private' collective collaboration. They pointed out that some visitors collected information for investigation rather than other purposes.

Japanese enterprises and government were eager to know how to form and operate a public-private R&D consortium which commercialised a product in a very short period of time. Japan has been perceived as a country with government involvement in the development of technology, so Taiwan's experience might provide a superior model for their future manoeuvres. Besides, many components manufactured through the Alliance have not only increased Taiwan's self-reliability to provide components rather than rely on Japanese sources, as in the past, but also to become the most important supplier of NPC's components and parts to a large market. This changed the condition of supply system of international NPC industry from a situation in which Japan and USA were dominant in the markets to one where Taiwan has became a new supplier gradually, starting from less sophisticated parts to high-value-added components[51].

The US was keen to know how and to what extent the Taiwanese government was involved in the Alliance. At that time (1991) international regulations on R&D subsidy had not reached any agreement in terms of permissible areas and financial limits for subsidy. If NPC Alliance had a large government subsidy, the US might apply countervailing measures to the export of NPCs from Taiwan, or more severely, they might deploy section 301 sanctions. The US left no stone unturned in order to investigate the matter[52], but the Taiwan government provided no financial assistance. The CCL researchers and technologies applied in the NPC Alliance, although cultivated by government, could not be deemed to have received financial assistance in relation to the NPC Alliance. As a matter of fact, the NPC fund (slightly more than US$2 million), contributed solely from private firms, is enough to develop a product, while the related

[51] This evidence shows the Taiwan indigenous efforts to upgrade its technological capability, instead of taking Japanese technologies as 'given' like the theory of Flying Geese model suggested that Japan as Asian technological driving force has diffused technology through relocated its production facilities to Asian tigers. Besides, the flying geese model also neglected the importance of the US economy as a market and as a source of technology, and the feature of personal connection in Chinese business circles (Hobday, 1994a).
[52] They did not believe that a successful commercialisation of a product in a short time could be achieved without direct government involvement in financial terms. When they could not find any evidence from government branches, ITRI, and TEEMA, the direction of investigation turned to the participating firms (Interviewee No.7).

experience, technologies, and researchers were available from CCL[53].

After the NPC Alliance, large international corporations frequently required information from ITRI about what kind of products it was developing or planning to develop. Their concern was that profits would be less good once Taiwan entered the product market. They wanted to avoid the overlap of market. Mr. Lo always asked them in return 'why should you ask what is the next product that ITRI will develop? All products were advanced by you (large international corporations). Taiwan, at best, is a fast follower' (Interview No.25). This demonstrated that international actors acknowledged Taiwan as a competitor in the field of high tech industry after a prosperous public-private R&D alliance.

4.2. The Criticism of NPC Alliance

The critiques of NPC Alliance were for the most part concentrating on detailed aspects in relation to its operations, rather than on the R&D outputs. The pessimistic voices towards the NPC Alliance were strong at a time when many members were bankrupt and when the price of NPC was in disarray, but soon to be overtaken by prosperity in the global market.

4.2.1. In a management perspective

CCL/ITRI was the leading actor in the NPC Alliance. It called for the formation of a strategic consortium which should take the responsibility of managing the operation of the alliance, at least nominally. However, the staffs of CCL were not sufficient to tackle the task. They were good at laboratory activity not at management, so CCL could only concentrate on R&D. Therefore, the general administration was moved to TEAMA, and the management and decision making were under the supervision of the NPC Joint Development Committee. The logistic support of TEAMA in terms of documentation,

[53] In this respect, the income of ITRI is about US$1 million (half of the total payment from private firms) for providing technologies, facilities and researchers to conduct R&D. However, the budget for Packaging STP was about US$4.5 million in this year.

accounting, providing meeting places, and communication, left little to be criticised, similarly the R&D progress monitored by CCL.

A development fund, 45% of the total payment from the private sector, was controlled by the Committee in order to procure materials and to designate suppliers who took contracts for design components. The outsourcing contracts and material procurements were in total disarray because there was no well-defined procedure and written penalties for delayed supply and poor quality (S. Wang, 1991:57-8). Besides, the phenomenon of participating firms getting outsourcing and procurement contracts revealed the result of dysfunctional management. This had been caused by taking advantage of 'insiders' and not regulating the overlapping identities of member and supplier which could lead to materials and components being supplied which were not the best choice. However, it was flexible enough for the R&D technical groups to obtain what they needed without experiencing a long procurement procedure which might delay R&D.

Even the Committee itself raised many problems. Firstly, the Committee announced itself affiliated to TEAMA, but TEAMA had no great say on its decisions due to the fact that participating firms were TEAMA's members and any action in favour of a particular firm would cause difficulties. Secondly, the organisational charter of the Committee was provided two months after the tripartite contract was signed. This charter failed to give a precise definition of members' obligations and rights. Thirdly, the Committee also failed to regulate the firms' cut-throat competition in terms of production and marketing because it lacked lawful authority to do so. This is an inherent defect of this type of arrangement since R&D resources and risks can be shared by members, but the market cannot. However, a cartel-like price agreement would lead to the violation of the fair trade law.

The inefficiency of the Committee in a management perspective was not really the result of a dysfunctional management, but rather an unworkable arrangement for the whole management. This was because the tasks of the Committee had not been properly thought through in advance, as well as an ambiguous delayed charter. In the perspective of learning about management and strategic alliances, the NPC Alliance is a failure in the sense that most members sank in the market. A successful strategic alliance is aimed at created a winning position for their partners. In the NPC case, it was a market-oriented R&D consortium which should lead to winning market share for its members. The result of this alliance in terms of corporate strategy hardly matched the nature of the alliance--to win together.

4.2.2. Selection of participating firms

There was no qualification required to join the NPC Alliance except that the firm had to be a registered firm with the ability to pay NT$1.2 million (about US$45,000). Thus, CCL and TEAMA did not have right to examine the background of members in terms of technological/manufacturing capability and financial capacity. This brought on bankruptcies in the stage of mass production. After firms accepted the technology and production module from the NPC Alliance, they could produce NPC either by self-manufacturing or by OEM. The situation for firms with weak technological or manufacturing capability was that they could not differentiate the product by extending functions, so the competitiveness of their products decreased gradually; for firms without a sound financial structure, they went insolvent when market returns would not balance their investments. According to Ms Cheng (Interview No.9), firms which fell down in the very beginning were those which underestimated the market competition and expected a rich return to repay their investments; firms bankrupted in the later stage, were those could not upgrade their products to catch the ever-changing demands of market. For less than ten survival firms, they all have/had the financial capacity to support continued investment and the technological capability to upgrade their products.

Too many entrants in an alliance also contribute to chaos in management and coordination. The management of NPC Alliance has been termed the integration of 'many chicken heads on a cow's body' which illustrated the difficulties in the process of decision making and management (Interview No.25). For example, the large firms required a relatively high standard of product reliability and comprehensive technical reports, and the requirements of smaller firms were biased towards a highly commercialised product and the complete production module (S. Wang, 1991:59). Besides, the larger the firm, the stronger the influence in the Alliance. Thus, how to reconcile various intentions added to the burden of management. It was suggested that a longer time of pre-alliance activities to survey the intentions of the private sector would have solved this problem (Interview No.30).

The low-cost sharing principle of NPC Alliance attracted many business opportunists to join in. Many opportunists free rode the result of research without a positive contribution in the process of R&D. Most of them might have an intention of 'hit and run' in the market, so they did not make a strong commitment to the Alliance. Once their product was marketed, they lost commitments to the Alliance. However, how to determine an appropriate cost sharing is a dilemma since a high cost deterred firms' willing to participate and a lost cost created free riders.

According to a survey on the relationships between NPC members' evaluation of the Alliance and their attributes (D. Lee, 1992), the background of firms and the rate of NPC production shared in a firm's turnover would affect their evaluations. The intra-industrial firms and the higher rate of NPC shared firms' turnovers led to a positive evaluation. Besides, a highly active attitude of a firm towards the Alliance also showed a confident evaluation. However, some variables (the size of the firm, the age of the firm, and the firm's expenditure on R&D) did not appear to be clear differences on evaluation[54]. 'Firms from the same industry create fewer conflicts than firms from

[54] This survey was conducted in 1991 at a time when most members were in their profitable period. If possible, a re-survey of participating firms on this point in 1993-4 would tell another story, but many firms had disappeared at that time. They might change their attitude towards the success evaluation after the appearance of financial difficulties and the appearance of technical hindrance of upgrading the level of product.

different industries in a R&D cooperation' (J.C. Wang, 1991:27). Correspondingly, selecting members should be restricted to intra-industrial firms, or at least, firms in related industries, and to active participants rather than those motivated by 'a chance to share the cake'.

4.2.3. *High dependence of key components and high product convergence*

The sources of key components, in particular, CPU and LCD, were controlled by foreign companies which made the Taiwan NPC industry subject to their supplies. Taking the supply of Japanese LCD as an example, Taiwan's shortage of LCD was very serious in 1991-92, for two reasons, as D. Lee (1992:20) suggested: first, the suddenly increasing global NPC market resulted in supplying Japan's domestic demand as a priority; second, Japan depressed Taiwanese firms' price-destroying competition by controlling the supply of LCD in order to protect a high profit.

The high dependence on foreign components limited the product profit in the short term. In the long term, however, it is better to reduce this dependence and rely on home manufacture. Otherwise, it is likely that the outcome would simply be a foreign company's assembly factory. Nonetheless, the time to create a prototype NPC for the Alliance was just a few months, and it would be too severe to criticise dependence on foreign key components in these circumstances. It was more important to make a commercial product rapidly so as to capture the immediate demand of market than to avoid using foreign components at this stage. Some components take a long time to develop, and Taiwan took 3 years in R&D to produce indigenous LCDs, for example.

As a consequence of the NPC Alliance high product convergence was also inevitable. Limited time for development could be the reason. To differentiate product should be the responsibility of each firm since the aim of the NPC Alliance was to create a uniform NPC. However, it provided a lesson to other alliances to avoid the same coverage of firms' backgrounds.

In response to the high dependence on key components and high product convergence, to incorporate up-, middle-, and down-stream industry into an alliance would provide a solution. Then, the firms in up-stream industry are in charge of parts; middle-stream, components; and down-stream, industry end products. The division of labour in an alliance solves problems of dependence and convergence. Most importantly, a centre-satellite supply system in a product/industry will be established through the consortium. It also avoids members competing with each other on the same market segment or the final product. It is true that, sometimes, the profit on component is much higher than that of final product, in particular, the components can capture a large market share[55].

4.2.4. Competition and subsidy problems

Some large firms criticised the fact that a public research institute should not organise a R&D consortium because small firms could get technology for a tiny payment compared to the R&D investment of large firms. In their language, it is a punishment to those firms with technological capability which had invested in NPC development because the government equipped small firms with technology to compete with large firms. Moreover, it also discouraged small firms from doing R&D because if they could get technology from ITRI's alliance, why should they do R&D themselves (Interview No.9).

Acer and Mitac, the two largest computer companies, complained that a cooperative research consortium was organised by a public research institute because the market would be monopolised by them if there were no such alliance (Interview No.1 & 19). However, Mitac took part in the NPC Alliance for two reasons (Interview No.19). First, it could enlarge its technology source. Second, it could monitor events

[55] According to the smiling curve theory of Acer's Stan Shih, a anti-traditional business theory which rejected the product assembly as the highest value-added industrial activity, stressed that the components and distribution were the ones. The cost and speed are two important factors leading to the competitive components on a global market. (Interview No.1)

and avoid the risk that rivals might gain from the project[56]. Acer, one of the top three international PC manufacturer in 1997, did not join the NPC Alliance in a consideration that if it did, their NPC product would lost its distinctive character, so Acer in spite of its good reputation in quality, did not catch the market shares in the beginning (Interview No.1). The market share of Acer's NPC did not perform as well as their desk-top PCs and other peripherals. The result was that Acer was in financial difficulty in 1991-2 which was probably caused by a failure to catch NPC market demand. However, Acer's NPC is still the best-seller in Taiwan now and among the top ten in international markets due to their brand name and strong technological capability.

The case of Packaging STP is an issue of R&D cross-subsidisation[57] to create private benefits, but not necessary at the expense of the exchequer (or large companies) because the whole economy will benefit. Taking the industry as a whole, the total investment in NPC production was increased as well as the productivity by the government project. This could not be considered as a direct subsidy to production from the government in terms of unfair measures, unless a new setting of international regulations, because the government involvement in the technology development is a growing fashion to increase national competitiveness. In addition, Packaging STP confined its R&D activities to the pre-competitive stage. The term cross-subsidisation may be more suitable to describe the indistinct and indirect grant to the technology development for the industrial sector. In the case of Teamate project, the open-to-all policy thereby avoided conditions of asymmetric competition in the monopoly case by selecting only one or a few large firms. It can not be argued that government subsidised SMEs to compete with large firms since all firms could join the Alliance according to

[56] This matches the suggestion of Porter (1990:635) that some Japanese firms participated in MITI's project based on defence to avoid benefits giving to their competitors. Unlike Taiwan whose SMEs were heavily dependent on public research institutes to support their technology, Japan's firms put more effort into their own private research in the same technological field, rather than those of the MITI's cooperative projects.

[57] According to Pass & Lowes (1993:106), cross-subsidisation is the practice by firms to shift resources between different departments -- the internal subsidies from the profits generated by one product or department to certain products or departments. This is normally as a means of financing new product development, diversification into new areas, or to support price cuts to cope with intense competition. The meaning of cross-subsidisation for the application in a national setting in this chapter was derived from its two characters: cross-sectoral subsidy and financing new product development.

their own corporate strategies. Therefore, as far as the government policy is concerned, the government had invested a large amount in the development of related technology and hoped to diffuse technology into the private sector in as far-reaching a way as possible (Interview No.13).

Competition also produced two problems, one was the fear of collusion in theory, and the other was over-competition by price variations in practice. Economically, the process of firms striving against each other to secure customers for their products, defined as competition, is a form of market structure. The nature and strength of competition has an essential effect on market performance from a public-interest angle. There is a worry that the side effect of R&D collaboration between firms in an industry will create an anti-competitive environment in which firms tends to collectively collude (J.C. Wang, 1991:23-4). Nonetheless, it is unlikely to happen in the case of Teamate. Taiwan's products did not have a significant market share with which to manipulate world markets by a domestically collusive agreement and by anti-trust regulations applied by most countries in an international setting. In Taiwan's market, import liberalisation and Fair Trade Law also countered collusion. All this suggests that the risk of collusion is very slim.

After the NPC product was marketed competition became unpredictable. When the relation between firms turned from cooperation in the R&D period to competition in the manufacturing period, firms acted individually in a capitalist way to raise market share rather than collectively in a conspiratorial fashion to monopolise the market and maintain a high profit. Anti-competitive practices did not occur, instead fierce competition developed by (low) price variations, not by product differentiation or by low cost. As a consequence, many members of the NPC Alliance were bankrupted.

A very high rate of bankruptcy was presented as the failure of NPC Alliance in corporate terms. The closure of companies is very common in Taiwan's SME-dominated economy, but this does not mean the closure of business is mainly caused by bankruptcies. Companies may leave a business because of low profit or may shift from one sector to another. For less than ten among 46 members to survive was abnormal. The basic character of high-tech industry is high profit, and it also denotes high risk. To survive in the high-tech product/industry, as well as technology-intensive and the capital-intensive requirements, speed is very important[58]. Many firms underestimated the risk and this led to a wrong corporate strategy in terms of further investment without integrating high speed product innovation into marketing. Besides, no one could expect 46 rivals, emerging from Taiwan and competing in the international market to survive at the same time.

The present situation on the NPC market reveals the low achievement of the surviving NPC members in the field of NPC industry. It demonstrates that the NPC producers now are not those in the initiative group. There are only two members (Tatung & Mitac) still among the top ten producers in Taiwan's NPC industry. Many other existing firms' main products are not NPC, for example, Proton (electronics, TV, and monitor), Dbtel (telephone-related & electric product), ADI (PC peripherials), and AOC (TV & monitor). The features which the survivors share are that they are not SMEs and have experience of manufacturing in the relevant industry.

However, seven years is quite a long period of time to observe the evolution of a high-tech industry. It is far more difficult trying to trace the mobility of trained engineers and the movement of participating firms because of the high mobility rate of engineers and capital in Taiwan. The information about the mergers between participating firms, mergers between participating firm and outsiders, and re-engineering of firms, is unobtainable. Also, whether there were other cases where large enterprises joined the Alliance through their spin-off companies, like Mitac did, is hard to prove now.

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[58] According to Interview No. 18, the product of high technology characterised as 6-3-3 model--6 months for R&D, 3 months for fast marketing, and 3 months on the decline. Thus, the speed-oriented product innovation is the core to capture the market. The determinants of speed are, time to market, time to volume, time to cost of goal, time to customer satisfaction, and time to decision making.

4.3. The Influence of NPC Alliance

The influence of the NPC Alliance in Taiwan was very positive except for the management issues and the failure of some members' corporate strategies relative to the deployment of manufacturing and marketing. Taiwan not only created a competitive product for export, but also built a new arrangement for technology diffusion in accordance with the model of NPC Alliance. One point that has to be made is that the success of the NPC Alliance could not have been achieved, if there were no support of technology from the public research institute and no support of a sound infrastructure for the PC industry.

4.3.1. Standardisation and creating a competitive product

The NPC Alliance had two very basic results from the development of a uniform Teamate. First, it built a very competitive product. Second, the Alliance standardised the NPC which would take a longer time to reach an agreement if let the firms to compete each other with their own formats. In other words, the Alliance had facilitated the establishment of product standardisation.

The standardisation of a NPC makes a crucial contribution to the PC industry as the advantages described by Mowery:

> 'The establishment of technical standards can assist the adoption of new technologies, since they can reduce uncertainties concerning the performance of a new device or technology, reduce the costs of "customizing" a piece of equipment to be connected to other devices, and may facilitate entry into the production of a new technology, thereby lowering prices. The process of establishing technical standards also generates considerable information about the performance characteristics and other aspects of a new technology that may assist broader public programmes of technology extension and assistance to potential adopters. All of these characteristics of standards are likely to be especially important to information and electronics-based technologies, since there are often applied in networks and require the interconnection of numerous components that are often produced independently' (Mowery, 1995:536).

Table 5.3 The Productivities and Value of Outputs in Taiwan's NPC Industry (1990-96)

Year	Productivity		Value of Outputs		Memo
	Thousand Sets	Growth Rate	Million (US$)	Growth Rate	
1990	217	-	319	-	Teamate project
1991	534	146%	688	157%	-
1992	861	61%	947	38%	Market share in order: Japan, US, Germany, Taiwan
1993	1,291	50%	1,667	76%	World 3rd largest NPC producer
1994	2,057	59%	2,729	64%	World 2nd largest NPC producer (28% world market)
1995	2,592	26%	3,339	22%	Japan's produced 2,650 thousand sets. Taiwan produced 2,592 thousand sets (27% world market).
1996	3,370	30%	5,300	59%	World largest NPC producer; 32% world's NPC market share; 90% of NPC for export
Total/ Average	10,915	62%	14,989	69%	89% of NPC for export in 1992 91% of NPC for export in 1993 94% of NPC for export in 1994

Source: 1990-93 data from III (1994:10); 1994 data from DIT (1996b:3) and CDN (12/09/95); 1995 data from DIT (1996d:44) and Communication Bank (Nov. 1996:30); 1996 data from Economic Daily News (23/11/96; 24/03/97). Data for export ratio from III (1995:86).

The data in Table 5.3 shows the extraordinary growth of the NPC industry in Taiwan. The 1990-96 average annual growth rate of productivity is 62% after the NPC Alliance. In particular, the 1991-92 growth rate is 146% demonstrating immediate market return after the creation of a uniform Teamate. The total value of outputs is nearly US$15 billion, and the total R&D investment of the NPC Alliance is only US$2 million. Thus, the cost-efficiency of this investment is tremendous. The cost-efficiency of NPC Alliance is 7,500 times in a 6-year span, if the outputs divided by investment (15,000 ÷ 2 US$ million), but the investment merely indicates collective R&D which excludes the Packaging STP, investment in production and in further R&D by the private sector.

The international competitiveness of Taiwanese NPC and key components is now the highest in quantitative terms in terms of market share. This is not totally attributable to the NPC Alliance as the continued efforts to advance NPC technology also occupy at least the same weight, however, this Alliance broke the most difficult part -- the entry barrier, and provided a uniform model for future advancement which is invaluable. Moreover, the standardisation of components has had an essential effect on the further development of the NPC industry. This cuts down the waste on the duplication of the development of the production module within the industry, and more importantly, led Taiwan to becoming a principal supplier of NPC components. Intel's Taiwan manager commented, 'I don't think any computer company can survive nowadays without buying from Taiwan. Taiwan has become the arms dealer of the computer wars (Business Week, 28/06/93:36).' Table 5.4 demonstrates the procurement relationship between international corporations and Taiwan.

Table 5.4 The Procurement of the Eight International Largest Companies from Taiwan in PC Industry in 1995

World Ranking		Desk-top PC & Motherboard	NPC	Monitor
1	Compaq	20-25%	15%	50-60%
2	IBM	35-40%	15-20%	50-60%
3	Apple	-	25%	20-30%
4	Packard Bell	50-60%	-	65-75%
5	NEC	20-25%	-	20-30%
6	Acer	100%	100%	100%
7	HP	-	60-70%	60-70%
8	Dell	50-60%	25%	80-85%

Source: MIC.

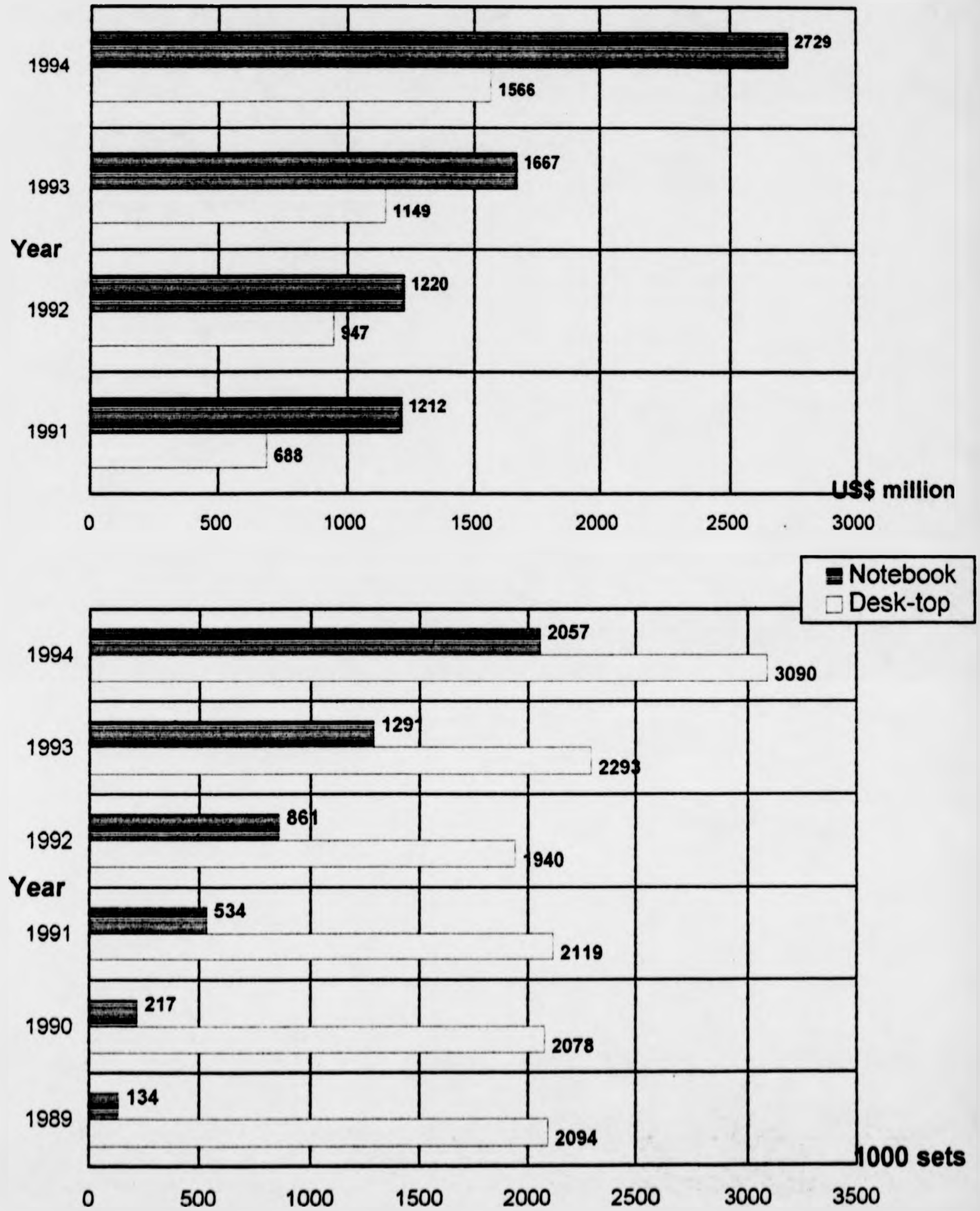
4.3.2. Strengthening computer industry

Taiwan's overall production value of computer products still maintained a high level in 1991-93 in spite of a sluggish worldwide market. It is argued that the high growth rate of the computer industry will not be maintained without a constant increase in the share of NPCs among all PCs produced in Taiwan. According to Mr. Chang (Interview No.2), a researcher of NPC intelligence and author of III (1994 & 1995), the relative decline of the share of desk-top models is because of weakening demand and increasing production by overseas subsidiaries of Taiwanese firms. While the sluggish desk-top PC market stagnated the growth of Taiwan's exports, the increasing export of NPC has compensated for the decline. Also, the rapid growth of NPC export led Taiwan to be the nation with the third largest information industry in 1995, only behind the US and Japan, from the fifth position in 1993 (DIT, 1996d:43).

The high-value-added character of NPC has become the principal momentum of the growth of the computer industry. Figure 5.5 shows that the price of a single NPC was about 2.5-3 times that of desk-top PC. In 1993 (1994), the volume of the output of NPC shared 36% (40%) of the total volume of the output of PCs, and the value of the output of NPC shared 60% (64%) of the total value of the output of PCs. In 1993 (1994), the volume of the output of desk-top PCs shared 64% (60%) of the total volume of the output of PCs, and the value of the output of NPCs shared 40% (36%) of the total value of the output of PCs. Accordingly, although the total volume productivity of NPC was less than that of desk-top PC, the total value productivity was more than that of desk-top PC.

High value-added also led to indigenous production, unlike many other products of PC peripherals which moved out of Taiwan, looking for a cheaper cost production location. The timing of the rise in the NPC sector has weakened the possibility of deindustrialisation in the information industry, and also strengthened Taiwan as a base of information technology in the world. It does match the expectation of government that the more high tech, high value-added industries are rooted in Taiwan, the more possibilities Taiwan has to become a technology island. The continuing efforts of NPC R&D coping with other R&D fields related to digital and electric industries might make Taiwan form a strong R&D infrastructure (or a strong industrial cluster) in the next wave of high tech production.

Figure 5.5 PC Outputs by Model, Value & Volume



Source: III (1993:88-9, 1994:9-10, 1995:86-7), DIT (1996b:3 & 1996d:48), Communication Bank (Nov. 1996:3).
Note 1. In 1994, NPC shared 28% world market, Desk-top shared 8% world market.
In 1995, NPC shared 27% world market, Desk-top shared 10% world market.
Note 2. In 1989, the NPC referred as Lap-top PC.
In 1990, the outputs of NPC combined NPC and Lap-top PC.
In 1992, the 98% outputs of NPC was 'real' NPC.
In 1993, the 99% outputs of NPC was 'real' NPC.
In 1994, the outputs of NPC included 3% of Sub-Notebook-Sized PC.

4.3.3. *Accelerating technology diffusion and technician cultivation*

A very important contribution of the NPC Alliance to the computer industry is speeding up the pace of technology diffusion and widening the effect of technician cultivation. The open-to-all policy to gather firms joining the Alliance had increased the difficulties of management, but it had a good effect on accelerating technology diffusion and technician cultivation. Through the process of 'learning by doing' with CCL's researchers on the development of Teamate, engineers from the private sector have been educated in the latest technologies and packaging know-hows.

The number of engineers who benefited was hundreds. Every firm had to assign a few engineers to participate in the R&D activities in each R&D Technical Group, and there are six of them. In addition, many training courses, technical reports of every stage, and production modules organised by CCL certainly served as essential learning materials. At the time when NPC technology was still new to Taiwan's PC industry, a large amount of expertise did inject fresh blood into PC manufacturing. Although many firms disappeared, the additional skills would never vanish and they could always find places to apply their knowledge in Taiwan.

In terms of technology diffusion, NPC technology has been widely spread through the NPC Alliance. Without this Alliance and 46 participating firms, the pace of technology diffusion would have been slower. Even if many large firms invested in their own R&D, technology diffusion might take a longer time to diffuse to the whole industry. The number of firms with ability to manufacture NPC products increased from no more than 5 firms before the Alliance to two-digit firms after the Alliance, revealing a wide spread of manufacturing know-how.

To evaluate the effectiveness of technology diffusion is not easy, in particular, there is no statistical evidence to exhibit how and to what degree Taiwan's NPC technological capability was promoted by the Alliance. Besides, it is also impossible to rule out how those 'learning by doing' teams were actually benefitted because no relevant material was obtainable. The phenomenon of free-riding the result of R&D by organising a perfunctory team, a layman or inexperienced team, to meet the requirement of IDB exists, very possibly in the teams of non-manufacturing members. This should shrink the scale of technician cultivation. If the increasing productivity and market share are the indicators, even though it is unclear that there will be a connection between production and technology diffusion and technician cultivation, then the effectiveness is clear.

4.3.4. Integrating of R&D and manufacturing

The pattern of technology transfer from the public technology-supplying institutes to the private sector was a waste of time in a new era of global competition. The key technology development and the industrial application of technology were separated in Taiwan in the past, although this pattern did not affect traditional industries and less sophisticated sectors seriously. However, this brought about two time-delaying consequences in meeting market demands, in particular, in the high tech sectors. Firstly, technologies developed by the research institutes supported by the government could not be transferred to the private sector until they were fully developed. The outcomes of R&D might be postponed by the public research institutes, and firms might not accept incomplete or obsolete technology. Secondly, it took a period of time for the firms to commercialise technology, even when they could apply technology to production successfully. This normally delayed the time of product to market.

In the case of NPC Alliance, the technology development and the commercialisation of technology proceeded synchronously. The government project, Packaging STP, sponsored CCL for the R&D of packaging technology which could be applied to the development of a miniature computer. Meanwhile, the Teamate project, a public-private cooperative product-oriented research plan led by CCL, attempted to create the uniform NPC for the PC industry. Two projects were developing simultaneously, which cut down the time for development and avoided a long process of technology transfer and of product commercialisation by the firms themselves.

The effectiveness of coordination between the government project and ITRI-firms consortium were not only shown in terms of the short time span for development, but also resulted in promoting the rapport between research-oriented innovative activities and manufacturing-oriented product design. The linkage of pre-competitive research and practical competitive production provide a feasible way to integrate technological development, technology diffusion, and industrial application at the same time. However, it would not be realised if the research groups of both projects were not the duplicate team from ITRI. Under this circumstance, the R&D of key technology and the design of Teamate became more efficient and manageable by the control of the same researchers. Before, the work was divided into two segments, each with a different team -- the pre-competitive work of technological development by ITRI and the transitional work of industrial application by the private sector.

Moreover, the vertical collaboration brought the laboratory-based experience of technological development and the practical experience of production-oriented development together which has had a cross-fertilisation effect on product development. The integration of different technological specialities and images into a R&D team fertilised the facility in the process of product development. It also provided a channel to exchange ideas and promote mutual understanding between two different levels of technology development.

5. NPC ALLIANCE AS A NEW STATE-INDUSTRIAL ARRANGEMENT

5.1. Government-Industry Cooperation

The Teamate project succeeded because it involved technologies directed to industrial concerns which stimulated the aggressive interest of the private sector. However, it could not be effective without the contribution of the public sector. Rather than leave the private sector to discover the competitive advantages of their own, ITRI, a public sector research institute, was the leading actor in the project. It identified the importance of NPC as a new generation PC product, and initiated a proposal for organising a public-private R&D consortium.

Mutual trust is seen as a core factor for the effective operation of a cooperative project. However, the source of mutual trust came from the objective third party. It was not generated between the firms themselves. Given that the project only succeeded at the stage of R&D, not at the stage of production and marketing, CCL/ITRI, which did not involve any market interest, is important. It was mainly because ITRI played not only the role of a technology supplier, a facility provider, but also a R&D project organiser. Powerful and neutral representatives from ITRI mediated conflicts between firms in relation to the direction of technological development and accelerated the process of agreement on basic technical standards.

TEEMA played more a secretarial role than that of a decisive leader. As mentioned before, TEEMA provided all the necessary logistic support to cover the area that CCL was unable to tackle. It was also in charge of the administrative coordination. The participation of business associations in the public-private cooperative project has become a part of institutional arrangements in technological development. The increasing weight of the association in the case of HDTV development will be examined in the following chapter. However, TEEMA did not involve itself in the role of interest representation to negotiate with ITRI or the government, and this is not what would be expected of a liberal corporatist agreement.

The final goal of government projects is to foster the competitive strength of the private sector which can only be realised through the operation of firms. Firms are the main actors which compete in the international market because the government and ITRI were not the manufacturers of any product. Firms brought their resources and engineers into the Alliance which enabled the Teamate project to achieve economies of scale normally enjoyed by large enterprises. The results sharing by the participating firms were created by the public-private cooperation which they would never acquired by their own efforts. Technology has been deeply and widely diffused to the industry through the Alliance.

The relationships between different actors in the NPC Alliance was displayed in Figure 5.2. An unprecedented combination of the efforts of the government and industry in order to create new products is disclosed. This new relationship between the government and industry can be characterised as an institutional strategic partnership. ISP not only has had a key improvement on employing government resources in a more efficient way, but also put public and private resources together in the same field. The product-oriented R&D consortium served as the dynamic for public-private cooperation. This has overcome the distance between the two sectors and led to convergence in technological development. The government policy instrument, STP, was able to apply its technological outcomes directly to industrial products. Individual firms saw the Alliance as a main source for gaining technology and as a risk-sharing shelter. In particular, the government has been the largest risk-share for the very heavy investment in fundamental technology.

ITRI represented a surrogate for government intervention in civil technology development. In Taiwan, public research institutes have been one of the most important policy measures to implement the goal of upgrading technology. In the eyes of industry, public research institutes are partners to provide solution to manufacturing obstacles and to provide technology to increase productivity.

ISP has had a considerable effect on technology development and diffusion. This is an innovative attempt to establish cooperation between public agencies and the industry in the process of high-tech innovation. In the concluding chapter, the essence of ISP and its comparison with the next case study will be treated comprehensively, showing how a strategic partnership has been brought into an institution.

5.2. The Effects of the Teamate Project on International Competitiveness

The influence of NPC Alliance on international competitiveness in individual firms and in the industry as a whole varied, is shown in Table 5.6. The influence of NPC Alliance in terms of export performance was positive in the member firms and the industry in the short term; in the long term, it was very successful in the industry as a whole, but the performance of member firms was determined by their technological capability and financial capacity.

Table 5.6 The Impacts of NPC Alliance on International Competitiveness: A summary

	Individual Firm	PC Industry
Short Term	Success	Success
Long Term	Depends on financial & technological capability	Very Successful

The instantaneous increase of NPC exports by 2.5 times in the following year after the creation of Teamate exhilarated the government in an expectation that other public-private cooperative research projects would follow suit by modelling the NPC Alliance. The public-private cooperation has been justified in aspects of avoiding duplication of effort and reaping economies of scale, and has been encouraged by fast commercialisation of Teamate. In the 1990s, many STPs were required by the MOEA that the proposal should have the industrial participation design-in. This symbolised a changing face of government intervention in terms of industrial technology development.

The effectiveness of R&D cooperation was hampered by management difficulties. However, those difficulties did not seriously destroy the technological outcomes, which happened mainly at the marketing and the production stage rather than at the R&D stage. In the following cases caution should be focused on correcting the defeats of management in the process of development. However, any collusive agreement arising from the cooperation should be carefully regulated by the government to ensure a fair and competitive market.

The time lag with major new PC products of leading international companies has been narrowed since 1980s. The lag was 25 months for 286 PC in the 1980 (C.N. Wang, 1994:16). However, Taiwan's NPC was in the market only few months after Toshiba's in the 1990 because the collective efficiency of Teamate project shortened the gap to a substantial degree. The time gap of new PowerPC microprocessor between the USA's and Taiwan's manufacturers was only one day in June 1995. The PowerPC microprocessor was a new product from the alliance of IBM, Motorola and Apple, intended to challenge Intel in setting a new industrial standard in the second half of the 1990s. 'Taiwan had achieved the technological sophistication to be the first outside the USA to develop a range of products based on PowerPC' (Mathews & Poon, 1995:43). The development of PowerPC-based technology was through a NPC-like consortium called 'Taiwan PowerPC Alliance' with 30 participating firms.

This new alliance was organised by CCL-TEEMA axis in November 1993. CCL was still the driving force for technological progress and collective negotiations with foreign enterprises (IBM and Motorola). This new alliance has avoided many mistakes made by the NPC Alliance. Particularly, the improvements on identifying firms for membership and assigning members to different working groups have had decisive effects. Members of Taiwan PowerPC Alliance with reasonable size and strength were selected from PC industry and related industry covering the up-, middle- and down-stream industry. The divergence of firms' backgrounds enabled the development of PowerPC to a wide range from special chips to final products. This also avoided the direct competition of members in the same market segment. Firms joined different working groups according to their sophisticated field of technology speciality, so the different voices about the direction of development had been disregarded. The convergence of technology in each group enabled firms to uptake the technology transfer. Thus, firms were able to differentiate the product. This case demonstrated the integration of vertical cooperation and horizontal cooperation for the development of new technologies and products, unlike the NPC Alliance which concentrated mainly on horizontal cooperation.

5.3. Changing Pattern of Technology Diffusion

Successful innovation is associated with institutional-specific routines, it develops over time and through trial and error. Taiwan took a period of time to search for a feasible arrangement so as to strengthen industrial competitiveness and to deploy government resources efficiently.

In the 1980s, the main effort of government in the development of industrial technology was concentrated on a less effective institutional array. This institutional type isolated technology development from industrial adoption. The implementation of STPs was solely organised by the public research institutes without the participation of industry. However, the information asymmetry between the government, research institutes and the industry meant that the research outputs might not match the demand of the private sector. Moreover, it also took some time for technology transfer and adoption by the firms.

At the end of 1980s, the government attempted to bring the private sector into the process of R&D, but the results were not as successful as expected. Two public-private cooperative research projects, the Software Engineering Environment Development for the computer industry and the Two-stroke Engine for the automobile industry, with the government subsiding the full cost of R&D activities did not produce a decisive effect on the industries. The main reason leading to inefficiency was the research-oriented nature of projects which could not stimulate the interest of the private sector (J.C. Wang, 1991). The case of software development, organised by III with 32 participating firms, aimed to establish technical standards of which only a small part of the technological results can be transferred to firms. The case of engine development, organised by ITRI with 5 local participating firms[59], produced mostly fundamental knowledge which could hardly be applicable in manufacturing immediately. Both projects, which were originally designed to run for three or four years, were terminated after one year of implementation because the government was dissatisfied with the results.

Since 1990, two main tendencies have influenced the pattern of STPs, inspired from the development experience of NPC Alliance. One is the incorporation of the private sector into the R&D activities instead of firms' waiting for transferable technology. Another is the field with which firms participated, directly connecting to industrial concerns, which means that the nature of collaboration is product-oriented rather than basic research-oriented.

Table 5.7 NPC-related News During the NPC Alliance

Date	Newspaper	Title
14/02/90	Industry and Commerce Daily News	Toshiba's NPC, first to market.
28/02/90	Industry and Commerce Daily News	CCL makes suggestions to develop NPC in a form of R&D consortium.
02/06/90	Industry and Commerce Daily News	Technology for NPC maturing. The orders for laptop PC declining.
02/06/90	Economic Daily News	80386 SX NPC - the best 'Sharp Weapon' in PC markets this year.
04/06/90	Economic Daily News	NPC and laptop PC become very popular in world's PC market. But it is difficult for Taiwanese PC industry to compete with Japanese.
07/06/90	Industry and Commerce Daily News	Intel's 386 SX NPC comes out. 15 companies are willing to join the alliance to develop NPC.
12/07/90	Economic Daily News	42 firms join NPC Alliance.
03/08/90	Economic Daily News	The prelude of NPC Alliance gets intensive. American and Japanese PC companies: Intel which intends to design specific IC, and Hitachi which intends to produce specific LCD in Taiwan.
28/08/90	Industry and Commerce Daily News	NPC Joint Development Committee is established, which contains four divisions.
30/08/90	Economic Daily News	NPC Alliance's uniform model named as 'TEAMATE'.
05/10/90	Economic Daily News	NPC uniform model will show on 09/10/90.
06/10/90	Economic Daily News	46 companies gather to raise consciousness.
08/10/90	Economic Daily News	Disagreements on the price of NPC.
10/10/90	Economic Daily News	The sample of NPC is presented to the public.
31/10/90	Economic Daily News	NPC 'Made In Taiwan', developed by 46 allied companies, comes out.
02/11/90	Taiwan Hsinsheng Daily News	NPC comes out and will be produced next year.
02/11/90	United Daily News	Uniform NPC: A generator of second spring for information industry.
02/11/90	Taiwan Daily News	The success of NPC R&D injects a strong 'cardiotonic' into IT industry.
02/11/90	Liberty Daily News	Prototype Teamate comes out.

[59] There were ten automobile manufacturing firms in Taiwan, but only five firms joined the cooperative research project. The other five firms with a high percentage of foreign shares relied on the supply of technology from the foreign parent companies which would be more advanced than Taiwan's.

04/10/90	Industry and Commerce Daily News	Global NPC market will reach 13 billion US dollars. There will be more than one hundred firms hoping to share the pie.
08/11/90	Economic Daily News	47 companies reach agreements on the sales price.
12/11/90	Economic Daily News	NPC development problems: key components dominated by Japan.
17/11/90	Industry and Commerce Daily News	US COMDEX's Hot topic: NPC. US, Japan and Taiwan are potential competitors.
20/11/90	Economic Daily News	Teamate, unforgettable; Taiwan NPC, famous
22/11/90	Economic Daily News	In order to stabilise the supply of NPC key components, ITRI plans to produce by their own.
26/11/90	Economic Daily News	Disagreements on collective procurement among companies, which threat the NPC allied development plan
26/11/90	PC Week	'30million NT dollars spent on only 100 NPC sets' done by ITRI- criticised by NPC Alliance members.
06/12/90	Economic Daily News	Two different ways for NPC Alliance: Allied development-- focusing on low price market, Development by individual--nearly 10 companies involve on higher level market.
14/12/90	Economic Daily News	NPC: a threat to desktop PC and terminator of laptop PC.
20/12/90	Industry and Commerce Daily News	NPC Alliance decides to show 1200 NPC sets in CEBIT, Hannover Computer Show.
25/12/90	Industry and Commerce Daily News	IBM's new-born NPC will compete with portable PC which will be in the market in Feb. 1991.
28/12/90	Economic Daily News	X window terminal: A new alliance after NPC
01/01/91	Economic Daily News	Many break-ups inside NPC Alliance.
04/01/91	Computer World	A broken NPC Alliance? Self-regulation of firms will be the only force to effective development.
05/01/91	Economic Daily News	The number of company of producing NPC has increased sharply. Predicted that there will be a fierce competition.
01/02/91	Industry and Commerce Daily News	Strategic alliance becomes the most popular weapon for product development. The second generation NPC attracts nearly 100 companies.
27/02/91	Industry and Commerce Daily News	1. NPC Alliance steps into the stage: large firms decide to manufacture by themselves, small firms by OEM. All aim at CEBIT. 2. Inevitable Price War: small firms will adopt low-price competition due to the lack of brand name and productivity. 3. 35 companies are willing to co-develop the second generation NPC.
05/03/91	Economic Daily News	NPC-makers search for 'style' because design and standard are alike.
23/03/91	Economic Daily News	Taiwan NPC becomes 'Hot Topic' in Hannover Computer Show. The order of NPC exceeds twice of the productive goal.
05/04/91	Economic Daily News	'Bloody-Price War' between Taiwanese NPC companies at CEBIT Computer Show leads to the NPC price down by 20 percent.
12/04/91	Industry and Commerce Daily News	The second generation of NPC Alliance becomes stronger and the joining companies increase to 60.
25/04/91	Economic Daily News	Philips decides to produce NPC in Taiwan.
25/04/91	Industry and Commerce Daily News	The second generation of NPC Alliance divides into: 1. Ultra-thin style--led by ITRICCL; 2. Portable style-- designed by the companies themselves. 386SX becomes the key model of the second generation of NPC Alliance.
28/04/91	Economic Daily News	The capacity of producing NPC is widely recognised by foreign companies.

*** List of 46 participating firms:**

九光電子，大鵬科技，大同股份，大霸電子，大洋實業，三光惟達，台灣科華，百鈞電子，艾德蒙，光速科技，何泰興，臣益實業，兩儀科技，欣凱企業，松捷企業，東元資訊，東極電子，宗浩資訊，昆盈企業，皇旗資訊，神達電腦，春聲電腦，海力電子，凌巽企業，國豐興業，國威電子，郭家電子，惠肯電子，勝亞股份，順台有限，第三波資訊，凱美電機，普騰半導體，誠洲股份，資電工業，精模企業，嘉爾企業，環隆電器，環隆科技，聯銷實業，聯智工業，聯興電腦，優創股份，隴華電子，聿隆股份，加華資訊.

CHAPTER SIX

CASE STUDY: HIGH-DEFINITION TELEVISION CONSORTIA

> **The politics of high definition television provides a window into the world of business-government relations in a new international economic environment of intensive competition among the advanced industrial nations (Hart, 1994:213). The standards are usually decided on political rather than technical or logical reasons, a task that manufacturers of sets should not have to cope with, and HDTV is no exception (DataQuest, 1992:6).**

The development of high-definition television (HDTV) has been the focus of the TV industry in advanced countries since the middle of 1980s. Taiwan too, with its considerable strength in electronics, has realised the significance of HDTV in the light of market niches at the turn of century as a means of rescuing its declining consumer electronics industry. While the progress of the three main economies, namely, Europe, Japan, and the USA, is acknowledged, the efforts of the Taiwan government to probe the development of HDTV have received little attention.

It is still too early to predict that Taiwan will become a competitor in the field of HDTV, but its efforts, both in the public and private sectors, to establish its technological capability in this field deserve more recognition for two reasons. First, Taiwan has seldom been deemed an active actor in the frontline of technology development attempting to take part in the technology war of HDTV. The difficulties of development in such an area lie not only in the technology itself, but also, since it is a new field, in the absence of internationally agreed standards. In these circumstances, how Taiwan obtained a foot hold in the development of HDTV is worth exploring. Second, the framework for developing HDTV which required more than just an industrial policy, was constituted from many policy fields and the interaction of many actors. By its institutional arrangement in technology development, Taiwan has revealed that a small nation with an SME-based economy can increase its technological capability even though its competitive advantage was relatively low in the beginning.

1. HDTV AS A FUTURE INDUSTRY

1.1. A Definition of HDTV

The development of HDTV is a revolution in the history of television. HDTV will improve the audio and video performance of TV, as well as the transmission of broadcasting. The merits of HDTV are summarised in Table 6.1. This shows that the product has a significant improving effect on living standards. The replacement of traditional TV by HDTV is a trend that can not be doubted, but the time for the coming of the HDTV era is unpredictable and has been delayed by the war between different systems. Two factors have fatally handicapped a worldwide standard: first, there is a lot of national pride in the standard adopted in a particular country or region; second, the acceptance of a foreign standard might lead to the huge market being dominated by rivals.

Table 6.1 A Comparison of HDTV and Traditional TV

	HDTV	Traditional TV
Horizontal Line Solution	High -- more than 1000 scanner	Low -- 525 scanner (NTSC)* 625 scanner (PAL & SECAM)*
Sound Signal	Digital-quality stereo sound & multiple tracks	Analogue stereo (FM)
Picture Quality	Excellent, the quality of movie	Bad colour quality, flickers, interline flickers, ghost shadow, Interference between signals
Aspect Ratio	16:9	4:3
Monitor	Multi-functions	TV screen
Compatibility With Programme/Movie	Compatible	Incompatible
Industrial Application	Wide (professional, military, medical and industrial)	Limited
Market Scale	New market, high demand in the future	Saturated market

* There were three TV systems that were incompatible to each other in the sense that the programme produced in one system could not be directly broadcasted by the other two. Now, PAL and SECAM become compatible. USA-led NTSC (National Television Standard Committee) system covers 36 countries including North & South America, Japan, Korea, & Taiwan. Germany-led PAL (Phase Alternation by Line) system covers 63 countries including West Europe, UK, China, and ex-European colonies. France-led SECAM (Sequential Colour and Memory) system covers 42 countries including France, Russia, East Europe, & some African countries.

However, the race between HDTV systems came to an end by the end of 1993. The USA's fully digital system overtook the other systems and became accepted worldwide. At the end of 1996, a technical report on the details of HDTV was published by Federal Communications Commission (FCC). This is likely to be adopted as the standard for the rest of world. Future development of TV will then, hopefully, integrate into the same system.

1.2. HDTV as a New Wave of Digitalised Consumer Products

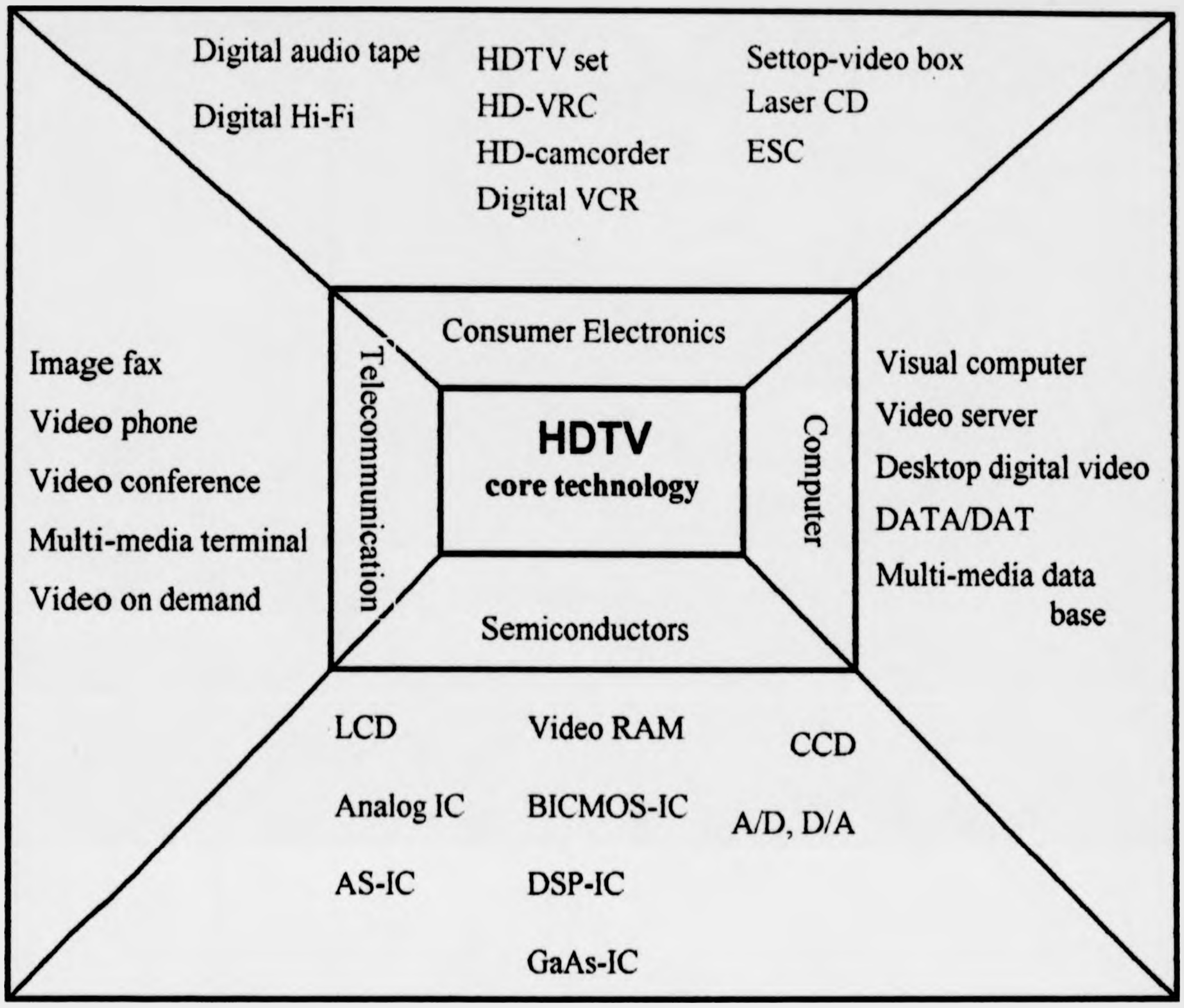
The development of HDTV initially focused on the entertainment industry but it provides great opportunities for other industries in only a few years with the 'go digital' development. The video products industry, which has not been digitised, is the last virgin land among the consumer electronics industries. The creation of digitised visual products also led to the discovery of new markets, since the TV set and video recorder are necessary home entertainment equipment for every family, the 'jewels in the crown' for consumer electronics manufacturers.

The growing convergence of entertainment TV and digital electronics has eroded the boundaries between electrically-based industries. Chart 6.2.A demonstrates the application of HDTV technology to other industries. Following the standardisation of the world HDTV system, the hardware and software markets in the related consumer end products have also benefitted. Chart 6.2.B shows the interdependence of stand-alone (camcorder & digital camera), software-dependent (LCD player & VCR), broadcast-dependent (TV & Radio), and network-dependent (Cellular Phone & E-mail) products, all these products will take advantage of the digital technology derived from the development of HDTV (Cawson, 1994:145-8). Accordingly, the development of HDTV can be justified as of strategic importance in three senses:

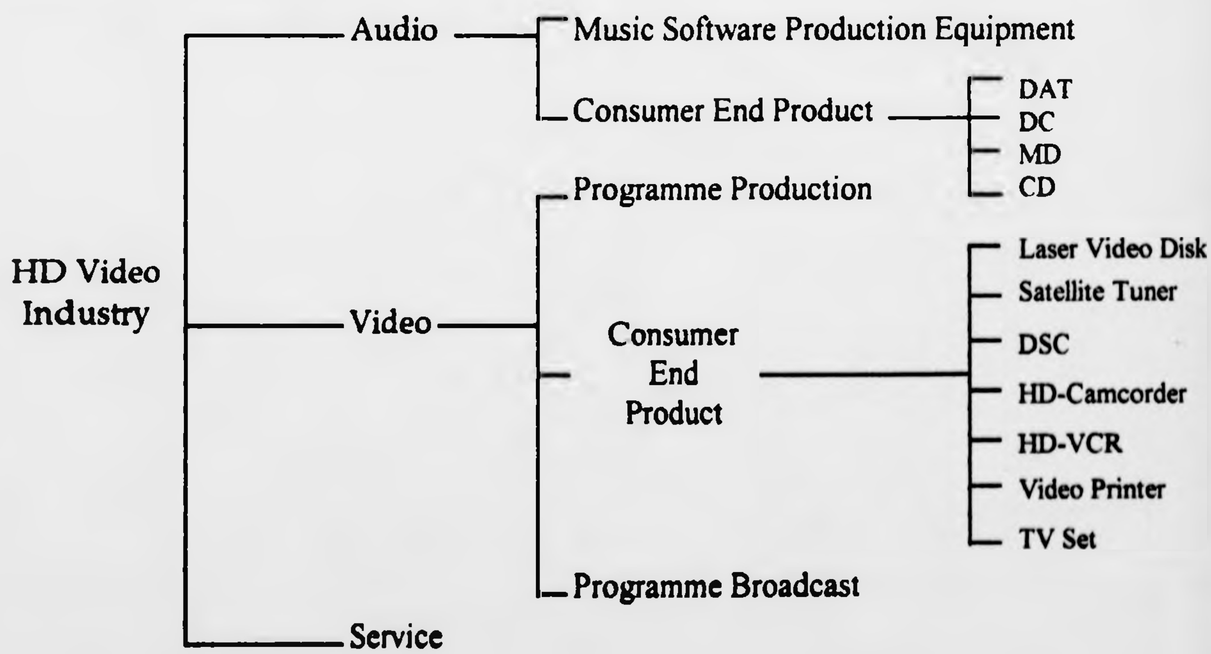
> (1) it was regarded as the most important element in the new generation of consumer electronics products, and hence an important part of the strategic thinking of any firm in this area, (2) its technology was agreed to be generic and was likely to have an impact in many other domains of computing and communications, and, most controversially, (3) it was argued that the nature of the technology is such that market outcomes are sensitive to strategic behaviour of firms and governments. (Dai, Cawson & Holmes, 1996:150)

Chart 6.2 The Industrial Application and Linkage of HDTV Technology

A. Classification by Industry Source: CEPD, 1991:401.



B. Classification by Consumer End Products Source: ITRICCL, 1994:2.



However, the strategic significance of HDTV in terms of market size is much more difficult to prove. The forecasts of HDTV market size change from region to region, from institution to institution, from time to time, and with different concerns, but all of them share the same optimistic view that the market will grow rapidly[60]. None of the forecasts has a scenario for failure. Nonetheless, HDTV was not an instant success because of the delay in establishing a world standard. 'Thus, some scepticism about the timing, if not the size, of HDTV's eventual market success seems warranted. ... The likely effect of HDTV on other electronics markets seems clearer[61]'.

Moreover, the strategic significance of HDTV for the competitiveness of the electronics industry varies from country to country. It might not noticeably change the competitiveness of US industry as a whole in HDTV market terms, but it would seriously affect Taiwan's competitiveness in the electronics industry because of the economic centrality of this and related industries to exports and to the economy as a whole.

'Competition for the future is competition for opportunity share rather than market share (Hamel & Prahalad, 1994:31)[62]'. The HDTV development reveals competition for the future given that HDTV market is still a 'potential' instead of an existing market. In this sense, the countries in the race for HDTV development intended to maximise the share of future opportunities which a nation could potentially access.

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[60] Some examples are: the USA Darby report -- annual sales of 18.6 million units and $16.2 billion by the year 2008; the USA Electronic Industries Association -- 13.1 million units by 2003; the American Electronics Association -- 11 million units and $10.9 billion by 2010 (above data from Congressional Budget Office, 1989: 5-8); Japanese Forecast Volume -- 4 million units sales in Japan by year 2000; USA ACATS -- 6.2 million sets in the USA by 2000; DataQuest -- 1 million sets in the USA by 2000; DataQuest -- 45 thousand sets in Europe by 2000 (above data from DataQuest, 1992:7-17); and ADL -- US$50 billion by 1995 (ADL, 1989:4).

[61] This quotation is from USA Congressional Budget Office's summary (vi) which might have a negative influence on the Bush Administration's decision to turn down the idea to subsidise the HDTV industry. It also suggested that HDTV is unlikely to play a pivotal role in the competitiveness and technology development of the electronics sector as a whole. However, it can be justified by reasons of employment, national prestige and scientific advancement; other than competitiveness.

[62] The meaning of market share in markets that are not currently existing, can not explain what a company is competing for. Hamel & Prahalad (1994:31) asked the question: 'how can one maximise market share in an industry where the product or service concept is still underdefined, where customer segments have yet to solidify, and customer preferences are still poorly understood?' They identified the highlight as the bid to capture a share of future opportunities -- 'how to attract and strengthen the skills that form the competencies that provide a gateway to future opportunities'.

The strategy for competition in a future industry, or 'to gain a disproportionate share of future opportunities', is to possess the requisite competencies presented as 'the patient and persistent accumulation of intellectual capital' (ibid.).

The core requisite competency in HDTV development is the technology for the Motion Picture Expert Group (MPEG). The importance of the MPEG lies not only in the fact that it is the core technology for digital-visual products, but also in the wide convergence covering the communication, computer and broadcasting industries (HDTV Newsletter, Oct. 1995:27). The US standard for the HDTV by FCC has been postponed several times (from 1994-96)[63]. The industry, in particular, the television industry, finally gave up its insistence on using interlaced scan in Nov. 1996, instead, it was agreed that the digital-visual transmission would adopt interlaced scan or progressive scan[64]. The reason might be that there has been a shift of interest from HDTV to emerging phase-in visual products which are also new products with immediate viable profits. HDTV is seen, therefore, as far more than a short term commercial reality, but a long term digital dream. Even though HDTV is unlikely to be a global commercial success in this century, the application of MPEG in the 1990s has created a substantial market for visual products. For a country with investment in the development of MPEG, it means hopefully that competencies have been built up and the competitiveness of products derived from the application of MPEG has been strengthened. Table 6.3 lists some MPEG-applied products which have become available in the 1990s, and their current development.

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[63] The standardisation of HDTV took FCC ten years, starting from the advanced TV standard in 1987 and concluding with a digital TV standard on 03/04/97. A digital TV standard was expected to be reached in 1994 (Grand Alliance formed in the middle of 1993), but three interest-involved industries (consumer electronics, computer, & communication) disagreed about the standard in terms of scanning (MPEG accepted by all walks) (HDTV Newsletter, Jun. 1997:1-2).

[64] This decision led to a competition in the digital visual products between the consumer electronics industry and computer industry because that computer industry can use the computer technology of progressive scan in the production of visual products (HDTV Newsletter, Jan. 1997:10).

Table 6.3 The Commercialisation of Digital Visual Products

Product	Technological Application and Product Character	Current Situation
VCD (Video CD)	MPEG-I (which is a less sophisticated technology than MEPG-II). VCD is a lower cost product than LD, suitable for Karaoke, but not for film because of the low capacity of CD (shorter time playing).	A replacement of VCR in major developing countries where the previous VCR market was underdeveloped. In particular, China & Southeast Asia have an increasing demand which overtook VCR. VCD, a relatively high-tech product, has replaced VCR.
DBS (Direct Broadcasting Satellite)	MPEG-II Multi-channel broadcasting, transmission by direct satellite (wide signal coverage) & excellent picture quality. A major threat to Cable TV (high cost on the establishment of transmission wire). American Electronics Association--'The most successful consumer of electronics product in history' (DBS reached 1 million users in one year compared with Colour TV (in 8 yrs), VCR (4) & CD (3).	USA-- was the first to use DBS (1994 by DirecTV). There are 6 companies (DirecTV, USSB, Primestar, Echostar, Alphastar, MCI/News) in this business which led to a price war (the price dropped from US$700 to 200). About 50% of DBS users transferred from Cable TV. USA subscribers reached 4.22 million by 1996. EU-- DBS service was started in Apr. 1996 by Canal Satellite Numerique. The European DVB-S (Digital Video Broadcasting) standard, widely adopted by European and Asian countries, which might become the standard with the largest number of participating countries. Japan's-- NHK BS (Broadcasting Satellite, not digital DBS) emerged in 1984 and a quarter (10 million) of Japanese families are BS subscribers. Perfect TV (DBS) commenced in Oct. 1996, and DirecTV Japan and SkyB in 1997.
WTV (Wide-Screen Television)	MPEG-I/MEPG-II WTV although not defined as HDTV was marketed because it is cheaper than HDTV. It transformed 4:3 picture to 16:9 one to cope with laser disc and new programmes. The audio/video quality is much better than traditional TV.	The manufacturing of WTV does not need extra cost to improve production equipment which can be done on the standard TV assembly line. In 1996 alone, the sale of WTV increased in Japan (3.5 million sets-very close to traditional TV sales) and Europe (0.5 million sets) due to the broadcasting of 16:9 programmes. There was no WTV market in the USA because there was no match of TV programme, but large screen TV emerged (more than 30" and projection TV) as new product. The share of WTV in TV market will reach 22.3% in 2000 from 4.5% in 1996, according to the forecast of Electronics Industry Association, Japan, because of the development of digital technology and more 16:9 TV programmes.
STB (Digital Set-up Box)	MEPG-II STB is used as the home receiver equipment to connect with video, audio, or data services which can transform incoming signals (through cable, satellite, or terrestrial broadcasting) to display on TV or monitor. STP for using on digital DBS also known as IRD (Integrated Receiver Decoder). STP will play an important role in the visual industry, at least until the TV market has been fully replaced by all-digital-design-in TV.	The wide application of STB created a huge market. It can be used in many ways, such as cable TV decoder, DBS receiver, or emerging interactive TV tuner, and it also enables traditional TV with an additional STB to show digitised programmes -- the cheapest way to receive digital signals (but the quality is not as good as WTV or HDTV). This type of STB has the largest business opportunity until traditional TV becomes obsolete, given that most TV sets in the world are still in analog format. The semiconductor industry has benefited from the high demand for chips and chip-sets by STB production. According to DataQuest, STB brought about US$1.1 billion market to the semiconductor industry, and this number will rise to 3 billion. The same source suggested that the market will increase from 5 million sets in 1996 to 1.15 billion sets in 2000 in DBS-STB alone.

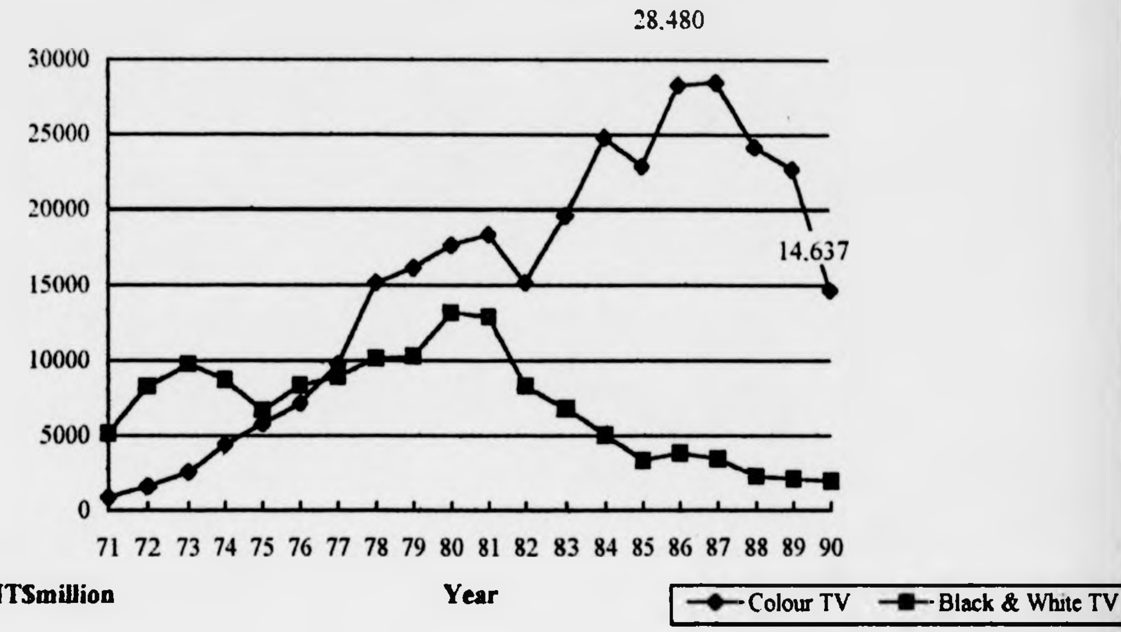
DVD (Digital Video Disk or Digital Versatilite Disk)	MPEG-II DVD, with better audio & video quality, will become the future VCR. The data storage of DVD (4.7GB) is 7.5 times that of CD (650MB) in the same size disc (120mm diameter). DVD has distinctive characteristics, such as a rewritable (if the pirate copy can be regulated), world standard (valid for different TV systems-NTSC, PAL & SECAM, and adjustable for 4:3 & 16:9 TV), computer compatibility (DVD-ROM will replace CD-ROM), multi-language function (choices of 8 languages and 32 different characters), multi-viewing function (up to 9 angles from which to watch the programme), and flexibility in story-line (choices of preferring ending or content, if pre-recorded when produced).	The products of DVD divided into Movie DVD-ROM (player, consumer electronics), Movie DVD-RAM (player & recorder, consumer electronics), DVD-ROM (player, computer accessory), DVD-RAM (player & recorder, computer accessory). Movie DVD-ROM was marketed in 1996, and the rest will be on the market before 2000. The following discussion focuses on Movie DVD (thereafter DVD) only. DVD was advanced by Sony/Philips (called MMCD or HDCD) at the end of 1994, but Toshiba/Time Warner Group (with 7 joiners, called SD-Digital Video Disc) proposed a different format at the beginning of 1995. Two groups reached an agreement on a standard format (DVD) to avoid another format war (like VHS vs. Beta) in the end of 1995. The forecasts of DVD player sale are various depending on the price, but all believe DVD will eventually expel VCR out of market. The titles (software) of DVD will not be released for mass production until two facts are agreed between title suppliers and player producers. One is the standardisation of the anticopy regulations (SFF-8090) in the early 1997. The other, far more complicated, is the de-internationalisation of the DVD standard. Nowadays, video cassettes have been released at different times, to different regions, and by different languages that would maximise the profits of film companies. In particular, the world standard and multi-language function which will lead to the integration of the three systems into one and the easy access by any nation or region. An agreement between software suppliers and player producers reached that players will be produced in accordance to 5-7 regional standard for software supplier to control film distribution.
Others	MPEG-II Card will be widely utilised at the multi-media equipment. ITV (Interactive TV) might be developed at the turn of next century.	

1.3. The Rise and Fall of the TV Industry in Taiwan

The consumer electronics industry was the first established of the electronic-related industries in Taiwan in the 1950s[65]. It was one of the leading export sectors in the 1970s and 1980s. The TV set was the champion product for the consumer electronics industry in which black & white TV was the product with the highest productivity before 1976. Colour TV took over in 1977-1989 except in 1984 when it was the radio cassette & walkman (CEPD, 1991:317). The production value of colour TV increased rapidly at an average annual growth rate of 14.7% from the middle 1970s reaching its peak in 1987 (Figure 6.4).

[65] It is difficult to give a precise definition of the consumer electronics industry because it overlaps with the markets of telecommunication, information systems, office products, and electronic toys. Besides, the manufacturing activities of major consumer electronics companies are involved in most of these sectors. The use of consumer electronics products here refers to traditional consumer electronics of the home and personal application.

Figure 6.4 The Production Output of Taiwan's TV Industry



Source: CEPD, 1991:316.

However, the economic importance of the consumer electronics industry and TV products has decreased dramatically since the late 1980s. The share of the consumer electronics industry in the whole electrics-related industry fell from 49.5% in 1978 to 18.5% in 1989 (CEPD, 1991:315). The output of colour TVs dropped by half in only three years (1987-90). All these have been caused by the rising productivity of the PC industry. The compatibility of the consumer electronics industry with the PC industry in terms of manufacturing assembly, has allowed many consumer electronics companies to transfer their production lines into the relatively high-value-added PC-related industry. Besides, outward investment from Taiwan's consumer electronics industry to other countries has had a serious impact on the performance of this sector. In addition, the competitiveness of Taiwan's TV exports to the USA has been seriously affected by a 14.2% anti-dumping tax since 1972 which followed an accusation by Zenith (HDTV Newsletter, Aug. 1994:12-3).

The fast rise of the PC sector squeezed the space of the consumer electronics sector and changed the industrial structure (Interview No.17). The rise of one sector at the expense of the deindustrialisation of the other has given the government serious concern about how to deal with the accelerating withdrawal of a past national champion export product. Thus, the government had to consider whether to tolerate the decline of or to revitalise this sector by effective measures. By transferring traditional consumer electronics products to a more high value-added products provided a promising solution, as an IDB technocrat suggested (Interview No.13). The potential market which might be created by HDTV in the late 1990s is seen as a possible means of regaining the glory of Taiwan's consumer electronics industry in the eyes of policy-makers in the end of 1980s.

A state-industrial arrangement in which public resources, as well as private resources have been mobilised into the development of HDTV technology and products derived from the process of technology development, has been put into action to revive the withering consumer electronics industry.

2. INTERNATIONAL SCENARIO ANALYSIS

The international development of HDTV system among the world economic triad presented different pictures of government-industry relationships, and revealed a serious race to take the lead in the standards of HDTV system. From Table 6.5, the evolution of world competition in HDTV systems can be observed. Japan was the first to develop a feasible MUSE/HiVision based on analog technology, hoping to become the international standard. The European countries strongly opposed the Japanese HiVision as an international standard, and decided to go for its own approach fearing commercial losses and cultural invasion[66]. While European and Japanese version were of mainly analogue transmission, the USA electronics industry pushed for a fully digital HDTV approach motivated by a chance to re-enter world electronics markets if their system became the international standard.

[66] At a time when USA delegation for 1986 CCIR meeting was supporting the NHK proposal. EC feared the acceptance of HiVision would be same as the concession to the combination of 'Japan, Inc.' in terms of market share in the consumer electronics industry and of 'Hollywood' in terms of inviting penetration of non-European films and programmes (Hart, 1994:215). In particular, Japan's walkman and cordless telephone were examples of products which changed people's lifestyles and captured a large market share. Will the HDTV follow suit? European manufacturers belatedly woke up to this danger and began to develop their own alternative HD-MAC after 1986 CCIR meeting (Financial Times, 20/03/90 & 03/12/90).

Table 6.5 The Chronology of International HDTV Development

Date	Main Events
1968	Japan- NHK (Nippon Hoso Kyokai) initiated HDTV R&D
1970	Japan- NHK started the R&D of HDTV & wide screen monitor
1974	International Radio Consultative Committee/ International Telecommunications Union (CCIR/ITU) established a commission to research a possible HDTV standard under the request of 1972 NHK proposal
1978	UK- BBC advanced 1501-line standard
1979	Japan- NHK's first test transmission
1980	Japan- the public unveiling of HDTV broadcasting by NHK
1981	USA- CBS started HDTV R&D
1982, Jun.	Audio standards were decided by CCIR
1982, Nov.	USA- FCC permitted direct Broadcast Satellite (DBS) application
1983, Jan.	USA- RCA unveiled MAC system for DBS
1983, May	USA- Advanced Television System Committee (ATSC) was set up
1984, Jan.	Japan- adopted Multiple Sub-Nyquist Encoding (MUSE) as HDTV standard
1985, Feb.	Japan- first programme of experimental broadcasting of HDTV in the world
1986, May	Japan- proposed MUSE as international standard to CCIR, but EC rejected in an international meeting in Dubrovnik, Yugoslavia.
1986, Oct.	EC- Eureka 95
1987	USA- FCC set up an industry-run advisory committee, which began evaluating 23 rival systems
1987, Jun.	Japan- HiVision promotion committee created
1988, Jun.	USA- the establishment of Advanced Television Testing Center (ATTC), a non-profit corporation for HDTV testing
1988, Dec.	USA- Defence Advanced Research Projects Agency (DARPA) planned a $30 million R&D project to HD displayer and displayer processors
1989, Mar.	USA- Congress proposed 'HDTV Competitiveness Act of 1989' Japan- 18 enterprises planned to invest $1.8 million to develop large size HD monitor S. Korea- government subsidised 400 billion Korea dollars to HDTV consortium
1989, Jun.	Japan- MITI proceeded the production of HDTV programme USA- American Electronic Association (AEA) proposed a commercial plan to Congress and asked an assistance of $1.35 billion. Government objected DARPA's subsidy to 5 companies
1989, Oct.	EC- exhibited HD-MAC system
1990, Feb.	Taiwan- evaluated on the feasibility of HDTV development
1990, Jun.	USA- one (Digi Cipher) of 5 R&D Teams adopted digital system
1990, Jul.	S. Korea- 5-year plan for HDTV R&D
1990, Oct.	S. Korea- Samsung & Goldstar exhibited MUSE system Japan- MUSE system for home application marketed EC- vision 1250 to promote the programme production in MAC standard
1991, Feb.	Taiwan- plan for the R&D of HDTV technology USA- ATTC tested 5 HDTV system, NHK's withdrew from FCC competition
1991, Jul.	S. Korea- gave up analog MUSE shifted to digital HDTV Taiwan- ITRI commenced '5-year HDTV STP'
1991	EC- failed to persuade satellite broadcasters to use an early version of Europe's HDTV, despite offering a subsidy
1991, Nov.	Japan- NHK started to broadcast daily 8 hours of MUSE programmes
1992, Nov.	EC- ministers failed to agree on the further subsidies
1993, Jan.	China- listed HDTV technology among ten key technologies
1993, Feb.	USA- the result of FCC test came out, 'digital' is the direction, but 'no superior system which led to the merge of four systems'
1993, May.	USA- the birth of Grand Alliance EC- totally abandoned HD-MAC plan
1993, Jul.	EC- subsidised to the production of 16:9 programme

1993, Aug.	China- the establishment of Rainbow ([illegible]) Electronics Co. to engage on the R&D and production of HDTV
1993, Sep.	EC- DVB Plan founded
1993, Oct.	Taiwan- exhibited HDTV-related products by HDTV consortia-complexes
1995-96	USA-digital TV standard had been postponed several times
1997, Apr.	USA-the standard for digital TV & timetable for the implementation of digital TV

2.1. Grand Alliance in the USA

State policy for the development of HDTV in the USA was mainly driven by a government authority – FCC, which is responsible for setting broadcasting standards. Two efforts calling for privileged policies towards the industrial sector, one by DARPA and one by AEA, were blocked by the Bush Administration in 1988-1990. DARPA announced a new US$30 million grant for the development of HD displays and display processors in order to push for greater government leadership in promoting civilian technology in 1988, but the administration did not share the enthusiasm of DARPA and Congress in 1990[67]. The end result was that only US$20 million out of DARPA's discretionary fund was awarded in 1988-90, and the head of DARPA, an important supporter of HDTV policy in the Department of Defence was removed. The efforts of the AEA and allied members of Congress in 1988-90 linking the issue of HDTV to broader industrial policy concerns to get government funding of US$1.35 billion (US$350 million direct subsidies and US$1 billion loan guarantees) were also unsuccessful.

The USA government policy towards the development of HDTV was defined by the FCC as the policy 'to reconcile the interests of consumers and broadcasters with those of the electronics industry' (Hart, 1994:225). On the one hand, it protected the interests of traditional TV owners (in the phase-out period decision) and local broadcasters (in the simulcasting decision that a HDTV standard would be compatible with the current 6 MHz channelisation plan); on the other hand, it protected the

[67] The 1988-90 government subsidy (from DARPA) allocated to the development of HDTV in the private sector has been cited as evidence of American style corporatism in that this is a bureaucratic decision to assist civilian technology development (Hanson et al., 1992). However, this decision was backed by the director of DARPA, not the central administration. In fact, this particular type of HDTV policy was a lower priority item in the national agenda, and the highest levels desired to avoid 'endorsing any form of industrial policy for any purpose whatsoever' (Hart, 1994:218).

interests of the USA electronics industry in favour of a digital system (ibid.).

Although direct government subsidies on the development of HDTV were limited before the USA system dominated the world standard, the contribution of the political rejection of the NHK narrow MUSE system on the 'free competition' in the process of testing existing systems by FCC was far more substantial than any financial assistance. The Japanese system was forced to leave the test when FCC announced its preference for a digital system at a time that MUSE was still the most practically sophisticated one in the world. The result of the test was that there was 'no superior system' among the four tested systems[68]. In order to shorten the time for development and save the cost of re-testing after allowing the teams to perfect their systems, a merger between the four systems formed the Grand Alliance, made up of 25 participants, none of whom were Japanese. Soon after the digital system appeared likely to become the world standard, in 1994, the Clinton Administration provided a subsidy of about US$700 million for an essential HDTV component field (flat panel displays) where Japanese technology and manufacturing led the world. This revealed that the USA government and industry shared the fear of losing market in a strategic part of HDTV.

The success of the USA digital HDTV system can be attributed to two main factors. First the factor that manufacturing firms are prepared to fund the technology and system which lacks compatibility with Japanese and European plans for technical standards in transmission and reception. This is adventuristic bearing in mind the 1988 requirement of FCC that future HDTV should not outdate current TV receivers. The breakthrough in compressing the two-bandwidth signal into one bandwidth by converting it into a digital signal by General Instruments has denoted the coming era of digital HDTV. Second, the co-determination of 'digitisation' by FCC and the industry suggests a protectionist cooperation to defend the interests of the USA electronics

[68] The four systems are developed by three technological teams: (1) Digital Spectrum Compatible by Zenith, AT&T & Scientific Atlantic; (2) Digicipher & MIT system by General Instrument & the Massachusetts Institute of Technology (MIT); (3) Advanced Digital TV by Philips, Thomson, David Sarnoff Research Center, Compression Labs & NBC; (4) CC-Digicipher by GI & MIT.

industry. The digital system is different from the European MAC or Japanese MUSE and is unique to US industries where they may have a lead in components and technology development.

In 1997 the FCC digital TV standard (through terrestrial transmission) was published. However, it is unlikely to become a world standard in the short term because the European DVB standard (through satellite transmission) has been established and accepted by many countries, and Japan also has its own standard (through satellite transmission).

2.2. Japan's Analog HiVision

Japan was the first country to broadcast HDTV and the first to have HDTV sets in the shops based on analog MUSE/HiVision. However, it has been overtaken by the USA digital system and that has led to much embarrassment for the government, NHK and the companies who supported the MUSE standard. It is politically unthinkable at present for the Japanese to shift their standard to an all-digital one immediately since they have invested at least ¥60 billion in the infrastructure and broadcasting costs by 1992. Japan will keep on developing MUSE for the domestic market until next century when MUSE will be nearing the end of its life-cycle (DataQuest, 1992:4).

Japan lost its battle in the standard war to the USA which means it lost its chance to monopolise the world market with its MUSE standard. This does not necessarily mean that Japan has been forced out of HDTV markets. The USA has set the standard which is not a guarantee that US companies will win in manufacturing low-cost digital TV sets, VCRs, and receivers (Valigra, 1994:78). Japanese companies have already set up many laboratories in the USA to keep abreast of USA standards. In fact, many of the key components and internal designs of HDTV receivers and studio equipment are already in digital formats except for transmission in Japan's HiVision.

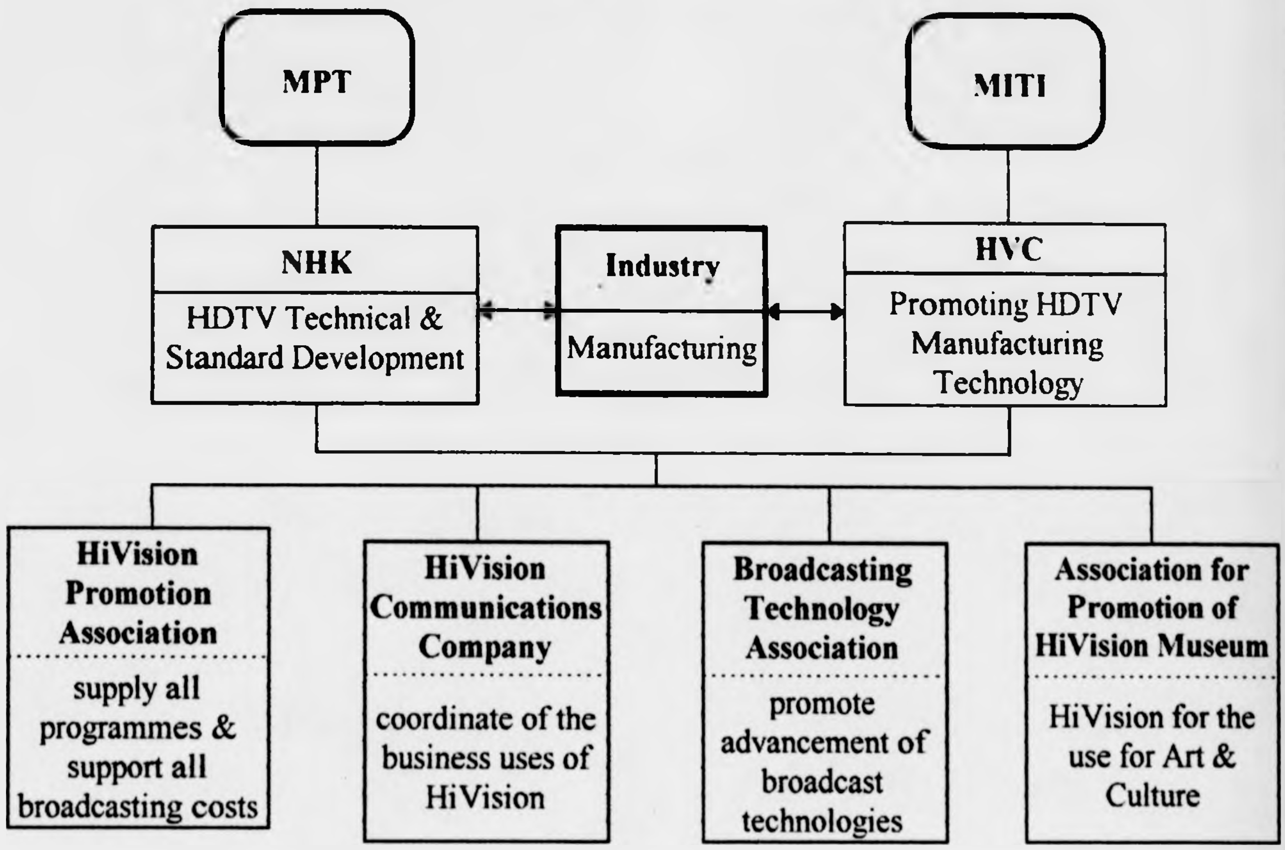
Two major agencies at the ministerial level governed the government policy for

HDTV in Japan, namely, the Ministry of Post and Telecommunications (MPT) & MITI. MPT, the regulatory body over NHK (semi-public broadcaster and developer of MUSE) and other broadcast and communication systems, which responded to viewer needs and saw itself as the guardian of the strategies of the manufacturers of consumer electronics equipment. Even in the early 1990s although the breakthrough of digit HDTV technology was clear, MPT and NHK were still the main force behind the continuing support for HiVision standard. MITI, viewed itself as a servant to the Japanese globalising industry, and was not as stubborn about standards as MPT. MITI believed that 'whatever standards are used in any country or region the Japanese should be happy to make them' (DynaTech, 1992:14). Time has shown that MITI may be right and MPT's position was too impractical[69].

There are many public and private organisations working closely to make up a large body of interest focused solely on HDTV (see Chart 6.6). MITI with a contribution less than US$6 million established the HiVision Promotion Center (HVC) in Tokyo to promote HDTV development in 1988, which is now supported by over 100 companies with an annual budget of US$75 million. HVC's main tasks are to encourage the growth of HiVision-related industries and to spread the application of HiVision software. There are also some private organisations involved in the development of HiVision in Japan, which are mainly made up from the industrial sector and communication sector. NHK is actively participating in all organisations regarding R&D and promotion of HDTV system.

[69] According to Japan's 1997 reform proposals, which will slim 22 ministries and agencies to 12 or 13, the MITI will lose its control over energy policy and seize long-sought control over telecommunication industry from its long-term rival, MPT, while the MPT will be dismantled with telecoms distributed to the MITI and other tasks privatised (Far Eastern Economic Review, 04/09/97:63). If so, there will be a more cohesive policy towards HDTV development under a giant 'Economics Ministry' in Japan in the future.

Chart 6.6 The Framework of HDTV Development in Japan



2.3. European HD-MAC

It may seem to outsiders that there was a cohesive government industrial policy towards HDTV in Europe. In fact, there were numerous fragmented policies under a more formal influence of the European Community in a directorate of the Commission known as DGXIII (Cawson & Holmes, 1995; Dai et al., 1996). The Eureka HDTV project EU95 was set up in 1986 to develop a MAC (Multiple Analog Component) system that would enable Europe to create a single emission standard and make pan-European broadcasting with several languages simultaneously[70].

In July 1990, the first European Economic Interest Grouping was formed, which was a European Commission sanctioned unit which permitted collaboration for the

[70] EU95 was an evolutionary programme on the gradual introduction of HDTV by three compatible phases (D2-MAC 4:3, D2-MAC 16:9, & HD-MAC 16:9) to ensure that no part of the audience is cut off from their programmes and no broadcaster is cut off from its audience. The initial EU95 project proposal came from Bosch, Philips, Thomson, and Thorn EMI (later became part of Thomson). Nokia and a consortium representing participants in Italy also joined the Directorate in 1990-91. In addition to the five members of Directorate, there were at least 40 'B-participant' companies and organisations involved in the project from 11 countries in Europe.

early mutual development of industries in pursuit of common objectives. This first group was called Vision 1250 and was made up of members including the EC itself and most of the television set and production equipment manufacturers. Its aim was to stimulate growth in the interest of producing programmes of MAC standard. The total government direct funding for Vision 1250 is about US$200 million[71].

The 1986-1992 budget for the Eureka HDTV project, according to official reports, was 625 million ECU from the Commission, a figure which excluded national government contributions (Bruce & Buck, 1994:171)[72]. While the Eureka project funded by public money had a blueprint for the industry in developing MAC technology (ignoring its technological obsolescence), the project's benefits for European broadcasters, consumers or taxpayers were hard to identify (Peterson, 1993:511).

In the case of the Eureka HDTV project, collusion between DGXIII and the electronics industry took place to adopt an interventionist industrial policy to support a European standard against USA and more particularly, a Japanese standard. At the end of 1992, the EU officially announced that it would give up its effort to build its own standard and adopt the digital system chosen by FCC.

The failure to establish a European (let alone world) HD-MAC standard for HDTV led EU, in particular, DGXIII, to take the blame for an inappropriate policy decision. However, the leading firms did not suffer from the collapse of the HD-MAC system because they absorbed new analogue technology from MAC development and, in the case of Thomson and Philips, kept abreast of digital development by undertaking R&D in the USA. As Dai et al. (1996:158-9) argued, the leading European firms' behaviour also undermined European HDTV policy in the sense that they lobbied the

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[71] Most of the funding was for acquisition of equipment suitable to produce the HDTV programmes and receivers for the 1992 Barcelona Olympics. The receivers were placed at government/industry expense in public locations to inspire the public to buy at least a wide screen TV when wide screen MAC was an interim product (HDTV would not be introduced until 1995).

[72] In Britain, the Independent Broadcasting Authority and BBC were funded to seek a new HDTV standard; in France, Thomson (state-owned enterprise) received 366 million ECU from the government in 1991; in 1990, Philips and Thomson agreed to spend US$3.2 billion on HDTV joint venture (Bruce & Buck, 1994:171-2). According to Times (10/02/92), EU95 had spent 2.682 billion ECU (£2 billion) by the beginning of 1992, of which half was from the EU member states (from Dai et al., 1996:155)

European Commission to keep analogue HD-MAC going in Europe, even though they had lost interest in it, while forming a R&D consortium to propose digital techniques for FCC's testing.

At the end of 1993, the Commission shifted its support from the revised 1992 MAC directive to DVB which has developed common standards to foster the prevalence of all-digital TV (WS & digital television formats) in Europe. This change revealed 'a movement from industrial policy concerns favouring producers, towards more general measures to stimulate demand for new television technologies, and more emphasis on competition policy measures rather than enforced technical standards in order to regulate the supply side (Cawson & Holmes, 1995:650).'

2.4. Different Approaches

The US government's only involvement in HDTV is through FCC and there was no direct government funding and leadership in developing the HDTV industry in the 1990s. FCC invited firms to join a competition where the standard would be selected from proved technologies. In contrast, Japan and Europe adopted the concept of industrial policy as a way of development in favour of the manufacturing sector in the 1980s and early 1990. The government-backed R&D consortia were monopolised by leading actors who could not take the lead in high technology competition. Neither the Japanese nor the European consortium, termed as 'pre-competitive collaboration', made a breakthrough in technological progress as did the American style of free competition, termed as 'pre-collaborative competition' (Cawson, 1994:152). It can be argued that the ideas of technology development in the pre-competitive collaboration were pre-dominated by certain obsessions (such as MUSE and MAC) which significantly constrained innovative dynamics.

The direction of technology diffusion was different in Japan and Europe. Japan's NHK was the developer of MUSE system and then persuaded the manufacturing sector to accept technology/standard, while European giant TV makers (Philips and Thomson) pushed private satellite broadcasters to accept MAC in Europe. Japan was from broadcaster to manufacturers, Europe (and Taiwan), the other way round.

3. TAIWAN'S GOVERNMENT POLICY TOWARDS HDTV DEVELOPMENT

Table 6.7 The Formation of HDTV Policy in Taiwan

Date	Main Events
06/88	ITRI advanced the idea of HDTV development
02/89	IDB/MOEA established a strategic planning group to evaluate the feasibility of HDTV development for Taiwan.
09/89	IDB suggested to CEPD and confirmed that the HDTV industry would be the 'star' industry according to Arthur D. Little's report.
02/90	'Year 2000 Strategy For Emerging Industries Conference' reconfirmed HDTV as one among ten rising star industries.
05/90	ITRI presented '5-Year Plan for the Development of HD Video Technology' to DIT/MOEA.
06/91	Two research reports by USA-based DynaTech Development Corporation and DataQuest helped to plan the development of HDTV.
07/91	* Inter-ministerial seminar on 'The HDTV industry Development Programme' hosted by MOEA. * '5-Year HD Video System & Products Development Plan' was ratified by DIT. * HDTV-related industrial consortia established.
10/91	CEPD reviewed the 'The HDTV industry Development Programme'.
11/91	'The HDTV industry Development Programme' was authorised by the Executive Yuan.
04/92	'The HDTV industry Promotion Office, MOEA' was approved by the Executive Yuan.

3.1. HDTV Policy Formation

The HDTV policy is not solely decided by the central government in Taiwan. There are many actors involved in the process of policy making including economic technocrats, technical specialists, vested interests, and even foreign advisors. All of them have their own contributions in the process of policy making. It can be said that the government is still the driving force in the process of HDTV development. However, an active state can not produce an effective HDTV policy without an active response from the industry.

Some characteristics of economic policy, such as, its centrality in the political process, high internationalisation, highly technical character, and specialised important institutions are also important for success (Grant, 1993:3-5). In relation to the economic policy for the development of industrial technology, these characteristics are far more explicit. Their importance to the case of HDTV development will be illustrated in the subsequent discussions.

3.1.1. *The process of 'picking winners'*

Although the concept of 'picking winners' is still debatable in western societies, some successful examples in the East Asian countries have demonstrated evidence to justify this concept on theoretical grounds[73]. However, it is arguable whether bureaucratic foresight of government economic planners can be as successful at foretelling the future of an industry as the private sector does. If industrial technology policy is determined within the bureaucracy the result can be an policy implementation which lacks feasibility, misdirecting technology development against the international trend. Then, the risk of bureaucratic failure is certainly more likely than market failure. The EU95 is a case in point. If the European Commission had left the private sector to take the risks according to their own judgements, there would not have been a huge public investment in vain, especially, when an all-digital format was emerging as a future tendency.

The selection of the HDTV industry as a targeted industry was modestly considered in the late 1980s in Taiwan. In order for Taiwan to stay on its economic trajectory as the year 2000 approached, new opportunities need to be pursued and new strategies for capturing these opportunities need to be designed. The government recognised this and acknowledged that ultimately industry and, principally, the private sector will have to take responsibility for moving ahead aggressively. However, in its capacity for creating an appropriate environment for meeting the challenges that lie ahead, the government is seeking to identify what some of the more promising new directions might be and how Taiwan can seize them. The government picked ten 'star' industries as industrial priority targets for technological development in the 1990s[74].

[73] The rise of the semiconductor industry in Japan, South Korea, and Taiwan provides a very persuasive case explaining the nature of 'picking winners'. These three countries are among the top four competitive manufacturers in the world. Japan's case was cited as the effective operation of industrial policy by MITI (Okimoto, 1989), while the other two were the evidence of institutional arrangements in terms of industrial policy (Hong, 1997) or the argument of the developmental institutions of developmental resource leverage (Mathews, 1995).

[74] Ten priority industries were put into three categories: 1. Export-oriented industries (consumer electronics, information, telecommunications, semiconductors and automation & precision machinery) to promote international competitiveness of Taiwan's products; 2. Primarily support-oriented industries (advanced materials and specilaty chemicals & pharmaceutical products) to underlay the demand of whole manufacturing industry; 3. Domestic market-

And many sets of industrial policies have been designed to fulfil the 'Taiwan year 2000 industrial development approach'[75].

Many seminars have been held by public agencies and the departments concerned (mainly CEPD, DIT, and IDB) with active participation from the industrial sector, business associations, and research institutes, to discuss the selection of promising fields (industries, technologies, and products) within the sector. Regarding the industry of consumer electronics, the focus was on the new generation of television and visual product technology, as a reflection of the predicted high market potential and also that HDTV, by then will be an international race between Japan and Europe.

In 1988, CEPD and IDB commissioned Arthur D. Little (ADL), an international technology management consulting firm based in Cambridge, Massachusetts, to undertake a two-phased investigation of industrial opportunities for Taiwan early in the next century[76]. A workshop, held at ADL's headquarters on 9-11 January, 1989, presented its results, together with written support material to Taiwan's delegation with representatives from CEPD, IDB, and ITRI. The final version of the report was submitted to the authorities in Taiwan in March 1989. It recommended ten emerging industries for Taiwan to develop in the 1990s. The content of each individual industrial report included international trends in technologies, products, and markets, as well as an analysis of the strengths and weaknesses of Taiwan in entering that particular industry.

The 1989 ADL report has had a very decisive effect on the choice of emerging industries in Taiwan. The ten recommended strategic industries by ADL are very similar to the final decision of the Taiwanese authorities except that the aerospace

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oriented industries (aerospace, pollution control, and medical & health care) to reduce heavy dependency on imports.

[75] Except 10 emerging industries, there are also 8 key technology fields, 24 key products, and 42 key parts and components selected by the government. Most of those technologies, products, and components are supporting the development of 'winners'.

[76] The objective of the first phase has been to identify some of the more promising opportunities for Taiwan; the objective of the second phase is to recommend specific strategies for pursuing these opportunities. In the first phase, the consultants based their preliminary conclusions and recommendations on their own insights into industry trends over the next decade and general information provided by IDB about Taiwan's capabilities and goals. (ADL, 1989:1-2)

industry and pollution control replaced the food processing industry and biotechnology. It is because, as supposed, food processing was not a high-valued-added industry and the foundation of Taiwan's biotech industry was too weak in terms of experience and expertise. The importance of this report on picking winners was underestimated by some interviewees, and this might be because appreciation of this report would lead to the devaluation of indigenous contribution by national expertise. However, this report is not only for 'reference', as one interviewee termed it. In fact, many development directions and strategies in Taiwan's policies are influenced by ADL's report. But it is difficult to rule out whether the local elites shared the same insights with ADL, and 'who is the chicken and who is the egg'.

The foreign advisors of STAG also had a role in the process of 'picking winners'. They provided their professional insights into the specific industries at the 1991 National S&T Conference which identified the international trends in technological development and encouraged the government to proceed with the 'Year 2000 plan'.

The decision of selecting strategic industries has been highly influenced by foreign actors. CEPD and IDB had to be assumed to be confident that the right industries were chosen, at least in terms of international trends, before any further government policies were put into action. This revealed an internationalised process in which government decision making depended more on international sources than on national sources (Keohane & Milner, 1996). More international information, less the chance of choosing wrong sectors. The government could not be too careful about picking promising sectors and avoiding the failures of investment in the future.

The criteria for 'winners' lies in their value-added characteristics and their contribution to the future economy. Thus, the government decision on the selection of winners was independent from private influence.

3.1.2. Preparation for the development of new technology

The government agent consulted with the consumer electronics manufacturers in relation to their technological needs and the products that they would develop in the next few years. The government feared that the technological investment of the government in ITRI might not diffuse to the manufacturing sector, they needed the commitment of firms. However, the industry was not very interested in the ultimate product of HDTV in the short term, but expressed their desire to upgrade the technological capacity for visual products to capture the foreseeable market. This was quite important in order that the private sector could repay their heavy investment in new products. As far as the industry was concerned, products, such as advanced TV, projection TV, and the electronic still camera are more realistic than HDTV (Interview No.8 & 10). Although the fact that the HDTV would dominate the whole TV market in the long run was widely perceived, in the eyes of manufacturers, the time was still too far ahead. They were reluctant to take the risk of supporting a long term government policy.

The industrial sector concentrated more on products, which can be derived from the application of visual technologies to the process of development, than on the technology itself, while the government was more interested in the effect of technology diffusion. The divergence of views between the public and private sectors has been reconciled by elastic measures. A phase-in approach was decided on to fulfil the requirement of the industry, and the industry had committed itself to a long term support to a HDTV policy.

The phase-in approach keeps product development abreast of technology development at each stage in which the ITRI took the responsibility for the R&D of visual technology. In the meantime, the private sector organised product development consortia to absorb the phase's outcomes of technology. In the 1991-96 HDTV STP, there were thirteen product development consortia in operation and each lasted for 1-2 years. So the private sector could take part in the development of technology and the commercialisation of technology simultaneously.

The development of HDTV policy in Taiwan took place according to the 'Programme for the Development of HD Video Industry' (高畫質視訊工業發展方案). This programme was initiated by IDB as a result of consulting with other government agencies in July 1991, reviewed by CEPD in October 1991, and ratified by the Executive Yuan in November 1991. However, two foreign reports by DynaTech and DataQuest were very influential in guiding the direction of the HD video industry and providing the information on the international technology movement[77].

ITRI advanced its plan for applying '5 Year High-definition Visual Technology Development' in May 1989. After reviews by IDB, DIT, NSC, and STAG, a '5-year Special Technology Project for the Development of High-definition Visual System and Products' (HDTV STP,高畫質視訊系統與產品發展五年科技專案計畫) was granted to ITRI from July 1991.

3.2. Government Technological Investment: Technology Innovation and Product Creation

The development of technology supported by MOEA can be divided into two different functioning policy measures administered by DIT and IDB (See Chart 6.8). IDB is the competent authority in charge of the strategic planning of sectoral industry development and general industrial policies related to incentives, subsidies, and loans, while DIT technically initiates the directions and fields of technology development at sectoral level to support the goals of strategic planning by IDB.

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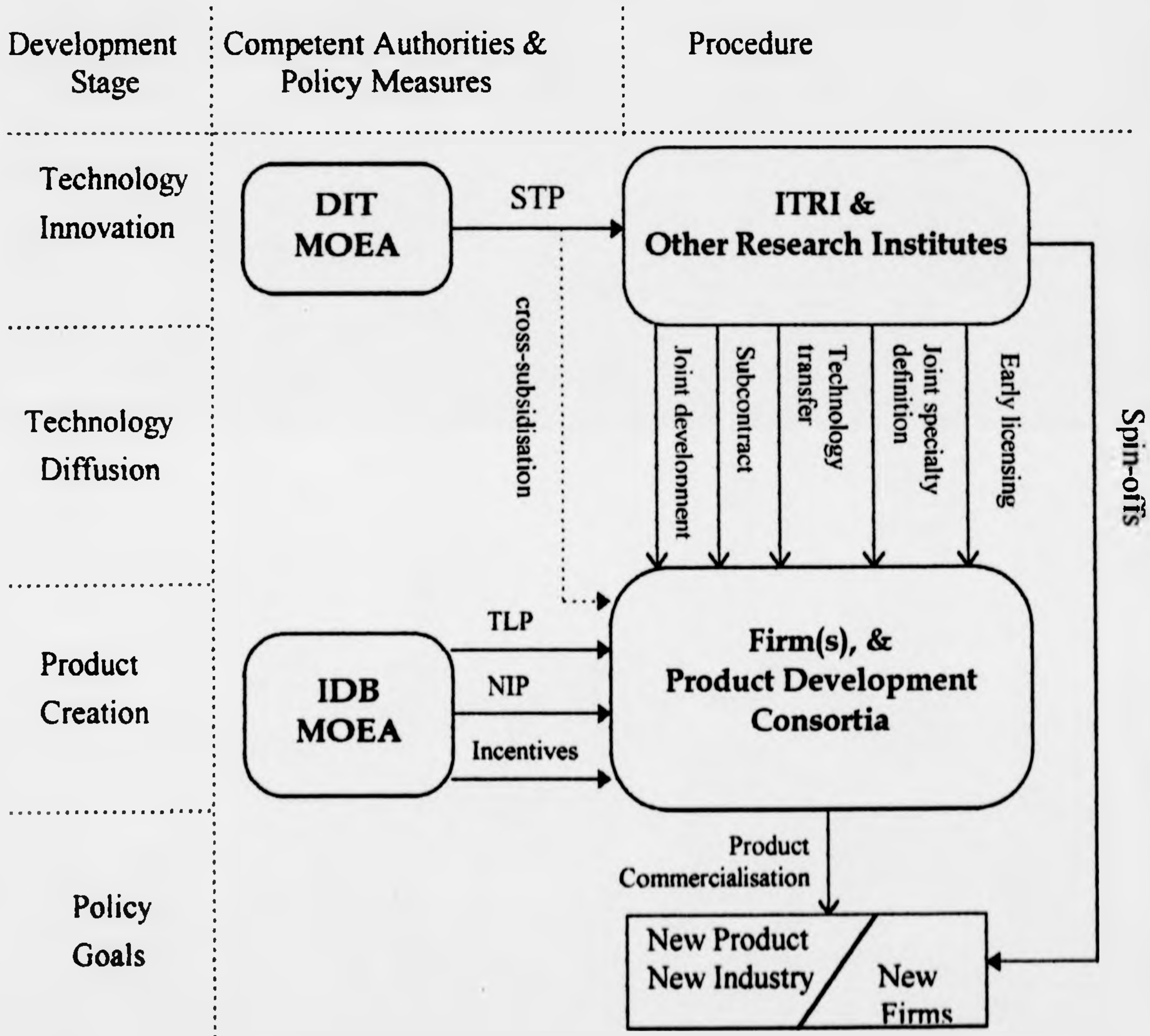
[77] The DynaTech Development Corporation is a USA consultant firm which has built a close relationship with the second division of IDB since 1988. It had produced many consulting projects in strategic planning and high-tech industry studies in the late 1980s, and a series of studies regarding the development of a HDTV industry in Taiwan. DataQuest, another USA consultant firm and databank, also has a long term relationship with IDB. Its tasks included strategic marketing studies on global trend and the movement of large international electronics enterprises in relation to products at each stage through the 5-year HDTV policy. Besides, two international firms, Understanding & Solutions, Inc. and Scientific Technology, Inc., also engaged in collecting intelligence for ITRI in a form of up-to-date from-time-to-time memo rather than a form of precisely full analysis.

The public-private interactions in relation to technology innovation and product creation are classifiable into four development stages by time series, namely, technological innovation, technology diffusion, product creation, and goals accomplishment stages. At each stage, the role of actors changes in functional terms and different measures are employed to fulfil the phase's aim.

Chart 6.8 The Relations among Supporting Policy Measures, Technology Innovation, and Product Creation



3.2.1. Stage one: technology innovation

In this initial development stage, DIT is the financial sponsor to back the activities of technology innovation necessary for industrial development. The policy measure is a special funding, STP, to public research institutions[78]. The STP recipients, such as ITRI, should take the duty of technology innovation as designed in the proposals whose progress and budget were reviewed by DIT quarterly. The government maintains the right to cease funding if the phase outcomes do not meet the target.

In the case of HDTV STP, CCL/ITRI was the recipient, in which the Visual Information Technology Division was the powerhouse in R&D. HDTV STP was divided into six main R&D projects to underpin the development of the HDTV industry which included Signal Processing Technology, Display Technology, Image Acquisition Technology, Video Tape Recording Technology, Advanced Media Technology, and Visual IC Components & Process Technology. The research outcomes of each sub-project would apply to different types of products. In particular, these sub-projects were essential core technology to the video industry.

HDTV STP was a supra-industrial development project involved with electronics, electrics, advanced material, opto-electronics, and machinery research, which required the coordination and integration of R&D efforts among related laboratories in ITRI. CCL was the leading laboratory in HDTV STP, other research institutions (ERSO, OES, MIRL, & MRL) had their respective responsibilities in HDTV STP.

3.2.2. Stage two: technology diffusion

The success of STP very much depends on effective technology diffusion which would spread STP's technological fruits to the industry sector. The means of technology diffusion from public research institutions to the private sector, taking ITRI as an example, include:

[78] The STP funding to R&D was limited to the public institutions before 1997. In the 1998 fiscal year starting from July 1997, the private research institutions and enterprises with ability to conduct large-scale R&D also allowed to apply for the Civilian STP (民間科專), if their proposals were passed by the DIT and their technological outcomes could benefit industrial upgrading. A budget of NT$285 million allocated to Civilian STPs in the 1988 fiscal year. There were eight Civilian STPs approved by DIT that the government has funded NT$187 million plus the matching funds from the private sector which was NT$58 million (CDN, 26/05/97). There were still some proposals waiting the results of review on May 1997.

(1) Subcontracting: A small part of technology, which can be developed by a firm and is necessary to STP, is allowed with the consent of MOEA, to be subcontracted to the private sector from the STP finance.

(2) Joint Specialty Definition: For a new product or a new standard in the industry, ITRI will invite firms to define the specialty jointly. This would accelerate the pace of technology diffusion.

(3) Technology Transfer: A typical method of technology diffusion from ITRI to firms in which firms can get technology that is ready and available by paying a royalty and licence fee. The instances of this static technology transfer have decreased since 1990 since the new, and more effective, approach has been found.

(4) Early Licensing: This is a method where firms have to pre-pay the royalty and licence fee before the commencement of R&D activity. Generally, the payment for early licensing is less than technology transfer. Firms have to share the risk of R&D failure, but they can get access to the process of R&D from the very beginning. Early licensing lets the firms gain the experience of technology innovation instead of taking research outcomes as given, which might promote their ability to conduct R&D in the future. It is normally applied to the development of core technologies.

(5) Joint Development: The objectives of joint development can be either of product or technology. Under conditions where firms have a certain degree of capability to develop technology, or intent to develop a product, but still need ITRI's technical support, joint development between ITRI and firms may be set up. The genesis of joint development was around 1990, and this method has been intensively employed since the NPC Alliance has brought about its market share-accelerated consequence.

3.2.3. Stage three: product creation

No matter by what means the firms obtain the technology necessary for product development, another government agency, IDB, will provide subsidies, loans, and other incentives to assist the private sector. These advantageous measures reduce the financial burdens of firms in the process of product creation, as well as motivating the private sector to engage in new high value-added products.

At this stage, IDB is the competent authority in distributing financial resources to the private sector according to SUI. Under the SUI, loans, subsidies, and incentives regarding matters of upgrading industry are supplementary to enhancing the competitiveness of national firms which have been approved by IDB. Two policy measures, in particular, leading to product creation, TLP and NIP, deserve to be mentioned again here, while other detailed operations of financial assistance are referred to in Chapter Four. TLP is a subsidy measure assisting the development of 'targeted leading products' by which an approved plan can be granted 50% of its R&D cost, while NIP is a semi-subsidy measure encouraging the development of 'new industrial products' by which up to 50% of R&D cost in the approved case can be loaned interest-free. That is to say, if a plan of product creation by the industrial sector qualified for both NIP and TLP, it does not even take a penny out of firm's pocket in the process of product development.

Fourteen cases related to HDTV development have been subsidised by TLP by July 1996 (HDTV office, 1996:50)[79]. Only two cases (WS ATV and DAT) are consumer end products, the rest are key components of HD video industry. This was because each leading firm in the product development consortium was granted subcontracting fees respectively to conduct product creation. The subcontracting fee to a leading firm was equivalent to the amount of TLP subsidy. Therefore, TLP subsidies to the HDTV industry were focused on the development of key components.

TLP has exploited the international regulations on industrial subsidy and the countervailing measure of the World Trade Organisation (WTO) at a very marginal

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[79] During 1991-July, 1996, there were 173 approved LTP applications for ten star industries and the budget for LTP was around NT$3.8 billion. The approved amount for one fiscal year was NT$10 million, NT$450 million, NT$925.9 million, NT$866.2 million, NT$855.4 million, NT$725 million from 1991 to 1996, respectively. (http://www.moea.gov.tw/~meco/EcoDev_c/a071.htm)

limit, in which the subsidies to the precompetitive stage of production should not be in excess of 50%. Moreover, NIP as a supplementary measure to TLP has provided another half of the cost in the form of repayment-deferred interest-free loan. And the loans for product development remain an issue of domestic policy away from international scrutiny, so far.

3.2.4. Stage four: the accomplishment of policy goals

The government's attempt to create a new product/industry relies primarily on two-levels of support, upstream level for technology innovation by DIT and public research institutions, and downstream level for product creation by IDB and the industrial sector. It covers the comprehensive process from the generation of technology, to the application of technology, finally leading to the commercialisation of the product. All efforts are aimed at creating a competitive product/industry.

It is easy to understand how this development process will result in a new product, but it is necessary to explain how it will lead to the formation of new firms and industry. According to the preceding discussion, a STP is a series of relevant sub-subjects on developing a cluster of technologies in a confined industry. Among the outcomes of those sub-subjects, a single technology might apply to one product (digital still camera), or some technologies might jointly contribute to the needs of a product (HDTV). There will be many opportunities in product terms that could be derived from the technology diffusion of a STP. The new products range from components to industry end products covering up-, middle-, and down-stream industry. In the case of HDTV STP, the derivation of visual technology created many key components, systems, functions and more than ten industry end products. Thus, a new digital visual industry was built in Taiwan[80].

[80] There were some examples of creating the new industries, all of them benefited under the STPs, for example, the semiconductor industry and the computer industry in 1980s. This is not to say that all STPs can lead to the generation of new industries, rather more STPs are concentrated on continuing upgrading of industrial technology so as to sustain the competitiveness of established industries.

If a public research institution makes a technology innovation which is a totally new technology to Taiwan's firms and the firms have no ability to undertake this technology, the researchers who made the breakthrough will be encouraged, and assisted in most cases, to form a new firm to apply the new technology. For instance, many semiconductor companies, included the first fabrication one -- United Microelectronics Corporation, were formed as the spin-off companies from ERSO/ITRI with technical staffs from ITRI[81]. Accounting the heavy weight of total outputs of these companies, technology diffusion through spin-off is the most important and effective way of creating Taiwan's semiconductor industry. Taiwan Aerospace Corporation (TAC), a spin-off aircraft maker, split off from CIS, so as to build a civilian aircraft industry in the late 1980s[82]. TAC is a joint venture between the government and KMT (Chen et al., 1991:80), in which 29% of initial capital (US$50 million) from the government and the rest from 'the private sector' (MOEA, 1995:62). It is arguable that public development technology spun off to become a mostly party-owned company in the sense that Aerospace is a monopoly industry in Taiwan and there should be a clear line between the state and the ruling party. No wonder KMT is the richest political party in the world because it has invested on many profitable high technology companies by taking advantage of its position as a half-century ruling party in Taiwan. For a full discussion of KMT-state capitalism refer to Chen et. al., 1991, in which a deeply

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[81] Four companies in the semiconductor industry spun off from ITRI, namely, United Microelectronics Corporation (UMC) in 1979, Taiwan Semiconductor Manufacturing Company (TSMC) in 1987, Taiwan Mask Corporation (TMC) in 1988, and Vanguard International Semiconductor Corporation (VISC) in 1994. In addition to the contribution of technology and technical staffs from ERSO/ITRI, the public sector played a role as a joint venturer. UMC was entirely a creation of ERSO/ITRI which provided designed products, technologies, facilities and staffs in the beginning, and MOEA raised a capital of NT$500 million (the contribution of private capital was limited). TSMC began operations by leasing fabrication facilities from ITRI and the Development Fund of the Executive Yuan as the major shareholder (47.5% out of US$145 million, together with 27.5% from Philips). The initial situations of TMC and VISC were identical to those of UMC and TSMC, with 43% out of NT$350 million from ITRI's venture capital fund in the case of TMC, and 33% (the estimated value in the form of manpower, technology and assets) out of NT$18 billion in the case of VISC (Data for the public shareholders from Mathews, 1995:67, 73-4, 95, & 102). In 1995, UMC and TSMC were the top two manufacturing companies in Taiwan, and the total productivity value of these four spin-offs was NT$59.1 billion, 42% of value outputs in this industry (ITRI). In this respect, technology diffusion through Spin-off companies is the most important and effective way of creating new industry in Taiwan. Taiwan's semiconductor industry ranks at the fourth in the world. In 1996, TSMC was the largest semiconductors manufacturing firm in the world, shared 7% of US$130 billion world market (CDN, 09/07/97).

[82] The technologies, technical staffs, and facilities of TAC benefited from the national programme for the development of IDF fighter, a military programme conducted by CIS. TAC now shares 40% of McDonnell Douglas's commercial-aircraft division, but that is not to say that TAC has built its ability to manufacture entire aircraft (but some components) because McDonnell sold its stake for US$2 billion to TAC to pay off a US$2.6 billion debt in 1991 (Nester, 1997:174).

intertwining relationships between state-owned enterprises, privatisation, and KMT-owned enterprises has been explored.

There are two spin-offs, Ho-Bang Electronics (合邦電子) and Chien-Cheng Vision (阡成視訊), from CCL/ITRI in the HD video industry so far. The technical staffs of both companies are mainly from the researchers trained under the 5-year HDTV STP[83].

4. A NATIONAL FRAMEWORK FOR HDTV DEVELOPMENT

Unlike other experiences of countries and regions in the development of HDTV, Taiwan set up a temporary functioning office at central government level in charge of the coordination of all HDTV-related activities to assist the establishment of the HDTV industry. The reasons for the establishment of a supra-ministerial office was threefold (Interview No.13). First, the development of HDTV has involved more than manufacturing concerns, a domestic enabling environment for HDTV development is also important, under which broadcaster, market, software, and transmission standards will influence the spread of HDTV. In this respect, the coordination of many government forces in HDTV development becomes of paramount importance. Second, IDB's administrative capacity is such that it can not burden its second division with this extra task. Moreover, IDB can not coordinate with other ministerial organs, such as, the Ministry of Transportation (in charge of transmission standard), the Information Bureau of the Executive Yuan (in charge of broadcasting system), and the Ministry of Education (in charge of engineer training), because of its lower level in the government hierarchy. Third, a functional office to promote the HDTV development would harmonise vertical cooperation and horizontal integration. It can shorten the time taken to circulate information and promote administrative efficiency.

[83] The Deputy general manger (Mr. Chang who was co-director of HDTV STP), three out of four directors, and, many project managers, in the Ho-Bang Electronics came from CCL. General Manager (Mr. Feng) and many core staff members of Chien-Cheng Vision are also from CCL. Mr. Chang and Mr. Feng believe that the contribution of HDTV STP to Taiwan's emerging visual industry is extremely important in terms of technology diffusion and the cultivation of experts (HDTV Office, 1996:34-5). The main products of the former are key components (visual IC) in the visual industry, and those of the later are video-on-demand relative products.

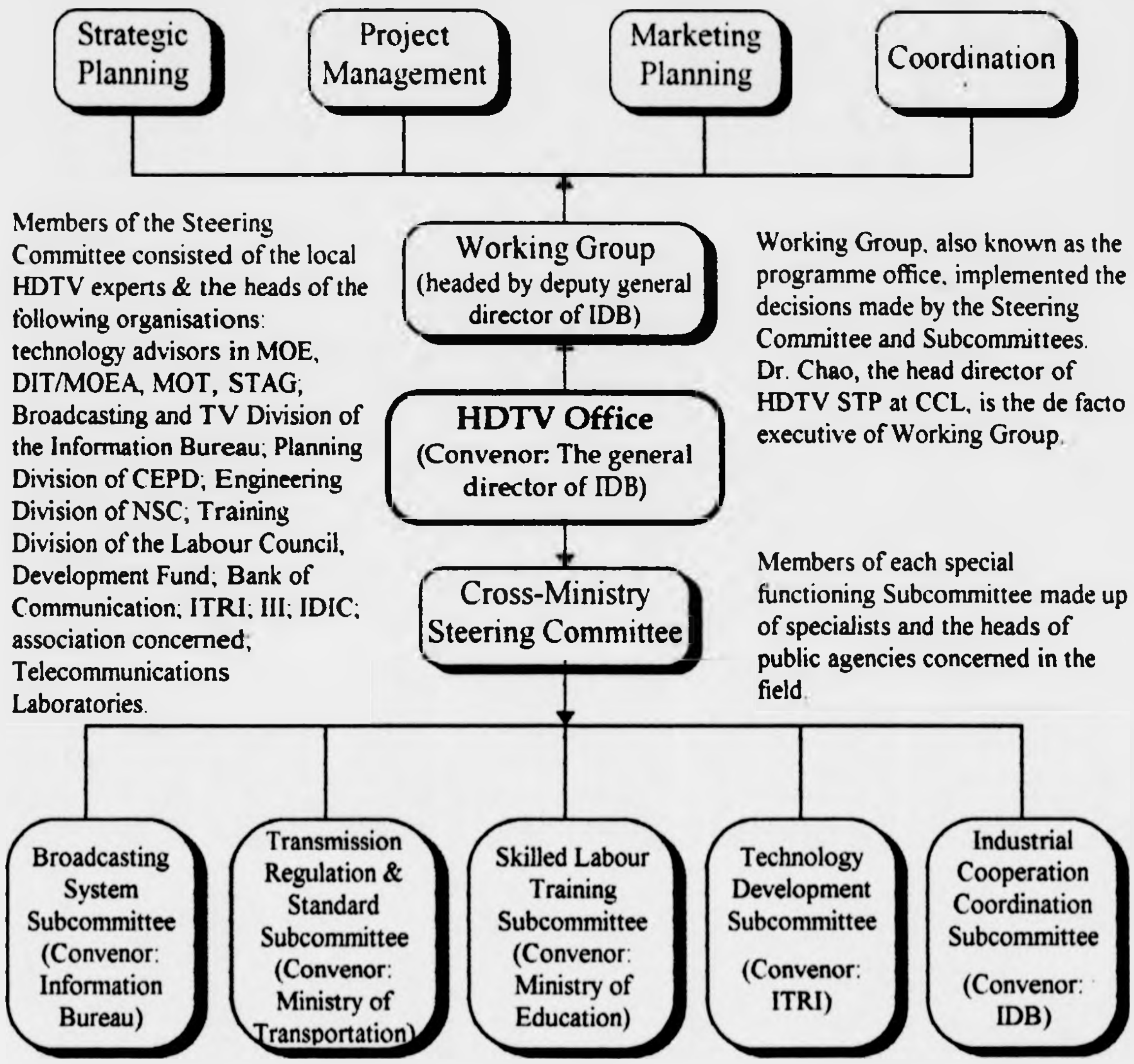
4.1. High-Definition Video Industry Promotion Program Office (HDTV office)

The idea of setting up an office to handle HDTV development and promotion was advanced by MOEA in the Programme for the Development of HD Video industry. However, the functions and objects of this office and its committee were planned by DynaTech Development Corporation. DynaTech's report was drawn from a survey of four key consumer electronics companies, opinions from related government agents and ITRI, and the experiences of foreign countries in promoting the HDTV industry.

According to observations, the basic operation and framework of HDTV office (Figure 6.9) in 1992-96 are identical to the policies and strategies suggested by DynaTech's planning of a steering Committee/Programme Office except for details in staffing, budget, and subcommittees. It was argued by DynaTech that the HDTV office should follow a Japanese-style operation in the promotion of the HDTV industry. Nonetheless, the promotion activities of Taiwan and Japan are quite different in their nature. While Japan's HVC (initially established by MITI) and HPA are operated by the industrial sector to coordinate and promote HDTV development, Taiwan's HDTV office is a functioning organisation solely supported and supervised by the government. In particular, the budget to run the office is from IDB and professional and technical staffs comes from CCL. Taiwan is unique in establishing a promotion office to administer HDTV development at a central government level[84].

[84] HDTV Promotion Office was the first industry-specific promotion office established in Taiwan. There are another four offices to promote strategic industries, including aerospace, biotech & pharm., precision machinery, and information industry. An Advanced Material Promotion Office may be established in the near future. It shows that the government valued these industries, and gave promotion offices special status and budget in order to manage the development of strategic industries.

Figure 6.9 HDTV Office/Steering Committee Organisation Chart



The main tasks of HDTV office, including a Working Group and a Steering Committee are summarised below:

1. To coordinate with the related ministries concerned, ITRI, and other research institutes to carry out the R&D projects and transfer the resulting technologies to industries (key components and products).
2. To work with the government branches concerned to develop a plan for cultivating skilled labour for the visual industry.
3. To work with related agencies to develop a system for the promotion, taxation, and rewarding of the HDTV industry.
4. To coordinate with the Ministry of Transportation and Information Bureau to develop domestic HDTV standards, the broadcasting system and to plan a schedule for HDTV broadcasting.
5. To set up an HDTV system demonstration centre.
6. To develop other important activities related to the development of the HDTV industry.

The framework for the development of the HDTV industry under the HDTV office is deliberate. It incorporated all the necessary forces into a centralised entity so as to coordinate activities, and intended to create a favourable environment for HDTV development. The cost for the operations of the HDTV office was solely supported by government, there was no private contribution[85]. In 1994, the budget for HDTV office was about 7% of that of HDTV STP (NT$420 million) (IDB, Dec.1994:344) which revealed that the government had invested more on manufacturing industry than on the TV media & broadcast industry. However, the efficacy of its outputs is less satisfactory than expected in some Subcommittees.

Table 6.10 Taiwan's Initial Timetable for HDTV industry Development

Fiscal Year	Policies	Strategies	Industries	Broadcasting
1992	-Plan & promote the HDTV industry in Taiwan	-Set up a Steering Committee to coordinate all Taiwan's HDTV activities	-Organise interest group -Share test equipment	-Study foreign HDTV studio equipment -Test broadcast ATV
1993	-Establish government funding programmes to encourage industry R&D	-Promote R&D & develop sources for HDTV key components	-Work with CCL/ ITRI on key components R&D -Increase own R&D efforts	-Set up Taipei demo centre -Use mobile studios for live broadcasting
1994	-Select and develop Taiwan's own HDTV broadcasting standards	-Study standards of leading countries -Train skilled labour force	-Automated manufacturing -Product cost reduction	-Start test broadcasting using own standards
1995	-Promote international cooperation to develop a global market for HDTV products	-Establish strategic alliance -Promote HDTV products export from Taiwan	-Export local products -Seek joint sales & marketing channels with foreign firms	-Work with industry to promote HDTV receivers -Produce programming
1996	-Achieve 5% world market share -Begin Taiwan's own HDTV broadcasting	-Provide easy transition from NTSC to HDTV -Use local market to help develop the HDTV industry	-Create domestic market of own HDTV equipment -Promote foreign sales	-Start local commercial programming

Source: IDB.

[85] The budget for the HDTV office, directly from IDB, was around US$ 1 million each year to cover the expense of HDTV demo centres, HDTV experimental broadcasting equipment, broadcast testing centres, HDTV programme productions, special research projects, committee meetings, and HDTV conferences. The budget in a fiscal year for HDTV office was NT$22 million in 1993, NT$30.1 million in 1994, NT$28 million in 1995, and NT$24.5 million in 1996 (http://www.moea.gov.tw/~meco/EcoDev_c/a071.htm).

According to Table 6.10, the aim of HDTV broadcasting indigenous HDTV programmes was expected to be achieved and the export sales of related products in the world market was targeted at 5% by the end of 1996. However, neither of these could be proved to have hit the targets. The plan and the goals have been amended almost every year (in particular, in 1993) since this initial development plan announced by IDB. It is argued that the plan has been transformed from its ambitious outlook to a more practical approach. The reason leading to the anti-climax of the plan, according to many interviewees, was the delaying of an international standard for HDTV. In their language, US Grand Alliance has postponed advancing the standard since 1993 and this affected Taiwan's timetable for determining its 'own' standard.

There were other factors influencing HDTV development, not in Taiwan alone, but worldwide. First, the forecasting of the HDTV potential market was overexaggerated by most international actors, in particular, in terms of its optimal timing marketed in the middle of 1990s. This made all the countries and regions mark the start of HDTV broadcasting around the mid-1990s, but none of the countries or regions achieved this goal except Japan's 8-hour MUSE programmes daily. Taiwan, on the suggestion of foreign advisors (ADL, DynaTech, and DataQuest) believed that a worldwide standard would be reached before that time. Second, there was no consensual standard among international rivals. Europe, Japan, and US had developed their own standard, not to mention their different formats. This technically disintegrated development delayed the timing for HDTV broadcasting. Taiwan has technically followed US development and can not determine its standard without referring to US standard.

Third, the motivation for broadcasters to go digital high-definition was not very strong, even with the subsidies allocated to them. The cost of re-establishing equipment for them was larger than their commercial returns in the sense that the buyers of commercial advertisements, the main source of income to broadcasters, would not pay extra money to get the space for advertisements when the programme was high-definition. The cost for a TV station to change from an analogue to a digital one is estimated about US$8-10 million in the USA, and this excludes the cost for frequencies (HDTV Newsletter, Jun. 1997:12). So the broadcasting industry had no interest in changing to a digital system, unless the government forced them to do so. A paragraph was written by Interview No.30 which showed that the task of promoting HDTV in terms of TV programmes and broadcasting was very frustrated: 'the inputs of TV programme producers, broadcasters, and industrial sector were very limited. This should be politically pushed through the communication between the high level of government and the leaders of those key enterprises so as to let those enterprises to accommodate the whole strategic planning. Then, the promotion of HDTV shall be moved ahead (IDB, Dec. 1994:348).' This implied that the effects of Transmission Regulation & Standard Subcommittee, and Broadcasting System Subcommittee were obstructed by the reluctant behaviours of TV media.

The government policy will change in the near future to end the distribution of frequencies for analogue broadcasting (and sell off the frequencies for mobile communications), then the broadcasting industry will have no choice but to transform its system to cope with digital transmission. When all programmes are broadcast in digital form, then the market for HD video products will take off. This shows that the HDTV development is highly politicised. If the state did not make a deadline for full digital broadcasting, there would never be an HDTV era.

Fourth, HDTV seemed suddenly to fade out before the mid-1990s. The term -- HDTV, the original ambition of this wave of television revolution, was soon substituted by digital TV, which is not necessary high-definition. One of advantages of digital delivery systems is the increase of channels that is probably preferred to 'HD' by consumers because HD programmes reduce the amount of channels broadcasted. Unless you want to receive the new WS pictures, or even HD pictures (if delivered), a traditional TV with a decoder will suffice for digital broadcasting. In relation to transmission, there will be three ways to choose from -- terrestrial, cable, and satellite.

Indeed, the US is the only one country to insist on a digital terrestrial HDTV. The merit of terrestrial delivery is that you do not need to put a dish on roof or to connect a cable to the TV. However, consumers will do nothing and wait to see what happens when they face three competing digital delivery systems (Financial Times, 19/05/97).

Last, but not least, the consumer factor was the main determinant in the lack of HDTV development. 'It is difficult in advance to be certain about consumer reaction (to radically new products), and very large investments can be made' (Cawson et al., 1995:1). The benefits that consumers can get from the HDTV programme are better quality in vision and audio, and more channels (depends on what kind of broadcasting system, cable, satellite, or terrestrial). The problem is that these benefits do not merit consumers paying several times the price of a conventional TV. The market reflects that consumers will not pay such a high price to buy a WS TV/HDTV if it is available because they have become used to TV being relatively cheap[86]. A black box, a STB which can decode digital signals to analogue ones by adding it to traditional TV, is the cheapest way to receive a digital programme, but without a wide-screen picture. According to a survey in Taiwan, consumers would be only willing to pay 20-30% price difference between traditional and 'high-tech' TVs (Interview No.28).

The whole structure of the HDTV office was led by IDB, and all the measures and the functions of the Subcommittees were designed to accommodate the development of the HDTV industry. Moreover, IDB is the competent authority in charge of industrial development, so a departmental preference for the electronics industry comes naturally. It, thus, tended to focus on the benefit to manufacturing industry rather than on those of broadcasters and consumers. Furthermore, the HDTV industry as one of ten emerging industries demonstrated its privileged position on the

[86] Japan is the only country in the world broadcasting HD programmes and has HDTV sets in the street shops currently. However, the sales of HDTV were grown at a very slow rate in the past. The total sale of HiVision TV was 126,000 sets by the end of 1995. The sale of HiVision TV was 22,000 sets in 1994 and 87,000 sets in 1995. The 1994-95 annual growth rate was nearly four times. The reasons leading to the sharp increase of sale are the price, down to US$4,000 (was five times in the early 1990s) and more programmes being made available (HDTV Newsletter, Mar.1996: 17).

national agenda.

'An enabling environment' has two special meanings, one is to stimulate the domestic market for HDTV products if the broadcasting system could deliver HD programmes; the other is to strengthen the export competitiveness of the HDTV industry by enlarging the domestic demand in order to reduce the production costs based on the doctrine of economy of scale. Most of the government measures decided by the HDTV office were biased towards the renaissance of the consumer electronics industry rather than the protection of the interests of the broadcasting industry and consumers.

If the preceding analysis is correct, HDTV development in Taiwan is represented chiefly by the development of HDTV-related products. All other efforts, it could be argued, assist the growth of video industry. That is to say, four subcommittees are supporting actors while the industrial cooperation subcommittee is the main actor.

4.2. Tactics for the Technology Development

The direction of technology development for the HDTV industry was considerably affected by certain factors which indicated the strengths and weaknesses of Taiwan's consumer electronics industry. The following discussion addresses the factors which have constrained, as well as provided opportunities for technology development. Five tactics have been employed to guide the direction of R&D.

4.2.1. Standard tactic: all-digit

Digital TV was the standard that Taiwan intended to develop. Taiwan has followed the US NTSC for several decades, a technical change of standard in USA would be easier for Taiwan to adjust to than the Japanese and European ones. The HDTV standard war changed very quickly with new proposals coming from every quarter, but no system was yet in widespread use at the turn of the 1990s. Taiwan had to choose one system. Fortunately, it chose the right one, even though the Japanese MUSE was the most well-developed system at that time. Besides, all-digit, the language of the computer, matched the strength of Taiwan's computer and semiconductor industry where some technologies are compatible with HDTV technologies.

This might be the answer to why Taiwan's technologies in HDTV are a step ahead of Korean (Interview No.3), even though Korea's HDTV R&D was launched much earlier than Taiwan's effort (about 1.5 years). Korea bet on the wrong side of this technological race in which the large Korean industrial conglomerates worked closely with NHK of Japan to develop the MUSE system in the beginning. They shifted their concentration to digital HDTV after the USA all-digit system became the lead in the field. But many investments and time have been wasted.

As far as the standard is concerned, Taiwan gave up the ambition to be involved in establishing any regional standard. This was on the advice of DataQuest, a major consultant to IDB in terms of product information and technology suggestion. A paragraph of recommendation on HDTV standard influenced the decision of IDB:

> 'The history of broadcast standards has led to many twists and turns which, from a manufacturers viewpoint, has led to a vast waste of money and resources. .... The R.O.C. has no control or input to any of the major regional standards, it just has to accept them when they become solidified, a status not achieved in any of the major regions. The R.O.C. must therefore watch the market and not the standards. In addition, since the market is influenced by other factors than just a standard, the standard is just one of the issues in an increasingly complex maze.' (DataQuest, 1992:6)

4.2.2. The market tactic: focus on the US

The market was also a factor which led to Taiwan's following US standards. Taiwan's attitude towards the markets of future HDTV and relative products can be described as looking first at the US market in spite of the short term Japanese market and ignoring the European market. The US market was the main destination for Taiwan's exports in the past, so the concentration on the US meant easier access than European and Japanese markets, at least, in terms of existing distribution connections or existing assemblies within the countries of North American Free Trade Agreement. The Japanese market was the only one which had the soon-to-be-blooming sales, but to break the fortress of the strong distribution system in Japan seemed as difficult as to make a technological breakthrough[87]. The European market was also hard to get into, in particular because of Taiwan's weak connection with this market. As DataQuest (1992:15) suggested, the diversity of Europe and current confusion in systems would result in an insignificant number of HDTV sets sold within Europe[88]. For the rest of the world outside the triad, the market for HDTV sets shared only a negligible contribution in the near future.

4.2.3. *Manpower tactic: utilising overseas Chinese engineers*

Research manpower was essential to develop the technology. However, Taiwan was lacking in experts in HD video industry in the beginning. There were almost no trained engineers for the TV industry from Taiwan's Universities and Polytechnics in the 1980s because TV manufacturing was simply assembly. The technology was provided by Japanese companies, so the course on TV development (deemed as sunset technology) was less popular than those of computer and other electronics. However, there is no lack of such experts abroad. The fast way to build brainpower in HD video industry was to incorporate overseas Chinese engineers and many Taiwanese who studied and worked in the US, were headhunted to Taiwan. Those returning engineers have been the main force for technological development since the 1980s[89]. At CCL and the industrial sector, many of the researchers were formerly employed at AT&T[90]. This factor that engineers and researchers were mainly from the US led to the development of HDTV in

[87] It proved to be a correct decision to abandon Japan's market in 1990-91. In 1995, Japan's colour TV sales was 11.5 million sets in which high value-added model (WS TV & HiVision TV) was solely manufactured by Japanese domestic firms, and 7.5 million sets of traditional TV were imported from Japan's overseas subsidiaries in China and South East Asia (HDTV Newsletter, June 1996:17).

[88] The market data showed that DataQuest's forecasting in HDTV sales in Europe was incorrect. Even the WS TV is not the real HDTV, there were no WS TV sale in the US up to 1996 because of no broadcasting programmes and focus on HDTV. The sale of WS TV was 0.5 million sets in Europe (3.5 million sets in Japan) in 1996 (HDTV Newsletter, April 1997:1) which could be the efficacy of PALplus, a broadcasting of WS programmes started in 1994.

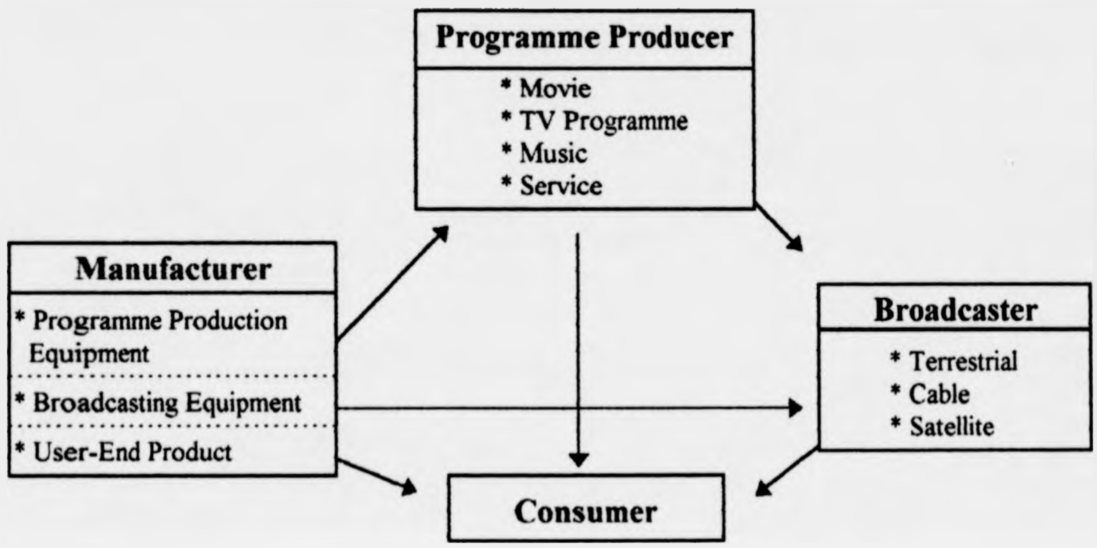
[89] One in four candidates for doctorates in electrical engineering at American universities is from Taiwan (Economist, 16/11/91). In 1980-89, returning postgraduates (including scholars, experts & newly graduated students) were 14,822 persons, about 44.4% of the all postgraduates (including masters & doctorates) from domestic universities in the same period. In 1990-94, the number of returning highly-educated experts increased to 23,613 persons (Sun, 1996:10). This shows that Taiwan has experienced a process of high-tech industrialisation since 1990 which provided more jobs for industrial experts.

[90] An AT&T Alumnus Club, organised by returning engineers used to work at AT&T, has more than one thousand members in Taiwan (Interview No.21). They are the momentum to push the development of many electronic-based industries.

Taiwan being biased towards an all-digit format. Even the industrial sector might prefer that to an analogue system because some firms had strong links with Japanese firms. The public sector researchers took their lead from a direction of R&D familiar to them.

4.2.4. Product tactic: user-end products

Figure 6.11 Industrial Connections in HD Video Industry



The equipment products in the HDTV industry included broadcast equipment, programme production equipment, and user-end equipment (see Figure 6.11). However, Taiwan's strength lay in current manufacturing and assembly industries in terms of consumer electronics manufacturing rather than broadcast and cinema equipment manufacturing. ADL suggested that Taiwan should focus on user-end products, and not on the development of broadcast and cinema equipment because there heavy R&D and investment favoured large enterprises. There was almost no broadcast and cinema equipment industry in Taiwan, thus it could not compete with others. As for software production, Taiwan might have an opportunity to capture the markets in China and Hong-Kong, and overseas Chinese by providing Chinese movies, and TV programmes in the future.

It was the original expectation of government to build a consumer electronics industry as one of the strategic industries, not a broadcast and cinema equipment industry. HDTV development became the catalyst to revitalise the consumer electronics industry, in particular, HDTV user-end products. These are in the rising field of the consumer electronics industry.

4.2.5. Technology tactic: product-oriented development

In order to maintain the effectiveness of STP, the tactic for technology development was left with intermediate product development (Interview No.3). This was partly because of the requirements of the private sector, and partly because of the fear that ITRI might fail to develop the complete technology or that HDTV market might fail to take off after the end of plan. Technology development in HDTV STP concentrated on core technologies and key components for relative products rather than on technology for new standards.

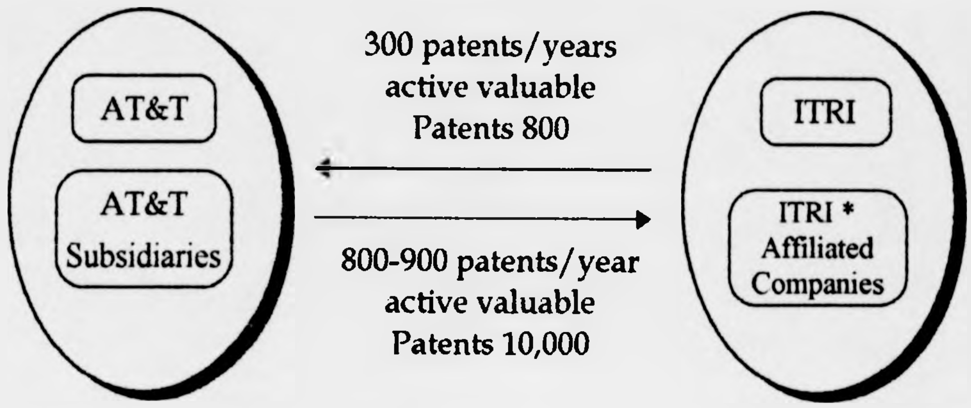
The product-oriented technology development served as the base for product development consortia, which were prerequisites to support the HD Video industry. Indeed, the HDTV did not take off as predicted but some interim products have been marketed, and the investment of HDTV STP and of private sector has not been wasted.

4.3. Other Technology Sources

201 HDTV-related projects funded to leading national universities during 1991-96 by NSC from which 82 patents were derived (HDTV office, 1996:45). However, the importance is not the funding of these projects, but the application of R&D results by the industry. The R&D outputs by university professors, if applicable to HDTV products development, have been transferred to CCL for developing key component prototypes. These prototypes could then be manufactured by local companies to be used in their HDTV products.

ITRI has been actively engaged in incorporating technologies from international sources. ITRI represented the whole industry in negotiating technology transfer with foreign institutes. In the case of HDTV, the finance for technology transfer from foreign sources was paid by HDTV STP. In other words, it is the government incorporating technology for local industries, an invisible subsidy.

Figure 6.12 AT&T/ITRI Patent License Agreement



Grant Area	Communication, semiconductor, optical.... 18 fields of use	Information Products
Benefits	Efficient Royalty Collection Scheme Increase use of AT&T patents in Taiwan	Avoidance of patent infringement Royalty rate reduction

* Taiwanese vendors that sign on the patent license agreement to access AT&T patents
Source: ITRI

Figure 6.12 shows the cross-license agreement between AT&T and ITRI which benefited those firms who signed a contract with ITRI. In this example, ITRI provides the access to AT&T's patents for the industrial sector. Without ITRI's efforts to marry with international institutions, local firms would find it difficult to get the technologies they wanted by their own efforts. However, Taiwan is not only just a technology importer but adopter and improver of technologies acquired (Mathews, 1995:244).

5. HDTV-RELATED PRODUCT DEVELOPMENT CONSORTIA

In the preceding chapter, a product R&D consortium was the key leading to the rise of the NPC industry in Taiwan. The NPC Alliance linking the research institute with the industry in order to 'create' a strongly competitive product bridged the time gap between the development of generic technology and of product commercialisation. This model of effective operation of the product development consortium has become an institutional norm in Taiwan's innovation system. Since then, under the requirement of MOEA, the incorporation of 'industrial cooperation' has developed into one of the very important criteria used to assess the application for STP by the public research institutes (Interview No.6 & 27). The government intends to bring the industrial sector into the process of technology development from the very beginning which would possibly be the most effective method of technology transfer ever employed in Taiwan. Moreover, the connections between research institutes and the industry have improved 'mutual understanding' through the product development consortia.

The operation of each HDTV-related product development consortium is very similar to the case of the NPC Alliance. The following discussions will stress the improvements and the characteristics of these consortia. The advantageous benefits of these consortia, have been expressed in chapter 5. The most distinctive difference between NPC and HDTV is the scale of product creation. The NPC Alliance focused on just one product, HDTV consortia on more than ten products in five years that intended to build a 'new' industry. The analysis will be biased towards the collusive cooperation of all participating firms and its impact on the development of the HDTV industry rather than on the operation of an individual consortium.

5.1. The Formation of Joint Development Consortia

The formation of consortia was divided into three periods, namely, design period, warm-up period, and contracting period. The whole process was organised by CCL and TEEMA. In the design period, CCL and TEEMA invited leading firms, who had better manufacturing experience and R&D capability, to discuss about developing certain products in their expert fields. If the firm was willing to lead a product development, it should advance a plan to define the time, manpower, and budget needed in the R&D process, and to design the functions and standards of product.

In the warm-up period, CCL and TEEMA held seminars on new technologies/ products, inviting firms to join development consortia. TEEMA collected the initial institutional norm in Taiwan's innovation system. Since then, under the requirement of MOEA, the incorporation of 'industrial cooperation' has developed into one of the very important criteria used to assess the application for STP by the public research institutes (Interview No.6 & 27). The government intends to bring the industrial sector into the process of technology development from the very beginning which would possibly be the most effective method of technology transfer ever employed in Taiwan. Moreover, the connections between research institutes and the industry have improved 'mutual understanding' through the product development consortia.

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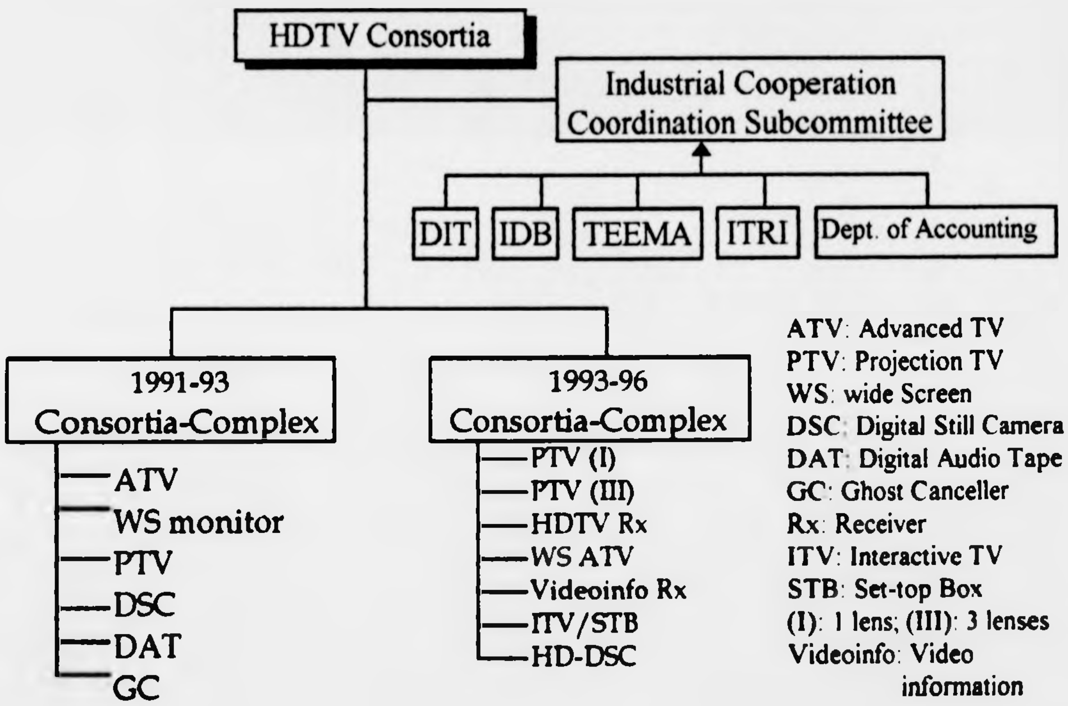
In the warm-up period, CCL and TEEMA held seminars on new technologies/ products, inviting firms to join development consortia. TEEMA collected the initial agreements signed by those firms interested in consortia after the seminars. In the contracting period, ITRI, TEEMA, leading firms and firms interested, discussed the contract in terms of technology, product, and details for cooperation. Normally, the contract could be agreed in a short time. If it was too extensive and the technology was too complicated to be determined immediately, a preparation committee (with a little money pay by firms to cover costs) would run for 2-3 months until agreement was reached by all parties. Thirteen consortia were formed under HDTV STP in 1991-96. The criteria for selection restricted participation to those firms with considerable manufacturing experience in the related industries. In order to avoid market disarray after the product was created, the number of firms in each consortium was less than ten except the ITV/STB consortium which aimed at creating domestic standardisation.

Chart 6.13 HDTV-Related Product Development Consortia



All HDTV consortia were organised by and affiliated with TEEMA except that technology per se was still associated with ITRI. TEEMA functioned in the same way as in the NPC Alliance, but the tasks were much heavier because several consortia operated simultaneously. Nominally, consortia hosted by TEEMA, and ITRI became contractors in two technological terms, transferring technologies to firms through early licensing contracts and entrusting product development to leading firms by subcontracting.

Chart 6.13 demonstrates the relationships of all HDTV-related consortia in which 13 consortia belong to 1991-93 and 1993-96 consortia-complexes respectively. Table 6.14 shows the details of each consortium regarding the leading firm, participating firms, time span, and finance.

Table 6.14 HDTV Consortia, 1991-96

Consortium	Plan time	Subcontracting		Early Licensing	
		Leading firm	Contracting fee, NT$	Participating firms	Licence fee (total)
ATV	01/07/91-30/06/93	Proton	15,500K	Proton, Sampo, Sanyo, Chung-Shin (中興), Tatung	7,000K
WS Monitor	01/07/91-30/06/93	Sampo	15,500K	Proton, Acer, Sampo, Tatung, Sanyo, Sony, Kolin, Matushita, Teco	12,600K
PTV	01/07/91-30/06/93	Tatung	15,500K	Proton, Sampo, Acer, Tatung, Sanyo, Sony	8,400K
DSC	01/07/92-30/06/94	BTC	14,000K	BTC (extended to 30/06/95)	2,500K
DAT	15/01/92-15/09/92	Long-Shine	1,653K	Long-Shine	2,000K
Ghost Canceller	01/07/91-30/06/93	CCL	40,000K	Proton, Sampo, Kolin, Tatung, Sanyo, Sony, Teco, Matushita, Cung-Hsing	900K
PTV(I)	01/08/93-30/06/95	Sony	16,000K	Tatung, Sony, Proton, Sampo, Teco	4,000K
PTV(III)	01/08/93-30/06/94	Tatung	16,000K	Tatung, Sony, Proton, Sampo, Teco (extended to 30/06/96)	4,000K
HDTV-Rx	01/01/94-30/09/97	Sampo	38,000K	Tatung, Sony, Proton, Sampo, Teco, Kolin, Matsushita, Sanyo, Chung-Shin	27,000K
W.S.ATV (32" & 36")	01/08/93-30/06/95	Proton	23,900K	Tatung, Proton, Sampo, Teco, Sony, Matsushita, Acer	14,100K
Videoinfo receiver	01/03/94-31/12/95	TECO	12,000K	Tatung, Sony, Proton, Sampo, Teco, Matsushita, Acer	3,500K
ITV/STB	01/07/95-30/11/95	CCL	-	Tatung, Sampo, Acer, Philips, etc. 21 firms in total	2,100K
HD-DSC	01/07/94-30/06/96	Umax	15,000K	Umax (another two firms suspended)	2,000K
Total	5 years	-	183,053K	86 time/firms	88,000K

Source: ITRI (Mar. 1996:29-30). K=1,000.

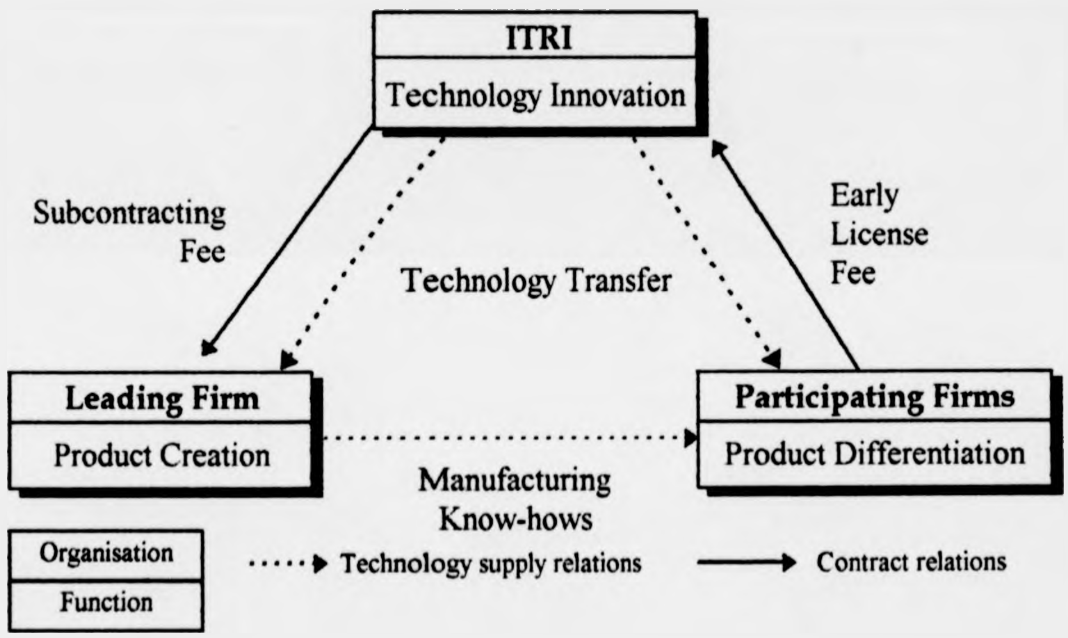
Note: Sony, Matushita (National/Panasonic), Sanyo and Philips are joint ventures of Taiwan's capital and foreign firms.

5.2. The Operation of a Single Consortium

5.2.1. Contract relations

The relations between ITRI, leading firms and participating firms were identical in all HDTV consortia. Figure 6.15 displays a general picture of the interaction within a consortium. Unlike the NPC case where the private sector as the unity interacted with ITRI in the process of product development, the participating firms divided into two parts to make a contract with ITRI. The leading firm took the responsibility of product creation and other firms were simply technology recipients.

Figure 6.15 Relations between ITRI, Leading Firm, and Participating Firms



ITRI played the role as a technology innovator to develop supporting technologies for product development. However, it was no longer doing the job of product creation. This might be a response to foreign criticism of ITRI's R&D activities being directly involved in commercial production. In order to avoid further criticism, or even more worse results, such as violating international regulations leading to the imposition of economic sanctions by trading partners, ITRI retreated from the commercialisation of technology, and concentrated on pre-competitive technology development.

Subcontracting and early licensing underlay the new model of joint development.

The leading role of product creation performed by ITRI has been shifted to leading firms by subcontracts. The subcontracting fee to the leading firm was paid from the HDTV STP budget, which was at ITRI's discretion, in order to cover the costs of product creation. The main work of the leading firm was to create a product as defined in the contract with necessary support from ITRI, such as core technologies, facilities, and technical advice. The R&D team was organised solely by the leading firm's engineers. According to the contract, the leading firm had to submit technical reports to CCL, to hold meetings to teach engineers from participating firms quarterly. CCL monitored the progress of R&D.

Early licensing, or pre-competitive technology transfer, is the contract between ITRI and firms. This is designed to encourage firms to take part in the process of technology development in order to cultivate their own research experience. Participating firms (including the leading firm) should pay the early licensing fee as a condition of joining the consortium. Being a member of a joint development consortium, a firm can obtain two kinds of technological resources, one is core technologies from ITRI, and the other is manufacturing know-how (including a prototype product in most cases) from a leading firm. Product differentiation is the task of the individual firm so as to avoid a high convergence of products. The only involvement of a participating firm in relation to technology was the definition of the product in the pre-operation of the consortium.

More detailed operations of a consortium, using the ATV consortium as an example, will be illustrated[91]. This was a consortium led by Proton with another five participating firms. The supporting technologies from ITRI were ghost cancellation, analogue-digital signal conversion, and image compression and process, and these technologies were transferred to participating firms as well. All other TV technologies

[91] There were too many HDTV-related consortia in operation in 1991-96, so it is too difficult to elaborate every case. Two interviewees (Interview No.8 & 10) are the heads of R&D departments in two leading firms (Proton & Tatung). I have better knowledge about four of the consortia, which are ATV and WS ATV by Proton, and PTV and PTV (III) by Tatung. I use the ATV consortium as the demo case because this product can be seen as the closest to previous products of HDTV.

applied on ATV were from Proton's own research.

The subcontracting fee to Proton was NT$15.5 million paid by ITRI, and the total early licensing fees to ITRI were NT$7 million. The difference between the two fees was invisibly subsidised from HDTV STP in the name of subcontracting. This kind of subsidy can not observed from the national budget which was hidden inside the budget of STP. The firms did not need to burden the participating consortium with a large R&D investment because most costs were paid by the government. As far as the firms were concerned (Interview No.8), the benefits of obtaining new technologies and entering the field of new products are tremendous compared with the small sums of money needed (about US$55,000 in the each case of ATV, WS monitor & PTV) for the early licensing fee. No wonder three main TV manufacturers (Proton, Tatung & Sampo) joined 11 out of 13 consortia.

Normally, technical consultation meetings were held every three months at TEEMA with up to five engineers (most of whom are senior engineers and R&D managers) attending from each firm. Proton had to answer the requests advanced by participating firms and gave lectures to those attending. Meantime, technical reports (containing design type, structure, materials and material sources), submitted to CCL quarterly, were given to firms. The production line of Proton was open for visiting by other firms to assess and understand the manufacturing procedures. Most importantly, Proton would teach technology recipients how to make adjustments in terms of product functions and system integration. Thus, participating firms would learn the technology know-how necessary for product differentiation.

According to Mr. Chuang (Interview No.10), director of Proton R&D department, the new model of the consortium has the following competitive advantages:

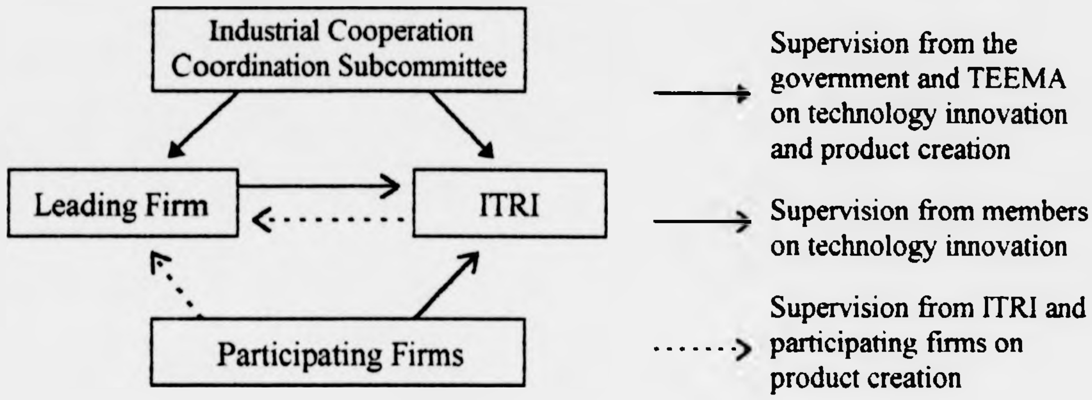
> '(1) Subcontracting the TV product development to the leading firm is very wise because the manufacturing firm is the expert on product design which ITRI may not able to cope with. ITRI should put more energy into developing generic technology with patent rather than on commercialisation.
> (2) It promotes the quality and experience of engineers for product design and system integration. It strengthened the technology foundation of firms, both leading firm and members.
> (3) It saves the resources of the industrial sector. If there were no such consortium organised by

ITRI and TEEMA, each firm would deploy resources to do the same product, an overlapping waste.

(4) It regulates the standards of the product by all members before the commencement of the consortium could integrate technology development and product creation. ITRI could develop core technologies according to defined standards and design, and supporting technologies from ITRI could be immediately applied in product which did not need to be transformed to fit in.'

5.2.2. *Supervisory relations between actors*

Figure 6.16 Supervisory Relations in a Consortium



The progress of technology innovation and product creation are the top concerns in a consortium. Three kinds of supervision represent the expectations of different actors in order to ensure the quality and timing of research outcomes (Figure 6.16). The objects of supervision are the ITRI and the leading firm which conducted R&D activities. These intertwining relations monitor the efficiency of a joint development consortium.

The highest supervision came from the Industrial Cooperation Coordination Subcommittee which represented the MOEA branches (DIT, IDB, ITRI, and Department of Accounting) and TEEMA in monitoring the operations of the consortium. DIT authorised HDTV STP to CCL/ITRI and presided over the effectiveness of the technology project. IDB, in charge of industrial technology development supervised the movement of the consortium to match the strategy for the development of the HDTV industry. The Department of Accounting scrutinised the use of HDTV STP budget allocated to ITRI and the subcontract to leading firm. ITRI and TEEMA, the co-organisers of the consortium, took the responsibility for the success of the consortium.

Beside the supervisory functions, a Subcommittee coordinated all participants to enable the smooth running of the consortium. This Subcommittee, mostly representing the government, monitored the process of product creation and technology innovation aiming at the effectiveness of technology diffusion.

The supervision from leading and participating firms was on technology development conducted by ITRI. In contract terms, they paid the early licensing fees in order to transfer the technology results, so they have the right to monitor progress. In particular, the leading firm depended on supporting technologies to further product creation. Any delay of technology innovation would affect the headway of product creation.

The supervision of the progress of product creation came from ITRI and participating firms. ITRI subcontracted the task of product creation to leading firms, its role was to supervise the R&D outcomes as defined in the contract. As the technology recipients of a joint development consortium, participating firms also have the right to monitor the leading firm in order to get the best technology know-how. Teco, the leading firm of Videoinfo receiver consortium, was replaced by Sampo in 1996 because other actors were not satisfied with the progress made. At that time, Teco had difficulties to obtain a certain key component and to solve some obstacles.

ITRI and the leading firm were both under supervision from three directions. The relations between consortium actors can be characterised as the combination of collaborative cooperation and mutual supervision.

5.3. HDTV Consortia-Complexes

It seemed that the essence of collaborative research has changed to the extent that only the leading firm and ITRI were conducting R&D, while the rest of members were passively waiting for technology transfer. This might be so in observing only one consortium. However, another story is apparent when one observes the operations of all

HDTV-related product development consortia as a whole. Collaborative research is deeply rooted in industrial cooperation which was realised by an innovative arrangement -- consortia-complex.

This innovative arrangement was constituted by a few consortia in the process of HDTV development. Through their multiple-benefited behaviour, the members of all consortia intimately collaborated in the work of product creation. Firms committed to each other devoted their resources to enlarging their returns and manufacturing know-how to many products. The government interest in this arrangement is to revive consumer electronics and to create a new video industry, and that of member firms is to obtain technology capabilities to emerging products as much as possible.

The product-oriented technology development of HDTV STP led to the generation of many products. Thirteen industry end products and several key components were developed under HDTV STP and related projects[92]. Most industry end products derived their technologies from HDTV STP. In order to absorb interim technological outputs, joint development consortia were organised keeping abreast of technology and product development.

None of these products aimed at ultimate HDTV, which was the experimental task of ITRI. As far as firms were concerned, they would not take part in projects that could not lead to production in a short time. The attitude of leading firms towards accepting a project was simply based on the commercialisation of a product. As frankly stated by Proton (Interview No.10), 'if we failed to create a commercial viable product on piloting the R&D of a consortium, how could we face those participating firms and the government'? Under these circumstances, markets were the main driving force behind multi-dimensional product development consortia.

All HDTV consortia can be divided into two groups of consortia-complex in time

[92] There were many consortia aiming at the development of HDTV-related key components which were operating at the same time, for example, consortia for CRT (cathode ray tube), thin-film-transistor LCD, and many IC modules. However, some component consortia were under the aegis of HDTV STP, while others were related to other STPs.

order, a 1991-93 consortia-complex and a 1993-96 consortia-complex. The former contained six consortia, the later seven. The characteristics of the 1991-93 consortia-complex is less clear than the 1993-96 one because two consortia (DSC & DAT) in 1991-93 were joint developments between one firm and ITRI rather than a leading firm and a flock of participating firms. The picture of the 1993-96 consortia-complex is more explicit in the sense that only the HD-DSC consortium was a one firm consortium, the other six were in the form of a cross-benefit grouping network.

The 1993-96 consortia-complex will be elaborated to explain the new type of collective mutual-collusive congruency in terms of interactions, supervisory relations, cross-grouping networks, and intra-industrial trusts.

5.3.1. The dynamics of industrial cooperation: joint development

Technology development has been regarded as the dynamics of industrial cooperation. However, industrial cooperation is not a guarantee of the success of innovation. Because of the heavy competition among large companies, the R&D efforts of a large company are normally conducted internally. Although some of them were strategically allied with others, the joint development did not appear to be well coordinated. The key to a successful joint technology development depends not only on effective management of the alliance, but also in mutual trust and consensus.

Taiwan's domestic strategic alliances like the case of HDTV consortia have three significant features in comparison with its foreign counterparts. First, Taiwan's alliances were public sector R&D institute-generated cases. Unlike international alliances formed by an agreement between firms, firms in Taiwan were invited to join consortia by ITRI and TEEMA. The deep involvement of ITRI in forming R&D consortia shows the importance of the public sector in promoting industrial cooperation.

Secondly, joint development including the efforts of ITRI and the government (HDTV STP) was the main motivation for industrial cooperation. Essential technology developments were contracted out or financially subsidised from the government to the private sector in most advanced countries, while Taiwan took advantage of public laboratories for the development of industrial technology. To maintain a R&D team which is considerably larger than those of most multinationals[93], is unthinkable for Taiwan's firms, let alone its regular finance (given as STPs) from the government.

Thirdly, the benefits of industrial cooperation by consortia were twofold; one is technology transfer from ITRI, the other is manufacturing know-how transfer from leading firms. While technology development and format/system standardisation are basic reasons for the formation of international alliances, only very few alliances aimed at product development. Therefore, product creation as the dynamic for industrial cooperation in Taiwan was rare in an international perspective. As with the rules of MOEA with regard to STPs in the 1990s, the incorporation of industrial cooperation into STP was essential, in particular, early licensing and product creation (Interview No.27).

5.3.2. Cross-grouping network: a fair mechanism of division of labour

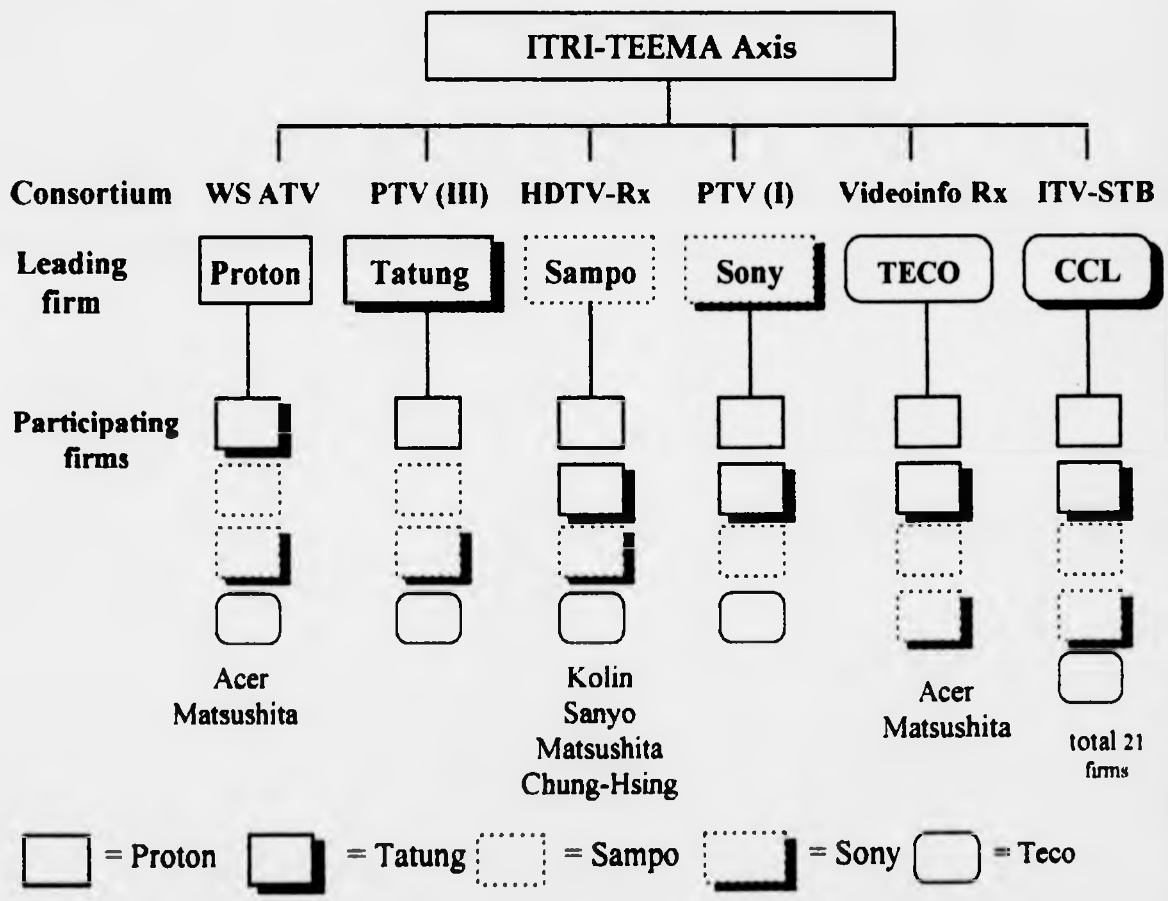
The initiation of a cross-grouping network reflected two facts that led to a new division of labour. The first is that the retreat of ITRI on product development is unavoidable. Besides, it is an impossible mission to develop a new area of digital video technology and to commercialise several new products at the same time according to CCL's manpower and time limitation. The foundation of digital video technology in Taiwan was weak, almost started from nothing. Thus, ITRI had to concentrate on the development of generic technology rather than on the creation of a prototype product model as the Teamate project did. The tasks of product creation shifted to the hands of leading firms.

The second fact is that to maximise resource utilisation the R&D of a product

[93] In March 1995, the number of employees in ITRI was 5,780 in which half had postgraduate degrees and 37.7% (31%) had more than 10 (5-10) years professional experience. It is almost impossible for the private sector firms to keep such a R&D organisation not only because of huge personnel expenditure, but also because of its non-profit operations.

must be allocated to firms. The R&D manpower could only learn the process of product creation but not cultivate their own experience on product design and integration when ITRI was in charge of product commercialisation. Moreover, many research resources in the private sector were idle (may be they were doing their own work, but not for the whole industry). While many participating firms in a consortia-complex were assigned R&D tasks, the R&D resources should be efficiently and collectively deployed in the targeted field. In this way, firms conducted the product of their responsibility and they could still access the process of technology innovation by ITRI and of product creation by other leading firms.

Table 6. 17 Cross-Grouping Network in 1993-96 HDTV Consortia-Complex



The operation of the consortia-complex was based on a 'cross-grouping network' in which a network has been constituted by interacting groups. On Table 6.17, the leading firm of each consortium is also a participating firm in other consortia. Therefore, there are overlapping identities of leading firms in every consortium. For example, Sampo was the leading firm in the HDTV-Rx consortium while Proton, Tatung, Sony, and TECO were participating firms in this consortium, but they were also leading firms in other consortia. Another four firms (Kolin, Sanyo, Matsushita, and Chung-Hsing) were simply participating firms in HDTV-Rx consortium, those firms did not charge any R&D for product creation as well in other consortia.

The cross-grouping network has created an effective division of labour and fairness. Five firms with double identities were the cardinal members of the 1993-96 consortia-complex. Each of them was in charge of the development of a certain product, and also the participating firm in another five consortia (ITV-STB was led by CCL). This led to six R&D teams operating at the same time, and the leading firms could get access to all technologies and products in the consortia-complex (except HD-DSC) while the participating firms could get the same in their respective consortia.

The cross-grouping network enlarged the number of products for development which meant members could obtain technologies to the maximum extent in the same period of time. Cross-benefited results to each member were at the heart of the feasibility of the consortia-complex. The division of labour was the principle underlying the cross-grouping network. This is to say, one firm only devoted its resources to one product creation, but accepted technological know-how for six products. It could be argued that if the R&D tasks were not equally allocated to leading firms, and the R&D outputs were not discriminatingly shared by leading firms, the operation of a consortia-complex would be impossible. It is the way that all firms can work together -- cross-grouping benefits.

Fairness was important to the effective operation of the consortia-complex in the sense that leading firms could not monopolise the technological outcomes. It was the rule of MOEA that the ownership of these technologies or patents belonged to the government rather than the firms which developed them. As the subcontracting projects were entrusted and core technologies were supported by ITRI, firms only had the right to use technologies but not to own them. Members still need to pay royalties besides early licensing fees when they use technologies. It is normally about 1-2 % of the product price. In the case of a TV set, a fixed fee of NT$150 (less than US$6) per set is payable. The rationale leading to state-owned technology is that MOEA hopes the technology can be diffused as widely as possible (Interview No.27). If some non-member firms wish to transfer that technology during or after the running of a consortium, they have to pay a higher amount for technology transfer, for instance, the payment for technology transfer was increased by 40% per year, and fixed at the highest amount after the end of consortium in the case of 1991-93 consortia-complex.

It might be criticised as unfairness to leading firms that the participating firms shared the same outcomes by paying a tiny amount for early licensing without doing any R&D activities. They might want to develop a product on their own (because the government paid for it) but their R&D capabilities did not qualify them (those partly Japanese-owned assembly companies normally lacking a R&D department) or they did not have experience in the development of related products (Acer produced monitor but not TV). It seems that participating firms without R&D responsibility free rode in the consortia-complex. Again, as far as the government is concerned, technology diffusion is the priority. Thus, leading firms had to accept this fact before they participated. However, the disadvantage of sharing technologies with others was superseded by the interests of being a member. These were obtaining several product technologies at the same time and saving on huge R&D investments. Besides, if R&D standards applied were against trends, especially international ones, then the research outcome was meaningful (Interview No.8). If a firm did closed door product R&D regardless of domestic or international standards, it was likely to lead to a useless product on the market when there was a group of firms operating according to the standards set by the consortium.

5.3.3. *Mutual-supervisory relations: the efficiency of consortia-complex*

According to the preceding analysis, the key to the efficiency of a consortium is the supervisory relationship in monitoring the quality and timing of technology development and product creation. CCL and leading firms were the bodies to be supervised from three directions, namely, top-down supervision by Industrial Cooperation Coordination Committee, bottom-up supervision by participating firms, and CCL-leading firm mutuality. The supervisory relationships in the consortia-complex have similar characteristics to those in the single consortium. However, the scale of the supervisory relationships between a consortia-complex is larger than that of a single consortium. Supervision was imposed on ITRI by all members, the same as on leading firms. The Industrial Cooperation Coordination Subcommittee has to monitor all the R&D activities under the consortia-complex. Supervision between actors has created positive pressure on innovators keeping their progress as planned. These webbed mutual-supervisions led to the efficiency of technology development and product creation.

In addition, a new type of supervisory relation has formed among leading firms. This relationship embraces competition and cooperation among leading firms. Leading firms acted as technology providers when they led a product development and as technology recipients when they were participating firms at the same time. The meaning of cooperation under the consortia-complex has crystallised so that leading firms collusively developed several products through the division of labour in order to accumulate technological and manufacturing know-how.

There were two kinds of competition which might occur during the running of a consortia-complex. One is positive competition concerning the 'face' problem among those leading firms which were large consumer electronics manufacturers in Taiwan. All firms in the field would assess their R&D results and judge which firm produced the best commercially viable product. If the results would not satisfy technology recipients, this would damage the reputation of technology providers in the industry. The face problem seriously concerns Chinese family-based firms[94]. Leading firms did their best to perfect their product commercialisation. Proton, the leading firm of ATV and WS ATV, put 80% of its researchers and time into developing products for consortia, while Tatung, leading firm of PTV and PTV (III), also deemed the consortia's projects as the priority and put advanced technology into the product[95]. Positive competition based on 'value of face' did promote the R&D performances of leading firms. According to a survey about the evaluation of technical outputs by the leading firms, most firms gave a certain answer[96].

The other is negative competition connected to market considerations between leading firms. Unlike ITRI, a public sector institution which does not aim at commercial returns but at providing technologies to the industrial sector, leading firms under the consortia-complex will be future competitors on product sales. There is a possibility that a leading firm might conceal part of the technology from other members in order to strengthen its own competitive advantage. Once a firm's self-interested behaviour is discovered, others might follow, then the selfishness of firms could jeopardise the operation of the whole consortia-complex.

There are means of preventing negative competition which might occur in the consortia-complex. For instance, ITRI could examine the periodic outputs from technical reports, and participating firms could sense whether a leading firm had concealed something by testing the functions and physical design of products. Besides,

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[94] It has to be admitted that this cultural assertion is neither well-justified nor theory-backed, rather a personal sense that derived from the long experience of living in Taiwanese society for more than two decades. Most consumer electronics firms are family-run. Customarily, Taiwanese put business name in front of family name when referring to a family with large business, for instance, Tatung Lin family and Sampo Chen family. Thus, the reputation of a family is closely linked to that of the enterprise. The negative image of enterprise is seen as damage to the family. This is also applied to the cases of product creation by leading firms, because the outcomes were comparable.

[95] Tatung has long-term cooperative relations with Japanese Toshiba. Those technologies used in PTV products derived from the cooperative development between Tatung and Toshiba. As the statement of Interview No.8 demonstrates, if Tatung was unwilling to publicise its technologies, Tatung would not have joined the consortia.

[96] This survey was based on the three consortia (ATV, PTV & WS monitor) in the 1991-93 complex. The indicators of evaluation of the product were classified as high, middle, and low satisfaction. Only one firm answered as high in all three consortia, and this firm is the leading firm itself. In the ATV case, three firms answered in the middle and one firm in the low; in the PTV case, all firms in the middle; and in the WS monitor case, five firm in the middle and three in the low. According to the finding of this survey (J.F. Lee, 1994), the evaluation has been affected by the firms' attributes. This was similar to the findings of the NPC Alliance case by D. Lee (1992).

the stronger the positive competition and mutual benefit results, the weaker the negative competition and selfishness. Inter-firm trust needed to be established within the consortia-complex to erase any selfishness and speculation.

5.3.4. *Intra-industry trust: based on intermediate organisation*

The intermediate organisations are important factors in establishing intra-industry trust. Firms compete with each other to increase their market shares. Although strategic alliances tie them together, conflicts of interest can not be avoided, such as resource sharing, duty allocation, and the management of alliance. ITRI, TEEMA and Industrial Cooperation Coordination Committee have played the role of third parties with no profit motive or vested interests. Coordination by these intermediate organisations has been accepted as the norm by all firms.

The intra-industry trust stemmed from three sources, all with direct connection to intermediate organisations. In financial terms, there were no financial relations between members, so firms can expect mutual trust. The government undertook most R&D cost, and firms only paid a little for early licensing fees. Each leading firm has been granted a substantial amount for product creation, which was independent of members. In technological terms, core technologies transferred to firms, and manufacturing know-how cross-benefited members, equivalently. ITRI was the central point dealing with technology transfer, in which generic technology transferred from ITRI to members, and manufacturing technology submitted to ITRI by a leading firm was then transferred to members. In cross-grouping network terms, the ITRI-TEEMA axis designed the framework of consortia-complex. Thus, firms participated in consortia based on their trust in intermediaries rather than on other firms.

Once the inter-firm trust has been established in an industry, further consortia in the future will be easier to form and run. The relationships between firms through the running process of consortia would grow as long as that cooperative experience was satisfactory. These relationships include personal network, centre-satellite system, channels for exchanging technology and information, and most important, the mutuality of trust.

Intra-industrial trust mutuality is hard to establish. Three conditions are essential for building trust mutuality: cooperative opportunity, satisfactory experience and equal-shared benefits. In fact, HDTV consortia were not the first cooperative case in Taiwan's TV industry. In 1980-81, there was a cooperative project for a common TV set with 11 participating firms[97]. However, the effects of this project were relatively small and did not decelerate the decline of TV exports. This did nothing to help the development of trust between firms. The HDTV case is an example of establishing intra-industrial trust by these three means.

5.3.5. Non-conflict congruency: the key to success

The similarity of intention in the development of HDTV for both the public and private sectors are the foundation of success. An outward-oriented goal was the common characteristic of all parts.

The government is the main support for the consortia-complex in terms of budget. The final aim was to promote the international competitiveness of the strategic consumer electronics industry. STPs were the policy instruments to enhance the technology capability of selected industries. ITRI was the implementor of HDTV STP so as to provide basic digital video technologies needed for competitive products. HDTV consortia-complexes have been institutionalised as a means of keeping technology diffusion and product creation under the associational management of ITRI and TEEMA.

The aim of the industrial sector was concentrated on international markets. All

[97] This was a typical 'administrative guidance' case in forming a consortium in which IDB required TV industry to organise a project for the development of common set in order to reduce production cost when Taiwan's TV exports had been seriously threatened by more competitive Korean products. The government only paid lip service, and assigned Tatung as the directing firm in charge of all efforts (Interview No.8 was the director then). There was no subsidy from IDB, the costs were shared by members. This was not a sector-initiated case, but a case that firms had to keep the face of IDB by following its guidance.

members' attempts to create a strong industry have converged on the competitive products. In answering why large firms joined consortia, Tatung stated (Interview No.8), 'it hopes to inspect and learn from each other's work so as to strengthen the infrastructure of industry'; and Proton stated (Interview No.10), 'only in an industrial environment where everyone is strong, then one can become strong because we (leading firms) focus on overseas markets'. While multi-product creation through consortia-complexes brought about industrial cooperation, firms have cohesively collaborated to achieve the same goal of learning more technology know-hows by fair division of labour. Products are the objectives to achieve ambitions either for promoting industrial competitiveness by the government or for increasing international market shares by the industry. Many interim products have been marketed as the achievement of consortia-complexes.

The non-conflict congruency of all actors leading to the formation of tacit understanding in HDTV development is the key to the successful operation of consortia-complexes. The congruency resulted in vertical integration of the efforts of different levels, namely, strategic planning of the government, technology innovation of ITRI, and the product creation of the industrial sector; and horizontal division of labour by leading firms.

6. STATE-INDUSTRIAL ARRANGEMENT AND INTERNATIONAL COMPETITIVENESS

6.1. State-Industrial Arrangement in HDTV Development

After the NPC Alliance, the incorporation of industrial cooperation coupled with the public research institutes has been institutionalised as a new mechanism of government-industry interaction in conjunction with technology innovation and diffusion. In this new state-industrial arrangement, the state plays a significant role in the strategic planning and funding of technology innovation. The responsibilities of technology innovation and design of joint product development are performed by the public research institutes, while the tasks of product creation have been allocated to the industrial sector. Business associations functioned as intermediaries providing necessary logistic support for consortia and coordinating ITRI, leading firms and participating firms.

The HDTV development has been presented as a model of an institutional arrangement in which all necessary forces were organised into a coordinating framework under the HDTV office. This was expected to create an enabling environment for the HDTV development. The Steering Committee and functioning Subcommittees were in charge of respective tasks. It could be argued that whole operation of the HDTV office was state-mandated because the Committee and Subcommittees had representatives from many public agencies. Functionally speaking, the HDTV office could be seen as a small IDB in charge of the development of the video electronics industry alone, while there are also another five industry-specific offices in charge of respective work in relation to other strategic industries.

As for the concerns of technology diffusion, consortia-complexes are the best mechanism ever created in Taiwan. 'Successful innovation relies on interaction among different activities (Mowery, 1995:515)', which means that scientific/technological research alone is not sufficient without the accommodation of industrial application. Consortia-complexes are not only linking the industry and knowledge-based institutions, but also integrating activities of technology innovation and product creation. The effectiveness of consortia-complexes on technology diffusion is comprehensive through which almost every firm in the consumer electronics industry has benefited.

The momentum of consortia-complexes lies in DIT's HDTV STP. Government-funded projects can be characterised as a diffusion-oriented technology policy in which R&D outcomes lead to commercial products and technology activities have cooperation and participation from the industrial sector. Thus, the outlook of consortia-complexes is, to a large extent, defined by the state and the detailed operation and formation of consortia-complexes is left to the ITRI-TEEMA axis.

The HDTV development was sublimated to a higher level of government concerns which has affected the nature of public-private cooperation. The whole plan of HDTV development was to upgrade the added value of the digital video industry and, to some extent, to create a new industry by substituting existing products with new ones. Unlike the NPC Alliance which concentrated on a product, HDTV consortia-complexes focused on a wide range of products generated by new digitalised video technologies. As a result, the degree of government intervention has increased in the sense that the many public agencies concerned were directly involved in the process, instead of just using ITRI as a surrogate. The institutional arrangements of public-private cooperation are confined to technology diffusion, apart from which the state dominated most activities supporting the development.

The nature of state-industrial arrangements on technology diffusion remains the same as the NPC Alliance, but the coverage of arrangements has been expanded by cross-grouping consortia. Industrial cooperation has been mobilised maximally so as to spin off a sector-wide collaborative complex leading to the commercialisation of many products simultaneously. The process of technology diffusion, however, was still under the dominance of ITRI-TEEMA axis.

It is the state that set up TEEMA and firms to accommodate its policy by deploying NT$2 billion STP and other incentives which were an irresistible attraction to industry. This is the method to promote industrial cooperation without authoritarian coercion. It relied on interdependence between the two sectors since the state needed industry to promote international competitiveness and the industry was lured by public investment. The state did not apply neocorporatism, nor industrial dirigisme. 'Neocorporatist theories of organised interest intermediation between state and civil society offer the possibility for the assertion of public authority, but under limited state sovereignty (Hollingsworth & Boyer, 1997:15).' It is right that TEEMA offered an entering point for the assertion of state intervention into the industry, but TEEMA acted more as an intermediary to implement state policy rather than to negotiate collectively with the state. The state has moved from its regulatory role to a more enabling role, and the nature of its policy has released it from unilateral action (administrative guidance) to voluntary exchange (beneficial interdependence). Even in 1990s, the Taiwanese state is certainly not a state which does nothing, but one which supplies almost everything except interfering with the operation of firms.

This style of state-industrial arrangement was not created spontaneously by the public-private interaction, but by gradual institutional evolution. This arrangement has been modified through time and learning from errors. Effective state intervention has been perceived as one means of economic management (Developmentalist literature), rejecting the market as the ideal and universal economic arrangement, but state-industrial arrangements like that in Taiwan are assumed to be an integral part of successful capitalist development. Hollingsworth & Boyer (1997) concluded that (1) 'any institutional arrangement has its strengths and weaknesses; (2) such institutions evolve according to a logic specific to each society; (3) institutions continuously respond to changing circumstance, and are not static entities'.

6.2. Its Impacts on International Competitiveness

The measurement of the effects on international competitiveness of the state-industrial arrangement for the HDTV development in Taiwan faces the same difficulties as trying to measure the output of S&T activity. 'It may be able to indicate industries where (R&D) returns have been specially high or low, but it will not be able to tell us whether a particular proposed R&D project is a good bet or not (Griliches, 1995:80-1)'. There are only two kinds of measurable data, concerning the contributions of R&D, in industry and national real output accounts (ibid.:83). In terms of industry, the growth of productivity can be observed from the market indicators (domestic sales and exports). However, to evaluate the R&D outputs of HDTV STP and consortia-complexes in this respect is far more difficult at this stage since markets for digital video products are still very new and reliable statistics for sales are unavailable. Moreover, even if reliable market statistics for both domestic sales and exports were available, it is still difficult to distinguish digital and advanced TV from traditional TV because TV products are categorised now only as Colour TV or Black and White TV.

However, the exact time structure of the effects of R&D on productivity is difficult to estimate. It might take decades to prove the contributions of R&D to a particular industry. For instance, the technology investment of Taiwan government in the IC industry was initiated in the 1960s, however, the commercial returns only became positive in the early 1980s; the same situation happened in the automation industry in which a spin-off company from ITRI took seven years to start making profits (Interview No.27). Some invisible effects of technology investment can not be simply observed in such a short time. Increasing technological capability and cultivating industrial specialists are of paramount importance to the industry as a whole and influence long-term competitiveness rather than the immediate growth of productivity.

It is too risky to jump to a conclusion that HDTV STP and consortia-complexes are failures by judging the productivity outputs of the video industry. HDTV STP is a courageous attempt by the Taiwan government to develop a future industry in which the product market is currently unpredictable. The uncertainty and risk of a technology project which is one step ahead of the market are greater than those of following the market, but the opportunity and profit of the former are relatively higher than those of the latter. It always means that the opportunities and high profit period have gone when the market is certain and the direction of product/technology is clear. Moreover, in developing this sort of future industry there will be competition with large international firms. Thus, the government should take the risks and pay the 'tuition fee' for the industry, even if the investment is eventually proved to be wrong, as suggested by the head of DIT (HDTV office, 1996:6).

HDTV STP is a government investment entirely. The total input was NT$2 billion and 850 person/year in five years. The income from technology transfer fees was NT$88 million, shared only 4.4% of total STP budget (HDTV office, 1996:22). The investment of the private sector in the process of R&D was negligible except for inputs of brainpower. It was the government which selected the consumer electronics industry as one of the strategic industries within which digital video technology had been chosen as a key technology to revitalise the industry. The huge investment in HDTV technology served as a temptation to attract local firms to participate in the process of technology innovation and product creation.

The effects of HDTV STP and consortia-complexes are easier to measure in other terms than in competitiveness terms. In terms of technology innovation, Taiwan has narrowed the gap with early developers. It started to catch up with the development of digital video technology in 1991 when most advanced countries had accumulated several years of experience. Betting on the right side (all-digit not analogue) saved so many resources which might have been deployed in the wrong direction. The substantial achievement of HDTV development is shown by CCL's director of HDTV STP (Interview No.3), 'we did not have digital video technology five years ago, but we have had more than 60 patents after 5 years efforts'. Taiwan has built a considerable foundation of digital video technology, although it is a 1-2 years behind the most advanced technology generally (ibid.).

The explicit evidence of the progress of technology was the experimental results in HDTV (HDTV office, 1996:23). In December 1993, CCL produced the fifth HDTV decoder and the third ghost canceller in the world. CCL finished a prototype HDTV set in June 1996, and a small trial production will take place through industrial cooperation with Sampo in 1997. The R&D of 'real' HDTV was solely done by ITRI because the private sector deemed HDTV to be a 'hot potato' project. Taiwan's progress in HDTV relieves it of competition from developing countries in the traditional TV market, by entering the high-value-added advanced TV market. Basically speaking, the technology needed for production of ATV/HDTV was handy but it was waiting for the market boom (Interview No.9 & 28).

In terms of product creation, many ready-to-market and marketed products have been developed through consortia-complexes. The development of these interim products (consumer end products and components) upgraded manufacturing technology as well as their added values. Many firms are manufacturing or have plans to manufacture some products. For example, WS ATV, WS Monitor, PTV (I), DSC, VCD, and STB have been marketed. Only a little data about the sales of these new products can be found so far. The export of STB by OEM was about 1 million sets in 1996, and estimated to be about 2-3 million sets in 1997 (HDTV newsletter, Dec. 1996:5-6). In 1992, the sale of ATV was 1,500 sets and the output value was NT$72 million. During 1993 to 1995, the domestic sale of WS ATV was about 15 thousand sets and the total output value was over NT$1.2 billion which shared about 60% of the budget HDTV STP (ITRI, Mar. 1996:31). The sale of a single product (exports excluded) amounted to over half of STP's budget in only a 3-year sale. As a consequence of HDTV STP, sales should be achieved in total which are several times the STP investment. The judgement of the effect of HDTV STP on productivity should wait for another five years, when there will be enough information.

In terms of technology diffusion, it is argued that the case of HDTV was very successful in the sense that digital video technology has been widely transferred to the industrial sector. Firms absorbed technology know-how as well as application know-how, not confined to the field and the product alone but to all of the newly emerging innovations in the digital video industry. It would be impossible for a firm to develop so many technologies and products in only a five year span with as little money as the fees which they are required to pay. Taking a firm joining 11 consortia as an example, it is estimated that about NT$15 million would have been paid in early licensing fees, but the returns in the form of technology transfer and manufacturing know-how were invaluable.

In terms of the externalities of technology development, firms and the industry have benefited from the spillover effects. Beside the possession of the technology and the product, the process of consortia-complexes served as the best on the job training opportunities for engineers in the private sector. According to the opinions of Proton and Tatung (Interview No.8 & 10), access to the process of technology development at the CCL and the technical meetings provided by other leading firms have had very strong impacts on strengthening the capacity of engineers. The experience which engineers absorbed and learned in five years has been worth at least ten years of professional experience. This was also one of the reasons that firms participated in as many consortia as possible. The establishment of cooperative experience and intra-industrial trust could be the dynamics for further collaboration. Moreover, regarding the joint development efforts with public sector research institutes, the leading firms were actively engaging in the development of HDTV by consolidating their own resources (finance, research manpower, and experience) with outside research organisation and other companies. The strong technological innovator-adopter linkages, on an unprecedented scale in this industry, have enhanced processes of learning and creativity.

In a word, Taiwan's competitiveness in this industry is still ambiguous at this stage. The past five year should be deemed as a training period for domestic firms. The effects of training can only be measured when the soldiers are in the battle which is not far off now. If Taiwan could get a certain position in the battle as it did with the computer and semiconductor industry, then the consumer electronics industry would be revitalised; if Taiwan missed the opportunity, it might become an assembly line for foreign firms and a low-end products manufacturer forever.

7. CONCLUSION

Two points deriving from the Taiwan's experience of HDTV development should be addressed here. One concerns the question whether the market or the state was the driving force behind the development of HDTV. The second is whether this new form of state-industrial arrangement, seen as the non-economic by-product of the HDTV development, is a feasible institution for Taiwan's technology development.

The press (Liberty Time, 07/04/96) criticised the effectiveness of the HDTV STP in the sense that many core technologies for products (such as DVD, digital vision process technology, and HDTV set) were underdeveloped, and the ultimate target of HDTV, to broadcast, failed by the end of project. The time to broadcast digital terrestrial TV is by the end of 1998, almost at the same time as most advanced countries. Although the press understood the long delay in achieving international standards, which was an obstacle to further development, the reason lay behind that, probably, there was no market data to be assessed. However, the non-economic results were ignored by most of the analysis while attention was focused on technologies and products.

It is right to suggest that the market is much more important than the state in the development of HDTV. The cases of Europe, Japan and Taiwan all show that the efforts of government still can not create an enabling market environment for HDTV. The market factors (price sensitivity, willingness of broadcasters and consumers' preference) seem to be the driving force to raise the new market for HDTV. With the accommodation of the market, HDTV might be necessary living room equipment in every home. Technology alone which is where the government's efforts focused (at least in financial terms), is insufficient to promote the growth of the HDTV industry.

This is not saying that the state is less important than the market in HDTV development. Without the support of the state, the HDTV R&D would never have reached its present level in Taiwan. The private sector was reluctant to invest in the development of frontline technology because of the lack of short term commercial returns. Therefore, the government encouraged by foreign advisors took the responsibility for the development of HDTV technology. HDTV technology, as the technology of 'if-we-don't-do-today-regret-tomorrow' (Interview No.6), is essential for the consumer electronics industry. Furthermore, those interim products which sprung from the HDTV development would not be available if there was no STP to promote the technology innovation and product creation.

As for the concerns about the motivation of the state, it can be interpreted in Chinese language terms. The government hopes to cause the effects of 'to throw a brick and to get gems in return' (拋磚引玉)-- a polite term in making a donation (investment) to a worthy cause in the hope that others may follow suit. The NT$2 billion investment of HDTV STP was the brick and the future investments of the private sector in production were the gems. The calculation of the state was that the R&D investment of government would stimulate private investment by more than ten times[98]. In other words, the public investment has been multiplied several times by private investment which the private firms would not have made without the endorsement of the government in basic technology investment.

It is argued that the best achievement of HDTV development in Taiwan is increasing its opportunities for the future video industry. By concentrating the HDTV development process on product-oriented technologies, in particular, MPEG, technological competencies have been established.

The emerging trends in technology and global markets will continually present new opportunities and challenges in the video industry. Thus, the government has approved another STP, Digital and Interactive TV STP for another three years, to stay abreast of the international trend which has shifted its emphasis from HDTV to practical digital and interactive TV. It is argued that the market is important, but the government is also important in Taiwan's case of HDTV development. The market is

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[98] According to Interview No.27, the ratio between public investment on technology and private investment on production was varies from industry to industry. Generally, the ratio was at average ten times, higher in high-tech industry and lower in traditional industry. As for the efficiency of LTP (for new products in high-tech industry), the private investment was about 17 times that of public investment by 1995 (http://www.moea.gov.tw/~meco/EcoDev_c/a071.htm)

the driving force for the HDTV development, while the government is the driving force for innovation.

The state-industrial arrangement in HDTV development could be deemed to be an institutional innovation. It is also the by-product of HDTV development in terms of forming a feasible arrangement. However, it is the factor that should not, and could not, be measured by economic assessment. The non-economic fruit from the experience of HDTV is at the heart of public-private cooperation, and it will be deployed to most cases linking public research institutes and the industries in the near future. Subsequently, many strategic sectors have followed this state-industrial arrangement, which is likely to lead to an economic institution for technology innovation and diffusion. There is an implicit influence of this new state-industrial arrangement on the process of high-tech industrialisation which the next decade will reveal.

The new state-industrial arrangements can also be characterised as an 'institutional' strategic partnership, but it differs from the NPC case. The strategic partnership in the NPC Alliance is an accidental event which has not been pre-arranged by economic bureaucrats, while the strategic partnership in the HDTV case has been subsumed under the STP structure. The concept of ISP will be discussed in the following chapter, and the differences between both cases are compared in Table 7.1.

CHAPTER SEVEN

CONCLUSION

State-societal arrangements have been considered as an endogenous and institutional factor which forms a necessary part of the explanation and understanding of the promotion of international competitiveness. As a consequence of the rising domain of global markets the domestic policies, in particular in an outward-looking economy like Taiwan, have been sensitive to the moves of the international political economy. 'Technology matters to international relation/international political economy because it alters state power and adds to the agenda and instruments of state policy - not the least because it changes the competitiveness of nationally based sectors of economic activity' (Talalay et al., 1997:3). In the case of NPC Alliance and HDTV consortia-complexes, the generation of innovative activities were motivated by rising and potential market demands.

It is less possible that the state can act on its own and impose an IP on a specific sector without the active participation of the industrial sector. Under circumstances of fierce international competition, rapid technological changes, and heavy investment (physical and human capital) for innovation, conditions are created that favour an institutional arrangement in which the state actors and industry can cooperate and associate. Besides, domestic political and economic changes also forced the state to change its IP from direct involvement in the market towards a functional one in order to adjust the industrial structure.

1. INSTITUTIONALISED STRATEGIC PARTNERSHIP

1.1. Lessons from Empirical Findings

In chapter four the policy activism on the issues of upgrading technological capability can be identified from the pervasive assistance to the private sector. These measures have been widely deployed to promote the willingness of the industrial sector in engaging R&D activities, as well as to stimulate industrial investment on high-tech and high-value-added industries. Many of them have exploited the international regulations to their marginal allowance, and this shows that, on the one hand, state policies are considerably limited by international political economy, and on the other hand, the Taiwanese state is enthusiastically promoting industrial development. However, a high concentration of policy measures on high-tech industries denotes the nature of selective intervention. In addition, a national innovation system favouring the development of industrial technologies has also contributed to the pace of high-tech industrialisation. The effectiveness of state efforts is evidenced by the facts that the manufacturing share of high-tech industries in the economy has rocketed and their share of total exports has increased to be more than half.

The NPC Alliance initiated a noticeably successful case of cooperation between the government laboratory and the industrial sector. It not only combined the resources of both sides, but also discovered a paradigm which incorporated the efforts of the industrial sector into the implementation of government technology projects. This case has shortened the time needed for technology diffusion, and finally, led to a 'Made in Taiwan' champion product. Moreover, the efficiencies and merits of this alliance have attracted the attention of economic bureaucrats, and the consequent result is that the incorporation of private cooperation has become the condition for STP. It could be said that an accidental event has been sublimated into an institution.

The case of HDTV consortia-complexes illustrated how GI cooperation has been brought into an institution and how it operated in an industry-wide setting. The 'paradigm' of one product creation has been extensively deployed in order to revitalise a declining industry by introducing many products' creation. After GI collaboration became an institutional arrangement, the operations of these consortia have been redesigned to cure the shortcomings that had happened in the NPC Alliance. However, we also detect that state involvement in this new state-industrial arrangement has been deepened in the sense that the coordination and management of these activities was undertaken by a government established HDTV Office except those for technology development.

Table 7.1 Comparisons of STP, NPC Alliance and HDTV Consortia-Complexes

	STPs in the 1980s	1990-91 NPC Alliance	1991-96 HDTV consortia-complexes
Character	Government policy	Tripartite contract between ITRI, TEEMA, firms	Complex contract relationships
STP's role	-	Back-up for product creation	Back-up for product creation
Cooperative method	-	Strategic alliance	Group of consortia
Budget source	Government	Participating firms	Mostly government
R&D type	Technology innovation	Product creation	Technology innovation & product creation
Management/ Supervision	DIT/MOEA	CCL-TEAMA Axis	HDTV Office
Firm's background	-	Multiple	Intra-industrial
Number of firms	-	46	86 time/firms
State involvement	A policy measure	Low	High
Commercialisation	No	Yes (by ITRI)	Yes (by leading firms)
Technology transfer/diffusion	Indirect/slow	Direct/fast	Direct/fast & industry-wide
Technician cultivation	Confined on ITRI's researchers	Wide	Industry-wide
Main benefits	Upgrade technological capability	Creating an effective way of public-private cooperation	Institutionalisation of public-private cooperation

In Table 7.1 the differences between the case of the NPC and HDTV industries are compared and the evolution of STP in the 1990s in terms of coping with the creation of one new product and the creation of a series of new products is indicated. Although both case studies can be described as strategic partnerships, each one provides different lessons to be learnt in relation to the promotion of innovative activities. In an institutional perspective, the NPC case can be deemed as the inspiration of a new institution because it has not yet been subsumed under the STP framework, while HDTV has been institutionalised fully. In terms of organisation, both cases are similar in their effective way of creating product(s). The NPC case is through a strategic alliance in which the relationships between ITRI and firms are singular, and these relationships are plural in the HDTV case where a consortium is constituted by two different contracts between ITRI, the leading firm and participating firms, and the consortia-complex is composed of a group of consortia. However, the nature of cooperation is the same and is aimed at simultaneous operations of technological innovation and product creation. Furthermore, there is no state intervention except with supporting technologies from Packaging STP in the NPC case, but there is much more intervention in the operations of HDTV complexes because HDTV development involved cross agencies coordination.

The major change of STPs in the 1990s by incorporating GI cooperation in the process of STP implementation, has evolved the attribute of STP from a simple government policy measure which was enforced by public research institutes to a joint GI effort by which STP/technological diffusion would be achieved in a more effective mode. This institutional evolution has led to direct and fast technology diffusion instead of indirect and passive technological transfer.

1.2. Three Elementary Characteristics of Institutionalised Strategic Partnership

1.2.1. IP-driven institutionalisation

The state has put forward a set of IPs to help capture the economic rents from tacit knowledge, which has been termed 'the new mercantilism' by Sharp (1997:105). 'The new mercantilism looks to value-added and seeks to maximise the value-added of local activities', while 'the old mercantilism focused on the location of production' (ibid.). In Taiwan, most IPs are aiming at promoting value-added industrial activities, a feature of the new mercantilism.

IPs are the main elements which underlie the institutional mechanism for state-industrial cooperation. Two different types of IP have turned the ISP into an institution, a cardinal technological IP (STP), and diverse general IPs. STP, a tool to promote the

R&D of industrial technology, to bring private enterprises and public research institutes together in a form of strategic alliance or consortia-complex, is seen as a vital part of ISP. Cooperation between both sectors was carried out within the operation and limitation of STP which is under the careful supervision of the industrial authority. General IPs, ranging over every aspect to upgrade industrial development are deemed to be complementary policy instruments to cover the areas where STP is disabled.

'Policy is an essential ingredient in the transition from one institutional regime to another' (Hollingsworth & Boyer, 1997:441). It is not an exaggeration to state that current state-societal arrangements in Taiwan are mainly shaped by the enforcement of IP instruments. Taiwan's institutional arrangements shifted from a state-dominated system towards a state-industrial cooperation that can be attributed to the replacement of the policies for encouraging investment by the policies for industrial upgrading. Thus, IPs, both functional STP and supplementary IPs, are the driving forces behind the evolution of institutional change.

1.2.2. Selective intervention

The new pattern of arrangements is concentrated in the emerging industries, the so-called winners, those considered to have enough growth potential for the state to place heavy bets on them. More state efforts on technological IPs are concentrated on accelerating the process of the creation of winners, and fewer on decelerating the deterioration of losers.

In Taiwan's technology development, state intervention is not a negative occurrence in relation to technology diffusion, but it is hardly a matter of life or death. If there was no such institutional push from the state, the industry would find its own solutions either by sector-generated cooperation or international linkages. It is just a matter of time. However, state intervention has shortened the time for technology diffusion, integration of technology innovation and product creation, and efficiently combined resources in both sectors. This had a constructive impact on international competitiveness so that, if Taiwan's products are not the first-to-market, at least, they are one of the fast followers. This would allow Taiwanese products to be on sale in a market skimming period.

There is a popular image that the state might reduce its influence over the economy as a consequence of globalising industrial activities. In Taiwan's case, the state has liberalised some harsh regulations, such as trade control, and the ban on private banking, but it pays more attention to the technology development of rising industries. Those measures of economic liberalisation concentrated on the areas that were highly regulated by international organisations or had been deregulated under pressure from the USA (Kao, 1995). They are no longer controllable by the state. But, in the grey area, notably state intervention in technology innovation, the state is aggressive in setting a framework, and redistributative in allocating resources, to promote strategic industries.

Collaborative innovation between the state and industrial sectors creates a new form of state intervention which is functional, interactive and associative, and different from direct, paternalistic and authoritative. State intervention aims at the function of the mechanism of innovation and not at directly involving the market. ISP would not be possible without the responsive actions of the industrial sector to associate with the public sector. This view is distinct from the paternalist view that the industrial sector would endure what ever was imposed on it by the state and the authoritarian view, that it would be unable to resist state intervention based on power.

1.2.3. State-industrial reciprocity

In the partnerships between government, business associations and firms, the government's role is that of facilitator, catalyst, financial sponsor, and, to some extent, banker to new firms. The role of business association is that of administrative assistant and impartial broker, but never a pressure group. If 'bargaining' is one of the corporatist characteristics, then the application of corporatism does not explain both cases. The firms' role is that of participants in the innovation process and performers in promoting competitiveness. The GI relationship is not adversarial, rather, it is cooperative and reciprocal, also 'partnering'. Industry obtained the resources necessary for R&D from the state, whereas the state catalysed more private investment in the respective areas. As a consequence, state-industrial reciprocity has been established by increasing competitiveness in the sense that national competitiveness in specific industry was promoted, and the technological competency and market share of firms in certain products upgraded.

Partnerships are built based on the circumstances in which the state is willing to support the development of key technologies financially and firms are willing to 'voluntarily accommodate' policy measures. The former is because key technologies are deemed to be of strategic importance to emerging industries, the latter is because firms benefitted from following state policy. While the policy itself is not attractive to firms, the policy accessories are attractive. Precisely speaking, government resources, including budgets for the research institutes and their scientists, as well as allied relationships with other actors, are the backbone of partnerships. This also made the selective intervention feasible.

The state sees the industry as a policy instrument to fulfil developmental strategies whereas the industry sees the state as a sponsor to corporate strategies. The outward-looking strategic convergence of the state and industry has served as the main dynamic to form a reciprocal partnership. Nonetheless, the state played the part of the senior partner and industry the junior partner. Three aspects show the relative autonomy of the state sector. First, the state picks the winners. There is no evidence to say that individual industry strove for its own privileged statutes. Secondly, the state sets up 'the rules of the game', such as how to form an alliance and consortium, and the criteria for participating firms (not in the NPC case, but subsequent cases). The firms can only bargain with the state in the areas of technological development and product creation. Third, money talks and the state provides the budget. Compared with the total negligible joining fees of firms, the state sponsored most R&D costs. Even so, it does not change the nature of ISP as a state-industrial arrangement. At least, state-industrial cooperation in relation to the materialisation of STP is consensus-based, reciprocal, and interactive.

In a word, this institutional arrangement creates a new form of industrial governance combining a partly top-down meso-policy and an implementation network on the basis of collective action from the industrial sector and public agencies (IDB, DIT & ITRI). It differs from the conception of one-sided interventionist governance and purely free market solutions. Rather, government policies and planning, information availability, the utilisation of social creativity by mobilising the capacity of industrial actor are synthesised into an institution.

2. THEORETICAL APPLICATIONS

2.1. Focal Theory: Hart's Model

Three associated assumptions made in chapter one need to be examined. First, there is no difficulty in applying to Taiwan Hart's model. A framework designed to analyse advanced countries would also be applicable to the situation in Taiwan as the rising technological competencies of Taiwan's industries in the 1990s showed. However, it is not suggested that it is generally applicable to 1980s and other decades since no data prior to 1990 is tested in this study, and very few industries, maybe none of them, had the ability to challenge top competitors at that time.

The second assumption (see also Figure 3.3) is shown to be correct because Taiwan moved from a state corner position, a position suggested by neo-statist theories, to the Japanese pattern, strong state and business. According to the analysis in chapter 3, this was the optimum move for Taiwan to make, and remain competitive. As argued by Hart (1992:290-2), state-societal arrangements in a two actor coalition position are more conducive to diffuse new technologies than these in a one actor dominant position.

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This explains why Taiwan rapidly increased its competitiveness in the 1990s. Although the state plays the role of a senior partner in this new institutional arrangement, the enthusiastic participation of the private sector should not be neglected. Thus, it should be deemed as a pattern of strong state and business but weak labour.

The third assumption illuminates how the economic functions of the state, industrial policy and GI relationships will be affected by the changing domestic and international climate. This assumption is also proved true by the empirical findings. The role of the state in industrial development has been transformed from controller, regulator and protectionist into catalyst, sponsor and partner. IP has shifted its nature from governing the market towards facilitating the market in a narrow sense that IP is aiming at creating value-added and market share. The GI relationship is away from a state-dominated one, to ISP.

The validity of these assumptions can be justified not only in theoretical terms, that Taiwan fits into Hart's model in the position of state-business side, but also in de facto terms that it, as a NIC, is becoming a 'rival capitalist'. Although Taiwan is in the same position on Harts' triangular model as Japan, the state-industrial arrangements of both countries are distinctive from each other in relation to the influence of industrial sector. The Japanese Keiretsu-dominated industrial sector had increasing influence in competing with MITI in a meso-economic policy, in particular, in high-tech electronics, by the end of 1980s. The Taiwanese SMEs-dominated industrial sector still follows the guidance of IDB in the 1990s, but not as much as in the past. It is premature to suggest that Taiwan's industry will follow the path of its Japanese counterpart. Taiwan might pursue its own pattern based on ISP but with respective weight between both sides.

The theoretical application of Hart's model is dynamic. It is conducive to the understanding of the diversity of institutional arrangements on the basis that every institutional arrangement was embedded in a national setting where the society, culture and ideology are variant from country to country. It provides a general model which can explain the institutional patterns of given countries which have competitive strength on world market, and distinguish the performance of different institutional arrangements. It does not confine the theory to a particular pattern, and this leads to a flexible adjustment to cope the evolution of institutional changes.

Also institutions themselves are not static, but evolving. Policies will be modified according to the changes in the domestic and international political economy. Policy changes bring institutional changes in their wake. Because Hart's conclusions were about the patterns of five countries drawn on historical evidence, it is necessary to update his arguments. To name a few, the British pattern can no longer be seen as a labour dominant one, after nearly two decades of conservative government. The USA business dominant pattern, neglected state involvement in terms of trade issues, in particular, patent protection. The French state dominant pattern, should also incorporate the influence of large enterprises into account. The response of public policies to changing environmental constraints has reshaped state-societal arrangements. Any notion for a static institution may be appropriate in a short term perspective, but it is arguably not the case in the longer term.

Every institutional arrangement has its own advantages and weakness. The USA business dominant system was once the most competitive one among rival capitalist systems from 1950s to 1970s. Japanese state-business and German business-labour patterns arose as the more competitive ones in the 1980s and 1990s. It is not suggested that currently well-performing systems can remain competitive forever. The strength of one system could be the weakness of another, and the strength of the institutional arrangements might become a hindrance across time. The effect of institutional arrangements is only justifiable when it seizes opportunities and accommodates to the changes. Moreover, institutional advantages can not be established spontaneously, rather, they have to be accumulated gradually through time and learning from trials.

The element of contemporary international competitiveness requires an endogenous institution that can create institutional advantages rather than be subject to environmental constraints. Hollingsworth & Boyer (1997:477) argued that 'The most competitive firms, regions, or nations are not mimicking the market but on the contrary, they are struggling to manufacture consensus, trust, collective forms of governance, and long-term vision'. Thus, competitiveness can be promoted based on mutual trust and long-term cooperation between institutional actors. It concurs with Hart's conclusion that two actor coalition arrangements are more competitive than one actor dominant arrangements and also matches the empirical findings of this study, that a state-industrial arrangement has created an innovative institution, characterised as an ISP, for cooperation between actors.

Three further research directions can be indicated. First, at a national level the state-societal arrangements of those countries in Hart's study must be updated in order to observe the evolution of institutional changes since the world economy and technologies changed in the 1990s at a faster pace than in any previous decade. If more countries were brought under the analytical framework of this model then the generalisation of Hart's theory would be established, based on a wide range of data and a more precise comparison concerning the international competitiveness of countries could be made. Secondly, more sectoral studies are required in the different sectoral structural backgrounds because there is no single way of structuring economic units and coordinating their activities at meso level, as well as at national level. Hart's assertion that sectoral state-societal arrangements tend to be similar in a country, lacks enough empirical data at meso level for its support. This study has the same finding, largely because two sub-industrial cases are subsumed under the electric-related industry. Thirdly, more studies concerning those highly competitive industries among world top rivals have to be done in order to understand how states and industries respond to international challenges, in particular in the industries such as telecommunication, information, electronics and biotechnics where their technological progress moves fast. All this research will contribute to our knowledge by exploring the world of institutionalism and the varieties of capitalism in both national and sectoral perspectives.

2.2. Background Theory: East Asian Developmentalism

Retrospectively, the three elements which have constituted the developmentalist theories are policy activism, strong state capacity, and relative autonomy. All are under the umbrella of an authoritarian interpretation. However, the strong authoritarian regime in Taiwan has been transformed towards a more democratic partisan one, although it is still a KMT-dominated state. The use of coercion is to be deemed no longer appropriate in the intervention of economic affairs. In the case studies, the state still intervened in technology development, but it was not by the means of authoritarian power. The discussion which follows focuses on the drifting nature of the three basic elements after authoritarian withdrawal.

IPs is still the main instrument by which the state intervenes in industrial development. This is the very nature of developmental government using public policies to direct activities of the private sector. It could be said that the policy activism of the national government in the 1990s did not change the nature of selective intervention substantially, but the areas of policy activism have shifted from other protectionist and regulatory policy areas towards assistant and sector-biased polices for industrial upgrading. It denotes not only a change to cope with the needs of structural adjustment, but also a shift of IP from direct involvement in the market to functional involvement in product-oriented technology development.

Strong state capacity as the dynamics for policy implementation is somehow broken-down. The administrative capacity of the bureaucratic elite to control policy implementation and outcomes has deteriorated because the private sector would not accommodate policy measures if there was no institutionalised 'sweetener'. It became more difficult for the state to push the private sector to follow its administrative guidance in the 1990s than in the authoritarian period. The most apparent example is the unsuccessful 'go-south' policy for outwards investment in which 'the capable state' appealed to firms to invest in South East Asian countries instead of Mainland China so as to partly reduce the heavy dependence on China's economy and as bargaining power for talks on the Taiwan Straits. The results were fruitless and upset the state because innumerable (including registered and 'illegal') firms still went west to Mainland China (many go-south firms are state-owned and KMT party-owned). It is because the investment decisions of firms depend on corporate strategies and the incentives provided by host countries rather than administrative guidance of home government. Institutional design-in benefits instead of the state capacity are the keys to the compliance of the industrial sector in 1990s. However, the failure of inadequate policies to prevent profit-seeking business from rushing to the mainland market (Leng, 1996) was because the benefit was one-sidedly obtained by the state to achieve its political ends which was not reciprocal in the eyes of business.

The relative autonomy of the state as the institutional foundation for policy-making is slightly affected by influences other than the state. The political autonomy of the state elite to determine state interests and policy priorities in relation to economic and technological development remains quite strong but consultancies from the industrial sector in general and foreign sources in particular (most members of STAG and consultant firms) have influenced policy-making. This is not to say that the private sector has penetrated the policy-making process. At best, their opinions can be heard by the authorities. The decisions on picking winners are still in the hands of the state elite, while the implementation process leaves much space for participation from the industrial sector.

It could be argued that the characteristics of sectoral influence, or meso-corporatist decision making, was not explicit in the process of picking winners. Considering the fact that only a few selected industries (semiconductors, information, and the consumer electronics industry) had strength in the economy at that time, the choices were, in very large part, dependent on international information and suggestions.

However, the economic centrality of the electrics-based industries is too significant to be neglected by the government. Naturally, these industries were targeted. Some industries were either too weak to compete internationally (machinery and telecommunications) or too new (aerospace and pollution control) to Taiwan. These industries were unlikely to affect the decision making. In fact, some traditional industries had more political power than new industries in the sense that they have built a long term relationship with the bureaucracy. However, only one (specialty chemicals & pharmaceutical products) of the traditional industries was privileged. All labour-intensive and low-value-added industries were excluded. So the decision making process was not penetrated by the private sector in general.

Nonetheless, it seems that state autonomy in terms of traditional industries has considerably declined compared to high-tech industries. The reality is more concerned about state strategy than the decline of state autonomy. Those traditional industries have been seen as losing their competitive advantages to those of other rising countries which are based on labour intensiveness. It is the state that gave up these industries by removing resources from them to emerging sectors. It is natural that the state should lose its control over these sectors when they could not expect any institutional benefit from the state.

The authoritarian interpretation as the theoretical base of East Asia developmentalism is dated, new directions should be advanced to capture the recent changes in these countries. When the three basic elements of the developmentalist theories have been fundamentally converted, an incorporation of institutional arrangement perspective into developmentalist theories is desired. This will provide a new approach that explains the economic growth/competitiveness of these countries in the 1990s in a different way which emphasised institutions for GI cooperation rather than the state as an prevalent actor. In addition, international and technological factors are brought into the analysis instead of being trapped in the debates between ISI and EOI which have mirrored the response to economic globalisation.

There is a need to re-examine these developmental states in a non-authoritarian era. According to 1997 World Development Report (World Bank, 1997), the effective state, in relation to the effectiveness of promoting state policies and institutions, is the key leading to high growth rather than the capable and autonomous state. It is a sign of a sudden U-turn of the World Bank, who never exaggerated the role of the state in the economic development and favoured a liberal market, starting to emphasise the importance of the state. 'An effective state....is central to economic and social development, but more as partner and facilitator than as director (ibid.:18)'. Bearing this in mind, further research in the developmentalist perspective will have to be concentrated on the changing nature of state's role and its interaction with societal actors to respond to the changes of technology and international political economy.

It is also necessary to analyse why the 1997 and 1998 financial crises jeopardised those countries, such as Korea, Indonesia and Thailand where currency values have dropped by more than 50%, more serious than Japan and Taiwan where the drop is only about 10-15%. Generally speaking, the political regimes of the former countries tend to be more authoritarian and the latter ones more democratic. At least, the former's financial measures are more dirigible by the state while Taiwan's is more liberal (Economist, 03/01/98:73). If this implies a connection between the vulnerability of financial structures and their political regimes, then a fundamental reversion of an authoritarian explanation in financial terms is very obvious. The voice of some Asian NIEs who defended so called Asian values, which were strongly related to authoritarian measures of economic development, against western based democracy in the high growth era, have disappeared since the economic crises, in particular after negotiating with the International Monetary Fund for assistance. The reality of crisis leads to a doubt about the abilities of developmental states to manage financial crisis. In advocating the policy measures of developmental states which would result in a higher growth rate, now and in the future, it is necessary to consider the weakness of these measures to avoid economic crisis.

3. POLITICAL DEVELOPMENTS AND ISP

We can not talk about Taiwan's industrial development without referring to its future and the forces that might influence it. The ISP as an institutional arrangement will be subject to politics. Many political developments are seen to have had a considerable influence on ISP. Three aspects of political changes, namely the China-Taiwan relation, power structure and the KMT party-state structure will potentially altered the operations of ISP. Although the China-Taiwan relation does not directly affect ISP as the other two factors do, it is the greatest uncertainty for Taiwan. The future of Taiwan is uncertain, no writer would give a concrete answer to the question such as political 'take-off' from China, military participation of foreign governments in the issue of China-Taiwan conflicts, and changing government in Taiwan (Ferdinand, 1996; Klintworth, 1995; Wu, 1995).

3.1. Hostile Relations across the Taiwan Strait

If Taiwan were occupied through force or reunited through negotiation with China, Taiwan's domestic environment, both political, economic and social, would have a dramatic change. It is predicted that ISP will be substantially affected, or disappear if Taiwan becomes ruled by China. The following discussion is concentrated on the relationship between China and Taiwan, rather than on how the political economy of Taiwan will be shaped after reunification because that is a premised question not a realistic condition. However, the hostile attitudes of both governments might lead to a situation that the Taiwanese state puts more resources to strengthen ISP in order to encourage high-tech business to stay on the island rather than to invest in China, implicitly speaking.

The deterioration of China-Taiwan relations since 1995 was principally caused by the trend of democratisation and the Taiwanisation of political legitimation (Chang, 1996), which have been taken as a move to independence by China. Consequently, a large scale military exercise in the East China sea in the 1995 summer and a series of missile tests surrounding Taiwan in the early 1996 before Taiwan's first presidential election were seen to be a message of warning from China to Taiwan for its inclination to independence even though there is no obvious attempt for independence, just some non-governmental assertions and the state strategy of 'pragmatic diplomacy' (Hsieh, 1996). This warning did not make reunification any closer, but led to indignation and understanding of the ruthless nature of China. The aggressive behaviours and the possibility of using force by China also led to a crisis of national identity which together with the China factor presented the biggest threat to democratic consolidation (Yu, 1996; Wu, 1995).

The political hostility brought about the consequent result of the Taiwan government wanting to reduce its economic dependence on China by discouraging outward investment to the Mainland. Only those declining industries are permitted outward investment to China. This, together with diplomatic activities, has annoyed China further, and seen in Taiwan's challenge to China because China's economic development relies on foreign investment substantially. In fact, Taiwan's high dependence on China's economy, and also China's dependence on Taiwan to a lesser extent, made the issues between both sides of the Taiwan Straits more complicated involving not only the two governments but also Taiwanese business (Ngo, 1995). China wants to absorb more Taiwanese investment on the one hand and to depress Taiwan's international role on the other hand. Taiwan also claims its own definition of one China and officially rejects the idea of formal independence, while Taiwan refuses to talk in unequal terms as a rebel province and insists on the possibility of reunification only with a democratic China and its living conditions close to Taiwan's.

Moreover, international forces, in particular the deep involvement of the USA, have played an important role in regulating the relations between both sides (Klintworth, 1995). It is the result of China's own strategy of 1995-96 military deterrence which has brought the USA from backstage to the forefront in fear of a war and the military expansion of China after 1996 that was evidenced by sending two fleets to the Taiwan

Strait in the crisis of March 1996, expansive explanation in the USA-Japan security treat to cover the surrounding areas of Japan, and developing a 'strategic partnership' with China in order to crystallise and constrain its military. The future of Taiwan depends very much on international politics, but a peaceful status quo is accepted by many actors under the conditions of no independence and no force.

Economic prosperity and democracy, in Taiwan's point of view, are the essential factors resulting in the protection from the USA (although the USA has its own interests and global strategic consideration on this matter). Thus, Taiwan will keep on promoting economic growth and political reform. High-tech industries, seen as the dynamics of growth-oriented export, will be treated in a privileged way. However, further economic liberalisation and the attraction of the mainland market might lead to a more foot-loose high-tech sector. In this circumstance, not only for the economic growth but also for security, ISP will be deployed continuously by using the institutional 'sweetener' to induce this sector to remain in Taiwan.

3.2. Power Structure

Rapid political development in the decade since 1987, including the lifting of martial law and the ban on new political parties, the opening up of elections at all levels, and constitutional reform, have been deemed as a 'political miracle' after an 'economic miracle'. After democratisation domestic politics have changed to party competition, nowadays, KMT is a majority party rather than one dominant party even though it has never left the government for the past half a century in Taiwan.

The increase of parliamentary power in shaping major political issues can be observed over the last ten years. The role of the Legislative Yuan in relation to the Executive Yuan has changed from 'a rubber stamp bureau of the Executive Yuan' into an influential institute in the process of policy-making with which the Executive has to consult regularly. After the 1995 legislative election, KMT commands only a tiny majority in the Legislative Yuan but it remains in near-total domination of the

Executive Yuan. On some special interest issues, the KMT government has to compromise its policy with the demands of the major opposition party, the Democratic Progressive Party (DPP), because it can not discipline its members in the Legislative Yuan effectively. However, these compromises have concentrated more on social and welfare issues than on economic ones, because the former topics have attracted more voters' concerns so KMT elected politicians tend to be more independent in that area.

The state control over the issues concerning the future economic development is still autonomous as public spending is unequally distributed with a bias to economic growth. In the realm of policy for economic development, there are fewer disputes about the budget for technology development and IPs but not in the cases of economic infrastructure. In particular, in public construction projects there are disputes where several interests are involved and more corruption exposed. Moreover, these high-tech sectors also produce an outstanding performance and use budget resources more efficiently. At least, corruption and interest conflicts have yet to be disclosed in this area. If the situation does not experience a fundamental change, STPs and their supplemental IPs will continue to be used.

As electoral politics increases its importance in the redistribution of political influence, further changes at the national level may have a considerable impact on economic issues. The KMT might lose its majority in the Legislative Yuan to the opposition parties, a large DPP and a smaller New Party in the future. Unless DPP can obtain more than half of the seats, a coalition government will be necessary. If this is the case, a coalition between the KMT and the New Party is more likely than a coalition between the DPP and the New Party in the ideological sense that the DPP prefers an eventual independence and the New Party tends to a reunification in the future with the KMT somewhere in between. However, political aspiration and consciousness are generally agreed between political parties regarding continued economic prosperity as a 'economy and trade first' strategy when faced with the potential threat of China at all times. Even if the KMT left the government, the centre-line of national development is economic rather than political and social.

3.3. KMT Party-State

As we discussed in section 4.3. of chapter three, the KMT, a quasi-Leninist structure party, is the power, more than state leadership, involved in Taiwan's economic development. Party decisions were the major factors in shaping the consequent state policy. The change of KMT ideology from actual authoritarian convictions to democratic ones by using the Three People's Principles of Sun Yat-sen in a pragmatic way has undoubtedly facilitated the democratic transition of Taiwan's political system (Hao, 1996). However, although the KMT ideology changed, this was not in order that as a political party in office, it should cease speculation on the national economy.

Although the administration of a government that is highly influenced by the ideology of the ruling party has been recognised, the whole state system and most political resources that have been manipulated through its party mechanism are unjustifiable. This is an authoritarian rather than a democratic approach. As Taiwan can be deemed a democratic regime now, the KMT's institutional capacity should confine itself to state affairs based on administrative regions. State policies should be the outputs of the interaction between public agencies and civic and economic associations on the formation of policy, and between the Executive Yuan and the Legislative Yuan on the ratification of these policies.

There is also a change inside the KMT in terms of the relationships between the party and its followers. It is argued that 'the nature of the long existing patron-client relationship' has been replaced by the influence of money politics, factional strife, and even organised gangsters, all of which are directly connected to local politics (Kau, 1996). This kind of 'informal politics is dominated by factions selling influence for money, challenging party discipline and integrity' (Scalapino, 1996:227). This explains why KMT was defeated in the middle-level local election in 1997 (held 8 out of 23 magistrates and mayors) and won in the basic-level election in 1998 (held 233 out of

319 town and village leaders, 524 out of 890 councillors). However, there is no effective rule in the KMT to regulate the behaviours of informal politics. Increasing public dissatisfaction about social and economic justice might become more serious, if informal politics still dominate the local politics, even at the national level in the future.

Nonetheless, a full democracy should at least embrace two elements, a government shift between political parties and a separation of the party from the state. As argued by Leng & Lin (1993), more remains to be done in the transition to democracy for the KMT to draw a clear line between the party and the state. According to the findings in the empirical chapters, many new high-tech spin-off firms are jointly ventured by the government and the KMT. These new profitable firms benefitted from technology innovation subsidised by the government STPs. Criticism will be developed on this matter as to why the advantages created by the economic institutions should be exploited by the ruling party. This party-state capitalism will have to be scrutinised stringently.

ISP as an economic institution should not become an auxiliary vested interest of the KMT. Otherwise, it will create the condition that the ruling party takes advantage of the state policy and the economy in an intolerable way. The KMT is already the richest political party in the world. And this kind of corrupted interest conversion makes the KMT stronger and the opposition parties relative weaker. If this phenomenon continues, politics only becomes worse and the party competition less just.

4. THE FUTURE FOR TAIWAN

Policy measures for industrial development in 1990s suggest that there are some internal economic impacts that the Taiwanese government should manage. This study suggests that ISP, as an institutional model to diffuse technology under state-industrial collaborative efforts, has an important effect on international competitiveness in both the NPC and HDTV sectors. However, further research in other sectors is required before this state-industrial arrangement is generalised to other Taiwan's industries. In general, traditional industries are unlikely to suit this model, and it is applicable to technology-based industries because of policy activism in this area.

However, Taiwan will be exposed to a danger no matter how effective or ineffective this new type of state-industrial arrangement. If the new state-industrial arrangements do not perform very well for all emerging industries, there is a real danger for Taiwan in the sense that the adjustment of industrial structure towards a high-tech industry-dominated one has failed. Even worse, those traditional industries have slid away because, the ongoing IPs which focused mainly on the emerging sectors made most high-tech industries stay at home to enjoy the privileged measures provided by the state, while labour-intensive industries voted with their feet. In reality, manufacturing deindustrialisation in terms of labour-intensive industries has already occurred in Taiwan, which also reflects the fact that the investment decision of firms depends, in large part, on what kind of IP the state enforced. High-tech industries are now the only hope for Taiwan since those 'walk-out' industries can not possibly be reinstalled. Taiwan is at the point of no return where high-tech industrialisation must carry on.

If it does work, it would lead Taiwan, on the bright side, to be one of the important bases for technological development. On the dark side, heavy dependence on the development of high tech industries would ensue. An economy which relied mostly on technology-based industries would be very sensitive to changes in the international political economy. Many factors seriously affect the development of these industries, for example, new international regulations, world economic recession, new international entrants, and slowdown of sectoral market demand. Too high a concentration on winners is dangerous. To be or not to be a technological island is the question which requires the wisdom of the state and societal elite to consider what is best for Taiwan's future development.

A potential threat for the future of ISP might be the reduction of government financial support on technology projects since STP budget has effectively lured cooperation from the industrial sector. Government resources for industrial R&D have grown steadily in the past (chapter 4), but expanded welfare proposals and military expenditures probably have squeezing impacts on it (Ferdinand, 1996:60-2). It is assumed that ISP would be weakened when STP resource was extracted.

Taiwan wants to be a key player in a game of international competition but more and more depends on creating its own terms. The innovative ISP can serve as an institutional foundation for technology development, but must modify its operation to take account of sectoral difference and environmental changes.

Appendix List of Elite Interviews

No	Name	Institute	Position	Date
1*	**Chang,** Alan (張博堯)	Acer Inc.	Special Assistant to Chairman	20/03/96
2	**Chang**, Huai-Chi (張淮杞)	Market Intelligence Center/III	Manager of System and Peripheral Research	30/05/96
3	Dr. **Chao**, T.H. Steve (趙子宏)	-HD-Video Industry Promotion Program Office/MOEA --Visual Information Technology Division, CCL/ITRI	-Executive Secretary --Director of HD-Video Program	12/04/96
4	**Chia,** Jack T.C. (賈大駿)	General Chamber of Commerce	Deputy Secretary General	26/12/96
5	**Chen**, John (陳子昂)	ITIS & Promotion Project Program Office/MOEA	Director of Program Office	22/04/96
6	**Chen**, Jee-Yuan (陳鐵元)	DIT/MOEA	Advisor	08/05/96
7	**Chen**, W.J. (陳文義)	TEEMA	Director of Business Department	06/05/96
8	**Cheng**, Linche (鄭麟哲)	Tatung Co.	General Manager of Telecommunications Division	10/05/96
9	**Cheng**, Sandy L.C. (鄭麗娟)	Industrial Research Department, CCL/ITRI	Manager	12/05/96
10	**Chuang**, C.K. (莊錦國)	Proton Electronic Industrial Co., Ltd.	Director of R&D Department	30/04/96
11	**Chuang**, Chun (莊俊)	STAG/the Executive Yuan	Researcher	26/04/96
12	**Ho,** Malcolm C.M. (何忠民)	National Federation of Industries	Section Chief	24/12/96
13	**Horng,** Jinn-Hsyong (洪進雄)	Second Division, IDB/MOEA	Technocrat of Electronic Industry	07/05/96
14	**Hsu**, David W.L. (許萬龍)	Products Office of Planning/ITRI	Program Manager	18/04/96
15	**Huang**, Chih-Peng (黃志鵬)	Sixth Division, IDB/MOEA	Director	07/05/96
16	**Kuo,** Qundi (郭坤地)	Chinese Association for Industrial Technology Advancement	Executive Vice General Secretary	18/12/96
17*	**Hwang,** Chin-Young (黃欽勇)	Market Intelligence Center/III	Director	28/03/96
18*	**Jong,** Dennis (鍾光智)	C&C Inventec (英業達集團)	Executive Vice President	20/03/96

19*	**Lee,** I.J. (李英珍)	Mitac International Corp.	President, Video Product Business Unit	27/03/96
20	Dr. **Lee**, Jen-Fang (李仁芳)	Graduate Institute of Technology and Innovation Management, National Chengchi University	Professor	29/04/96
21	**Lin,** Hsiu-Ching (林秀璟)	IDIC/MOEA	Researcher	27/12/96
22	**Lin**, Lily (林俐俐)	HDTV Office/MOEA	Project Manager	08/05/96
23	**Lin,** Michael M.K. (林銘貴)	Strategic Planning Department, ERSO/ITRI	Manager	17/04/96
24*	**Liu,** Lung-Lung (劉龍龍)	Products Development Division/III	Director	22/03/96
25	**Lo**, Barry Ta-Hsien (羅達賢)	Office of Planning/ITRI	General Director	18/04/96
26	**Sue**, Yin-Lin (蘇應麟)	Program Office of Key Components/ITRI	Program Manager	18/04/96
27	**Sun**, Chen-Yang (孫振揚)	DIT/MOEA	Researcher	09/05/96
28	**Tarng**, Huey-Huey (唐蕙蕙)	Industrial Research Department, CCL/ITRI	Industrial Analyst	18/04/96
29	**Tseng**, Ta-Yu (曾大有)	STAG/the Executive Yuan	Researcher	26/04/96
30	**Wang**, Sid H.C. (王錫成)	DIT/MOEA	Researcher	23/12/96
31*	**Wang,** Steve (王守仁)	United Microelectronics Corp.	Director, Sales Division	21/03/96
32	**Yang**, James K.C. (楊貴誠)	HDTVOffice/MOEA	Project Manager	15/04/96

Note: (1) The appearance of interviewees is according to the alphabetical order of their surname. The position and the institute of each interviewee is accurate when the interview was conducted.

(2) 6 interviews (1, 17, 18, 19, 24, and 31) were conducted in an informal condition when the author joined a two week intensive course concerning the operation and management of high technology industry. The author advanced questions in seminar or at class breaks. Some interviewees (9, 20, 23, and 25) also lectured in the course, but the author arranged another longer time to conduct an interview if the interviewee's position was highly relevant to this study.

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