INNOVATION AND GROWTH IN THE INDONESIAN ECONOMY

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Abstract

The major objective of this thesis is to provide an investigation of the role of new ideas and innovation in Indonesian economic growth, drawing heavily upon recent theoretical and empirical literature. A survey of recent literature shows that the process of learning through the production and use of ideas is a critical element in modern growth theory. For developing countries an important theme from the literature is the existence of 'idea-gaps' across countries and the opportunities this generates for international technology transfer. A second important theme is the social absorption capability of developing countries to effectively integrate and develop advanced country ideas.

The development experience of a number of East Asian countries over the 1960-90 period provides a clear example of how the process of learning through the production and use of ideas can lead to rapid economic growth. Latecomer firms in the region exploited various technology and market channels to acquire and develop the skills necessary to compete internationally. The role of policy was critical in this process, ensuring the necessary 'social capability' to use and produce ideas. Social capability is determined by technological factors such as the education levels and indigenous R&D, and also by determinants of the incentive environment for innovation, such as competition. Empirical work based on cross-country regression analysis and the construction of a number of tables reflecting regional growth characteristics further highlight the importance of using and producing ideas in modern growth.

Indonesia's growth over the 1960-90 period has been impressive. However changing circumstances in the global economy bring with them a new set of challenges for the future growth. Driving these changes is the process of international deregulation and the on-going revolution in information and communications technologies - the combined result of which has been the emergence of what is termed the *global knowledge economy.* A number of empirical measures are used to assess the nature and extent of the new demand side challenges confronting Indonesia. It is found that Indonesia needs to upgrade in favour of more sophisticated export activities if it is to better participate in the global knowledge economy.

Indonesian policy makers are clearly aware of the technological challenge which the emergence of the global knowledge economy poses for the country. Significant resources have so far been channelled into various government projects and programs to promote Indonesia's national industrial technological development. Despite such efforts, Indonesia is lagging most other countries in the region in the move toward more knowledge intensive activities. This is reflected, to a certain extent, in the country's continuing dependence upon primary commodities and labour and resource

intensive manufacturing, and the relatively underdeveloped nature of its computer and electronics sector.

There a are host of factors which have influenced Indonesia's ability to respond to the global knowledge economy. Five key areas are discussed where policy has and continues to be critical. The *first* is the historical orientation of industry and trade policies toward the domestic market. This has restricted opportunities for learning new ideas from foreigners through various channels associated with export manufacturing such as licensing and original equipment manufacturing. The *second* area is the restrictive regime for FDI pursued throughout the much of 1970s and 1980s which also restricted opportunities for learning from foreigners. The *third* area is poor human resource capabilities. The relatively small number of technically trained personnel has not only prevented Indonesian manufacturers from integrating and developing latest product and process technologies from abroad, but has also provided a clear disincentive for inflows of technology intensive FDI. A *fourth* and related area is the capability and relevance of local R&D institutions. Indonesia's R&D institutions, due essentially to poor linkages, capabilities or incentive structures, do not provide adequate technology support and/or basic R&D services for private industry. The *fifth* and final area relates to the distortions to the overall incentive environment for innovation due to the lack of competitive pressures in much of the industry sector. This is due to two factors: the public sector dominance of most high technology activities and the oligopolistic nature of the industry sector where profit seeking is often determined by rent seeking and other anti-competitive behaviour.

Abbreviations and Glossary

ANICS	Asian Newly Industrialising Countries (see Table 3-2)
ANU	Australian National University
ASEAN	Association of South East Asian Nations
ATB	Anti-Trade Bias
BKPM	Investment Co-ordinating Board (Indonesia)
BPIS	The Strategic Industries Co-ordinating Body
BPPI	Industry Research Institutes (Ministry of Industry)
BPPT	Agency for the Assessment and Application of Technology
BPS	Central Bureau of Statistics - Indonesia
BULOG	National Logistics Board
BUMN	State-owned Enterprises
Bappenas	National Development Planning Board
C&E	Computers and Electronics
CIDES	Centre for Information and Development Studies
CSES	Centre for Strategic Economic Studies, Victoria University
DRAM	Dynamic random access memory
EBRI	Economic and Business Review Indonesia
EDB	Economic Development Board (Singapore)
ERP	Effective Rates of Protection
FDI	Foreign Direct Investment
FE-UI	Economics Faculty, University of Indonesia
FEER	Far Eastern Economic Review
First Tier ANICs	Hong Kong, Korea, Taiwan, Singapore
GDP	Gross Domestic Product
GI	Growth Intensity (index)
GRPC	Growth rate per capita
HDI	Human Development Index
HPAEs	High Performing Asian Economies (see World bank 1993)
ICMI	Association of Moslem Intellectuals
IEDB	International Economic Database, Australian National University
ILO	International Labour Organisation
IMF	International Monetary Fund
IPTN	Industri Pesawat Terbang Indonesia (The Indonesian aircraft producer)
ISIC	International Standard Industrial Classification
ISO	International Standards Organisation
IT	Information Technology
ITRI	Industrial Technology Research Institute
KIST	Korean Institute for Science and Technology
LDC	Less Developed Country
LIPI	Indonesian Academy of Sciences
MOST	Ministry of Science and Technology (Korea)

MToT	Manufacturing Terms of Trade
NDIO	National Development Information Office
NICs	Newly Industrialising Countries
NSF	National Science Foundation
NTBs	Non-tariff barriers
NTSB	National Science and Technology Board (Singapore)
ODI	Overseas Development Institute
ODM	Original Design Manufacturing
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturing
PMP	Progressive manufacturing plan
PWT 5.5	Summers and Heston Penn World Table dataset (version 5.5)
R&D	Research and Development
RCA	Revealed comparative advantage
RERP	Real Effective Rates of Protection
SITC	Standard Industry Tariff Classification (trade data)
SMEs	Small and medium enterprises
SOEs	State owned enterprises
STAID	Science and Technology for Industrial Development
STMIS	The Science and Technology Management Information System
Second Tier ANICs	Malaysia, Thailand and Indonesia
TFP	Total Factor Productivity
TNCs	Trans National Companies
ToT	Terms of Trade
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organisation
USTR	United States Trade Representative

1. Introduction

1.1 The Argument

The major objective of this thesis is to provide an investigation of the role of new ideas and innovation in Indonesian economic growth, drawing heavily upon recent theoretical and empirical literature. The first section of the thesis (comprising chapters 2-4) considers the role of new ideas in the theory and practice of modern growth, whilst the second section (chapters 5-8) highlights a number of key trends arising from knowledge driven growth in the global economy and reviews Indonesia's supply side response to these new challenges.

Six central propositions emerge from the analysis, as follows:

- the generation and application of new knowledge is an essential element in most modern theories of economic growth;
- the rapid development of a number of countries in East Asia over the past quarter century is due in significant part to systematic activities in those countries to access and apply knowledge, involving both the use of some well-defined set of channels for utilising foreign ideas and some large scale programs to develop local capability to utilise such ideas;
- given continuing global trends, if Indonesia is to improve or maintain economic growth in the future it will need to upgrade its economic activities in favour of more knowledge intensive activities;
- one requirement for Indonesia to achieve that upgrading is that it make better and more systematic use of the channels for acquiring foreign ideas and for developing ideas locally;
- a second requirement is that Indonesia give greater attention to developing, at all levels within the community, increased capability to access and utilise new ideas in economic activities;

- a third and related requirement is that Indonesia develop systematic programs and incentives to encourage the private sector to take a leading role in accessing, generating and applying new ideas.

These propositions are outlined more fully in this Introduction, and discussed at length in the body of the thesis. It should be stressed that it is not my intention to draw from the analysis a detailed set of prescriptions for policy. This is because the approach employed throughout this thesis is to consider the problem of Indonesian technological development from a distinctly 'macro' perspective. It would therefore be inappropriate to propose a set of specific policy recommendations on, for example, firm level training programs, changes to the high school curriculum, the level of tax rebates for R&D activity etc or to provide a critical assessment of specific government programs or policies when the analysis pursued throughout the thesis has not considered these and other issues from a similar level of disaggregation. It is maintained, however, that these six propositions provide a useful framework within which more detailed policy analysis could be undertaken.

1.2 The Central Role of Ideas in Modern Growth Theory.

The second chapter of the thesis considers the theoretical dimension of the role of new ideas in economic growth. Whilst acknowledging that there is a broad range of theoretical paradigms within the literature which explore the role of new ideas in growth and development, the approach taken in this chapter is to consider two broad streams or aggregations of this literature: namely the *formal* and *appreciative* approaches to growth theory as originally defined by Nelson and Winter (1982). From within these two aggregations can be drawn five central themes which not only provide a strong theoretical foundation for the analyses carried out in subsequent chapters of the thesis, but also provide a useful analytical device to map out and explore the key differences in the various theoretical approaches to the relationship between new ideas and economic growth.

The first three themes consider the importance of ideas to growth in a general sense and are drawn mainly from the *formal* literature; namely that the generation and application of new ideas is an essential element in modern growth theory; that technological progress (which is a direct result of the generation and application of new ideas) is driven in large part by market incentives and is therefore an endogenous phenomenon; and that due to their inherently nonrival nature, ideas are able to generate increasing returns to scale and are therefore difficult to incorporate within standard neoclassical price-taking analysis. The final two themes considered are more relevant in the development context and are drawn mainly from the *appreciative* literature; that idea or technology gaps across countries provide an enormous opportunity for the less developed countries to enjoy rapid catch up growth; and that this rapid catch-up growth is conditional to having the necessary capabilities and policy conditions (ie what is commonly termed *social capability* - see below) conducive to being able to effectively import, use and develop new ideas from the advanced countries.

The five themes of growth outlined above are then distilled into a central theoretical proposition that the process of learning through the production and use of ideas is an essential element of modern economic growth.

1.3 The Role Of New Ideas In East Asian Growth.

The development experience of a number of East Asian countries over the 1960-90 period considered in Chapter 3 provides a clear example of how the process of learning through the production and use of ideas can lead to rapid economic growth. Attention will be focussed primarily on the recent development episodes in Korea, Taiwan, Singapore, Malaysia and Hong Kong. These countries were chosen not simply because of their impressive development record over the 1960-90 period, but also because of the substantial literature documenting how latecomer firms in these countries were able to exploit various technology and market channels to gradually acquire and develop the skills necessary to compete internationally. Whilst there are considerable differences in emphasis upon the various channels for technology acquisition (such as foreign investment, imported equipment, original equipment manufacturing, licensing etc), there are nevertheless two important commonalities which can be found across all sample East Asian countries. That is, the emphasis upon linkages with foreign transnational companies through which new ideas could be imported, and the critical role of the computers and electronics industries both as a rapidly growing export sector and as a conduit for industrial technological development.

As well as exploring the various channels for importing new ideas, it is also important to consider how these countries were able to successfully develop the necessary social capability to effectively use and develop these ideas. Social capability in this instance is defined to include technological capabilities and the incentive environment. The former is reflected in the skill level of the workforce and the sophistication and commercial relevance of the R&D and technology support institutions, whilst the latter includes a number of key policy issues directly influencing the incentives to innovate such as the maintenance of a competitive environment both domestically and internationally and the provision of fiscal and financial incentives.

1.4 Global Trends and the Need for Increased Knowledge Intensity

Indonesia's development record over the 1960-90 period has been impressive and is well documented. However changing circumstances in the global economy will bring with them a new set of challenges for the future growth. Important factors contributing to this change include the process of international deregulation which has seen a general freeing-up of trade and capital markets, and the on-going revolution in information and communications technologies which has spawned the development of new production and consumption activities the world over. The combined result of these two developments has been the emergence of what many refer to as the *global knowledge economy*.

The remarkable episodes of industrial development in a number of East Asian countries over the 1960-90 period highlight the importance of using and producing ideas within this changing global context. To better compete in the new global knowledge economy, Indonesia will need to follow the East Asian example by emphasising more knowledge intensive activities for which there is strong international demand.

Indonesian policy makers are clearly aware of the technological challenge which the emergence of the global knowledge economy poses for the country. Significant resources have so far been channelled into various government projects and programs to promote Indonesia's national industrial technological development. Despite such efforts, Indonesia is lagging most other countries in the region in the move toward more knowledge intensive activities. This is reflected, to a certain extent, in the country's continuing dependence upon primary commodities and labour and resource intensive manufacturing, and the relatively underdeveloped nature of its computer and electronics sector.

1.5 Channels for Acquiring Ideas

An important theme which emerges from both the theoretical and empirical growth literature is the opportunities for rapid catch-up growth through the existence of technology or idea gaps across countries. As noted above, this can be seen in East Asia where a critical factor in the region's success has been the ability of latecomer firms to acquire and develop the knowhow to compete internationally through various linkages with foreign TNCs.

One of the key reasons behind Indonesia's belated and modest response to the emergence of the global knowledge economy has been its inability to develop such linkages. This is due in large part to the policy environment associated with an inward-looking industry strategy pursued throughout much of the 1970s and early

1980s which, in effect, restricted opportunities for learning through various mechanisms associated with export manufacturing, such as licensing, original equipment manufacturing (OEM) and subcontracting as well as through export oriented foreign direct investment (FDI). An obvious case in point is the computers and electronics sector. As will be emphasised throughout the thesis, this sector has played a crucial role in East Asia's technological development as latecomer firms in the region, through their various linkages with foreign electronics TNCs, were able to acquire the skill and knowhow to develop highly competitive manufacturing capabilities. In Indonesia, the restrictive policy environment prior to the 1990 deregulation program clearly discouraged export oriented activities such as OEM and FDI, which precluded local electronics producers from important channels for learning. As a result, the local electronics industry at that time remained in most part inefficient and directed toward the domestic market. Although growing rapidly in the early-mid 1990s, the Indonesian electronics sector remains one of the least developed in the region in the second half of the 1990s. This in turn represents an important reason behind Indonesia's continuing comparative technological backwardness.

The broad policy lessons that can be drawn from the specific case of electronics are clear. Indonesia needs to ensure that there are adequate channels for learning new process and product technologies from abroad, if it is to better compete in the global knowledge economy. Following the example set by a number of other countries in the region, this means developing and enhancing linkages with foreign companies through various means, including licensing, subcontracting and FDI.

1.6 Building Local Capabilities

An important prerequisite to the use and production of new ideas is adequate domestic capabilities. A key stimulus to East Asia's rapid technological development has been its ability to improve its human resource base by rapidly increasing the supply and education level of local engineers, technicians and skilled workers, as well as by developing advanced indigenous R&D capabilities. This in turn has facilitated the importation and integration of new technologies from abroad, as well as the development and use of indigenous technologies.

An important factor constraining Indonesia in its response to the global knowledge economy is the lack of human resources necessary for the integration and development of new ideas within local production systems. Indonesia lags most other countries in region in the per capita supply of critical science and technology personnel, such as engineers, scientists, technicians etc. Moreover, the low level of technical sophistication and the lack or commercial relevance of local R&D activities has impeded the development of indigenous capabilities necessary to develop further international linkages through which new ideas can be imported and then developed. Thus, further effort is clearly required to ensure that local industry has the technological capability to import and utilise latest productivity enhancing ideas so that it can better participate in the global knowledge economy.

1.7 Better use of the Private Sector

Indonesia's response to the global knowledge economy has also been constrained by an incentive system which has discouraged private sector innovative behaviour. An important theme emphasised throughout this thesis is that innovation is to a large degree driven by market incentives, ie the competition among firms for limited profits. However, in Indonesia there are two factors which are particularly distortive of the incentive environment.

The first is the lack of competitive pressures from local and international sources. This has resulted in a manufacturing sector characterised by oligopoly and an inward looking industry orientation where profit maximisation is often determined by collusive and other non-competitive behaviour. Government privilege and protection for a select group of businesses plays a key role in generating such anti-competitive conditions. Policy assistance for certain firms or sector has been commonly practiced in East Asia. Most countries in the region have been able to extract some kind of 'performance guarantee,' usually in the form of improved export performance, in exchange for government protection or subsidies. However in Indonesia, policy assistance has usually resulted in rent seeking behaviour in a protected domestic market, which diminishes the pressures and therefore the incentive to innovate.

The second factor is the dominance of the state in virtually all high technology activities, which has not only 'crowded-out' many potential private sector participants by commanding a substantial share of the country's scarce human and financial resources, but has also, due to the lack of competitive pressures within these industries, distorted the overall incentive environment for innovation. For this reason, Indonesia has clearly benefited less from the efficiency seeking entrepreneurship which characterises the private sector driven technology development episodes found in a number of other countries in the region.

The six propositions outlined at the beginning of this introductory chapter can be distilled into a central argument that the process of learning through the use and production of new ideas will represent a crucial factor in the future growth of the Indonesian economy. Whilst labour and resource intensive activities have provided the growth until now, new developments within the global economy suggest a new set of challenges for future growth. In particular the increasing knowledge intensity of consumption and production activities the world over compels Indonesia to upgrade in favour of more knowledge intensive activities. However, to do this Indonesia needs to address the role of ideas and innovation in economic growth in a much more systematic manner. Appropriate measure need to be taken across three broad areas; that is, to ensure adequate access to foreign ideas through a variety of channels, to ensure adequate technological capabilities to use and produce ideas, and to ensure an appropriate incentive environment to facilitate innovative behaviour in the private sector. As will be shown in the first section of the thesis (ie. the subsequent three chapters), these three preconditions to the use and production of ideas represent key elements in both the theory and practice of modern growth.

2. Ideas in the Theory of Growth

"...our knowledge of economic history, of what production looked like 100 years ago, and of current events convinces us beyond any doubt that discovery, invention and innovation are of overwhelming importance in economic growth and that the economic goods that come from these activities are different in a fundamental way from ordinary objects. We could produce statistical evidence suggesting that all growth came from capital accumulation, with no room for anything called technological change. But we could not believe it." (Romer 1993)

2.1 Introduction

There is nothing new to the proposition that ideas are an essential element in modern economic growth. In 1930 Keynes, for example, wrote that one of major reasons why living standards had shown no major improvement in the four thousand years prior to the eighteenth century was due to the 'remarkable absence of important technical improvements and to the failure of capital to accumulate'[1]. Similarly, Maddison (1991) defines the modern industrial economy vis a vis the pre-industrial economy by its 'strong propensity to risk capital on new techniques that hold promise of improved profits.'

Those writing at the time of the industrial revolution were also aware of the economic importance of new industrial innovations. In 1837 Blanqui[2] wrote that the end of the eighteenth century was signalled by 'admirable discoveries which were destined to change the face of the world and increase in an unforseen manner the power of their inventors.' In 1845 Engels[3] described the recent industrial advances associated with the invention of the steam engine and of machinery for working cotton as a

[1]Written by Keynes in 1930 ("Economic Possibilities for our Grandchildren") to counter the economic pessimism so prominent in those years (quoted in Arndt 1978).
[2] Quoted in Tribe, K (1981).
[3] Engels, F (reprinted 1969).

'revolution which altered the whole of bourgeois society; one whose world-historical significance is only now beginning to be recognised.' Rostow (1990) notes that the social value of ideas was reflected even before the industrial revolution by the existence of a patent system in Britain and by the various forms of subsidy and reward for invention offered by the French government in the eighteenth century.

Although long recognised as a crucial element in economic growth, ideas have also been the most difficult element to explain and quantify (Maddison 1991). The theoretical and empirical work associated with the neoclassical growth model, which has framed most conventional thinking on growth in the modern era, evades such problems by assuming that technology is a disembodied and exogenously determined phenomenon whose economic effect can be proxied by the residual from an estimated constant returns Cobb- Douglas production function (see section 7.4.1). As noted by a number of critics, including Stern (1991), Sheehan (1993), Dowrick (1992) and others, since technology is not determined within the model the theory provides no framework for understanding the economic forces and policies that influence the most important source of growth.

Intellectual dissatisfaction with a view of growth that depended so heavily on an exogenous variable led economists in the mid to late 1980s to consider what were the key endogenous variables in modern economic growth and to construct their models accordingly. An important subset of the new literature (termed the 'new growth' or 'endogenous growth' literature) emphasises the growth benefits of technological externalities (or flows of ideas) associated with activities such as investment in physical capital (Romer 1986, Scott 1989), investment in human capital (Lucas 1988, 1993), investment in R&D (Romer 1990, Grossman and Helpman 1991, Aghion and Howitt 1990, Segerstrom 1991) and international trade (Grossman and Helpman 1991, Segerstrom, Anant and Dinopoulous 1990; Romer 1990, Young 1991, Stokey 1991 and Taylor 1992) . Although incorporating technology as a key endogenous variable, many of the new growth models maintain a strong neoclassical flavour through their continued emphasis upon Walrasian styled equilibrium analysis and intertemporal utility maximisation.

In an influential paper Nelson and Winter (1982) distinguished between two levels of economic analysis in theorising about the growth process: formal and appreciative. The former, they note,

> proceeds at some intellectual distance from what is known empirically and where it does directly appeal to data for support it generally appeals to 'stylised facts'...

whilst the latter is driven more by real world observation and attempts to provide causal interpretation of such empirical relationships. They add

> If the hallmark of appreciative theory is story-telling that is close to the empirical nitty-gritty, the hallmark of formal theorising is an abstract structure set up to enable one to explore, find and check, logical connections.

With a strong bent for abstraction, the neoclassical and new growth literature may serve as examples of this formal approach to theorising about growth. The development literature on technology diffusion on the other hand, fits well with a description of an 'appreciative theory' (Fagerberg 1994). According to Romer (1993) people in this area separated from the mainstream when mainstream economics adopted the assumption that technological change was exogenous. Included within this literature are those who focus on the importance of technology in some kind of historical perspective (eg Gerschenkron 1962, Abramovitz 1986, Maddison 1991, David 1991, Mokyr 1990, Landes 1969), those who concentrate on the institutional characteristics of different economies and the role of learning (eg the 'national system of innovation' literature: Lundvall 1992, Nelson 1993, Nelson and Wright 1982) as well as those who focus on a broad range of other trade, industry and development policy issues (eg Lall 1993, Lall and Najmabadi 1995, Pack and Westphal 1986, Dosi 1988, Soete 1985) An important theme to emerge from this diverse and substantial body of literature[4] is the gap between the level of technology in a developing country and that in the advanced countries and the opportunities for technology transfer from the latter to the former. A second important theme is the

[4] Romer (1993) generically terms this literature the *Appreciative Theory of Economic Growth.*

importance of the social absorption capability of the developing country to receive and use those technologies from advanced countries

The approach to be taken in this chapter is to draw, from both sets of literature, five themes about economic growth considered important in the development context. These growth themes will then provide a theoretical basis upon which the discussion of the policies and practice of growth in subsequent chapters can carried out. It must be emphasised that these are not the only important themes that can be found within the theoretical literature and that these themes may be equally important for a number of developed countries as they are for developing countries. However, given that the ultimate objective of this dissertation is to research the use and production of ideas in Indonesia, the context for which much of the theoretical and empirical work is to be carried in the first section is that of a developing country. However, before the themes of growth can be identified and explained it is appropriate to define what exactly is meant by the term 'ideas' and other knowledge and growth related concepts. This will be done within the context of Romer's (1992, 1993) *idea-gap* theory on economic growth, a recent addition to the formal growth literature.

2.2 Idea Gaps in Economic Growth

As noted by Kozul-Wright (1995), Maddison (1991) and others, there is now widespread agreement among economists as to the beneficial effects on productivity growth from the generation and application of new knowledge in production. It should be emphasised however, that economists interested in this knowledge-growth nexus have used a diverse range of methodological routes to arrive at this consensus. Moreover, within the relevant literature there is considerable diversity in approaches used to define important knowledge related concepts such as ideas, technology, innovation, imitation, invention, knowledge spillovers, technical change, technological progress and so on.

Before moving on to survey the various theoretical approaches to knowledge-based growth it is appropriate at this juncture to define a number of the important concepts to be used in this and subsequent chapters (see Table 2.1 below). To this end I refer to two papers by Romer (1992, 1993) where he postulates the so-called *idea-gap* approach to economic growth. It should be noted that this theoretical work does not represent the only conceptual basis upon which the analysis of this and subsequent chapters could be carried out. Rather, it should be considered as one of a number of potential approaches, yet one with some important advantages. *First*, in these articles Romer is able to encapsulate a number of important themes of the modern growth literature, such as nonrival technology, international technology transfer, and human and physical capital accumulation. *Second,* Romer is able to consider these important themes without the complexities as well as the analytical constraints of highly abstract and mathematical analyses typical of formal growth theory. *Third*, and relatedly, with a certain degree of generality and clarity, Romer is able to highlight the critical importance of the generation and application of new knowledge (or the application of existing knowledge to new circumstances) upon economic growth in a development context.

Table 2-1 Standardising Terms and Definitions

Term	Broad Definition
Ideas	Technology, knowhow, instructions to carry out a task, disembodied knowledge (including blueprints, designs etc)
Invention	Producing or developing new ideas
Imitation	Using ideas developed by others
Innovation	The use and production of new ideas and the application of existing ideas to new circumstances
Technological progress &/or technical change	The rate of development and application of new ideas or the rate of application of existing ideas to new circumstances.
Learning	The process of acquiring, understanding and accumulating new ideas (ie embodying new ideas in labour)
Human Capital	The sum of accumulated ideas embodied within labour (ie. accumulated embodied knowledge)
Technological capabilities	The capability to identify, assess, adapt, utilise and develop new ideas

Source: Adapted from Romer (1992, 1993) and other recent growth literature.

Central to Romer's (1992, 1993) analysis is the delineation between two broad categories of economic goods: ideas and objects. He defines ideas as the instructions by which we can produce goods and services of increasing economic value using a finite quantum of resources. Objects, on the other hand, are the finite quantum of resources that can be exhausted in the production process. Thus, a country is said to suffer from an *object gap* when it lacks objects such as roads, machinery, raw materials, skilled personnel and a well functioning legal, taxation or education system. Conversely, when a country lacks the technology to generate value in a modern economy it is said to suffer from an *idea gap*.

The notion of an idea gap, according to Romer (1993), is broadly consistent with what other authors refer to as a *technology gap*. He is cautious, however, about equating ideas with technology, maintaining that the word 'technology' invokes images of manufacturing and noting also that most economic activity takes place outside of factories. Thus he writes

> Ideas include the innumerable insights about packaging, marketing, distribution, inventory control, payments systems, information systems, transactions processing, quality control and worker motivation that are all used in the creation of economic value in a modern economy (1993, p. 544).

Romer's notion of an idea as an economic good is further clarified by making clear the distinction between objects and ideas. In many cases this distinction is intuitively obvious, such as that which can be made between an object in the form of a new piece of machinery and the ideas (or instructions) required to operate it. However, when the object is an intangible like human capital or an organisational system the distinction is not so obvious.

According to Romer (1992, 1993) the key difference between ideas and objects is that all ideas are nonrival goods, whilst objects in most part are rival goods[5]. Ideas are nonrival in the sense that one person's use of an idea does not prevent another's use of

[5] Romer (1992, 1993) does not argue that all nonrival goods are ideas. Air, sunshine, music etc are all nonrival goods that cannot be defined as ideas. He is also careful not to argue that all objects are rival goods. Clearly some objects such as public roads, parks, air, seawater are all nonrival to varying degrees.

the same idea. Developing new or improved ideas is equivalent to incurring a fixed cost. However once the idea has been developed it can be used over and over again at little or no additional cost. Objects on the other hand are more often described as rival goods in that two firms cannot simultaneously use the same piece of machinery or the same skilled labour, or two countries cannot employ the same taxation or monetary systems. However the ideas needed to purchase/build and use new machinery, or to train or employ skilled personnel, or to develop efficient taxation or monetary systems are clearly nonrival as use of these ideas does not prevent others from using the same ideas.

The notion of embodiment features strongly in Romer's distinction between ideas and objects. Ideas are clearly disembodied phenomena which can enhance the productivity of objects such as capital and labour or combinations of capital and labour[6]. However once ideas become embodied in either human or physical capital, the result is a private good which cannot be used readily by others without incurring an opportunity cost. Thus Romer (1992), noting the tendency to incorporate ideas into economic analysis as a form of human capital, emphasises the importance of delineating between these two economic phenomena. The former, as defined above, is the set of instructions we need to produce goods and services of economic value, whilst the latter represents the sum of accumulated embodied ideas. Human capital by this analysis is seen as analogous to physical capital. People are biologically the same as those one hundred years ago, just as the raw materials used to construct today's high technology equipment were the same as that one hundred years ago. The key difference which makes labour and equipment more productive is the degree of sophistication of embodied ideas. Thus ideas should be seen as the critical input in the production of more productive human and physical capital. However human capital in turn is the critical input in the production of better ideas[7].

[6] Improved combinations of capital and labour include organisational innovations and improved management practices such as those outlined by the UN (1992 p. 148).
[7] Clearly, computers and laboratories and other equipment (physical capital) may also be important in the production of new ideas but only when complimented by skilled labour.

According to Romer (1992, 1993) the nonrival nature of ideas generates a number of important implications for economic analyses. The *first* is that mainstream economic theory characterised by the standard assumptions of constant returns to scale, no externalities and all factors being paid their marginal product, by definition is not an appropriate vehicle to explore the economic importance of nonrival goods such as ideas. In an earlier paper, Romer (1990) was able to illustrate formally the difficulties of incorporating nonrival goods into a competitive equilibrium with the following argument.

If $F(N,R)$ represents a firm's production process that depends upon rival inputs R (equipment and labour) and nonrival inputs N (productive ideas), then it follows that $F(N,\pi R) = \pi F(N, R)$, where π is an integer. That is, increasing equipment and labour by the integer π will generate the same amount of output as increasing the number of plants (which use both rival and nonrival inputs) by π because ideas do not require replication. It then follows that $F(\pi N, \pi R) > \pi F(N, R) = F(N, \pi R)$ and F cannot be a constant returns production function. In a model exhibiting constant returns to the rival factors, the incorporation of a productive nonrival input such as ideas ensures the function is homogenous to degree greater than one, ie $F = N^{\alpha}.R^{\beta}$ whereby $\alpha + \beta > 1$.

Romer (1990) notes that a firm with these kinds of production possibilities could not survive as a price taker within a perfectly competitive framework. Euler's theorem would be satisfied if only rival inputs are considered

$$\mathrm{F(R)} = R \cdot \frac{\partial F}{\partial R}$$

whereby under conditions of constant returns to scale, the value of output is just exhausted in factor payments if each factor is paid the value of its marginal product. However with the incorporation of nonrival inputs it follows that

$$F(N, R) < N \cdot \frac{\partial F}{\partial N} + R \cdot \frac{\partial F}{\partial R}$$

If units of output were sold at marginal cost, revenue would just cover interest payments on the capital and wage payments, leaving nothing for research or other technology costs. Thus if the firm in a perfectly competitive neoclassical world were involved in any activities associated with the use and/or production of proprietary technology it would most likely suffer losses.

The *second* important implication of the nonrival nature of ideas emphasised by Romer (1992, 1993) is that ideas are much more difficult to quantify than objects. He notes that investment can be measured by physical capital, human capital measured by schooling and various policy measures represented by the use of proxies. However given their inherently nonrival nature, he emphasises that an idea is as valuable as a market is large. To make this point Romer (1992) writes that the ideas underlying the business activities of US firms *Walmart* and *Microsoft*, two US multinationals that have enjoyed a high degree of success internationally in the 1990s, would be far less valuable were their activities constrained to their respective home states or cities[8].

The *third* implication of the nonrival nature of ideas noted by Romer (1992, 1993), which logically follows from the first two discussed above, is that due to the problems of assimilating ideas, economists tend to focus greater attention on objects as these economic goods can be more easily measured or more easily represented mathematically in models than ideas. Thus most economic analyses to date, argues Romer, exhibits a distinct *object-focus,* whilst ignoring the economic importance of ideas.

[8] Others such as Arrow (1974) and Langlois and Robertson (1996) have also noted that what determines value in an idea would depend upon what one already knows. A compete blueprint outlining in the finest detail a particular product or process technology may be of little economic value to a firm with no accumulated experience or skills in that area. Conversely, to a firm with the requisite capabilities, even the smallest titbit may be of enormous economic importance (Langlois and Robertson 1996). Thus a firm would need to have the capability to be able to assess the economic value of an idea, or even to identify a valuable idea exists and is available in the first instance.

> All too often, economists concerned with the economy as a whole have been willing to treat the economics of ideas as a footnote to the rest of economic analysis - important for understanding some of the details but not something that changes how we think about big policy questions. A neoclassical model with perfect competition and exogenous technological change continues to frame many, if not most, policy discussions of growth and development. Ideas are routinely ignored. (Romer 1992, p. 63-64)

The earlier neoclassical approach, as noted above, was to assume that they are exogenously determined and therefore independent of any other variable in the system. As will be discussed in the next section, a common criticism of this approach is that it is unable to explain where ideas come from and through what mechanisms they can generate economic growth. An alternative to this standard approach is to incorporate ideas as a type of public good (eg Arrow 1962, Romer 1986, Lucas 1988). Such an approach, notes Romer, ignores the fact that ideas are often fully or partially excludable (although completely nonrival) as evidenced by the existence of patents, licenses and other means to protect proprietary technology. Romer also dismisses the possibility of incorporating ideas as purely private goods (eg as embodied in human capital), since in this form they would no longer exhibit their key defining characteristic, i.e. their nonrival nature.

A *fourth* and final implication of the nonrival nature of ideas relates to the possibilities for technology transfer across countries leading to rapid catch-up growth in the less developed countries. This optimistic picture by Romer (1993) is based upon the premise that the richer technologically advanced countries already possess the stock of ideas needed to improve the quality of life in the developing world's population. Developing countries should be able to benefit enormously from these ideas by encouraging foreigners to put them to use in their countries[9]. Conversely, the gains from the dissemination of ideas will not be realised if poor incentive structures and weak institutions prevent the holders of ideas from sharing in the gains that accrue when advanced country ideas are introduced to a developing country. For this reason, notes Romer (1992 p. 65)

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[9] Two examples provided by Romer (1992) where world wide dissemination of advanced country ideas have clearly improved living standards of the poor are the introduction of a vaccine for smallpox which eradicated the disease from all countries on earth, and the simple idea of oral rehydration which has prevented the deaths of millions of children suffering from diarrhoea.

...the logic behind the economics of ideas supports the new development orthodoxy that a policy of openness with a few distortions offers the potential for large gains in poor countries.

Having outlined the major differences between ideas and objects, it is also important to delineate between two different types of ideas: radical and incremental (or what Romer refers to as big and little ideas). *Radical* ideas can dramatically change the way in which things are produced and often lead to the development of entirely new industries or services (Kash 1989, Greene and Hallberg 1995). Examples of this type of innovation include the invention of electricity, penicillin, superconductors, fibre optic cable, the combustion engine and microchip technology. Generating innovations of this calibre tend to be beyond the capability of many developing countries whose technology effort is more geared toward importing, adapting and developing existing ideas from the industrial countries (Kakazu 1990). Moreover, it has been stressed by a number of writers including Rosenburg (1976), De Long (1991) and others that it is the many smaller *incremental* ideas[10], such as those decisions made on the factory floor to slightly improve the production process, which are more important to the growth process than the major innovations.

De Long (1991) for example stresses the continuity of technological development in the sense that it is not single discrete major inventions which drive productivity growth but "a continuous and ongoing process of improvement and adaptation, no one step which is particularly important or noteworthy." He reviews a number of US industry case studies which in large part see technological development driven not so much by the "individual acts of genius as emphasised in general theories or histories of science" but rather by the more gradual and incremental improvements in operation and design. Romer (1992) likewise challenges "conventional wisdom" on the history of science, arguing that it has overlooked the importance of "continuous improvement" in the production process. Rosenburg (1976) adopts a stronger position by discounting many new innovations as being relatively crude and inefficient and

[10]Or what Romer (1992) refers to as the "million of little ideas."

poorly adapted to circumstances where they might eventually be used. He therefore argues that it is not the original innovation which generates economic value but the many subsequent improvements to the technology.

2.3 Some Key Themes in the Theory of Growth

In the previous section ideas were defined and their importance in generating growth was discussed within the theoretical framework provided by Romer's *idea-gap* approach to economic growth. This section explores the treatment of ideas within the wider growth literature, with particular attention directed to the new growth literature. As will be shown, there has been a diversity of approaches used to incorporate (as well as ignore) the role of ideas in growth theory. From this diversity of theoretical approaches emerges five key themes about the role of ideas in growth, as outlined below. Note that the first three are derived from Romer (1990) which were originally used as a basis for his R&D based model of growth. Two further themes are drawn from other literature (both formal and appreciative) to complement Romer's original analysis as a means to consider ideas based growth within a development context.

Theme #1. *In both traditional and new growth and development literature, ideas are generally regarded as an essential element in modern economic growth.*

The microeconomic processes involved in the use and production of ideas, which are clearly emphasised in the contemporary growth and development literature, were also recognised to a certain extent by the Classical economists. In his *Principles of Political Economy,* Ricardo (1830, edition 1971 p. 378) for example remarks

> He...who made the discovery of the machine, or who first usefully applied it, would enjoy an additional advantage, by making greater profits for a time.

In the *Wealth of Nations* Smith (1777, edition 1937) emphasised that objects like raw materials and tools constitute the real wealth of nations, but also notes that these objects would be of little economic value without the knowledge to combine them into more valuable arrangements (Romer 1993). Smith also was able to preface important elements of the contemporary literature, by making clear the distinction between what can be interpreted in modern terms as incremental and radical innovations and by noting that the motivation to innovate was driven in large part by market incentives that accompanied the expansion of the market and the division of labour (Rostow 1990).

It is important not to overstate the emphasis given by the Classical economists to the role of ideas in the growth process. Although writing at a time of major new industrial innovations (such as those in the iron and textile industries as well as the development of the rotary motion steam engine), these writers appear to give little explicit attention to the ideas-growth nexus (Hunt 1979). Given the role of the machine in the industrial revolution, most had a clear preoccupation with the link between capital accumulation and growth[11]. However according to Rostow (1990 p.137) their analyses of capital accumulation, had a tendency to 'obscure the complex interplay of science, invention and innovation' despite the obviously critical role it played in European industrial development at the time.

Whilst the ideas-growth relationship received, at best, marginal treatment during the Classical era, it became virtually irrelevant in the neoclassical era (ie post 1870). The methodological changes brought about by the marginalist revolution in the 1870s meant that economists turned their attention away from growth in favour of issues of efficient pricing and allocation (Pribaim 1983). Central to the methodology employed by economists such as Marshall, Walras, Menger, Clark and their contemporaries was an initial assumption regarding a given quantum of resources. This meant there could be little attention afforded to the important questions of how this quantum was determined and how it could be increased (Spiegal 1971). Economics, in other words, became primarily concerned with the "division of the cake", not the increase in its

[11] See for example the separate subsections titled "Investment and Technology" for each of the Classical economists in Rostow (1990).

size. Thus there was little role for ideas as a determinant of growth, when growth itself was treated as an afterthought.

The state of the world economy in the late 1940s provided the political, social and economic context within which economists could return their attention to growth issues. The recent experiences of depression and war combined to put the attainment of better living standards through economic growth high on the public agenda in both the developed and developing world (Arndt 1978). Politically, both ideological and international rivalry meant that economic growth in the new world order had become a matter of prestige, both for individual nations and for rival economic systems (Arndt 1978). In policy making circles, the general acceptance of Keynesian thinking which characterised the immediate post war years enabled economists to understand much more clearly than before how policy could assist growth (Galbraith 1977, Heilbroner 1980).

In response to this growing awareness of the importance of economic growth, and of the expanded possibilities for policy to promote it, there has been an unprecedented number of formal growth models in the economics literature during the post war period[12]. Leading the charge was the Harrod Domar model of growth, a synthesis of the independent work of two economists, Roy Harrod (1939) and Evsey Domar (1946), which considered the growth effects of three variables over time: the savings rate, s which was assumed to be a simple proportional function of national income; the rate of growth of the labour force, n which was assumed to be constant and exogenously determined; and the assumed fixed capital output ratio, v. The requirement for steady state growth would be a matter of generating the necessary conditions whereby $n = s/v$. Critics of the model note that each of these variables were likely to grow in a sporadic and independent manner, hence the possibility of steady state growth was regarded to be a fortunate and completely unlikely coincidence (see for example Jones 1975; Solow 1956, 1988).

[12] Using the data based upon the bibliographic references to formal growth models 1936-1973 found in Jones (1975) - a well known historical survey of growth literature - Rostow (1990 p. 333) graphically illustrates the dramatic rise of formal growth modelling in the late 1950s/early 1960s and then its subsidence a decade later.

More importantly, the rigid assumption of fixed proportions meant that firms were forever locked in to a predetermined capital-labour ratio. Thus there was no role for new ideas in developing labour-saving or capital-saving techniques. Introducing a flexible capital output ratio v overcomes this problem as well as establishes a stable solution found for $n = s/v$. According to Sheehan (1993) this change in assumption alone is sufficient to define the basic neoclassical growth model of Solow (1956) and Swan (1956), noting also the incorporation of exogenous technology within the model as the key determinant of steady state growth.

The neoclassical model of growth first developed by Solow (1956) and Swan (1956) has come to represent the mainstream approach to both theoretical and empirical work on growth (Dowrick 1992, Brander 1994). According to Plosser (1992) the widespread influence of the model is based upon on a combination of its simplicity and its contribution to the quantification of various factors influencing growth (ie through the growth accounting work of Denison 1967, Solow 1957- see section 7.4.1). Central to the model's predictions about growth (and the role of ideas in generating that growth) are a number of key assumptions which include a production function exhibiting constant returns to scale and diminishing returns to capital, no externalities, perfect competition and exogenously determined labour growth.

An important implication of the assumption of diminishing returns to capital is that both theoretical and empirical work associated with the neoclassical growth model downplays the role of capital in long run growth (Sheehan 1993, Lucas 1988, Solow 1988)[13]. In the standard Solow (1956) model, for example, as capital per worker increases, the marginal productivity of capital declines and with it the scope for further increases in the capital labour ratio. Eventually the economy arrives at a steady state where capital, labour and output grow at the same exogenously determined

[13] See section 7.4.1 for a discussion on how the growth accounting framework downplays the role of capital as a determinant of growth. See also section 4.2.1 for a discussion of another important implication of the assumption of diminishing returns to capital: the prediction of long run convergence in cross-country growth and income level. As will be shown, the lack of evidence of convergence has provided further avenue for criticism of the neoclassical growth model.

growth rate, (ie no growth in per capita income). It is at this point that technology is introduced to be the key determinant of long run per capita growth (Solow 1956, Swan 1956). Empirical work based upon the same neoclassical methodology echoed this approach, finding that a significant part of measured growth was attributed to the so-called *Solow residual* - that part of growth not accounted for by increases in capital and labour - which in this analysis is taken to represent a proxy for technological progress (see section 7.4.1).

Most importantly, the neoclassical growth model is silent on where technological progress comes from and through which mechanisms it affects growth (Sheehan 1993, Plosser 1992, Dowrick 1992). That is, it is assumed to be disembodied and exogenously determined and is therefore independent of any other variable in the economic system, which means there could be no link between investment (in say R&D or human/physical capital) and the injections of new ideas into an economy[14]. It was for this reason, that Dowrick (1993) labelled the neoclassical model as a 'no-growth model' as it provided only a pessimistic prediction of the long run where the only opportunity for growth is the arrival of an exogenous (and therefore unexplained) phenomenon which by definition is not amenable to economic analysis and cannot be influenced by economic policy.

Theme #2 *In much of the more recent growth literature, the production and use of ideas is motivated in large part by market incentives. Hence technical change and innovation is considered to be endogenous.*

Grossman and Helpman (1991) note that early writers on the subject of technological progress saw scientific discoveries as the main driving force behind the development of new innovations. Scientists, rather than profit maximising firms and individuals,

[14] It is important to note that various models introduced ideas into the production process as embodied within new and different capital equipment (eg Phelps 1962, Kaldor and Mirlees 1962). However, even with this established link between investment and ideas, steady state growth in these models remain independent of the rate of capital accumulation. New investment injects new ideas into the model, however any gain is counterbalanced by the increasing rate of obsolescence of older capital, leaving no net change to the steady state growth rate and no link between investment and long run growth.

were seen to be in control of the direction of industrial research and hence technological progress was considered to be beyond the realm of economic analysis. Such a view is in many ways consistent with the standard neoclassical assumption that technological progress is exogenously determined as described above. That is, technological change is not the product of intentional or deliberate actions on behalf of firms to learn new and better process and product technologies as a means to maximise profits, but is determined outside of the economic system and then simply descends upon it like *manna from heaven*[15].

Economists such as Schmookler (1966), Schumpeter (1942) and many of those from within the new growth school share a different view on the determinants of technological progress. Schmookler (1966), using the results of his empirical study of almost a thousand inventions in four industries, challenged the traditional view arguing that the principal stimulating force behind innovation was the perceived economic benefit underlying that innovation. Such a view corresponds with earlier work by Schumpeter (1942), who emphasised the economic returns to investment in innovations and the role entrepreneurs play in generating those investments. His well known phrase 'creative destruction' refers to what he saw as the perpetual change in economic structure arising from the search by entrepreneurs for new goods and new methods of production and the abandonment of activities superseded and rendered unprofitable by the diffusion of the new innovation in order to maximise profits.

As discussed below this emphasis upon the economic incentives to innovate is also at the very core of many of the new growth models, in particular the R&D based models, such as Romer (1990) and Grossman and Helpman (1991), whereby firms can internalise at least part of the economic benefits to innovation. Growth in these models is therefore endogenous in that it is determined by the maximising behaviour of agents operating within the system. However it should be noted that not all models from the new growth literature adopt ideas as the key endogenous variable driving

[15] This aphorism has been commonly used by critics of the neoclassical model to highlight the intellectual weakness of the assumption of exogenous technology. Harcourt (1972) likewise uses this religious imagery when he describes technical change in the neoclassical model as a 'mysterious manifestation of grace'.

growth. Well known exceptions include Barro's (1991) model, where public capital raises the returns to private capital accumulation, the human capital model by Lucas (1988), where there is an externality deriving from the average level of human capital, and the 'big push' model by Murphy, Shleifer and Vishny (1989), where growth is driven by the external demand effects which the production of one industry or firm production has upon the production possibilities of others. Other important exceptions can be found in a group of models where output is expressed as a linear function of a broadly defined concept of capital which combines both human and physical capital and there is no role for knowledge externalities (eg Rebelo 1991, Jones and Manuelli 1990).z

Theme #3 *Due to their nonrival nature, the incorporation of ideas generates increasing returns to scale in a number of New Growth models.*

The seminal paper by Romer (1986) represents the first attempt in the new body of literature to endogenise ideas in the growth process. In this model ideas enter the production function as an externality effect on production driven by knowledge spillovers from capital investment[16]. Private investment activity helps generate a public stock of ideas which other firms can draw upon to enhance their production possibilities. Because firms or individuals can only partially internalise the benefits from the production of ideas through such investment activity, a market equilibrium will result in a sub-optimal investment in knowledge accumulation.

A simple representation of Romer's (1986) model sees the incorporation of knowledge externalities (E) into the aggregate production function $Y = K^{1-\alpha} L^{\alpha} E^{\delta}$ where $\delta + \alpha > 1$, which exhibits increasing returns to scale as represented by the summation of indices to exceed unity. Privately, firms are not aware of the externality

[16] This theme of growth being driven by knowledge spillovers from capital investment is also found throughout much of the recent empirical literature on growth. De Long and Summers (1991, 1993) and De Long (1991,1992) for example propose a "Machinery-Growth Nexus" whereby investment in machinery and equipment generates higher growth due to the diffusion of technology embodied within new capital equipment and the process of learning-by-doing which typically follows the purchase and installation of new machinery and equipment.

benefits from investment and base their investment decisions upon the production function $Y = K^{1-\alpha} L^{\alpha}$, which exhibits constant returns to scale. The outcome remains competitive but is not optimal because, due to the existence of positive externalities in the model, the social returns to investment exceed the private returns. This in turn allows some scope for government policy to generate a welfare improving outcome.

The model by Romer (1986) resembles earlier work by Arrow (1962), Levhari (1966) and Sheshenki (1967) which stress the learning by doing externality effects of production. Both approaches assume that knowledge is, to varying degrees, a public good and that knowledge enters the production function as a separate factor but is itself dependent upon the level of capital investment. The crucial difference, however, is that the Arrow-Levhari-Sheshenki approach maintains the standard neoclassical assumption of diminishing returns to capital. Hence this earlier models only considers the case where $\delta + \alpha < 1$ (ie. non-increasing returns to scale) and in the absence of technological progress, long run growth in these neoclassical models remains primarily a function of the exogenously determined rate of growth of labour.

The externality model by Romer (1986) represents an important development in growth theory. It recognises that ideas are important for growth due to their inherently nonrival qualities which generate technological spillovers, and ultimately increasing returns in the model. Hence the model is able to satisfy both Themes #1 and #3. Theme #2 however, that *technical change arises in large part because people respond to market incentives*, is given inadequate attention in the model. The assumption that ideas are a public good, and therefore nonexcludable means that there is little private benefit to investment in research technology as without restrictions to diffusion, such as patents, no-one would pay for an idea which was freely available to everyone.

A later generation of new growth models (termed the *R&D based models*) are able to overcome this problem to a certain extent by allowing for imperfect competition through the partial excludability of knowledge. This in turn provides producers with added incentives to commit themselves to knowledge creating investment activity. This alternative approach, most closely associated with the work of Romer (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992), is therefore able to incorporate both externalities and imperfect competition as a means to reconcile increasing returns with a competitive market. These models are sometimes referred to as neo-Schumpeterian (eg Romer 1994) due to the fact that technical change requires, to a certain extent, an intentional investment of resources by profit-seeking firms and individuals.

An important feature of the R&D based models vis a vis Romer's (1990) externality model is the identification of a research sector which produces productivity enhancing ideas. Given that technical progress is driven primarily by the activities of this research sector the key endogenous variable therefore becomes the amount of resources which are allocated to this sector[17]. In Romer (1990) and Grossman and Helpman (1991 chapter 3) the research sector is charged with the task of discovering new varieties of products. Grossman and Helpman (1991 chapter 4) and Aghion and Howitt (1992) on the other hand, the firm undertakes research with the intention of improving the quality of existing products. Grossman and Helpman (1991 chapter 11) and Segerstrom (1991) further develop these models through the incorporation of endogenous imitation.

The R&D based model by Romer (1990) is particularly important as it is in this model that he establishes the conceptual basis for his later work on ideas and objects. Like his earlier externality model, Romer emphasises the nonrival nature of ideas as the primary source of growth. Unlike his earlier work however, Romer uses the notion of nonrivalry to make clear the distinction between ideas and rival human capital, where the former is defined as the design or list of instructions necessary to produce a good and the latter represents the integral of training and education embodied within the individual (ie a type of object). It is the nonrival nature of ideas, and the associated increasing returns to scale in the sector that uses them, that generates endogenous

[17]Jones (1995) challenges the assertion made by the R&D based models (eg Romer 1990; Grossman and Helpman 1991; and Aghion and Howitt 1992) that growth rates should be monotonically increasing in the level of resources devoted to R&D. He notes that over the past 40 years there has been a dramatic increase in R&D expenditure, but no commensurate increase in growth rates. In his "semi-endogenous" growth model, growth is driven by the discovery of new ideas, which are themselves a function of the exogenously determined growth rate of the labour force.

growth. The nonrivalry of ideas also suggests there are important gains from trade between two countries of similar endowments (see below).

Whilst ideas are assumed to be entirely nonrival, they are also assumed to be partially excludable. This partial excludability of knowledge provides firms with an incentive to invest in new ideas, thus satisfying Theme #2. However an innovating firm has property rights over the use of the new design in the production of new goods but not over the use of the new design in research. This means knowledge can enter the production process in two ways: the initial research which generates the new design and the knowledge spillovers associated with the new design which enhances the productive capacity of human capital employed in the research sector. This suggests that the innovating firm cannot internalise all benefits of innovation and that there is a role for policy to play in providing the necessary incentives to encourage innovation.

Theme #4. *The existence of idea gaps across countries, suggests that there is enormous opportunity for rapid catch-up growth in the less developed countries by importing and using advanced country ideas.*

As noted earlier, a key theme in the appreciative literature is the technology gap between developed and developing countries, and the opportunities this represents for rapid catch-up growth in the latter. The central idea of the so-called *catch-up hypothesis* - an important element of the appreciative literature associated with the work of Abramovitz (1986), Maddison (1991) and others - is that follower countries can catch up with the advanced industrial countries by making use of the technological advances pioneered by those countries. Thus the marginal returns to the use of those new advances is higher (in terms of higher growth rates) in the developing countries than in the developed countries. The catch-up process, however, is self-limiting in that as the productivity gap between followers and leaders narrows so too does the scope for easy growth generated by the imitation of lead country technology[18]. Thus in its simplest form the hypothesis implies that the more technologically backward a country the greater is the potential for rapid growth. According to Abramovitz (1986), Heitger (1993) and others, the hypothesis provides a plausible explanation for the surge in productivity growth experienced by many relatively low income Western and East Asian countries in the post war period, as these countries were able to bring into production a large backlog of unexploited technology already in use in the United States and/or Japan. However as noted below (theme #5), most writers in this tradition also emphasise that developing countries need to have the necessary technological capabilities as well as the appropriate incentive and institutional structures to facilitate the use of advanced country technologies.

In the formal growth literature there is no clear consensus on the role of international technology transfer in the catch-up or convergence process. Moreover, as shown below, a number of models are defined in such a way as to preclude the very possibility of technology flows and/or different factor endowments across countries. The neoclassical model considers the case of rapid catch-up growth in the poorer countries leading ultimately to cross country convergence in growth and income levels. However driving this process of short run catch-up growth is the higher marginal productivity of capital and not the higher returns from the use of new ideas as is often the case in the appreciative literature. A key assumption of the neoclassical model is that all countries have the same access to, and enjoy the same economic benefits from international flows of ideas (Lall 1993). According to Fagerberg (1994) the following comment by Denison (1967) is typical of the neoclassical view of the role of international flows of ideas in growth:

> Because knowledge is an international commodity, I should expect the contribution of advances of knowledge...to be of about the same size in all the countries...

As noted by Lall (1993) a central feature of the standard neoclassical approach in this regard is that firms the world over are assumed to have full knowledge of all available ideas and have the same capabilities to use those ideas. In this way the transfer and

[18] Which according to Maddison (1991) represents one of the key reasons behind the productivity slowdown in many non-US western countries post-1973.

diffusion of technology is seen as not unlike the purchase and use of a physical product. That is, there are no tacit elements in having to learn to use and adapt those ideas to local conditions and all firms can use ideas with the same degree of efficiency.

Whilst the New Growth models have been heralded by some, including Fischer (1993), Krugman (1990) and Sheehan (1993), for the return of growth theory of some of the 'classic' themes of the development literature (such as technology transfer and diffusion, increasing returns to scale, imperfect competition, physical and human capital accumulation, economies of scale, international trade and the possible need to for a big investment push to break out of a low income low technology equilibrium), others are more cautious about the relevance of the new literature to developing countries. Dowrick (1993) for example writes that

> Most of the theoretical research into endogenous growth stems from the USA where economists tend to construct their models in the framework of a closed economy or where trade is not very significant and where the home country is the world technological leader. The conclusions drawn from such models may well be relevant to the US economy but their conclusions should not be carried over uncritically to [a] small economy...where home grown technology is at the leading edge in at most a few areas. (Dowrick 1993)

Discussed below are three broad approaches to the problem of endogenising growth in an international setting. These approaches have been categorised as per their treatment of the key development concepts of technology transfer and catch-up growth.

1. *Models which assume similar factor endowments across countries.* Included within this category are models where endogenous growth is facilitated through greater economic integration between two or more economies with similar factor endowments. Romer (1990) and Rivera-Batiz and Romer (1991) for example emphasise the benefits of increased international integration due to the non-rival nature of ideas. In both models a research sector is identified which produces productivity enhancing ideas. The nonrivalry of these ideas suggests that there are large dynamic gains from trade between similar economies (ie there is little point for

scientists or engineers in both countries to specialise in the same research area). Other models based upon similar assumptions emphasise the partial excludability of knowledge and the greater opportunities for earning monopoly profits when trade barriers are low (Baldwin 1992, Taylor 1992). In most models of this type there is technology transfer across countries, however the assumption of similar factor endowments, by definition, precludes any possibility of catch up growth (theme #4).

2. *Models that assume that technology flows are national rather than international in scope.* An alternative approach to modelling growth in an international context acknowledges differing income and technology levels across countries but assumes that flows of ideas are national rather than international in scope (eg Siebert 1991; Krugman 1991; Lucas 1988; Stokey 1991; and Young 1991). Such an approach is consistent with observations made by Grossman and Helpman (1994), Porter (1990), Siebert (1991) that high technology industries tend to be clustered in certain areas, such as Silicon valley in the US, due to advantages of improved access to physical, human and technological resources[19].

The idea that knowledge externalities are purely national in scope suggests that there is an important role for history to play in determining the long run comparative advantage of a country. If, for example, a country specialising in high technology manufacturing can internalise the knowledge spillovers associated with this sector, that country should continue to maintain an advantage over other countries specialising in traditional (low technology) manufacturing. In such circumstances Siebert (1991) argues that a country with high technology specialisation may become a "growth pole" in the sense that high technology industries from other advanced industrial nations will be drawn to it. Growth and income levels between developed

[19]Porter (1990) for example found that the close proximity of a number of related and supporting industries was an important determinant of a firm's ability to upgrade and improve itself. This is not only through the improved access to components, machinery and infrastructure but also through the flows of information and ideas that would naturally occur among high technology industries concentrated in a small geographic area. For example, skilled personnel with limited geographic mobility would tend to spread their ideas across the immediate vicinity only. Moreover, as noted by Grossman and Helpman (1994) the close proximity to rival producers would ensure better exposure to latest product and process technologies.

and less developed countries would therefore diverge as the technological lead enjoyed by the more advanced countries should persist overtime.

This conclusion that free trade impedes growth in an open developing economy is also found in a number of other endogenous growth models, such as Lucas (1988), Stokey (1991) and Young (1991), which emphasise the learning by doing effects of international production The general tenor of these models is that those developing countries that have a static comparative advantage in industries in which there are limited opportunities for learning will experience lower growth under free trade conditions. Conversely, the more developed countries which tend to have a comparative advantage in higher technology industries in which opportunities for learning are not yet exhausted will enjoy higher growth under free trade. This argument implies that in a developing country the protection of certain knowledge generating activities - activities that would otherwise not exist under conditions of free trade - could thereby ensure the more rapid technological development of domestic industry. Models of this type therefore allow for catch-up growth. However this catch-up growth is driven by the development of indigenous technological capabilities within protected industries and not by the use of technology transferred from abroad.

3. *Models which emphasise the polarisation between developed and developing economies.* Another approach to the problem of endogenising growth in an international setting gives explicit consideration to the international flows of ideas and the polarisation in economic activities between the developed North and the developing South (eg Grossman and Helpman 1991, Segerstrom, Anant and Dinopolous 1990, Edwards 1992). An important conceptual basis for many of these models is Vernon's (1966) 'product life cycle' thesis which describes the development of new industries and products in the innovative North and their subsequent relocation to the imitative South where production costs are lower. The central focus of these models is to explore the impact of new industries in the South upon innovation and growth in the North. In most cases the factors which determine Southern ability to absorb and use new ideas are assumed to be exogenously

determined parameters. These parameters are typically the critical variables which determine whether a developing country will be able effectively use lead country technology to enjoy catch-up growth or be caught in a low growth poverty trap.

Early attempts to capture this innovative North - imitative South relationship within a trade model include Krugman (1979) and Dollar (1986, 1987). In each case, however, the rates of innovation in the North and the rates of diffusion and imitation in the South are assumed to be exogenous parameters. In the later model by Grossman and Helpman (1991 chapter 11) innovation in the North is endogenised as per their expanding product variety and rising product quality models (chapters 3 and 4 respectively). The ability to effectively imitate Northern products by the South is through the development of local technological capabilities, or what they term 'knowledge capital' which is defined as the 'stock of knowledge useful in assimilating and adapting foreign technologies'. Knowledge capital however is determined by cumulative experience in imitation. Thus history has an important role to play in determining which countries are best placed to use Northern ideas.

A similar model by Segerstrom, Anant and Dinopoulous (1990) has as its central focus the joint effect of differential wage rates across regions, patent lengths and protectionist policies upon the rate of product innovation in the North. Imitation by the South is considered to be occur automatically after patent protection in the North is lifted, and the capacity to imitate Northern ideas is held exogenous. A later model by Grossman and Helpman (1991 chapter 12) considers the case where there are both efficient and inefficient imitators in the South, where efficiency is determined by research activity. However the central focus of this model, like most other models of this type, is the impact of Southern imitation upon Northern innovation, rather than the factors which determine the South's capability to use Northern ideas and the impact that has upon economic growth in the South.

One model which does not necessarily fall into this third category but is primarily concerned with the impact of the international flows of ideas upon developing country growth is that by Edwards (1992). In this model there are two sources of knowledge accumulation (A): 1) a domestic source which stems from local technological improvements; and 2) a foreign source related to the import of ideas from advanced countries. Although the first source of knowledge accumulation is from local sources, it is also directly affected by the gap between the local and world stock of knowledge. The only source of foreign knowledge accumulation is through international trade. Hence the ability to access foreign ideas is determined solely by the degree of openness of the economy.

The overall rate of knowledge accumulation $\frac{\dot{A}}{A}$ is expressed as follows

$$\frac{\dot{A}}{A} = \left\{\alpha + \delta \cdot \left(\frac{W - A}{A}\right)\right\} + \beta\omega$$

where α and δ are exogenously given parameters, W is the stock of appropriable world knowledge, ω is the rate of growth of the world stock of knowledge, and β is a parameter between zero and one that measures the country's ability to absorb foreign ideas, which is assumed to be a negative function of the level of trade distortions in the economy. The term {α + δ(W-A/A)} captures the local sources of knowledge accumulation where α is the exogenously determined local rate of innovation whilst δ(W-A/A) represents the technological catch-up term (ie the more backward a country is the more opportunity there is for rapid technological development). The term βω captures the proportion of available international ideas that is absorbed by the developing country.

The rate of technological improvement of a developing country, according to this model is determined by relative knowledge levels and the degree of trade openness. The model does not consider possible endogenous determinants of α, such as human capital stocks, indigenous R&D and local macro and microeconomic conditions. Nor does it acknowledge the host of non-trade mechanisms by which advanced country ideas can be imported. However, Edward's (1992) model, like others in this third category, provides a mechanism by which developing countries can enjoy rapid catch-up growth fuelled by imported technologies from the developed countries.

Theme #5. *Developing countries can benefit from ideas-based growth, conditional on having the necessary capabilities and incentive structures in place that facilitate the import and use of advanced country ideas. Conversely those developing countries without these requisite conditions may become caught in a low growth poverty trap.*

An important theme which emerges from the above discussion of the formal growth literature is that it fails to fully consider the endogenous factors which determine a developing country's capacity to absorb and use new ideas from the advanced industrial countries. As mentioned earlier, a central theme in much of the appreciative growth literature is the effort and institution building required by the developing country to be able to learn to use advanced country ideas. To be able to apply advanced country technology to new circumstances in the developing country, Pack and Westphal (1986), for example, emphasise the development of certain indigenous capabilities.

> Effort is required in using technological information and accumulating technological knowledge to evaluate and choose technology; to acquire and operate processes and produce products; to manage changes in products, processes and procedures... and to create new technologies. This effort takes the form of investments in technological capability which is the ability to make effective use of technological knowledge (Pack and Westphal 1986)

A number of writers within this tradition also commonly use the terms *social capability* (or *absorptive capability*) to describe the preconditions necessary to being able to use foreign ideas (eg Nihai & Stewart 1987, Oshkawa and Rosovsky 1973, Abramovitz 1986). Oshkawa and Rosovsky (1973) originally coined this term to "designate those factors constituting a country's ability to import or engage in technological or organisational progress." Abramovitz (1991) defines *social capability* to include not only technical competence but also the ability of the existing industrial, commercial, political and financial structures and organisations to adapt to and absorb new ideas.

A related concept is *conditional convergence*[20], a term commonly used in the appreciative literature which refers to the technological catch up process enjoyed by countries with the necessary *social capability*. That is, income levels and growth rates of the follower countries will ultimately converge with the technological leader *conditional* to the follower countries having the necessary social and institutional structures which facilitate the use of lead country technology. Historically, such a notion corresponds well to the development experiences of Japan and Western Europe in the 1950-1973 period. Due to the ravages of the Second World War these countries at the beginning of the period were industrially backward but had a relatively high degree of social capability. They could therefore rapidly imitate and use the methods of production and of commercial organisation that were already in use in the United States (Soete 1985). This notion of conditional convergence could also be extended to describe the recent and rapid development of the East Asian NICs. By developing country standards the Asian NICS have been extremely successful in raising the general domestic level of human capital thereby ensuring the more efficient use and adaptation of lead country technology (Heitger 1993).

Nihai and Stewart (1987), Lall (1992, 1993a, 1993b), Lall and Najmabadi (1995), OECD (1992), Hanna et al (1994) and others have provided a more disaggregated analyses of the important preconditions to being able to acquire and use new technologies. This literature is substantial and emphasises that absorptive capacity has many dimensions. Nevertheless for the sake of simplicity it is possible to aggregate these preconditions into three broad categories. (These categories are discussed in a more complete manner and related directly to the technology development experiences of a number of East Asian countries in chapter 3).

[20] See section 4.2.1 for a discussion of more formal interpretations of the term *conditional convergence,* as found with the new growth literature. As will be shown, the most common interpretation is to assume that there is multiple steady state growth paths and that countries with similar economic circumstances, as determined by key variables such as human and physical capital, would be expected to converge to a steady state. Thus if a developing country is to converge with a developed country on a higher steady state, these key variables must approach developed country levels.

The *first* category emphasises the different channels for acquiring foreign ideas. These channels include various formal and informal means of acquiring both proprietary and non-proprietary forms of technology such as foreign investment, machinery imports, original equipment manufacturing, licensing, acquiring foreign firms, returning nationals and reverse engineering.

The *second* category emphasises human resource capabilities. Included in this category are the efforts to ensure the adequate supply of engineers, technicians, managers and other skilled workers. Education and training are therefore extremely important in improving the capability of the workforce to use new and increasingly more complex technologies as the economy moves into more sophisticated production activities. Another important element in this second category is indigenous R&D. As discussed in the next chapter (section 3.3.2) indigenous R&D can better enable the developing country to incorporate new technologies into its production systems and to strengthen its position when negotiating strategic alliances with TNCs. Also important is the capability to provide a number of technological support services, such as information, metrology, standards and materials testing, as well as more fundamental economic infrastructure such as transportation, communications and utilities.

All other elements of absorptive capacity are often aggregated into a *third* category broadly defined as 'incentives'. Included within this category are a number of factors which may influence the local firm's decision to invest in new technologies, or the foreign firm's decision to relocate production activities to the developing country. These factors include, amongst others, stable macroeconomic conditions, a trade regime oriented toward competing in export markets, the promotion of a competitive domestic economy, the provision of fiscal and financial incentives to carry out R&D and other certain high technology activities, an efficient finance sector which provides sufficient financial resources for investment in new technologies and a well functioning legal system and executive to protect intellectual and other property rights.

As mentioned these preconditions for the use and production of ideas in developing countries are not a central feature of the formal growth literature. Those models that do incorporate knowledge flows from the developed to developing countries tend to assume that the process is automatic or a function of trade flows. Moreover the capabilities to use advanced country ideas is either exogenously determined, or a function of history. One model that is able to capture important elements of the appreciative literature is that by Aziaridis and Drazen (1990), who augment the neoclassical growth model to include technological externalities with a "threshold" property sufficient to produce multiple equilibrium growth paths. These threshold levels are most commonly determined by the quality of labour (i.e. human capital levels). Whenever a country crosses these threshold levels, returns to scale driven by technological externalities rise very rapidly allowing the country to move to a higher steady state growth path. Hence two countries with similar income levels but situated on either side of a threshold due to differing levels of human capital may experience diverging growth. Their analysis in many ways resembles Rostow's (1960) "stages of growth" model in that each threshold level of development implies a different equilibrium growth path. The key implication from their model is that initial conditions lead to large differences in development and that developing countries without the requisite capabilities may be caught in a low growth poverty trap.

2.4 Conclusion

This chapter explores the role of ideas in growth theory. Clearly evident from the discussion is the diversity of ways in which ideas can be incorporated into (or in some cases ignored by) the various theories of growth. Following Nelson and Winter (1982) the diverse range of approaches employed to explore the ideas-growth nexus are aggregated into two major strands of the growth literature: *Formal* and *Appreciative.*

From within these two subsets of the literature emerge five themes of growth, important in both a developed and developing country context:

1. *In both traditional and new growth and development literature, ideas are generally regarded as an essential element in modern economic growth.*
2. *In much of the more recent growth literature, the production and use of ideas is motivated in large part by market incentives, ie technical change and innovation is endogenous.*
3. *Due to their nonrival nature, the incorporation of ideas generates increasing returns to scale in a number of New Growth models.*
4. *The existence of idea gaps across countries, suggests that there is enormous opportunity for rapid catch-up growth in the less developed countries by importing and using advanced country ideas.*
5. *Developing countries can benefit from ideas-based growth, conditional on having the necessary capabilities and incentive structures in place that facilitate the import and use of advanced country ideas. Conversely those developing countries without these requisite conditions may become caught in a low growth poverty trap.*

These five themes of growth can be distilled into a central argument that the production and use of ideas is a crucial element in modern economic growth. The following chapter explores the practice of using and producing ideas to generate growth in a modern setting. This will be done by considering how a number of East Asian countries in recent decades were able to develop dynamic and highly competitive manufacturing capabilities through the process of learning by using and producing ideas.

3. Using and Producing Ideas: Policies and Practice in East Asia

3.1 Introduction

The central conclusion from the previous chapter is that the process of learning through the production and use of ideas is a crucial element in modern growth theory. Drawing from the modern theoretical literature, five major themes of growth were identified which captured key elements of the ideas-driven growth process, relevant to both industrialised and developing countries. To explore both the policies and practice of producing and using ideas in the development context, attention in this chapter will be focussed on the growth experience of the East Asia region over the 1960-90 period.

The rapid growth of the region has been well documented in the development literature. Within East Asia, eight economies have been given particular attention for their rapid rates of development, namely Japan, Hong Kong, Korea (South), Singapore, Taiwan, Indonesia, Malaysia and Thailand. Termed the *High Performing Asian Economies* (HPAEs) by the World Bank, this grouping of countries grew approximately twice as fast as the rest of East Asia and the OECD countries, three times as fast as Latin America and South Asia and twenty five times faster than Sub-Saharan Africa (World Bank 1993a).

Table 3-1 shows that a clear result of the HPAE's robust growth over the period was the dramatic increase in per capita incomes. Singapore for example had an initial per capita income of US $ 1712 in 1960, but after three decades of growth averaging 6.5% per annum, real per capita income had increased to US $ 10, 965 in 1990 (ie a 6.4 fold increase). From Table 3-1 it can be seen that the increase in per capita incomes for the other HPAEs is similarly impressive. For Australia, New Zealand and Philippines, however, the growth in per capita incomes have been significantly lower.

Table 3-1 Regional Growth Performance.

Country	Real GDP per Capita 1960	1990	Avg. Annual Growth (%)	Ratio of per capita income 1990/1960
Japan	3033	14836	5.7	4.9
Hong Kong	2210	14410	6.5	6.5
Singapore	1712	10965	6.5	6.4
Taiwan	1382	8510	6.2	6.2
Malaysia	1397	4904	4.5	3.5
Korea	907	6209	6.7	6.8
Thailand	929	3532	4.8	3.8
Indonesia	625	1942	3.9	3.1
Philippines	1119	1751	1.6	1.5
New Zealand	7920	11540	1.7	1.5
Australia	7879	14304	2.0	1.8

Note: 1) Korea data is for 1989.
2) All data measured in constant 1985 US dollars using purchasing power parities.
Source: Processed data using Summers and Heston PWT 5.5 dataset.

There is already a substantial body of literature within contemporary development economics providing both theoretical and empirical analysis on East Asia's rapid economic development. Within this literature, there are differing explanations of the key determinants of East Asia's success and differing views on what lessons, if any, other country groups such as the OECD and the rest of the developing world should extract from the region's success. Most of the debate has focussed on the relative importance of public policies and market mechanisms (see for example reviews of the literature by Petri 1993; World Bank 1991, 1993a; Leipziger and Thomas 1993, Wade 1990)

However, as noted by Hobday (1994), this debate has given little attention to how firms in East Asia were able both to acquire and to use foreign technologies and to develop indigenous capabilities in order to compete in foreign markets. The objective of this chapter is to focus on this technological dimension of East Asia's success. In line with the broad conclusions drawn from the previous chapter, this chapter will consider how a number of East Asian countries were able to enjoy rapid catch-up growth with the advanced countries by using and producing ideas. Section 3.2 considers the various mechanisms used by these countries to acquire foreign ideas. These include machinery imports, foreign investment, licensing activities, original equipment manufacturing and original design manufacturing, returning nationals and various other less formal mechanisms.

Two important elements of *social capability*, namely technological capabilities and incentives are considered respectively in sections 3.3 and 3.4. The former is represented by the level of education and skills in the workforce as well as the sophistication and relevance of indigenous R&D and technology support activities, whilst the latter is the incentive environment for innovative behaviour in the private sector as determined by competitive conditions (both domestic and international) and fiscal and financial incentives.

It will be proposed that an important element in East Asia's rapid growth over the 1960-90 period has been its strong access to international flows of ideas and its social capability to facilitate their use and development. These themes will be further explored in Chapter 4, using a number of aggregate empirical measures and a large cross-section of developed and developing countries.

Table 3-2 The ANICs - Asian Newly Industrialising Countries

First Tier ANICs	Second Tier ANICs
Korea	Malaysia
Taiwan	Thailand
Singapore	Indonesia
Hong Kong	

The analysis in this chapter will focus primarily on the four 'first tier' Asian NICs (Korea, Taiwan, Hong Kong and Singapore) and to a lesser extent on two of the 'second tier' Asian NICs (Malaysia, and Thailand). These countries have been chosen not simply because of their impressive growth performance over the period but also because of the substantial literature which shows that late-comer firms in these countries were able to exploit various technology and market channels gradually to acquire and develop the skills necessary to compete internationally. The lessons from the successful experiences of industrial technological development in these countries are then applied to Indonesia in subsequent chapters. Along with Indonesia, the six countries listed above will be collectively termed the Asian NICs (thereafter ANICs - see Table 3-2).

3.2 Access to Foreign Ideas

One of the striking features of the technology acquisition process in East Asia is the diversity of approaches employed. In the sample countries listed above, virtually the entire range of mechanisms are used, from original equipment manufacturing and subcontracting arrangements to machinery imports, FDI and licensing as well as a number of less formal means (OECD 1995, 1992; Dahlman 1994, Hobday 1995). However, as noted by Dahlman (1994), how much use is made of each channel depends mainly on the nature of the technology importing economy, in particular, its own technological capability. He finds that small city state-economies (such as Singapore and Hong Kong) and those at earlier stages of industrialisation (Malaysia, Thailand and Indonesia) tend to be dependent upon all forms of acquiring technology, with particular emphasis upon FDI. The more industrialised countries of Korea and Taiwan on the other hand, have relied more on indigenous technologies and acquiring foreign technologies at arms-length (through licensing and OEM/ODM arrangements) whilst de-emphasising FDI (O'Connor 1995, Hobday 1995).

Despite this diversity in approach, there have been two important commonalities in the technology acquisition process across all sample countries:

1. The emphasis upon linkages with foreign transnational companies (thereafter TNCs). At early stages of industrialisation, the relationship between TNCs and local firms has been characterised by a generally hierarchal joint venture arrangement where the local firm is clearly dependent upon its foreign partner for most if not all of its technological needs (Simon 1993). As local firms have developed their own capabilities, they have been able to progressively move into other kinds of production arrangements with TNCs such as licensing, original equipment manufacturing (OEM) and original design manufacturing (ODM), where the technological dependence upon

TNCs is gradually reduced (Hobday 1995). In the more developed East Asian economies, a number of late comer firms are beginning to forge strategic alliances with TNCs, whereby the latecomer firm, by virtue of its technological assets, can negotiate the relationship on a more equal footing (Simon 1993, Ali 1994).

2. The critical importance of the computers and electronics sector as both a channel for technology acquisition and development and as a rapidly growing export industry. Various authors including Wellenius (1993), Miller (1993) and Hobday (1995) have stressed the importance of computers and electronics to industrial technological development. Wellenius (1993) for example, notes that computers and electronics are embedded in most production processes and many consumer and capital goods, and in many cases play an important role in determining industry competitiveness. Moreover, he notes that they are the key enabling technologies in the communications and information revolution that is at the heart of the modern knowledge economy.

Table 3-2 The Importance of Computer and Electronics (C&E) in East Asian Manufactured exports

	Share of Total Manufactured Exports (%)				Avg. Growth in C&E Exports	Avg. Growth in Total Manu. Exports
	1980	1985	1990	1995	1980-95 (%)	1980-95 (%)
Hong Kong	13.9	14.7	17.1	19.7	7.8	5.3
Taiwan	14.2	15.0	22.1	33.0	17.6	11.2
Singapore	19.3	24.5	40.8	57.3	22.6	14.1
Korea	11.7	13.9	24.6	31.0	21.9	14.2
China	0.6	2.1	9.5	14.2	48.4	20.3
Thailand	2.2	2.8	19.0	24.1	38.9	18.3
Malaysia	19.3	27.7	39.8	51.1	24.9	17.1
Indonesia	3.3	2.6	1.1	8.7	23.8	16.0

Note: Computers and Electronic exports are defined as ISIC 3825 + 3832
Percentage figures based on current $ US.
Source: CSES estimates using data from IEDB, ANU.

For East Asia, various authors including Hobday (1995), Simon (1993) and others, report that the computers and electronics sector has provided an important channel whereby latecomer firms could narrow the technological gap between themselves and foreign TNCs. Although beginning modestly with simple assembly operations in the mid 1960s, by the early 1990s a number firms in East Asia were able to design and produce their own products, overtaking traditional market leaders in key areas such as dynamic random access memory (DRAM), semiconductors and computer peripherals (Hobday 1995).

Table 3-3 Channels for Technology Acquisition

Technology Transfer Mechanism	Explanation
Foreign Investment	FDI has in many cases facilitated the transfer of new product or process technologies as well as the introduction of new management and organisational techniques through a variety of channels including the training of host country personnel, a 'demonstration effect' for potential local competitors, the development of backward linkages with local firms, the mobility of personnel from FDI firms to local firms and the establishment of R&D facilities in the host country.
Machinery Investment	Latecomer firms can to a certain extent acquire the technology embodied within new machinery and equipment and also benefit from a 'learning-by-doing' process which typically follows the purchase and installation of new capital equipment.
Original Equipment Manufacturing (OEM) and Own Design Manufacturing (ODM)	Under OEM, the latecomer firm produces to the exact specification of the foreign company. The product is then marketed through the foreign company's distribution channels under its own brand name. All design and technological inputs come from the foreign partner. As local firms develop their technical capabilities they are able to carry out more design work within the general specifications set by the foreign firm. This activity is termed own design manufacture (ODM)
Licensing	Latecomer firms can purchase the right to use certain product or process technologies, either outright or through the payment of fees and royalties. It is generally accepted that licensing requires more technical capability on the part of the local firm than a joint venture arrangement.
Returning Nationals	Latecomer firms can also acquire new technologies from returning nationals from abroad who have either worked in foreign companies or studied in foreign universities or schools.
Acquiring Foreign Firms	Acquiring foreign firms enables the latecomer in East Asia, in some cases, to acquire and learn the key technologies of that foreign firm.
Foreign Consultants	Latecomer firms can acquire important new technologies by hiring foreign consultants, engineers, technicians etc.
Government Programs	Developing countries can acquire new technologies through government-to-government negotiated agreements and through various aid and educational programs.
Reverse Engineering	At early stages of industrial technological development, latecomer firms can acquire key product technology by disassembling imported products and learning first to imitate their composite components and then to produce identical or similar final competitor products
Other informal means	Latecomer firms in East Asia can access new technologies through a variety of other informal means such as the internet; international professional and scientific societies; publications such as books, magazines, newspapers and academic journals, the electronic media and attending international conventions and conferences.

Source: Adapted from Hobday (1994, 1995), Pack and Page (1993), Lall (1996), O'Connor (1995) and various Asian business magazines.

The computer and electronics sector is also significant in that it represents an important area for rapid manufacturing export growth in the region over the 1980-95 period. Computers and electronics now command a large and increasing share of total manufacturing exports for most of the sample countries (table 3-2). Moreover as a share of world trade in computer and electronics exports the eight countries listed in table 3-2 have in aggregate increased their share from 3.4 percent in 1970 to 35.5 percent in 1995 (IEDB data).

Whilst acknowledging the wide range of potential mechanisms that can be used by a developing country to import new productivity enhancing ideas, the approach taken in this chapter is to highlight a number of the important vehicles as summarised in table 3-3. The rest of this second section of the chapter considers in greater detail the various technology transmission vehicles.

3.2.1 Machinery Imports and Investment

Various authors including Lall (1996), Kakazu (1990), Dahlman (1994) and the OECD (1995) note that a key mechanism for acquiring technology in East Asia has been through the import of capital equipment from OECD countries. According to the OECD (1995), World Bank (1993a) and others, East Asia was better placed to use this channel for technology acquisition than most other developing regions due to its strong export performance which helped provide it with the necessary foreign exchange to finance capital good imports.

Strong human resource capabilities has also advantageously placed a number of East Asian countries to use and develop the technologies embodied within capital good imports (OECD 1992, Woronoff 1994, Lall 1996). However, various authors including Nihai and Stewart (1987), Lall (1996) and others, stress that the successful acquisition of such embodied technology requires prior knowledge of the equipment and process, or the educational background to permit self-training in its use. In Korea, for example, firms were able to benefit from a large supply of well educated engineers and technicians and usually insisted on thorough training and skills transfer by foreign capital goods suppliers (O'Conner 1995). Once such capabilities were in place East Asian manufacturers were able to enhance productivity and to improve quality by installing more recent and sophisticated models of machinery (Woronoff 1994). Moreover the development of capabilities to adapt and effectively use new foreign equipment in itself represented a major stimulus to the emergence of capital goods producers, such as the large textile machinery exporters from Hong Kong, Korea and Taiwan (OECD 1992)

The learning process associated with the use of new capital equipment is an important theme in the recent empirical literature on growth. Using a measure of equipment and machinery investment which incorporates both imported and domestically produced capital equipment, De Long and Summers (1991, 1992, 1993) were able to show that the social rates of return to equipment investment, far exceeded the private rates of return[21]. The former, they argue, was driven in large by the learning externalities of equipment investment (ie. the learning associated with acquiring embodied technologies and the learning-by-doing which typically follows the purchase and installation of new capital equipment), whilst the latter represented the productivity improvement for the investing firm associated with the operation of new capital equipment. Using a large cross-section of countries, their empirical analysis also reports a strong positive statistical relationship between equipment investment and productivity growth, with causation from the former to the latter. They conclude that those nations that have prospered are those that have invested heavily in machinery and learnt how to efficiently use machine technology, whilst those nations that have performed badly are those that have exhibited low machinery investment rates.

Table 3-4 uses De Long and Summers (1993) data to provide regional averages for the investment share in GDP across four major developing regions (as defined in table

[21] The social rate of return was estimated using the coefficient on equipment investment from a multivariate growth equation, whilst the private rate of return was determined using a standard neoclassical production function.

4-6). This table shows that, in aggregate, East Asia's[22] commitment to equipment investment was much stronger than that of other developing regions. Consistent with the results of De Long and Summers (1991, 1992, 1993), it can also be seen from Table 3-4 that this region on average grew much more rapidly than other developing regions over the 1960-85 period.

Table 3-4 Equipment Share and Per Capita Income Growth across Developing Regions

	Avg. Equipment Investment Share in GDP 1960-85 (%)	Avg. Real Per Capita GDP Growth 1960-85 (%)
ANICs (East. Asia)	6.6	5.3
Other Asia	2.8	1.8
Latin America	2.6	1.4
Africa	2.0	0.8

Note: For definitions and explanations of data (including sources and country groupings) see tables 4-6, 4-7 and 4-8 in the next chapter.

Important factors contributing to the high rate of equipment investment in East Asia were a number of policy incentives (such as tax, tariff and exchange rate policies) which distorted relative prices in favour of investment goods, and thus allowing more real investment in capital goods (OECD 1992, World Bank 1993a, Bhattarcharya and Page 1993)[23]. In Korea for example, the government used subsidised credit and selective rationing of credit to promote investment in favoured sectors (Amsden 1989). The government in Taiwan likewise actively and selectively promoted machinery investment in certain sectors, but relied more upon fiscal measures (Wade 1990). Similar policies were also employed in Singapore where selected 'pioneer'

[22] As represented by the seven ANICs listed in table 3-2.
[23] Bradford (1987), Bhattarcharya and Page (1993), Pfefferman and Madarassy (1992) and others have shown that prices of investment goods in these economies were low relative to international prices of such goods and, in some cases, to the prices of other goods in their own economies (particularly consumption goods) which is suggestive of a degree of price distortion. Further evidence is found in table 4-7 which provides regional summaries of the relative prices for investment goods over the 1960-90 period. From this table it can be seen that prices in the ANICs were consistently lower those than in Africa and Latin America.

industries could also enjoy certain fiscal incentives to invest in new machinery (O'Connor 1995, Simon 1993).

3.2.2 Foreign Investment

The expected benefits of investment activities of TNCs in developing countries include the transfer and diffusion of new process and product technologies, the introduction of new methods of management and organisational techniques and the training of host country personnel (OECD 1995, UN 1992). In the case of greenfield investments, Krugman (1990) notes that FDI activity may overcome the firstmover cost which had previously prevented the entry of local firms into that industry. For example, a transnational company (TNC) setting up operations in a developing country would bring with it new forms of process and product technology as well as knowledge on how to set up operations (eg the hiring and training of domestic and foreign contractors and the purchasing and installation of capital equipment) as well as how to market and distribute their products or services internationally. Such knowledge cannot be kept entirely proprietary and local firms may be able to benefit from the ability to imitate the actions that worked for the first moving TNC affiliate. Thus the activities of the firstmoving firm may ease the way for subsequent entrants.

Whilst foreign investment by TNCs represents a potentially important mechanism for technology transfer, there is as yet no conclusive evidence that FDI inflows generates a net economic benefit for the host developing country. The UN (1992) and the OECD (1995) for example cite a number of case studies where competition from more productive TNC affiliates had forced out less efficient local firms. Other case studies, however, indicate that competition from foreign affiliates compelled domestic firms to increase productivity by investing in new skills and technologies[24]. In Korea, for example, it was found that joint ventures initially had higher technological capability than local firms but the rate of technological improvement in local firms

[24]See for example Wilmore (1986) and Tambunlertchai and Ramsletter (1991).

was much higher due mainly to their aggressive management strategy to catch up and compete with the joint ventures in both domestic and international markets (Lee and Ramsletter 1987)

As noted by Enos, Lall and Yun (1997), after a period of decline, there was a resurgence of FDI flows in the 1980s, driven by several factors including policy liberalisation, structural adjustment and the opening up of a number of transition economies. As can be seen in Table 3-5 over the course of the 1980s and early 1990s, the economies of East Asia (ie. ANICs plus China) were able to increase their aggregate share in total FDI flows to developing countries from an average 35 percent over the 1980-85 period to 58.2 percent in 1994[25]. Tran and Shujiro (1995) note two important factors contributing to this rapid growth of FDI inflows in these economies, particularly in the second half of the 1980s. The first was the realignment of exchange rates in the mid-1980s which led to substantial outflows of relocation investments from countries such as Japan whose export competitiveness was adversely affected by appreciation in local currency values. The second was the activist policy measures employed by a number of ASEAN governments to promote FDI inflows, such as deregulation measures and fiscal incentives.

FDI represents an important point of divergence in the technology acquisition strategies of the East Asian countries. Korea and, to a lesser extent, Taiwan were relatively closed to FDI compared with the more open approach employed by Hong Kong, Singapore and Malaysia (Dahlman 1994). This is clearly illustrated in table 3-5 which shows accumulated stock of FDI as a proportion of GDP in 1985 ranging from 2 and 5 percent for Korea and Taiwan respectively compared to 27 percent for Malaysia and over 73 percent for Singapore.

[25] Preliminary figures for 1995 show that East Asia's share increased to over 60 percent for that year.

Table 3-5 FDI Flows into East Asia 1980-94 ($ US million)

	1980-85 avg.	1990	1994
Indonesia	227	1093	2109
Malaysia	1058	2333	4348
Singapore	1330	5575	5588
Thailand	264	2444	640
China	718	3847	33787
Korea	98	788	809
Taiwan	185	1330	1375
Hong Kong	542	1728	2000
East Asia	4422	19138	50656
Developing	12634	33735	87024
Total	49831	203812	225660
East Asia's share in			
- Developing Country Inflows	35.0%	56.7%	58.2%
- Total Inflows	8.9%	9.4%	22.4%

Sources: World Investment Report 1992 and 1996

Table 3-6 Accumulated Stocks of FDI as a percentage of GDP in 1985, ANICs.

	Accumulated FDI Share in 1985 (%)
Indonesia	28.6
Singapore	73.6
Malaysia	27.2
Thailand	5
Korea	1.9
Taiwan	4.7
Hong Kong	10.5

Note: as for Table 3-5.

However, these figures to a certain extent downplay the importance of FDI to technological development in some of these countries, particularly at early stages of industrialisation. As noted by Chen (1990) FDI played a critical role in the start up of electronics and computer industries in all sample countries. Even in Korea, a country with an explicit policy to de-emphasise FDI throughout much of the past three decades, FDI played a leading role in the establishment of the consumer electronics and semiconductor industries in the 1960s through the investment activities of TNCs such as Fairchild, Motorola, Sanyo, Toshiba and the Crown Radio Corporation (Lim 1990, Chen 1990). Where smaller or less developed economies such as Malaysia, Singapore and Thailand have continued to emphasise FDI as an important means of technology acquisition, Korea and Taiwan, although initially heavily dependent upon FDI, have given greater emphasis to a number of external means to acquire technologies such as licensing, OEM and other subcontracting arrangements and more recently, through technology sharing deals as part of an increasing number of strategic alliances being forged with foreign TNCs (Hobday 1995, Simon 1993, Dahlman 1994).

Discussed below are a number of key areas where FDI has facilitated technology transfer into East Asia.

1. Through the establishment of backward linkages with local firms. The UN (1992) reports that it is quite common for a host country firm supplying parts, components or services as part of a subcontracting relationship with a TNC affiliate to receive technical assistance from the foreign partner to improve product quality and production processes or to undertake new product development. For example in Malaysia, Intel (a large US semiconductor firm) is reported to have undertaken a major effort over the past few decades in transferring managerial and production knowhow to its various subcontractors and suppliers to help them upgrade quality to meet international standards (Meyanathan and Salleh 1994). Similarly, a study of foreign electronics firms in Malaysia found that domestic subcontractors had to introduce improvements in accounting methods, inventory control and scheduling to be able to meet the needs of foreign customers. In this study, virtually all subcontractors surveyed reported that links with TNCs had helped improve their product and process technologies (OECD 1995).

Mobility of engineers and technicians from the FDI producer to the local subcontractor has likewise been an important channel for technology transfer in East Asia. Hobday (1995), for example, reports that many Taiwanese technicians and engineers gained work experience with the TNCs and then left to set up their own businesses to supply market niches and services, often to their former employers. Tatung, one of Taiwan's most successful electronics firms, initially subcontracted for the TNCs, but then learned to imitate and then to compete with them. Harianto (1995) likewise notes that in Malaysia there have been a number of cases where local engineers have quit the foreign company to join the subcontractors or even to establish new ones. In one case, Motorola (Malaysia) sold one of its activities (which involved an obsolete labour intensive technology) and some of its assets to its engineers, while retaining them as a new subcontractor/supplier.

2. Through the establishment of R&D facilities in the host country. A common theme in the literature is the propensity of TNCs to undertake R&D activities mainly in their respective home countries (eg Dunning 1994, Papanastassiou and Pearce 1994, UN 1992, OECD 1995). The OECD (1995), for example, reports that US manufacturing affiliates abroad have the equivalent of one-third of parent firm employment and sales, whilst their R&D expenditures are 10-12 percent and their R&D employment 15 percent of their parents'. Dunning (1994) likewise finds that research by Japanese TNCs is almost entirely carried out in Japan, as evidenced by the low proportion of US patent rights awarded to foreign Japanese TNC affiliates. More importantly, even when US and Japanese TNCs establish R&D operations abroad they tend to be located solely in other OECD countries (Dunning 1994, Papanastassiou and Pearce 1994)

However, there is limited evidence that TNCs are increasingly using East Asian affiliates to carry out R&D and other technology intensive activities. The UN (1992) for example notes that over the 1980s there was a significant increase in R&D intensive exports for affiliates of American and Japanese TNCs based in Asia. More importantly there have been an increasing number of TNCs setting R&D facilities in the sample East Asian countries. Singapore has made attracting TNCs (in particular their research facilities) as an important element of its national technology plan (*Asian Business* April 1994 and July 1996). Other TNCs to establish R&D facilities in Singapore include Motorola, AT&T Siemens and National Semiconductor. In Taiwan, R&D facilities have been set up by IBM, GTE, Matsushita and Motorola (Simon 1993).

3. Through the provision of firm level training, either directly or indirectly. In an investigation of the technology acquisition process in Korea, Lim (1990) for example emphasises the role of off-the-job training and in-house apprenticeships provided by foreign investors in a number of large intermediate and capital goods industries in the 1960s and early 1970s. O'Connor (1995) describes how Korean importers of capital goods usually insisted on thorough training and skills transfer by foreign (usually Japanese) capital goods suppliers. Yamashita (1996) provides a detailed analysis of the various approaches employed by Japanese TNCs in the recipient nations in East Asia. He notes the major difference between Japanese and US FDI in the region is that Japanese TNCs rely more upon on-the-job training and training in the parent company in Japan, rather than through the use of detailed manuals as typically used by US TNCs. TNCs have also played an indirect role in the promotion of on- and off-the-job training in other parts of East Asia. In Malaysia for example, foreign firms have provided substantial funds for public training institutes, whilst in Singapore, TNCs collaborated with the government to set up a number of training centres within the public training infrastructure (Meyanathan and Salleh 1993, Lall 1996).

3.2.3 Licensing

Firms in East Asia have also been able to purchase the right to certain product or process technologies, either outright or through the payment of fees and royalties (Pack and Page 1993). Licensing, however, requires more technical capacity than joint ventures, where the foreign partner trains the latecomer to manufacture. As developing countries improve their technical capacity, more technology transfer is via licensing and more licensing is to non-affiliated firms (Nihai and Stewart 1987).

As a mechanism for technology transfer, licensing was particularly well exploited by Japan in the 1950s and 1960s as local firms and institutions lacked the resources to effectively carry out R&D (Pack and Page 1993). This strategy for the acquisition of foreign technology was later emulated with similar success by the first tier ANICs. In Hong Kong and Singapore, licensing has largely been carried out between local subsidiaries of TNCs and the parent firm whilst in the more developed economies of Korea and Taiwan, most licensing arrangements have been with independent local firms (Dahlman 1994).

Data on international technology payments (ie. royalties and license fees) are very patchy, which makes it very difficult to construct a complete and accurate picture of trends in transfers between OECD countries and East Asia. Of the two major sources of technology imports, the USA and Japan, data is only available for the former (see Table 3-7).

Table 3-7 US Receipts of Royalties and License Fees 1987-93, Selected Countries and Regions (US $ million).

	1987	1988	1989	1990	1991	1992	1993
Indonesia	5	5	8	11	20	13	18
Malaysia	*	*	2	2	2	7	18
Hong Kong	4	6	7	6	6	11	12
Korea	34	107	167	249	225	220	287
Taiwan	21	46	34	55	57	42	40
Singapore	30	13	8	19	21	20	20
Japan	723	883	897	1028	1219	1268	1392
Asia	936	1185	1248	1465	1638	1705	1932
Asia (excl. Japan)	213	302	351	437	419	437	540
Latin America	64	48	54	59	85	73	NA
Africa	NA	22	24	22	34	27	35
Europe	446	517	530	630	575	637	615

Note: * means less than $500,000.
Source: National Science Board (1996).

From Table 3-7 it can be seen that the Asian region (both including and excluding Japan) has been a major recipient of US technology exports over the 1987-93 period. The differences across the East Asian countries reflect their different approaches to technology acquisition. The figures suggest that licensing has been more extensively used in Korea than in the smaller or less developed ANICs, such as Malaysia, Indonesia and Singapore, where according to Dahlman (1994) foreign investment represents more important mechanism for technology transfer. Nevertheless, without the inclusion of data describing technology exports from Japan, any such conclusions drawn from Table 3-7 must be held as preliminary.

However, various authors including Pack and Page (1993), O'Connor (1995), OECD (1992) and Hobday (1995) have reported that licensing is decreasing as an option for closing technology gaps. This is because the narrower the technology gap becomes between the East Asian firm and the OECD leader, the more reluctant the latter is to allow access to critical technologies that confer on them temporary competitive advantages and innovation rents (OECD 1992, O'Connor 1995). This has been particularly the case in more knowledge intensive sectors such as electronics, chemicals and machinery, where firms perceive royalty payments as an inadequate return for action that may ultimately help competitors (Pack and Page 1993). As a means to overcome their dependency on licensing, East Asian firms (particularly those in the first tier ANICs) have been increasing their local R&D effort, acquiring overseas firms or forming strategic technology partnerships with many leading foreign companies (Hobday 1995, *Asian Business* July 1996)

3.2.4 Original Equipment Manufacturing and Original Design Manufacturing

Another important mechanism for technology transfer in East Asia has been through original equipment manufacturing (OEM) arrangements (Simon 1993, O'Connor 1995, Dahlman 1994). Under OEM a local firm produces a good to the exact specification of the foreign partner. The product is then marketed through the foreign partner's distribution channels under its own brand name. All design and technological inputs come from the foreign partner which can also be involved in the selection and/or provision of equipment and materials as well as the training and selection of local managers, engineers and workers (Hobday 1994, 1995). The motivation behind the foreign country's transfer of (sometimes proprietary) technology through this mechanism is to obtain lower cost products from the Asian supplier (Pack and Page 1993). Thus through OEM, latecomer firms in East Asia were able to share the costs of learning with their more advanced foreign partners or customers.

Confirming the importance of OEM to Korea are a number of studies cited by Hobday (1995) which estimate that in the late 1980s and early 1990s sixty to eighty percent of the country's exports were conducted on an OEM basis. The development of OEM capabilities (and licensing - to which OEM arrangements were often linked) represented an important element of the government's drive to de-emphasise FDI in the 1970s and 1980s (O'Connor 1995). The large *Chaebol* business groups such as Samsung, Hyundai and Anam thrived under OEM subcontracting relationships with foreign TNCs (such as JVC, Sony, Philips and GE), producing a broad range of consumer electronics and computer components and products for the international market.

As in Korea, OEM played a critical role in the continued development of Taiwan's electronics industry beyond the initial start-up phase involving FDI and joint ventures[26]. Local firms, such as ACER and Tatung, were able to imitate the TNCs and grew robustly throughout the 1970s and 1980s acting as OEM suppliers (Hobday 1994). Like Korea, much of the OEM arrangements were in computers and consumer electronics. Recently Taiwanese OEM production has been producing other electronics goods and telecommunications equipment such as modems, optical scanners and local-area-network (LAN) circuit cards and is positioning itself in other

[26] Hobday (1994) reports that in 1989 43 percent of computer related goods were produced on an OEM basis - a lower figure than in Korea due to the higher proportion accounted for by foreign invested companies.

areas such as internet appliances, digital cameras and multimedia gadgets (*Business Week* May 6 1996).

OEM also played an important role in the technology acquisition process in Hong Kong, particularly in the electronics industry (Hobday 1995). In Singapore the contribution of OEM has been far less significant due to the dominance of TNCs in the island-state's industry. In the lower wage countries of Southeast Asia, such as Indonesia, OEM arrangements are particularly common in the textile, garments and footwear industries as well as low end electronics (see Chapter 7). The Philippines also represents an important newcomer as an OEM supplier with a rapidly expanding, albeit small, electronics sector (*Business Week* April 1 1996).

OEM suppliers, particularly those in Korea, Taiwan and Hong Kong, evolved considerably during the course of the 1980s, developing the necessary technical capabilities to manufacture as per their own in-house designs and specifications. Termed ODM (own-design manufacture), East Asian firms are increasingly carrying out some if not all of the process and product design task according to a general layout provided by the TNC or foreign customer. This design work is often carried out as part of a broader strategic partnership which East Asian firms are now developing with their OECD partners (Hobday 1995).

The move from OEM to ODM is a recent phenomenon and is yet to be fully documented in the East Asian economics or development literature. It has been widely discussed in a number of international business magazines[27] - one of which, *Asia Business*, succinctly describes ODM in East Asia as follows:

> Rather than handing over a design and asking for it to be banged together, buyers now tell the supplier what they want the product to do, and then ask the manufacturer to make something that can do those things. Business relationships are evolving into cooperative partnerships with increasing levels of design input from the manufacturer (*Asia Business* January 1995 p. 30).

[27] Other journalistic accounts include *FEER* (31 August 1989 p 50-51), *Business Week* (May 6 1996 p. 24; July 31 1996 p. 36-37).

ODM is an important development in East Asia as it enables the latecomer firm to capture more of the production value added without exposure to the risks associated with marketing and distribution. It also indicates an advanced level of technological competence, particularly in engineering and design. This is usually applied, however, to generating incremental design improvements rather than radical product innovations (Hobday 1995)

3.2.5 Other Channels for the Acquisition of Ideas in East Asia

Whilst larger firms in the region have been able to better exploit formal technology acquisition channels such as licensing, OEM and FDI, smaller firms have had to rely more on copying and reverse engineering (Dahlman 1994). This was particularly the case in Korea and Taiwan (Lim 1990, O'Connor 1994, Hobday 1995). However, these mechanisms for learning have become increasingly more difficult as US and other OECD countries have been tightening restrictions on intellectual property rights (Dahlman 1994).

Another important channel for the transfer of economically important ideas to Asia has been through the large number of returning scientists and engineers to the region, many of whom had been part of the 'brain drain' in the 1960s and 1970s (Simon 1995, Pack and Page 1993, Dahlman 1994, Amsden 1987)[28]. This channel for technology acquisition has been particularly important in the newer, more capital and technology intensive sectors that are protected by patents or licensing agreements and employ specialised non-traded equipment, ie. where technology is kept proprietary (Pack and Page 1993, Pack 1993). Simon (1995) reports that many returning nationals

[28] In the business press there are a large number of personal accounts of nationals from Korea and Taiwan (and sometimes Singapore) being trained or educated in the US then working for a major US electronics firm, usually in a management, engineering or research role, and then finally returning home with their acquired knowledge to set up or join a local electronics firm. See for example reports in *FEER* (15 September 1988 p. 57-59), *Business Week* (31 July 1995 p. 32-37;) *Business Week* (May 6 1996 p. 22-26) and *FEER* (October 10 1996 p. 60-61).

have well established professional networks in the US (or other OECD countries) and can often use these networks to acquire information or even financial capital.

Acquiring foreign firms is another important means for learning in East Asia (Hobday 1994, OECD 1992). Malaysia, for example, was able to secure a channel to acquire important aerospace technologies when state oil company Petronas acquired a 50 percent stake in an Australian light aircraft manufacturing company (*Euromoney* June 1994). More recently, the national car maker Proton purchased the Lotus sports car and design group in Britain as a means to learn advanced automotive technologies (*FEER* December 12 1996). Hobday (1995) surveys a number of Korean firms that have invested in US high technology firms as a means to acquire new technologies[29]. He notes that not all have been successful and many have set up research operations close to US firm research facilities, such as those in Silicon Valley. Samsung Electronics is the Korean company most visibly employing this strategy of acquiring technology. By 1996 this company had established a global R&D network, which included eight research centres, two in the US, two in Japan and one each in Britain, Russia, India and China (*Asiaweek* May 1 1996)

Where necessary East Asian firms have also imported foreign technical assistance as a means to learn new production techniques (O'Connor 1995). This mechanism was particularly important in Korea, where Amsden (1987) notes that local firms could not afford full-time expatriate staff and relied more upon short term independent consultants.

Government fiat or agreement is another important channel for the flow of proprietary technology. As noted by Dunning (1981), governments can transmit technological resources to each other through negotiated agreements and through aid and educational programs, where in many cases the technology transfers are below market prices. Simon (1993) notes that USAID and US military programs played a key role in supplying important manufacturing technologies at the early stages of industrialisation in Korea and Taiwan. The subsequent capabilities developed though

[29]See the table provided on page 70 in Hobday (1995).

these various programs became important for attracting foreign TNCs to use local labour for manufacturing electronics components and consumer items.

3.3 Technological Capability to Use and Produce Ideas

The effective transfer, diffusion and use of ideas requires more than policies to promote access to international flows of ideas. Significant investments and efforts must be made to generate the domestic capabilities to effectively handle, adapt and improve upon foreign ideas (Dosi 1988; Lall 1992, 1993a, 1993b). Lall and Najmabadi (1995) note that different levels of mastery of the same technology commonly observed within and across a number of developing countries is driven in large part by differing levels of capability acquisition. Lall (1993), for example cites the example of a steel mill turning out to be three times as efficient in Korea as it did in Nigeria, despite the fact that the technology and source of technology were the same in both instances.

To be able to apply advanced country technology to new circumstances in the developing country, Pack and Wesphal (1986), Dosi (1988) and others emphasise the development of indigenous technological capability. Throughout this and subsequent chapters, technological capability is broadly defined as the wide variety of knowledge and skills needed to seek, assess, acquire, assimilate, use, adapt, change and create new productivity enhancing ideas. Outlined in this section are two key areas whereby policy can improve technological capabilities - namely in promoting education and training and indigenous R&D and technology support institutions.

3.3.1 Human Capital Accumulation

Human capital accumulation has long been considered an important element in attaining certain development objectives, such as growth, structural change and poverty alleviation (Behrman and Schneider 1992). In the recent growth and development literature strong emphasis has been given to the importance of human capital from both a policy perspective (eg World Bank 1991, 1992, 1993; UNDP 1990), as well as from a more theoretical or academic perspective.

Within this theoretical approach can be found a number of important studies from both the *formal* and *appreciative* growth literature (as defined in the previous chapter). Those from the former typically emphasise the dynamic effects associated with knowledge externalities and increasing returns from investments in human capital accumulation (Lucas 1988, 1993; Romer 1986, 1990; Azariadis and Drazen 1990; Stokey 1991; and Young 1991, 1993), whilst those from the latter typically see education and skills development as critical components of a developing country's capability to enjoy rapid catch-up growth through the use of advanced country technology (Abramovitz 1986, 1991; Oshkawa and Rosovsky 1973; Lall 1992, 1993a, 1993b). Providing empirical support in both instances are a number of regression studies which show that human capital (proxied by either enrolment rates, years of schooling or literacy) represents an important determinant of differences in growth rates across countries (Barro 1991; Barro and Lee 1993a, 1993b; Romer 1989, 1993; Pernia 1993)

In East Asia, the growth and transformation of the systems of education and training accompanied the dramatic changes in the structure and productivity of the region's economies. Over the course of the 1960-90 period both primary and secondary enrolment rates improved dramatically, resulting in much higher education levels (as represented by years of schooling and literacy rates) than that of other developing regions (table 4-9)[30]. Moreover, as noted by the World Bank (1993) rapid economic growth combined with a consistent fiscal commitment to education (as measured by the percentage of GDP devoted to public investment in education) resulting in much higher absolute levels of investment in human capital accumulation than in other developing regions (see also section 4.3). Furthermore, Birdsall and Sabot (1993) write that the rising quality and quantity of East Asian education and training over the

[30] See also the graphs in section 8.4 which illustrate the rapid growth in educational attainment in East Asia.

past three decades has resulted in cognitive skill levels among primary and secondary school students comparable to, if not higher than, those in OECD countries.

However, it is commonly emphasised within the appreciative and the broader development literature, that whilst basic skills (such as literacy and numeracy) are necessary for almost all forms and levels of industrial development, more sophisticated activities associated with advanced levels of industrialisation require greater technological know-how (eg Thee 1994a, Lall and Najmabadi 1995). The key prerequisite for technological improvement at these more advanced stages is the availability of industrial engineers, technicians and other technically trained personnel who can understand, assess and modify or develop imported technologies (Nihai and Stewart 1987). As noted by Lall (1996), OECD (1992), National Science Board (1993b) an important achievement of a number of East Asian countries, in particular Korea, Taiwan and Singapore, has been their ability to rapidly increase their supply of skilled personnel capable of using latest technologies. Table 3-8 shows that the quantity of science and technology manpower in these countries clearly exceeds that recorded by other major developing countries whilst approaching developed country levels.

Whilst most studies commonly emphasise the importance of formal schooling in East Asian growth, it is also important to acknowledge the contribution of firm level training in raising general productivity levels and technological capabilities. The World Bank (1993) for example reviews a number of studies which generally find that firm level training in East Asia enhanced worker productivity by encouraging better use of new technologies and generated social rates of return in excess of 20 percent. Whilst initially focussing on general industrial training to promote good work skills, attitudes and industrial discipline among the mass of relatively unskilled workers in labour intensive manufacturing, training in East Asia has progressively moved into more advanced activities commensurate with the region's economic and technological development, and in a number of the more advanced countries (ie Singapore, Taiwan and Korea) training now emphasises the production of highly specialised professional manpower, especially in IT related industries (Wong 1995).

Table 3-8 Science and Engineering Manpower - Selected Countries

Country	Year	Scientists and Engineers per Million Population Engaged in R&D
Korea	1992	1990
Taiwan	1992	1128
Singapore	1987	1284
Malaysia	1988	326
Thailand	1991	173
Indonesia	1988	181
Nigeria	1987	15
South Africa	1991	319
Mexico	1984	226
Brazil	1985	391
Colombia	1982	39
Argentina	1988	350
Spain	1990	956
United States	1988	3873
Italy	1990	1366
France	1991	2267
Australia	1990	2477

Source: UNESCO Statistical Yearbook 1996.

Various policies and institutions have been employed to promote both on-the-job and off-the-job training in East Asia (Lall 1996, OECD 1992, O'Connor 1995) This has included the establishment of training centres or training activities within research or technology institutes. In Singapore, for example, Lall (1996) notes that the Vocational and Industrial Training Board has developed an integrated training infrastructure which has trained and certified approximately 9 percent of the workforce since being established in 1979. Included in its broad range of activities are a number of training programs and apprenticeships for school leavers and workers, testing and certification of trainees and public candidates and the provision of financial assistance for employers to facilitate employee training (both on- and off-the-job). In Malaysia, Salleh (1992) and Meyanathan and Salleh (1993) describe the activities of the Penang Skills Development Center, a joint public-private venture, which provides training to member companies and also to the entire manufacturing sector, with a clear focus on bridging the gap in Malaysia's current shortfall in high level technical manpower, particularly in microelectronics and IT based activities. In Korea, Simon (1993) notes that various institutes have been charged with the responsibility to train a cadre of scientific, technical and engineering personnel capable of handling complex tasks in a range of priority areas including microelectronics, IT and manufacturing and process technologies. For example the Seoul National University's semiconductor laboratory since 1988 has provided training in advanced microchip technology for employees of private firms (Lall 1996).

The literature also describes a number of fiscal and financial incentives provided by governments to promote firm level training. Meyanathan and Salleh (1992) note that Malaysian firms that sent their employees for training at the PSDC received a 200 percent tax deduction, although this has now been replaced by a training levy for large firms (Lall 1996). In Singapore, Van Elken (1995) reports that as part of the *Pioneer Industries* program the Economic Development Board (EDB) awarded various fiscal incentives to foreign and local firms to encourage their participation in training programs. Still in Singapore, Hobday (1995) notes another important instrument of training policy in the Skills Development Fund, which was set up by the EDB to subsidise 30-70 percent of the costs of training for private firms. In Korea, the government has levied a 5 percent payroll tax on large firms, refundable if they undertook employee training in approved programs (Lall 1996). Whilst this type of taxation incentive is found in a number of East Asian countries, Lall (1996) describes the level set in Korea as exceptionally high, when compared to the 1 percent rate set in most other countries.

3.3.2 R&D and Supporting Institutions

There are two major sources of industrial technology for a developing country: the importation of foreign technology though various means (as outlined in section 3.2) or the development of indigenous R&D capabilities. According to Kakazu (1990) an advantage of imported technologies is that they have been tested and standardised and are therefore relatively risk free and inexpensive. However as noted by the OECD (1992) a continuing dependence upon imported technologies means that the latecomer firm in many cases remains locked into some kind of licensing, subcontracting or OEM arrangement whereby the foreign partner is the primary source of technology inputs. The alternative approach to develop technologies indigenously is a more expensive and risky approach (Kakazu 1990). This is particularly the case at later stages of industrial development as the costs and risks associated with investments in indigenous R&D rise with the sophistication of the technologies reached (Lall 1993a; Hanna, Guy and Arnold 1994).

The national "make" or "buy" decision is clearly a critical policy decision in the technological development of a LDC (Lall 1991). The varied experiences of the Asian NICs show that there are many viable strategic choices for policy in determining the balance between the level of dependence on foreign technology and the development of indigenous technology capacity (Lall and Najmabadi 1995, Dahlman 1994). As noted earlier, Korea and Taiwan have given greater emphasis upon developing advanced indigenous R&D capabilities than Hong Kong, Singapore and Malaysia who have been more reliant upon foreigners for their technology needs (O'Connor 1993, Dahlman 1994). Despite these differences, it is possible to draw from the literature three important themes which highlight the emerging and universal importance of indigenous R&D capacity for countries in the East Asia region.

First, a more developed R&D capacity has enabled firms in East Asia to move away from OEM and into ODM and in doing so, capture a higher share of total value added (Hobday 1995). Moreover, an advanced R&D capacity coupled with marketing and distribution capabilities enables the firm to compete in its own right in international markets with in-house designed and manufactured products[31] (Lall 1993a)

Second, more advanced R&D capabilities better enable East Asian firms to assimilate and diffuse latest foreign technologies and to capture more of the spillover benefits created by the operation of foreign TNCs (Lall 1996, Hobday 1995). Following the

[31] Or Own Brand Manufacture (OBM) as often referred to in the literature.

research of Cohen and Levinthal (1989), Blomstrom (1989), Mansfield and Romes (1980), Mowery (1983) it is now widely accepted that firms which conduct their own R&D are better able to use externally available technologies and that the ease of using and adapting foreign ideas is directly affected by the level of commitment to R&D. The more advanced or complex a new and foreign technology the greater the need for developing indigenous technological capacity to facilitate its exploitation. Likewise, the faster a technology develops, the greater the need for increased effort to keep up with it (Hanna, Guy and Arnold 1995). In this sense indigenous R&D capabilities enable a developing country to effectively plug into the international flows of latest technologies - providing what Rosenburg (1990) refers to as a 'ticket of admission' to an information network

The economic and technological benefits to East Asian firms through their linkages with TNCs is a theme has been emphasised throughout this chapter, and also in the literature on East Asian technological development (eg Hobday 1994, 1995; O'Conner 1995, Simon 1993, 1995). Initially the relationship between East Asian firms and their foreign partners was described as one of technological dependence as firms relied on TNCs and other foreign partners for their technological inputs through various arrangements such as licensing, subcontracting and OEM (Hobday 1995). However as argued by Simon (1993), the emergence of East Asia as a new centre for technical excellence (particularly in electronics), suggests that the old model of a (generally) hierarchal relationship is now replaced by a new one based upon new forms of cooperation, such as those associated with strategic alliances. Hobday (1995) notes that under this new model of cooperation, East Asian firms with established R&D credentials can negotiate strategic partnerships on a more equal footing by using their technological assets to bargain for leading edge technologies and/or access to markets[32].

[32] For example FEER (November 7 1996) reports that a number of major electronics TNCs (such as Compaq, IBM, Hewlett-Packard, Hitachi, Sharp Apple Computer and Dell) have outsourced production to the Taiwanese due not only to lower their lower production costs, but also their technological prowess in the design and production of laptop computers - which are considered significantly more complex to produce than desktop models due largely to their compactness and lack of standardised parts.

Third, as a number of the East Asian firms approach the technological frontier and competition intensifies between these firms and those in the OECD, the latter have sought to tighten their control over those critical technologies that confer on them temporary competitive advantage and innovation rents (O'Connor 1995, Simon 1993, *Asian Business* April 1994)[33]. Japanese electronics firms are reported to have been particularly reluctant about providing advanced technologies to East Asian firms (Simon 1993). Critical component technologies such as ink-jet print heads, laser printer engines, liquid crystal displays (LDCs) and charge coupled devices for use in camcorders have been kept secret by Japanese electronics firms (O'Connor 1995). In response East Asian firms and research institutes have been developing their own technologies, for example Goldstar in Korea is developing its own laser printer engines. The OECD (1992) notes that a number of OECD governments have also been actively restricting access to particular technologies. The US government for example has been restricting access to results from government sponsored R&D and in some cases restricting foreign participation in R&D consortia.

Although East Asian firms are, to varying degrees, still dependent upon foreign sources for their technological needs there is substantial evidence that a number of East Asian countries have developed advanced R&D capabilities. Included below is a brief discussion of R&D activities for a selection of East Asian countries.

Taiwan. According to the National Science Board (1996) the patent activity in the US for Taiwanese innovations over the past decade and a half illustrates the movement towards more R&D based activities in the region. They note that as recently as 1980 patent activity by inventors from Taiwan was mainly in the area of toys and other amusement devices. However by 1993 Taiwan was active in more knowledge intensive areas such as electronics, telecommunications, semiconductors, advanced materials, computer storage and display and other information technologies.

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[33] According to Woo-Hee Park (1991), in Korea the demand for indigenous innovation and diffusion began to increase from the mid-1980s as a response to the heightened technology protectionism of the developed world.

The government plays a critical function in carrying out basic research in Taiwan. According to O'Connor (1995) this reflects the limited capacity of the many small and medium enterprises (which constitute a significant component of the Taiwanese electronics industry) to cross the steep R&D thresholds involved in much 'high-tech' research. The government funded ITRI (Industrial Technology Research Institute) plays a particularly important role in this regard acting as a centralised laboratorium for the many firms that do not have the financial or technical capability to profitably carry out their own R&D. ITRI also plays an important technological support role in the training of local engineers in advanced microelectronics and in the transfer of technology to local firms (Hobday 1995, *Asian Business* April 1994, *FEER* 15 September 1988).

Korea. The National Science Board (1996) likewise identifies Korea as another East Asian country to have rapidly developed advanced R&D capabilities. Like Taiwan, Korean patent activity in the US is mainly in electrical products and electronic component technologies. The 1993 data shows that Korea has been recently focusing its R&D activities in semiconductors, telecommunications, superconductor technologies, optics and advanced materials (National Science Board 1996). Korea has recently received much attention in the business media for its development of fabrication technology of the 256 megabit Dynamic Random Access Memory (DRAM) chips (*Asiaweek* May 1 1996, *Business Korea* November 1995)

In contrast to Taiwan, Korean R&D has been performed mainly by the large *Chaebol* business conglomerates (Simon 1993). Initially Korean R&D activities were dominated by government bodies such as the Korean Institute for Science and Technology (KIST) and the Ministry of Science and Technology (MOST) (O'Connor 1995). However through their linkages with foreign TNCs, companies such as Samsung, Hyundai and Anam were able to develop the necessary technical skills and knowhow to undertake their own innovative activities (Hobday 1995). Driven in part by the rising technological protectionism in the OECD and the desire to reduce their technological dependence upon foreign (particularly Japanese) TNCs, Korean firms were able to dramatically increase their R&D effort during the course of the 1980s resulting in an increase in the R&D share of GDP from less than 1 percent in 1983 to almost 2 percent in 1989 (Lim 1990, Park 1991).

Singapore. Simon (1993) reports that Singapore has significantly less R&D capability than Korea and Taiwan. Rather than channelling public resources into the direct provision of R&D, the Singaporean government has instead focussed on a strategy of creating the necessary conditions conducive to investment in R&D by international high technology firms (O'Connor 1993). This has consisted mainly of large scale investment in scientific and technical education and training as well as a number of fiscal and financial incentives for foreign investors (O'Connor 1995, Hobday 1995, Simon 1993). According to Hobday (1995) this strategy of encouraging the establishment of R&D and other high technology facilities in Singapore has improved local capabilities, but notes that Singaporean industry overall still lacks significant R&D capabilities.

An important theme which emerges from the various surveys and studies of R&D activities carried out in the ANICs has been the strong focus toward the commercial needs of the private sector (OECD 1992, Hobday 1995). This can be highlighted by comparing the R&D activities of the first tiered ANICs with that of other major developing countries such as China, India and Brazil. The OECD (1992) notes that these 'quasi-continental' countries have an established tradition in basic and applied research (particularly in military related fields), but despite their scientific expertise, have been slow to acquire proficiency in the commercial application of new technologies, due in large part to a high degree of concentration of R&D activities in government laboratories and state enterprises, and a relatively narrow focus of such R&D on military related projects.

In the first tiered ANICs, by contrast, the private sector has played a critical role in carrying out R&D (Simon 1993, Hobday 1995). Wherever R&D is performed by government bodies, strong linkages with the private sector help ensure the commercial relevance of their research. Taiwan's R&D institutes, for example, include a number of public bodies with close links to the private sector. Moreover, the engineers and scientists from these institutes have been encouraged to establish their own firms to commercialise the results of their research (OECD 1992). A well known example is the successful semiconductor manufacturer United Microelectronics Corporation (UMC) which was established in 1979 as a private company using ITRI staff and facilities to take over the work of one of ITRI's laboratories, the Electronics Research and Service Organisation (Simon 1993, *FEER* 15 September 1988).

Another important theme from the literature on East Asian R&D has been the role played by technology support and extension institutions to foster the acquisition, development and diffusion of advanced technologies (OECD 1992; Lall 1993a, 1993b; Hanna, Guy and Arnold 1994). Lall (1996) notes that these institutions cover a broad range of activities which would otherwise not be provided to the same extent by the market[34]. These include the training of local engineers and technicians, the development and diffusion of generic technologies, information services on new technologies and assistance with their transfer and diffusion, the provision of science parks and other infrastructure as well as the provision of standards, metrology and quality testing facilities. For the many SMEs in the region, such institutions have been particularly important as they commonly do not possess the technical or financial capabilities to seek, identify, evaluate, negotiate and assimilate new technologies (Hanna, Guy and Arnold 1994).

3.4 Incentives to Use and Produce Ideas

The notion, first formalised by Schumpeter (1942), that innovation and technological progress is driven by economic phenomena plays an integral role in the contemporary growth literature. As emphasised in Chapter 2 (Theme #2), the incorporation of technological progress as an endogenous factor driven by the profit maximising behaviour highlights the importance of economic incentives to the innovation process.

[34] According to Lall (1996) many of these services can be regarded as 'public goods' in that they have large externalities and are therefore difficult to price on market terms. As a result their provision faces market failures which governments need to remedy.

It also provides new theoretical insights into the reasons behind cross-country differences in growth and income levels.

Within the appreciative and broader development literature, there are a number of studies which have given explicit consideration to the facilitating role of incentive structures to the acquisition and development of new ideas (eg Lall and Najmabadi 1995; Lall 1992, 1993, 1996; OECD 1992; Stewart and Nihai 1987). An important theme to emerge from this literature is that the incentive environment can be influenced by a broad range of factors. A number of these factors (such as macroeconomic stability and growth prospects) are clearly obvious determinants and do not require further elucidation here. Other determinants of the incentive structure are discussed below.

3.4.1 Competitive Conditions

According to Lall and Najmabadi (1995), Lall (1993a, 1993b), Industry Commission (1994) and others, the most important incentive to innovate arises from competition, both domestic and foreign. Such competitive pressures compel firms to continually invest in new processes, products or organisational innovations so as to produce cheaper, better quality and more diversified products and services (Industry Commission 1994). Artificial restraints to competition measures can impede the use or development of new technologies, or it may also direct the firm to invest in the wrong kinds of capabilities (Lall and Najmabadi 1995).

In domestic markets competition is determined by a number of factors, including the size of the production sector, its level of development, diversification and concentration and most importantly, government policies on firm entry, exit, expansion, prices, ownership, small-scale industry, state-owned enterprises and so on (Lall 1992, Nihai and Stewart 1987). Lall (1992) notes that most LDCs regulate domestic competition to achieve various policy objectives: to prevent fragmentation or excessive concentration, to promote employment, to protect SMEs and/or SOEs, to restrain inflation etc. Whilst some level of regulation is clearly necessary, high levels of intervention can impede the development of new technological capabilities and generate rents for firms that can manipulate the system to their advantage (Lall and Najmabadi 1995, Lall 1996, World Bank 1989). Moreover, domestic competition may in itself not be enough to stimulate the use and production of new ideas if it takes place in isolation from competition from foreign firms. This is because the average level of technical efficiency within domestic industry can be low and use of new technologies may lag behind world levels (Lall and Najmabadi 1995).

Various authors therefore emphasise the crucial importance of exposure to international competition as a key incentive to acquire and develop new technologies (eg Porter 1990, Lall 1992, 1993; Lall and Najmabadi 1995, Nihai and Stewart 1987). Lall (1996) for example notes that as well as providing further stimuli to cut costs, improve quality and to introduce new products, international competition facilitates technology transfer through the development of important 'feedback' linkages with foreign firms and customers and breeds dynamic managerial attitudes and flexible organisational structures.

A central theme across a broad cross section of the East Asian development literature has been the strong export orientation of the region's manufacturers *vis a vis* manufacturers in other developing regions (eg World Bank 1993, Brown 1993, OECD 1992). This is confirmed by empirical analysis in Chapter 4 (Table 4-7) which shows that the proportion of manufacturing exports in GDP for East Asia was more than four times the same proportion recorded for other developing regions over the 1965-85 period. However as noted by Lall (1993a, 1996), Brown (1993) and others, outward orientation in East Asia has not meant the absence of trade and other policy interventions as a number of countries in the region have combined strong incentives for exporting with a variety of other interventions to protect and stimulate certain industries. These interventions included the selective provision of subsidised credit and tax incentives, protection from tariffs, entry restrictions, import licensing and a host of other government concessions and privileges (World Bank 1993, Brown 1993).

Whilst such interventionist policies to nurture certain 'infant industries' were in no way unique to the East Asia region, various authors including Brown (1993), OECD (1992) and Amsden (1989) stress that it is the effectiveness of such policy measures which sets a number of the ANICs apart from other developing countries, particularly those in Latin America. According to the OECD (1992) governments in the latter have through their various industry interventions, tended to serve the interests of a small number of powerful business groups without extracting any *quid pro quo*. In Latin America for example certain policy measures facilitated 'rent seeking' activities by creating conditions conducive for such behaviour and then by demanding a share of the rents. They note that in many cases such behaviour was detrimental for industrial development as profit maximisation became a function of government privilege and protection rather than external competitive pressures to improve efficiency.

According to Amsden (1989) what distinguishes a number of the ANICs from other developing countries is the determination of the government to extract certain 'performance guarantees' from firms in exchange for policy assistance. In most cases the performance criteria was determined by export performance (Brown 1993, World Bank 1993) [35]. Hence as reported by the OECD (1992) latecomer firms in the region were not left to hide behind protective barriers indefinitely, as was commonly the case in other developing regions, but were able to 'pay back' the government for the special assistance they received by demonstrating their ability to export, which in turn help generate much needed foreign exchange to finance the import of capital and intermediate good imports to provide further impetus for the industrialisation process.

[35] The World Bank (1993) describes an elaborate incentive system in a number of the ANICs including Korea, Taiwan, Singapore, Hong Kong and Malaysia based upon contests between firms. The *rules* of these contests relate to a firms export performance, the *rewards* cover a broad range of assistance measures such as access to credit, tax exemptions, exemptions from import duties and technology import licences and the *referee* is usually a government department or state owned bank. Put simply, those companies that performed well in export markets were identified and additional government assistance provided.

3.4.2 Fiscal and Financial Incentives

Fiscal and Financial incentives represent another important stimulus for R&D and general capability development in East Asia (Lall 1993a; 1996; OECD 1992; Wong 1994, Song 1995, Meyanathan and Salleh 1994). The literature describes a diverse range of relevant policy measures which can be summarised into three broad categories as discussed below.

1. Tax Incentives. Most government's in the region provide some form of fiscal incentive to encourage innovation or to improve technological capabilities. The Malaysian government, for example, has been particularly active in recent years introducing a number of fiscal and financial measures to promote the development of high technology activity. As well as subsidies for capital intensive and high technology projects, a number of companies given 'pioneer' status (which has been redefined to narrowly target high technology investment) can enjoy 5 year corporate tax relief (Montagu-Pollock 1994). In addition, in 1995 the Ministry of Finance designated 21 research institutes whereby private firms would be allowed a 200 percent tax deduction when using their services (Lim Pui Huen 1995). In Singapore, there are similar incentives for those industries granted 'pioneer' status, and all companies can claim the double deduction (200 percent) on R&D expenses. In addition, there is a five year writing-down allowance of 20 percent on capital expenditure on imported technology (eg patent costs) and an investment allowance where firms can claim up to 50 percent of capital expenditure costs on new technology or equipment against tax (NTSB 1991).

2. Grants and Subsidies. Governments in East Asia have often provided grants or subsidies to those firms carrying out R&D or upgrading capabilities (Lall 1996). In Korea, for example, the *Designated R&D Program* over the 1982-93 period, provided R&D funds covering up to 50 percent costs for large firms and up to 80 percent for SMEs, for over 2400 research projects approved by the Ministry of Science and Technology. Moreover, as part of the *Industrial Technology Development Program* initiated in 1987, the Korean government has also funded up to two-thirds of the costs of joint research projects (deemed to be of 'national interest') between private firms and public research institutes (Song 1995). In Singapore, the government has subsidised a number of schemes such as the *Local Industries Upgrading Program* to promote skills and technology transfer from TNCs to local subcontractors (Wong 1995). In Malaysia, the *Industrial Technical Assistance Fund* was set up in 1990 to subsidise product development, quality improvement, feasibility studies and marketing (Meyanathan and Salleh).

3. Technology Financing. Governments in East Asia have also been directly involved in ensuring adequate finance for a number of high technology projects. In Taiwan, for example, the government set up a capital investment fund in the early 1980s which ultimately spawned the development of a number of venture capital firms investing in high technology industries (particularly in information and electronics). In Korea, government collaboration with the *Chaebol* led to the establishment of the Korean Technology Development Corporation, the tasks of which included the development of venture capital funding for technology intensive projects (Lall 1996). Likewise in Singapore, as part of the *Economic Development Assistance Scheme* initiated in 1987, the government has set up a venture capital scheme which invests in high technology projects to encourage the transfer of technology and to foster the local venture capital industry (Wong 1994).

3.5 Conclusion

In this chapter it has been shown that the development experience of a number of East Asian countries provides a clear example how the process of learning through the production and use of ideas can lead to rapid economic growth. This has involved the use of some well defined channels to acquire foreign ideas, as well as the development of the 'social capability' to effectively utilise and develop those ideas. The former includes machinery investment, FDI, licensing and OEM arrangements where linkages with foreign TNCs were critical. The latter has been determined by the efforts toward building domestic technological capabilities (such as improving skill and education levels, and in establishing and improving indigenous R&D and technology support institutes) and in ensuring the correct incentive environment for private sector innovative activities (such as the maintenance of competitive conditions and the provision where necessary of fiscal and financial incentives).

4. Ideas and the Sources of Economic Growth

4.1 Introduction

The analysis undertaken so far on the theory and practice of economic growth suggests that ideas are an important element in a developing country's growth process insofar as the developing country in question has access to international flows of ideas as well as the capabilities and incentive structures to facilitate their use and development.

In the previous chapter it was shown that these key elements played an important role in the recent growth experiences of a number of East Asian countries. Various studies were reviewed which describe how latecomer firms in the region were able to acquire foreign technologies through a variety of mechanisms and to develop the capabilities to compete internationally. The policy context was likewise found to be particularly important in generating the necessary conditions conducive to the acquisition and development of new technologies.

The objective of this chapter is to employ a number of aggregate empirical measures to assess the role of ideas in cross-country growth over the 1960-85 period. Two broad approaches are used to make this assessment. The first is based upon cross-sectional regression work using a sample of 101 developed and developing countries. The second approach uses a similar country sample and a larger range of explanatory variables to explore differences in growth characteristics across regions. For both approaches the results were consistent with the main theoretical proposition drawn from Chapter 2 that the process of learning through the use and production of ideas is critical in modern economic growth.

4.2 Cross Country Regression Analyses

4.2.1 Survey of Recent Literature

Cross country regression analyses represents a relatively new element in the modern growth literature. As noted by Fagerberg (1994), Sala-i-Martin (1996) and others, the recent and rapid growth in multivariate cross country regression analyses[36] was driven on the one hand, by the need to empirically investigate a number of key hypotheses of the modern growth literature and, on the other, by the development of various data sets (such as the Summers and Heston Penn World Table) which allowed for more accurate comparisons of real price, expenditure and GDP levels across a large sample of countries[37].

One of the key issues to be explored in this empirical literature is cross-country convergence; the existence of which is commonly proposed as the main test of validity of the modern theories of economic growth (Sala-i-Martin 1996). Earlier it was noted that the assumption of diminishing returns to capital in the neoclassical growth model suggests that income levels and growth rates across countries should converge over time. Critics of the standard model allege that it fails to explain observed differences in per capita income across countries, and instead posit alternative models of growth which typically emphasise constant or increasing returns to capital and generate diverging income and growth rates.

The differing theoretical approaches to the convergence problem provide a useful framework for classifying and analysing the various cross empirical studies of cross-country growth. Discussed below are three broad approaches which are based upon

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[36] An examination of the bibliography of important review articles by Levine and Renelt (1992) and Fagerberg (1994) shows that there were very few cross country empirical studies on growth produced prior to the mid-1980s.

[37] See Summers and Heston (1991) for a full description of their data set. Complimenting the Summers and Heston Penn World Table are a number of other cross country data sets providing information for a range of other variables including education, trade, political stability, macroeconomic performance, public policy and finance. See for example the data sets made available by the World Bank in relation to a series of articles on growth published in the *Journal of Monetary Economics* November 1993 (eg Fischer 1993, Easterly et al 1993, Barro and Lee 1993, De Long and Summers 1993).

differing theoretical perspectives on the convergence issue. It should be noted that not all studies surveyed displayed an explicit theoretical framework. In many cases, the cross country studies simply chart out the empirical correlations in the data. For these studies the implied theoretical framework was inferred by the type of equation and variables employed.

1. *Unconditional convergence to a common steady state.* In the first approach there is unconditional convergence and countries are approaching a common steady state. Studies of this type tend to include only one independent variable - initial GDP per capita - and are usually limited to a sample of OECD countries. For example, studies by Abramovitz (1979), Singer and Reynolds (1975), Baumol (1986), and Maddison (1979) have all shown that a large part in the differences in OECD growth rates in the post war period can be explained by differences in initial income. Whilst such results have been embraced by a number of authors including Baily and Schultz (1990) as evidence broadly consistent with the neoclassical model's prescription for convergence among countries, others such as De Long (1988) highlight what is commonly known as the *ex post selection bias* in the model; the idea that there may be long run convergence across a sample of today's rich countries (ie the OECD), but it would not hold for the rich countries of the previous century. Another important criticism of this first approach is that convergence does not hold when extended to a wider sample to include developing countries. Romer (1987) and Rebelo (1991) for example emphasised the lack of correlation between initial per capita GDP and the subsequent per capita growth rate for a broad sample of countries of about 100 countries and interpret this finding as evidence against the convergence implications of the neoclassical growth model.

2. *Multiple and diverging steady states.* A second approach discounts any possibility of convergence (both conditional and unconditional) due essentially to the historical circumstances from which the growth process began. This type of approach captures important elements of the history dependent growth models such as those by Krugman (1991), Azariadis and Drazen (1990), Durlauf (1993), Stokey (1991) and Young (1991) where membership of the club of higher growing countries is defined

by reference to the threshold level of a key component variable such as human or physical capital, aggregate demand, and the opportunities for learning or knowledge flows. Empirical studies in this tradition include Durlauf and Johnson (1995), Quah (1996), Azariadis and Drazen (1990), and Galor (1996) who generate results inconsistent with any convergence or conditional convergence hypotheses.

3. *Conditional convergence.* A third approach provides an alternative interpretation of non-convergence result in the large sample studies discussed above, by suggesting that there is more than one steady state around which countries ultimately converge. Within this third category, however, it is possible to identify two alternative interpretations of the convergence issue. The first is to assume that countries that share similar factor endowments will also share similar steady states. Baumol, Blackman and Wolff (1989) for example, using a large sample report that countries with similar educational levels were shown quite consistently to be converging among themselves, though not converging with countries whose educational levels were higher. Other studies which explored this theme of convergence clubs or clusters of similarly endowed countries include Blomstrom et al (1992), Barro (1991) and Levine and Renelt (1992).

A second interpretation is that all countries have their own unique steady state, and the process of convergence refers to the process by which countries approach their respective steady states. Mankiw et al (1992) and Knight et al (1993) provide a theoretical framework for this approach by suggesting that the existence of multiple steady states is consistent with the original Solow-Swan model, as this model predicts convergence to steady state only after controlling for the determinants of this steady state. However, countries are able to change their steady state growth paths by influencing the factors which determine those steady states. The model therefore provides a mechanism for less developed countries to 'catch-up' with more advanced countries.

The present study outlined below is one that is broadly consistent with the third category described above. Following Mankiw et al (1992) the approach is expressed formally as follows.

If y^* is the steady state level of income per capita for a country, and $y(t)$ is the actual value at time t, then the rate of per capita growth is given by

$$\frac{d}{dt}\ln\left(y(t)\right) = \lambda\left[\ln\left(y^*\right) - \ln\left(y(t)\right)\right], \tag{1}$$

that is, per capita growth is determined by the difference in the actual and steady state income levels. λ is an exogenously determined adjustment parameter constant across all countries, and by definition is independent of the determinants of the steady state.

Equation (1) can be integrated and re-arranged to get

$$\ln\left(y(t)\right) = \left(1 - e^{-\lambda t}\right)\ln\left(y^*\right) + e^{-\lambda t}\ln\left(y(0)\right) \tag{2}$$

where $y(0)$ is initial income per capita. Subtracting $\ln y(0)$ from both sides

$$\ln\left(y(t)\right) - \ln\left(y(0)\right) = \left(1 - e^{-\lambda t}\right)\ln\left(y^*\right) - \left(1 - e^{-\lambda t}\right)\ln\left(y(0)\right) \tag{3}$$

and substituting γ for $\left(1 - e^{-\lambda t}\right)$ to get

$$\ln\left(y(t)\right) - \ln\left(y(0)\right) = \gamma\ln\left(y^*\right) - \gamma\ln\left(y(0)\right) \tag{4}$$

shows that the rate of growth in per capita income (as represented by the right hand side of equation (4)) is a function of the determinants of the steady state and the initial level of income. The key question for theory to emerge at this juncture is what are the primary determinants of the steady state y*? With the assumption that λ (the catch-up parameter) is constant across all countries, it is possible to test for potential determinants of y*, and within this framework to estimate values of λ. Discussed below are two alternative approaches to identifying and the estimating the determinants of the steady state

4.2.2 Object Focus Approach

The first approach as typified by Mankiw et al (1992) is to assume that the steady state is primarily a function of key objects, such human capital (HC), physical investment (INV) and population growth (POP).

$$y^* = f(HC, INV, POP) \quad (5)$$

Surveys of the literature by Fagerberg (1994), Levine and Renelt (1992) and Thirlwell and Sana (1994) show that a common approach for many of the cross-country studies is explore a variation of a common theme: that is, a regression of GDP per capita growth against initial income and the 'core variables' in equation (4). These regressions are usually extended to include other variables depending upon the specific research problem to be considered, but typically begin with the standard form

$$YPC = \beta_0 C + \beta_1 GDPY_0 + \beta_2 POP + \beta_3 INV + \beta_4 HC \quad (6)$$

where YPC is income per capita growth, $GDPY_0$ is initial GDP (often expressed in relation to the US economy in 1960, or some other year, and in logs), POP is population or labour supply growth, INV is the investment share in GDP and SEC is human capital proxied by enrolment rates, literacy rates or years of schooling.

In equation (5) the coefficients β_3 and β_4 are typically robust and positive reflecting the importance of physical and human capital accumulation upon growth[38]. The

[38] Various authors have noted that due to the interrelatedness between these two variables (ie. countries tend to invest in both education and physical capital, not one or the other) that the impact of human

coefficient β_2 is usually negative (but often insignificant) reflecting in part the pressures which population growth imposes upon social and economic infrastructure. A negative value for β_1 is often interpreted as the standard finding of conditional convergence[39] driven by the diminishing returns to capital (Romer 1993).

As indicated above, a broad range of other variables are also typically incorporated to extend equation (5), depending on the particular growth relationship to be investigated. These include indicators of macroeconomic performance, such as inflation, budget deficits, external debt, exchange rate distortions and others (eg Fischer 1991, Levine and Renelt, Kormendi and McGuire 1985), the share of government consumption in GDP (Levine and Zervos 1993, Rogers 1995, Barro and Lee 1993), indicators of political stability, such as revolutions, coups, assassinations and riots per year (eg Rogers 1995, Barro 1991, Barro and Lee 1993, Levine and Zervos 1993) and various measures of trade openness (eg Feder 1982, Rogers 1995, 1996; Dowrick 1994, Kormendi and McGuire 1985; Knight, Loavza and Villanueva 1993).

4.2.3 Ideas-Focus Approach

From the above discussion it can be seen that there has been a broad range of factors incorporated within cross country empirical work. However, it has been noted by a number of authors including Fagerberg (1994) and Romer (1993), that few of the cross-country studies have given explicit consideration to the role of invention and innovation (ie the production and use of ideas) in the growth process. This, writes Romer (1993) is in part due to measurement problems.

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capital is sometimes reduced if not lost when physical capital is included (eg Barro 1991, De Long and Summers 1991, Levine and Renelt 1992).

[39] Most authors view the negative sign on the coefficient for initial income as evidence of 'conditional convergence' in the sense that this convergence is conditional to the inclusion of a number of other variables such as those in equation (1). Blomstrom et al (1992) and others have shown that initial income in isolation explains little or no differences in cross country growth (see also regression 1 in table 4-2).

> One problem in evaluating the importance of ideas in economic development is that there is very little statistical evidence that one can collect on the economic role of ideas, especially if one wants to do regressions on the performance of a cross-section of developing countries. We measure investment in physical capital, we measure schooling, and we can measure proxies for various policy measures, so recent cross country regressions have inevitably focussed on these issues (Romer 1993, p. 558).

This second approach, which forms the basis of the present study, is to explore the role of new ideas as a key determinant of steady state growth. Before outlining how this will be done it is useful to consider how other authors have included ideas or ideas-related variables into cross-country growth regressions.

As a proxy for innovative activity various authors have attempted to use patent statistics (eg Fagerberg 1987, 1988; Romer 1989; Verspagen 1991) or the level/change of scientists and engineers employed in R&D (Coe and Helpman 1993). However these studies tend to focus on high income countries, where such statistics represent a more accurate reflection of innovative behaviour. One exception is the study by Verspagen (1991) which uses a 90 country sample (including a large number of developing countries) but the coefficient on the innovation variable, as proxied by patent grants in the USA, is insignificant.

Rather than using direct proxies for innovative behaviour a number of authors have instead considered the various mechanisms or channels for acquiring ideas, such as trade and machinery investment. In the model and empirical study by Edwards (1992), for example, a country's ability to appropriate new ideas internationally depends positively on the degree of trade openness. Similarly, in the study by Knight, Loayza and Villanueva (1993) trade is assumed to influence technical progress in two ways: through technological transfers and through foreign exchange enabling countries to purchase technologically superior capital goods.

As noted in chapter 3, machinery investment is another important mechanism for the transfer of new ideas across countries. For a large cross section of countries, De Long and Summers (1991, 1993) were able to develop a measure of the machinery investment share in GDP which is shown to exhibit a strong correlation with productivity growth. According to their analysis this is due in large part to knowledge spillovers associated with embodied technologies as well as the learning by doing which typically follows the purchase and installation of new capital equipment. Similar themes were also explored by Romer (1993) using the same measure of machinery investment. Rogers (1995, 1996) considers a number of other proxies for the acquisition and diffusion of new ideas. These include the imports of newspapers, periodicals and books; the publication and circulation of newspapers and magazines and the number of students (by discipline) studying overseas. Of these variables only returning overseas students were shown to share a strong and positive relationship with per capita growth.

In the present study, emphasis is given to the various channels for acquiring ideas as well as the capabilities and incentives to use and develop those ideas. It therefore suggests alternative variables as the determinants of the steady state to that found in equation (5) and/or different interpretations of the functions of those variables. Drawing upon the lessons from previous chapters the primary determinants of steady state are identified in the present study as equipment investment (EQ), foreign investment (FDI), manufacturing export activities (MANU) and human capital (HC).

$$y^* = f(\text{EQ}, \text{FDI}, \text{MANU}, \text{HC}) \qquad (7)$$

The first three variables represent important channels for technology transfer as discussed in chapter 3, ie equipment investment carrying embodied channels, FDI introducing new organisational knowhow and product technologies through the activities of foreign TNCs in the host country and the linkages with foreign TNCs developed through licensing, OEM and other subcontracting activities within export manufacturing. The human capital variable is included to represent the capabilities required to use and develop new ideas. As the case for the object-focus approach, the core variables as outlined in equation (7) can be extended to include other elements of the specific growth relationship under consideration.

4.2.4 The Present Study

The primary objective of the present study is to use a number of regressions to highlight the key differences between approaches which emphasise either ideas or objects. The regressions were carried out using a large country sample consisting of 99 countries including 77 developing countries and 22 OECD countries. The samples were also divided into regional groupings as described below in Table 4-5 which enabled regional dummies to be utilised and a regional growth characteristics table to be constructed (see next section)[40].

As discussed in this and earlier chapters, there a broad range of factors influencing both ideas and object based growth. Accordingly, there were large number of variables used as potential regressors on per capita income growth. In the end a set of 10 independent variables were chosen on the basis that they were parsimonious and provided the best fit. Table 4-1 and the discussion below provides a brief explanation of the data, which includes their source and expected relationship with the dependent variable. Where possible the data represented averages over the 1960-85 period. In some cases limited data availability meant that the series had to be averaged over a shorter time period or taken from a single discrete year.

[40] Note that the sample(s) used for the regressions were two countries smaller than that used for the regional growth characteristics tables. Kuwait and Saudi Arabia were excluded from the former due to the unavailability of a number of key data series, including the dependent variable GRPC.

Table 4-1 Variables Used in Regression Analysis

Variables	Explanation and Source
GRPC (dependant variable)	Growth in per capita income, average 1960-85 (Summers and Heston 5.5)
LNREL	Log of GDP 1960 relative to the US (Summers and Heston 5.5)
INV6085	Investment share of GDP, average 1960-85 (Summers and Heston 5.5)
EQINV	Equipment investment share of GDP, average 1960-85 (De Long and Summers 1993 dataset)
S6085	Secondary enrolment rate, average 1960-85 (Barro and Wolf 1994 dataset)
P6085	Primary enrolment rate, average 1960-85 (Barro and Wolf 1994 dataset)
HOS73	Higher education students studying abroad per thousand population in 1973, or nearest year (Unesco Statistical Yearbook)
BMP	Black market premium, (black market exchange rate/ official rate -1) average 1960-85 (Barro and Wolf 1994 dataset)
FDI	Accumulated stocks of FDI as a percentage of GDP 1985 (World Development Report 1992)
MANU	Share of Manufacturing exports of GDP, average 1965-85 (World Bank)

Note: S6085 and P6085 are measured as the ratio of the number os students enrolled to the population of the corresponding age group.

Table 4-3 describes the results of the regressions. Following Blomstrom, Lipsey and Zejan (1992) regression (1) relates the catch up variable (log of GDP 60 relative to the US) individually to per capita income growth. This equation exhibits little or no relation[41] between initial income and per capita growth, suggesting that in the absence of other variables there is little evidence of convergence in the sample.

[41] As evidenced by the low r-squared and F-stats.

Table 4-2

Regression Results

Dependent variable: Average per capita income growth 1960-85 (GRPC)

Description	Absolute Convergence	Object-focus Approach			Ideas-focus Approach		
Equation	1	2	3	4	5	6	7
Constant	0.0252	-0.0217	-0.0318	-0.0291	-0.039	-0.0383	-0.0367
	(6.49)	(-3.46)	(-3.97)	(-3.86)	(-5.15)	(-5.11)	(-5.08)
LNREL	0.0032	-0.0073	-0.0074	-0.0082	-0.0095	-0.0095	-0.0101
	(1.66)	(-3.42)	(-3.53)	(-4.02)	(-4.66)	(-4.69)	(-5.14)
INV		0.1049	0.0917	0.807			
		(4.13)	(3.53)	(3.21)			
EQINV					0.2854	0.2492	0.2227
					(5.09)	(4.27)	(3.89)
S6085		0.0274	0.0201	0.021	0.0166	0.0136	0.0155
		(2.60)	(1.81)	(1.98)	(1.57)	(1.29)	(1.52)
P6085			0.0176	0.0185	0.0281	0.027	0.0277
			(1.94)	(2.12)	(3.57)	(3.61)	(3.71)
HOS73					0.0017	0.0015	0.002
					(1.44)	(1.31)	(1.73)
BMP				-0.0066			-0.0054
				(-3.03)			(-2.71)
FDI					0.013	0.0345	0.012
					(2.06)	(1.92)	(2.03)
MANU						0.0345	0.0277
						(1.92)	(1.58)
R squared	0.027	0.459	0.480	0.527	0.592	0.608	0.637
adj R squared	0.017	0.442	0.458	0.502	0.565	0.578	0.605
n	99	99	99	99	99	99	99
F-stat	2.7	26.9	21.7	20.7	22.2	20.2	19.8

Note: t statistics are in parenthesis.

In contrast, equations (2) to (4) provide evidence of conditional convergence by incorporating other variables into the regression. All three equations could be interpreted to emphasise the importance of objects in growth. By this interpretation, the negative coefficient on LNREL represents the standard finding of conditional convergence, driven by diminishing returns to capital (investment would be more productive in poorer countries). The measure of physical investment, INV and the proxies for human capital S6085 and P6085, predictably share a strong positive association with per capita income growth. The fit of the object focus approach is improved in equation (4) by incorporating a proxy for macroeconomic stability, BMP - a measure of distortion in exchange rates. The overall interpretation of equations (2) to (4) is that poor countries should be able to catch-up growth driven by higher returns to investment, conditional on having the necessary objects (physical and human capital) and stable macroeconomic conditions. However, as Romer (1993) who used similarly specified regressions notes, these equations represent a purely object focused view of growth, with no role for the international transmission of ideas and is therefore consistent with orthodox neoclassical growth theory.

By incorporating a number of different variables into the analysis, equations (5) to (7) illustrate the importance of ideas, as well as the conditions which promote the use of production of ideas, to per capita income growth. Equation (5) introduces three variables which represent different mechanisms for the import of productivity enhancing ideas into a country: EQINV (which substitutes INV) representing new ideas embodied within capital goods, HOS73 representing new ideas imported by returning higher education students and FDI representing new ideas brought in by investing TNCs. All three variables are significant and their introduction improves the overall fit of the equation by about 11 percentage points compared with equation (3). Capability to use these ideas is captured by P6085 and S6085 (respectively primary and secondary enrolment rates), and as expected both of these variables share a strong positive and significant relationship with per capita growth[42].

Equations (6) and (7) also incorporate MANU as a means to explore the impact of manufacturing export activity upon growth. As expected its coefficient is both positive and significant and its inclusion improves overall fit. MANU reduces the influence of EQINV, however collinearity between the two is not sufficiently high to warrant its exclusion (table 4-3). The final equation in Table 4-2 incorporates the proxy for policy distortions. As before the inclusion of this variable improves overall fit of the equation by about 3 percentage points, which suggests that the macroeconomic policy context is important for the learning process associated with the use and production of ideas.

Table 4-3 Correlation Matrix

	LNREL	INV	EQINV	S6085	P6085	HOS73	FDI	BMP	MANU
LNREL	1								
INV	0.5104	1							
EQINV	0.4883	0.8011	1						
S6085	0.7125	0.7849	0.7095	1					
P6085	0.5191	0.6822	0.5007	0.7281	1				
HOS73	0.2063	0.2557	0.2557	0.3126	0.201	1			
FDI	0.2365	-0.0114	0.1294	-0.0436	-0.0381	0.0036	1		
BMP	-0.2216	-0.2419	-0.2982	-0.2105	-0.1566	0.0549	-0.0565	1	
MANU	0.3962	0.527	0.599	0.5477	0.3981	0.2338	0.1352	-0.2741	1

A number of tests were carried out for heteroskedacity using the residuals from equation (7). First the residuals were plotted against EQINV, REL60 and S6085. Secondly a Goldfeld-Quandt test was performed and thirdly, a Bruesch-Pagan LM test was carried regressing the squared residuals against the explanatory variables

[42] However, the impact of S6085 may be diminished to a certain extent through the inclusion of EQINV and MANU as those countries that invest in equipment and undertake manufacturing export activities are also likely to invest in appropriate skills and education.

contained in equation (7). In each case the results were suggestive that there was no apparent pattern in the error terms, and hence the hypothesis of heteroskedasticity was rejected.

Table 4-5 provides an interpretation of results based upon estimated elasticities for equation in both samples. The results are consistent with a number of important themes emphasised in chapters two and three. That is, access to international flows of ideas (through the purchase, installation and use of new machinery and equipment; the return of foreign trained tertiary students; the hosting of foreign investment and the various channels for learning associated with manufacturing export activities such as OEM, subcontracting, licensing and ODM) is an important stimulus to growth given requisite technological capabilities (as represented by primary, secondary and foreign tertiary enrolment rates; as well as equipment , non-equipment and total investment shares) and conducive incentive structures (as represented by a relatively distortion free environment) that facilitate or promote the use and production of ideas. The results are also consistent with the conditional convergence hypothesis that less developed countries can enjoy rapid catch-up growth subject to having the necessary channels for technology transfer as well as the capabilities and incentive structures to bridge the technology gap with the more advanced nations.

Most importantly, the results across the two approaches, suggest that ideas represent an important determinant of the steady state growth, potentially more important than objects. This is evidenced to a certain extent by the stronger fit (higher r-squared) for the former in regards to the latter. Moreover the stronger and more significant coefficient on the catch-up variable suggests that the ideas-focus approach can better capture the growth effects of importing and using advanced country ideas. Whilst it may be possible to improve the object-focus approach by incorporating a number of other object-related variables, the results of the analysis carried out above would, nevertheless, would remain significant as they show that ideas should be held as a key determinant of steady state growth, and not overlooked as is commonly the case in cross-country growth analyses.

Table 4-4 Interpretation of Equation (7)

Variable	Change in independent variable	Change in dep. variable eq (7)
LNREL	a 1% rise in GDP 1960 relative to the US GDP 1960	0.51% fall
EQINV	a 1% rise in the equipment investment share 1960-85	0.39% rise
S6085	a 1% rise in the secondary enrolment rate 1960-85	0.26% rise
P6085	a 1% rise in the primary enrolment rate 1960-85	1.00% rise
HOS73	an additional 1 student studying abroad in higher education per 100 population in 1973	0.60% rise
BMP	a 1% rise in the black market exchange premium	0.09% fall
FDI	a 1% rise in the accumulated FDI share of GDP 1985	0.07% rise
MANU	a 1% rise in the manufacturing export share of GDP 1960-85	0.10% rise

There are a number of important caveats to the use of cross country regression analyses as a means to investigate the empirical linkages between long run growth and policy. Firstly as Levine and Renelt (1992) argue, much of the empirical work to date has in each case considered only a small number of explanatory variables when attempting to investigate the empirical linkages between long run growth and policy. In an earlier review paper Levine and Renelt (1991) found that in some growth regressions up to 50 variables were significantly correlated with growth which they argue generates uncertainty about how much weight should be put on any one study.

Another difficulty confronting this type of cross-country regression analysis relates more to how the variables on the right hand side are combined rather than their individual inclusion. Levine and Renelt (1992) and Levine and Zervos (1993) found that in many growth regressions small changes in the right hand side variables can produce completely different conclusions about the nature of the relationship between long run growth and the particular variable in question. Based on the work of Leamer (1983), both studies used extreme bounds analysis (EBA)[43] to evaluate the

[43] In both cases a linear ordinary-least-squares regression framework is employed

$$GYP = \alpha \mathbf{I} + \beta \mathbf{M} + \delta \mathbf{Z} + \varepsilon$$

where GYP is the average growth rate (1960-89) in GDP per capita, **I** is the set of base variables always present within the regression whilst **Z** is the set of up to three policy variables chosen from a pool of seven. **M** is the particular variable to be partially correlated with growth. According to Levine "believability" of cross-country growth regressions. Their general conclusion was that although there are several variables that appear to be positively related to long run growth, the relationship between growth and almost every other macroeconomic indicator other than investment is at best fragile. This is further complicated by the fact that many of the variables employed are not truly exogenous with respect to each other which makes it extremely difficult to tie down the channels and direction of influence or to determine which growth variables matter the most. Other concerns about cross-country regression work relates to the reliability of developing country data (Levine and Zervos 1993) and the practice of lumping together vastly different countries into the same growth regression.

4.3 Regional Growth Characteristics

Given the problems and limitations of cross-country regression analysis briefly outlined above, it is important to consider alternative means to investigate cross country determinants of growth. One approach explored below is to construct a regional growth characteristics table. This approach is a useful compliment to the above regression analyses as it enables the inclusion of a number of potentially important explanatory variables that could not be incorporated into the final equations described in the previous section. For example, macroeconomic stability is an important factor influencing the access, capabilities and incentives to use and produce ideas. However the various indicators of macroeconomic stability, such as inflation rates as well as budget and current account deficits were excluded from the final regressions as they lacked significance and did not improve the overall fit of the model.

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and Zervos (1993) EBA involves substituting in various **Z** variables in order to determine whether β (the coefficient on the policy indicator **M**) remains significant and of the same sign when the right hand side variables change. If this is the case then the result is known as "robust", if not it is labelled "fragile". The key to this type of analysis is to determine which are the most appropriate **I** and **Z** variables to include in the regression. Levine and Zervos (1993) differ slightly to Levine and Renelt (1992) in the way they specify their EBA regression. However they arrive at a similar conclusion that it is difficult to find robust partial correlations between individual growth variables and long run growth.

A one hundred and one country sample is used to construct the various tables and figures of regional growth characteristics. The sample is divided five ways into regional groupings:

1. Africa (33)
2. Latin/Central America and the Carribean (23)
3. Asia - excluding the seven Asian NICs and Japan(16)
4. the OECD (22)
5. the Asian NICs - ANICs (Hong Kong, Indonesia, Korea, Malaysia, Singapore, Taiwan and Thailand)

The numbers in brackets indicate the number of countries in each regional grouping. The five groups and their respective composite countries are listed in Table 4-6. Note that the Asia (non-HPAE) grouping includes mainly countries from central and west Asia as well as Cyprus, Papua New Guinea and the Philippines.

The principle source of the data is the 138 country dataset provided by Barro and Lee (1994). Other data sources include Summers and Heston Penn World Table version 5.5, Barro and Wolf 1989, various editions of the World Development Report, the De Long and Summers (1993) dataset, the Fischer (1993) dataset, the Easterly etal. (1993) dataset, the Barro and Lee (1992) dataset, various editions of the UNESCO Statistical Yearbook, the World Investment Report (1992, 1996). Data is not available for every series for all years and across all countries. Those countries with missing data for a large number of variables have been excluded. Some of the series have few if no missing variables. For example, Gpop (population growth) has no missing variables and GRPC (average growth in per capita income 1960-85) has two missing variables. Other series such as the publications, newspaper circulation, book imports and inflation data have a large number of missing variables.

Table 4-7 presents data on a number of investment, population and growth variables for the five regions and the ANICs individually. Average per capita growth and growth per employee has been two to three times higher for the ANICs than that for the other developing regions (see also Figure 4-1a). The first tiered ANICs (Hong Kong, Singapore, Taiwan and Korea) have grown the most rapidly over the sample period(s), averaging approximately 6 percent per annum. Population growth has been consistent across the developing regions, whilst labour force growth was slightly higher in the ANICs. The relative price of investment goods was similar across all regions in 1960 but in 1970 and 1980 was much lower in Asia than in Africa. The investment share was also low across the four developing regions in the 1960s, however by the 1980s the investment share in the ANICs was considerably larger than the three other developing regions, and just exceeding the investment share in the OECD.

Table 4-8 and Figures 4-1b to 4-1f summarises regional data representing some of the channels for the acquisition of foreign ideas. Machinery investment was particularly high in the ANICs, approximately 2-3 three times that of the other developing regions. Trade openness as measured by the ratio of exports and imports to GDP has been fairly consistent across the developing regions, however the manufacturing exports share was significantly higher in the ANICs than the other regions. This is consistent with the observation that an important part of the technology acquisition and development process in East Asia were a number of manufacturing activities such as OEM, subcontracting, licensing and ODM. FDI, another important mechanism for the transfer of foreign technology, commanded a far greater share of GDP in the ANICs than the other developing regions. This high FDI share was driven in large part by the high values recorded for Singapore, and to a lesser extent, Malaysia, Indonesia and Hong Kong. As expected the FDI shares for Korea and Taiwan in 1985 were relatively low. Other evidence that the ANICs were more open to foreign ideas can be found in the larger circulation and distribution figures of foreign publications as well as the greater proportion of tertiary students studying abroad in the 1970s and early 1980s.

The data summarised in Table 4-9 and Figure 4-2 illustrates the ANIC's strong commitment human capital accumulation. This can be seen in the consistently higher enrolment ratios (both primary and secondary) recorded for the ANICs group vis a vis other regional groupings. Thailand and Indonesia were particularly impressive in raising primary enrolment rates over the 1960-80 period, but significantly lagged other ANICs in improving secondary enrolment ratios which in 1980 were less than the averages for the Latin American and Asia (non-ANIC) groupings.

Interestingly, the ANICs (as a region) in 1960 did not display the highest human capital levels of the four developing regions. In that year Latin America on average displayed higher literacy levels and higher average schooling years than the other developing country groups. However, the ANICs greater commitment to education as indicated by consistently higher enrolment rates throughout the following decades resulting in higher literacy rates in 1990 as well as higher average schooling years (in the total population over the age 25) in 1985 vis a vis the three other developing regions.

Table 4-9 also indicates that the ANICs group committed less government expenditure as a proportion of GDP to education than the four other regions. However, rapid economic growth enabled the ANICs to dramatically increase the absolute level of per capita expenditure available for investments in education. For example, over the 1960-85 period the average growth in per capita income was 5.25 percent in ANICs, compared with 0.79 percent in Africa, 1.43 percent in Latin America, 1.81 percent in non-ANIC Asia and 3 percent in the OECD (Table 4-9). This implies that over the 1960-85 period a constant share of GDP allocated to education would have more than doubled (a 2.3 fold increase) the financial resources to education in the ANICs, much higher than in Africa (1.19), Latin America (1.35), non-ANIC Asia (1.45) and the OECD (1.75).

In the previous chapter it was shown that there are a number of important mechanisms for ensuring an incentive system conducive for technology acquisition and development. Two important elements of the incentive structure for which cross country data is available are macroeconomic and political conditions. From Table 4-10 and Figure 4-3 it can be seen that the macroeconomic and political conditions were more stable in the ANICs than in the other developing regions. Inflation rates, for example, were not only much lower in the ANICs but also significantly less variable than in the other regions. The relatively low BMP values for the ANICs suggest these countries pursued more realistic exchange rates than those countries in the other developing regions. Current account deficits in 1980 were significantly lower in the ANICs, driven mainly by the strong trade performance of the first tier ANICs. Accumulated debt in 1985 was lower in the ANICs than Africa and Latin America, however the figure for the ANICs could be potentially much lower if data for Hong Kong, Singapore and Taiwan were included. In 1980 budget deficits were also significantly lower in the ANICs than in the other regions. In regards to political conditions, the ANICs had considerably less revolutions and coups, assassinations, riots and strikes. Although the data described cannot capture a number of important elements of the incentive system for innovation, the available results are nevertheless suggestive that East Asia, in relation to other regions, had a better policy environment to encourage investment in the production and use of ideas.

4.4 Conclusion

The results of the empirical work carried out in this chapter, and of the survey of East Asia's development experience in the previous chapter, are consistent with the central theoretical proposition drawn from Chapter 2 that the process of learning through the use and production of ideas is an essential element in modern economic growth. In this chapter (section 4.2), various proxy variables were used in the regression analysis to represent some of the channels for technology acquisition and capability development which were discussed in preceding chapters. The strength and significance of these variables and the overall fit of the model suggest that ideas represent a strong and important determinant of steady state growth, potentially more influential than objects. Also in this chapter (section 6.3), a broader and more diverse range of variable were used to investigate cross-regional growth characteristics, focussing on the measures of openness to foreign ideas as well as the social capability to utilise and develop those ideas. The results from this analysis support the theoretical proposition state above, as the regions (and countries) with higher growth over the period were also relatively open to international flows of ideas and had the capabilities and incentives to promote their use and development.

In the first section of this thesis (Chapters 2-4), it has been established that, in both the theory and practice of growth, the use and production of ideas are critical. Drawing from this analysis a number of key themes and findings, it is possible to analyse and review the process of using and producing ideas in the specific case of Indonesia's economic development over the 1960-90 period. The following chapter provides an important link into the second section of the thesis (Chapters 5-9) by providing an historical overview of Indonesia's recent economic growth and by highlighting the emerging knowledge related challenges for Indonesian growth in the future.

Figure 4-1

Openness to Foreign Ideas in Developing Regions

Figure 4-1a

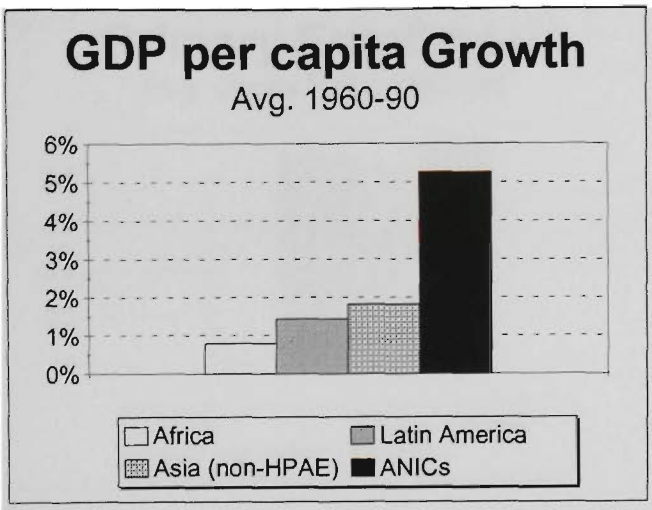


Figure 4-1b

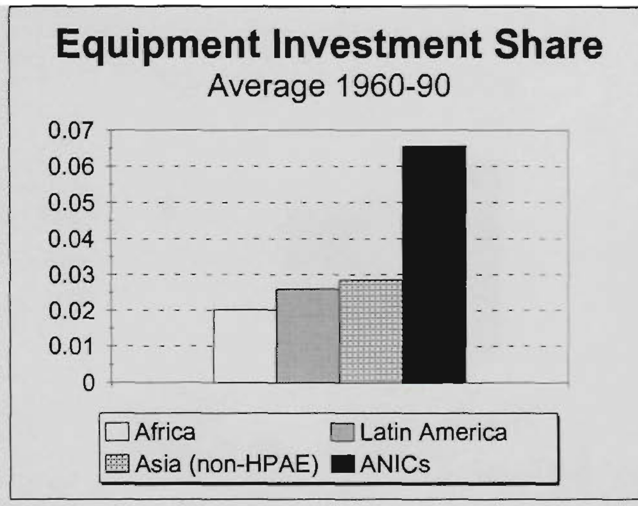


Figure 4-1c

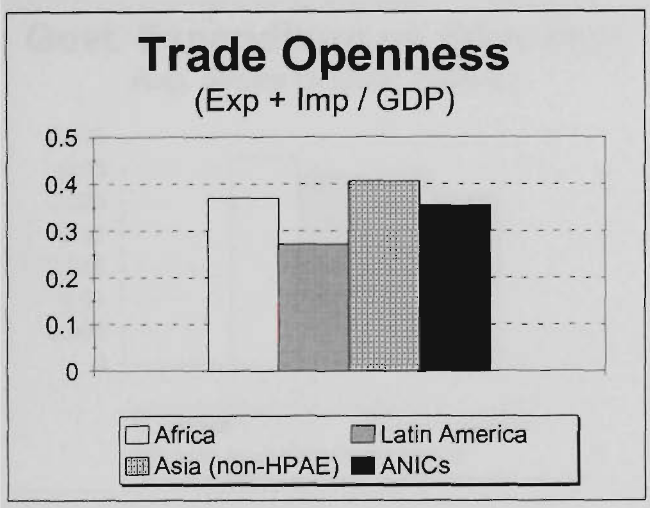


Figure 4-1d

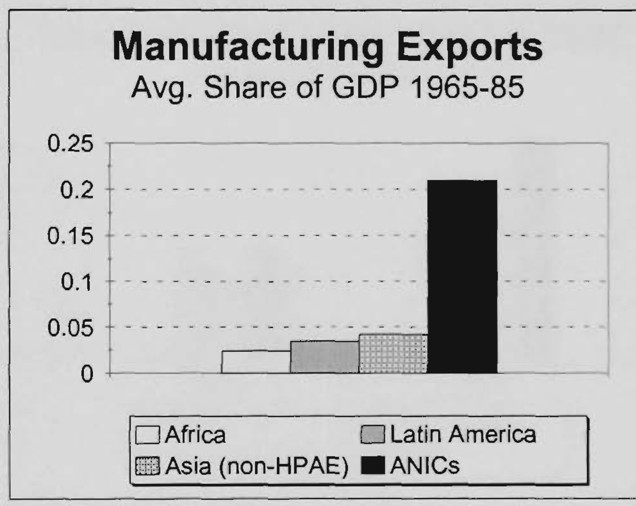


Figure 4-1e

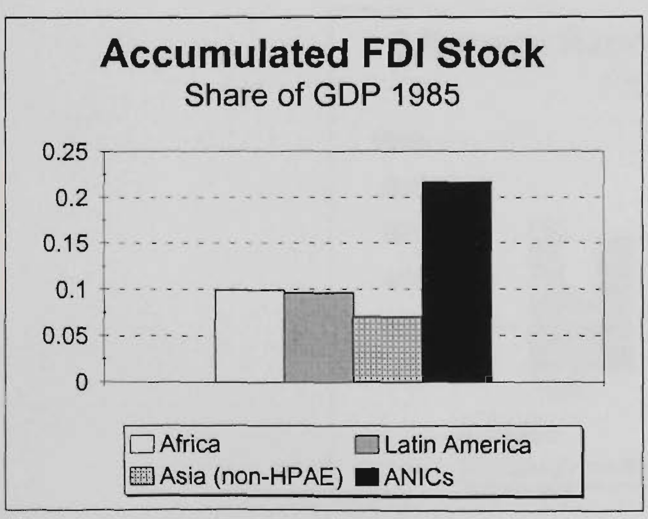
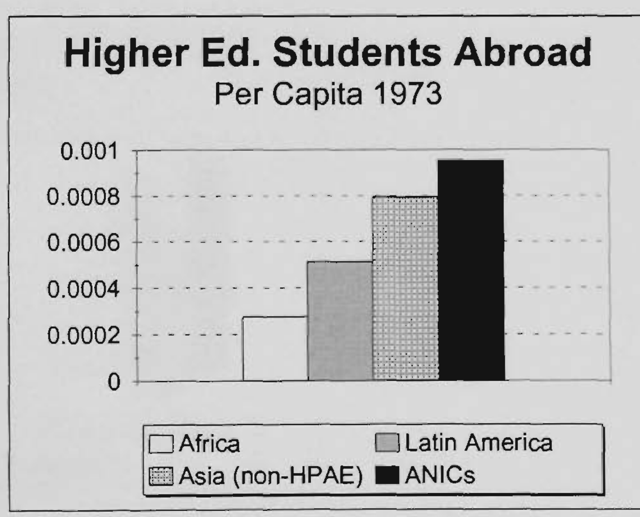


Figure 4-1f



Source: As per Table 4-7 and 4-8.

Figure 4-2
Development of Human Capital in Developing Regions

Figure 4-2a

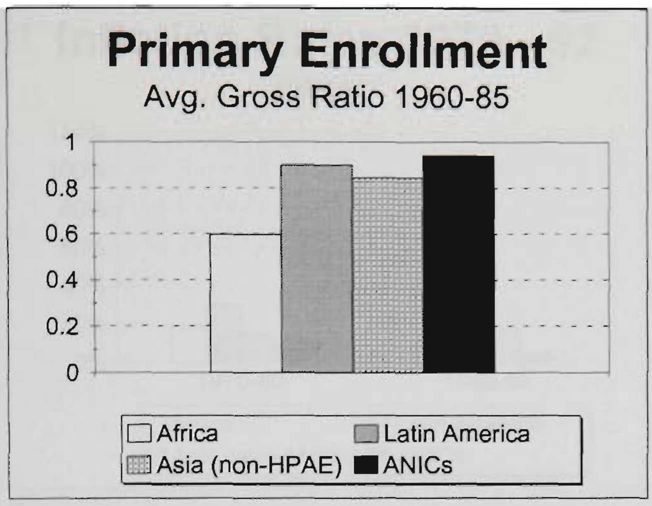


Figure 4-2b

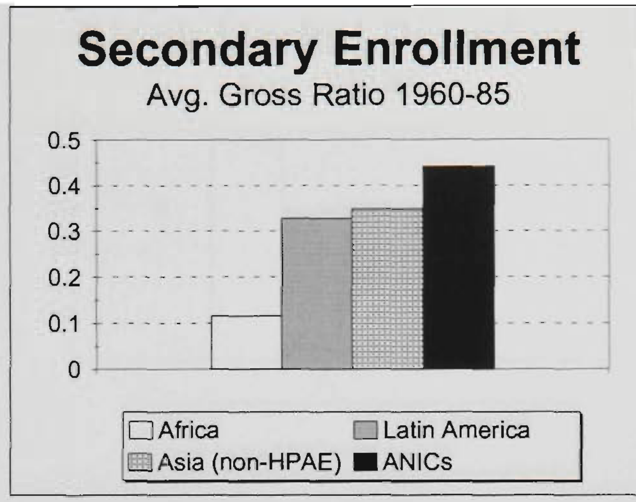


Figure 4-2c

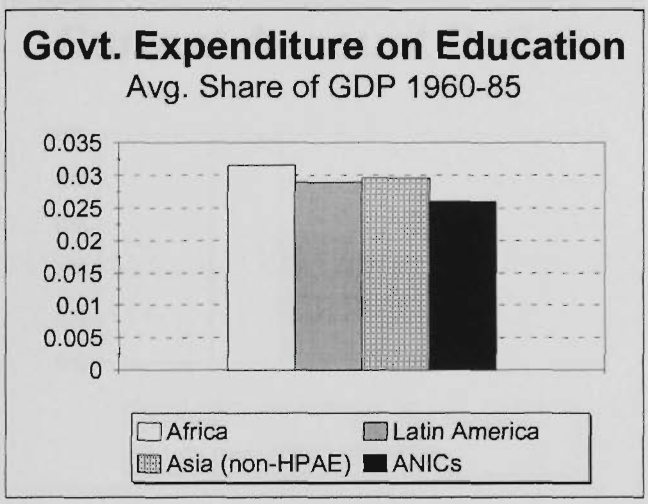


Figure 4-2d

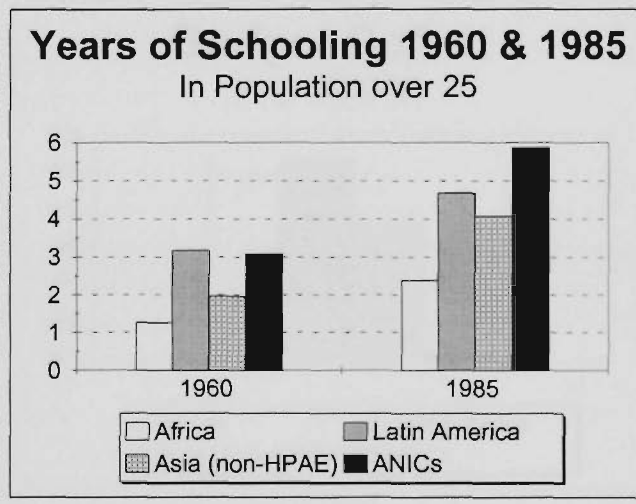
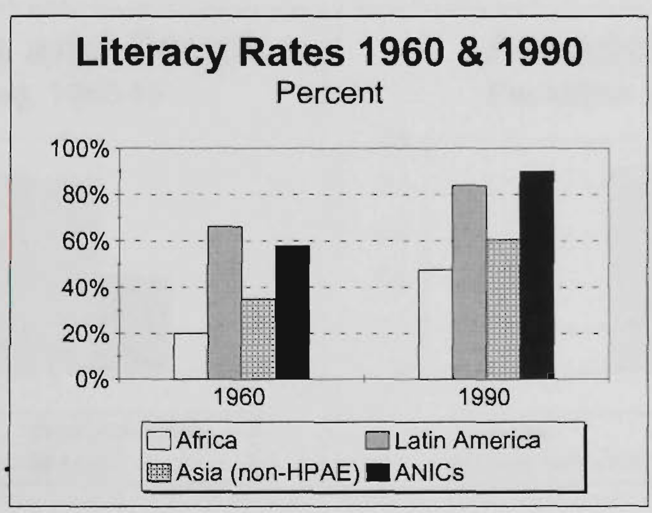


Figure 4-2



Source: As per Table 4-9.

Figure 4-3

Macroeconomic and Political Stability in Developing Regions

Figure 4-3a

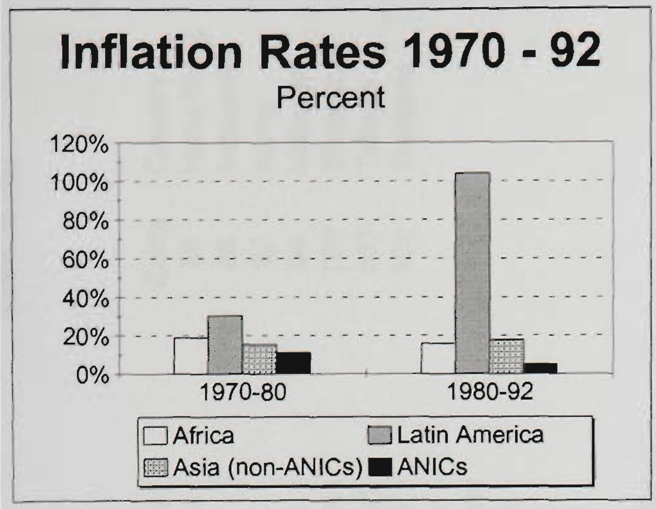


Figure 4-3b

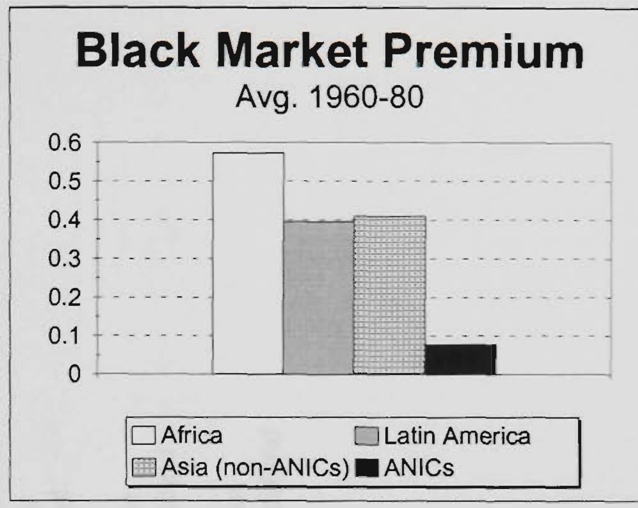


Figure 4-3c

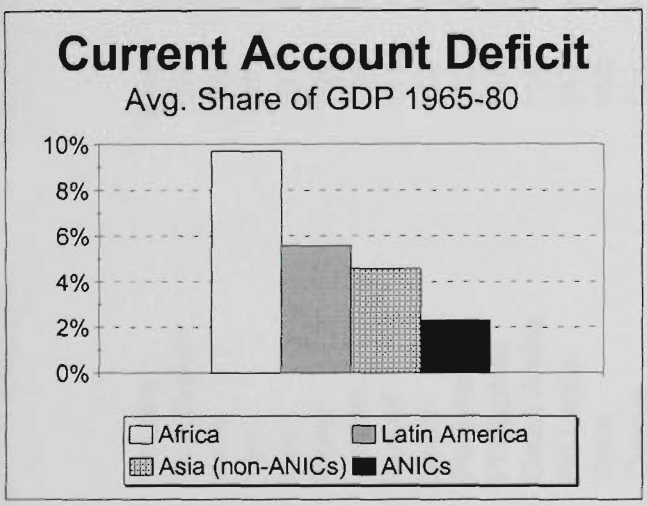


Figure 4-3d

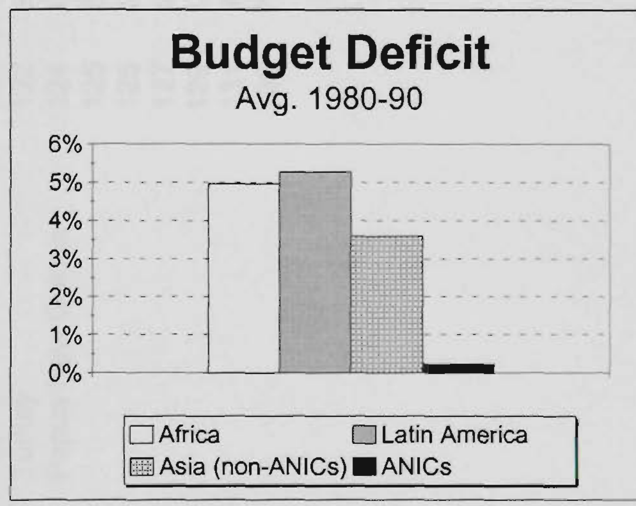


Figure 4-3e

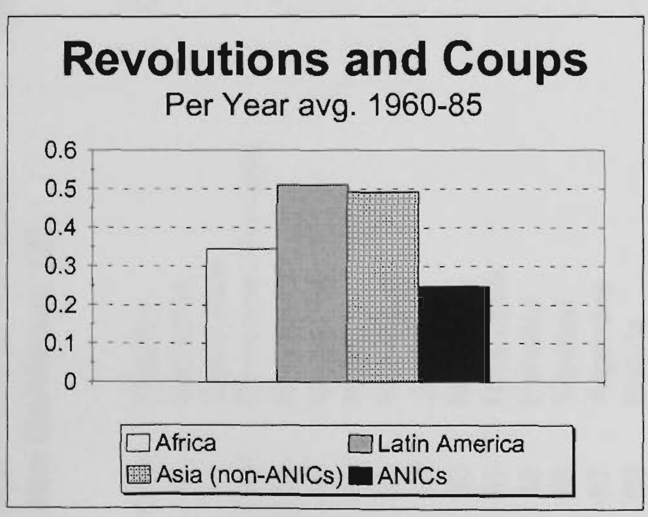
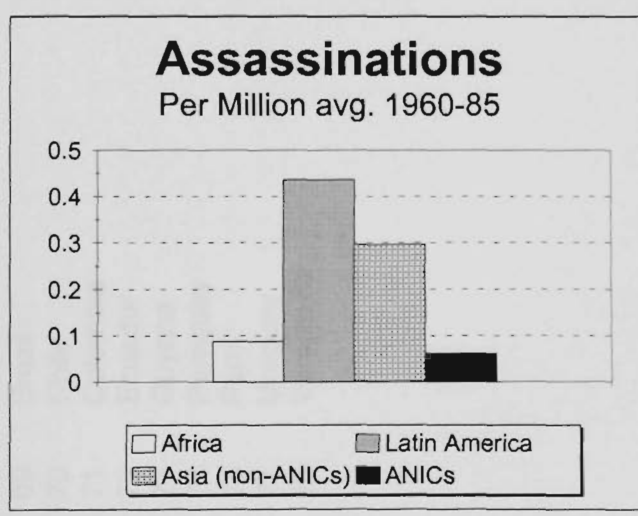


Figure 4-3f



Source: As per Table 4-10.

Country Codes and Regions

Africa (1)

Code	Country
1	Algeria
2	Angola
3	Benin
4	Botswa
6	Burundi
7	Cameroon
12	Congo
13	Egypt
14	Ethiopia
17	Gha
18	Guinea
21	Kenya
24	Madagascar
25	Malawi
26	Mali
27	Mauritania
28	Mauritius
29	Morocco
30	Mozambique
31	Niger
32	Nigeria
33	Rwanda
34	Senegal
36	Sierra Leone
37	Somalia
38	South Africa
39	Sudan
41	Tanzania
43	Tunisia
44	Uganda
45	Zaire
46	Zambia
47	Zimbabwe

Latin/Central America & the Carribean (2)

Code	Country
49	Barbados
51	Costa Rica
53	Dominican Republic
54	El Salvador
56	Guatemala
57	Haiti
58	Honduras
59	Jamaica
60	Mexico
61	Nicaragua
62	Panama
65	Trinidad
67	Argentina
68	Bolivia
69	Brazil
70	Chile
71	Colombia
72	Ecuador
73	Guyana
74	Paraguay
75	Peru
77	Uruguay
78	Venezuela

Asia (non-HPAE) (3)

Code	Country
81	Bangladesh
85	India
87	Iran
88	Iraq
89	Israel
91	Jordan
93	Kuwait
95	Nepal
97	Pakistan
98	Philippines
99	Saudi Arabia
101	Sri Lanka
102	Syria
109	Cyprus
128	Turkey
134	Papua New Guinea

OECD (4)

Code	Country
50	Canada
66	U.S.
90	Japan
107	Austria
108	Belgium
110	Denmark
111	Finland
112	France
113	Germany
114	Greece
116	Iceland
117	Ireland
118	Italy
121	Netherlands
122	Norway
124	Portugal
125	Spain
126	Sweden
127	Switzerland
129	U.K.
131	Australia
133	New Zealand

ANICs (5)

Code	Country
84	Hong Kong
86	Indonesia
92	Korea
94	Malaysia
100	Singapore
103	Taiwan
104	Thailand

Table 4-6

National Accounts

Region	Grpc 60-85	Grpc 60-89	Y/L Gr 60-85	LGr 60-85	Gpop 60-85	Pubinv 70-80	Pinv 60	Pinv 70	Pinv 80	Inv 60-69	Inv 70-79	Inv 80-90	Inv 60-90
Africa (1)	0.79%	1.11%	1.37%	2.27%	2.62%	0.092	1.153	1.125	1.645	0.098	0.116	0.098	0.103
Latin America (2)	1.43%	1.41%	1.50%	2.45%	2.27%	0.075	0.769	0.673	0.823	0.162	0.182	0.153	0.166
Asia (non-HPAE) (3)	1.81%	1.54%	1.96%	2.25%	2.62%	0.087	0.659	0.545	0.727	0.167	0.186	0.178	0.180
OECD (4)	3.00%	3.91%	2.61%	1.15%	0.77%	0.051	0.686	0.677	1.011	0.297	0.302	0.266	0.288
ANICs (5)	5.25%	5.30%	4.44%	3.07%	2.32%	0.085	0.660	0.525	0.747	0.175	0.256	0.280	0.237
Hong Kong	6.27%	6.38%	4.71%	3.52%	2.33%	0.041	0.670	0.633	1.082	0.235	0.220	0.216	0.224
Indonesia	3.85%	3.65%			2.54%	0.086	0.399	0.419	0.650	0.078	0.176	0.274	0.176
Korea	6.30%	6.64%	4.96%	2.78%	2.02%	0.064	0.925	0.470	0.690	0.155	0.271	0.317	0.248
Malaysia	4.32%	3.95%	3.41%	3.11%	2.60%	0.109	0.597	0.485	0.613	0.180	0.253	0.304	0.246
Singapore	6.38%	6.69%	4.35%	3.27%	1.76%	0.103	0.988	0.743	1.005	0.218	0.386	0.386	0.330
Taiwan	5.80%	0.00%	5.50%	3.00%	2.32%	0.123	0.529	0.467	0.629	0.183	0.288	0.269	0.247
Thailand	3.86%	4.52%	3.70%	2.74%	2.69%	0.071	0.512	0.456	0.558	0.175	0.197	0.194	0.189

Notes:

1. Grpc 60-85 — Average growth in per capita GDP 1960 - 1985 (source: Summers and Heston 5.5),
2. Grpc 60-89 — Average growth in per capita GDP 1960 - 1989 (source: as for 1.).
3. Y/L Gr 60-85 — Average growth in GDP per worker 1960 - 1985 (source: De Long and Summers 1993).
4. LGr 60-85 — Average growth in labour 1960 -1985 (source: as for 3.).
5. Gpop 60-85 — Average population growth 1960-85 (source: as for 1.).
6. Pubinv 70-80 — Ratio of nominal public fixed capital formation to nominal GDP (Barro and Lee 1994 - drawing on WDR and OECD) .
7. Pinv XX — Investment price level 1960, 1970 and 1980 respectively (source: as for 1.).
8. Inv XX — Investment share in GDP decade average (source: as for 6.).
9. Inv 60-90 — Investment share in GDP average 1960 - 90 (source: as for 6.).

Table 4-7

Access to Foreign Ideas

Region	Equip Inv	XM/GDP	Manu/GDP	FDI/GDP	News	MBook 80	MNews 80	HOS 73	HOS 83
Africa (1)	0.020	0.369	0.024	0.099	15	1.05	0.27	0.03%	0.05%
Latin America (2)	0.026	0.271	0.035	0.096	75	3.04	0.66	0.05%	0.05%
Asia (non-HPAE) (3)	0.028	0.406	0.042	0.070	73	0.82	0.08	0.08%	0.09%
OECD (4)	0.077	0.436	0.128	0.098	305	8.82	4.74	0.09%	0.10%
ANICs (5)	0.066	0.354	0.210	0.216	182	2.90	1.21	0.10%	0.10%
Hong Kong	0.068	0.210	0.364	0.105	455	2.32	0.65	0.42%	0.42%
Indonesia		0.257	0.009	0.286	13	0.02	0.00	0.00%	0.01%
Korea	0.062	0.215	0.172	0.019	126	0.27	0.10	0.01%	0.02%
Malaysia	0.040		0.076	0.272	105	1.51	0.36	0.01%	0.01%
Singapore	0.148	0.656	0.529	0.736	263	13.17	6.13	0.08%	0.09%
Taiwan	0.052	0.495	0.286	0.047	511			0.05%	0.05%
Thailand	0.023	0.291	0.033	0.050	29	0.10	0.01		

Notes

1. Equip Inv — Equipment Investment share in GDP, average 1960 - 1985 (De Long and Summers 1993 dataset - drawing on various sources).
2. XM/GDP — The ratio of Exports and Imports to GDP, average 1960-80 (source: Summers and Heston 5.5).
3. Manu/GDP — Manufacturing exports as a ratio of GDP, average 1965-85 (World Bank - IEDB, ANU).
4. FDI/GDP — Accumulated stock of FDI as a proportion of GDP 1985 (source: as for 12.).
5. News — Newspaper circulation per 1000, average 1965-85 (source: UNESCO 1995).
6. MBook 80 — Imports of books and pamphlets for 1980 ($ mill) (source: UNESCO 1994).
7. MNews 80 — Imports of newspapers and periodicals for respective years ($ mill) (source: as for 4.).
8. HOS 73 & 83 — Higher education students studying abroad per capita for respective years (source: UNESCO Statistical Yearbook - various years).
9. Owti — Own-imported weighted tariff rates on intermediate inputs and capital goods. (Source Lee 1992 - drawn from UNCTAD data).

Human Capital

Region	p60	p70	p80	p60-85	s60-85	s60	s70	s80	h60	h70	h80	GEdu 60	GEdu 70	GEdu 60-85
Africa (1)	0.420	0.558	0.647	0.595	0.115	0.042	0.097	0.159	0.007	0.012	0.024	0.026	0.036	0.032
Latin America (2)	0.849	0.911	0.952	0.899	0.327	0.185	0.309	0.462	0.030	0.064	0.136	0.024	0.031	0.029
Asia (non-HPAE) (3)	0.754	0.829	0.919	0.842	0.347	0.196	0.324	0.479	0.033	0.065	0.127	0.025	0.031	0.030
OECD (4)	0.993	0.973	0.992	0.986	0.708	0.527	0.731	0.808	0.096	0.173	0.269	0.032	0.044	0.040
ANICs (5)	0.896	0.926	0.991	0.942	0.441	0.240	0.387	0.574	0.035	0.067	0.105	0.024	0.026	0.026
Hong Kong	0.870	1.000	1.000	0.978	0.450	0.200	0.360	0.640	0.044	0.073	0.105	0.019	0.022	0.021
Indonesia	0.710	0.800	1.000	0.848	0.203	0.060	0.160	0.290	0.015	0.028	0.039	0.019	0.016	0.016
Korea	0.940	1.000	1.000	0.983	0.550	0.270	0.420	0.760	0.047	0.080	0.158	0.029	0.025	0.028
Malaysia	0.960	0.870	0.950	0.930	0.375	0.190	0.340	0.490	0.012	0.017	0.043	0.031	0.044	0.040
Singapore	1.000	1.000	1.000	1.000	0.507	0.320	0.460	0.580	0.064	0.068	0.079	0.035	0.025	0.029
Taiwan	0.960	0.980	1.000	0.983	0.790	0.510	0.800	0.970	0.046	0.169	0.179	0.019	0.026	0.024
Thailand	0.830	0.830	0.990	0.872	0.215	0.130	0.170	0.290	0.019	0.033	0.131	0.019	0.023	0.022

Region	yrs60	yrs70	yrs80	yrs85	lit60	lit90	fert65	fert85	% fall	mort65	mort85
Africa (1)	1.252	1.514	1.981	2.382	0.200	0.475	6.653	6.319	5.03%	0.033	0.020
Latin America (2)	3.170	3.680	4.469	4.685	0.662	0.838	5.782	3.968	31.37%	0.013	0.005
Asia (non-HPAE) (3)	1.947	2.573	3.523	4.068	0.349	0.606	6.319	5.137	18.69%	0.020	0.008
OECD (4)	6.416	7.023	8.336	8.547	0.947	0.945	2.845	1.818	36.10%	0.001	0.001
ANICs (5)	3.077	4.020	4.997	5.872	0.578	0.899	5.271	2.686	49.05%	0.007	0.003
Hong Kong	5.189	5.166	6.734	7.511	0.704	0.950	4.500	1.800	60.00%	0.002	0
Indonesia	1.107	2.285	3.086	3.750	0.390	0.770	5.500	4.100	25.45%	0.020	0.012
Korea	3.231	5.583	6.849	7.850	0.706	0.960	4.800	2.400	50.00%	0.006	0.002
Malaysia	2.336	3.404	4.489	5.361	0.530	0.780	6.300	3.700	41.27%	0.005	0.002
Singapore	2.987	3.780	3.691	4.553	0.498	0.950	4.700	1.700	63.83%	0.001	0
Taiwan	3.239	4.381	6.365	6.999	0.540		4.800	1.900	60.42%	0.005	0.001
Thailand	3.451	3.540	3.765	5.081	0.680	0.930	6.300	3.200	49.21%	0.011	0.003

1. pXX — Total gross enrollment ratio for primary education for the years 1960, 1970 & 1980 respectively (source: Barro and Lee 1994 - drawn from UNESCO).
2. p60 - 85 — Average enrollment ratios for primary education 1960 - 1985 (source: as for 1.).
3. sXX — Total gross enrollment ratio for secondary education for the years 1960, 1970 & 1980 (source: as for 1.).
4. s60-85 — Average enrollment ratios for secondary education 1960 - 1985 (source: as for 1.).
5. GeduXX — Ratio of recurring nominal government expenditure on education to nominal GDP - decade average.
6. Gedu60-85 — Ratio of recurring nominal government expenditure on education to nominal GDP average 1960 - 1985.
7. yrsXX — Average years of schooling in population over age 25 (source: Barro and Lee 1992).
8. litXX — Literacy rate for the years 1960 and 1990 (source: Barro and Wolf 1989, World Development Report 1992).
9. fertxx — Total fertility rate (children per woman) 1965 and 1985 (source: Barro and Wolf 1989).
10. %fall — Percentage fall in fertility rates 1965-1985 (source: as for 9.).
11. mortxx — Child mortality rate, ages 1-4 (source: as for 9.).

Macroeconomic and Political Stability

Region	SdINF	INF 70-80	INF 80-92	BMP 60-80	CAD 80-90	Debt 85	Sur 80-90	REVC 60-85	ASSASS	RIOT	STRIKE
Africa (1)	9.4%	18.87%	15.59%	0.57	-9.70%	0.790	-4.96%	0.34	0.09	0.34	0.03
Latin America (2)	32.1%	30.27%	103.88%	0.39	-5.57%	0.426	-5.27%	0.51	0.44	0.56	0.25
Asia (non-ANICs) (3)	27.6%	15.39%	17.79%	0.41	-4.54%	0.191	-3.58%	0.49	0.30	1.36	0.12
OECD (4)	12.0%	11.77%	7.33%	0.02	-0.32%		-4.42%		0.22	0.98	0.21
ANICs (5)	5.3%	11.17%	5.05%	0.08	-2.30%	0.216	-0.23%	0.25	0.06	0.54	0.01
Hong Kong	5.3%	9.20%	7.80%	0.00					0.00	0.00	0.00
Indonesia	5.9%	21.50%	8.40%	0.07	-1.51%	0.135	-0.94%	0.36	0.12	0.73	0.00
Korea	4.8%	20.10%	5.90%	0.27	-6.67%	0.271	-1.33%	0.13	0.12	2.12	0.00
Malaysia		7.30%	2.00%	0.01	-2.20%	0.317	-3.27%	0.17	0.04	0.54	0.00
Singapore		5.90%	2.00%	0.01	-0.14%		5.03%		0.00	0.05	0.00
Taiwan		5.00%		0.10	0.03%		0.99%	0.33	0.11	0.16	0.00
Thailand		9.20%	4.20%	0.03	-4.97%	0.140	-1.85%	0.23	0.04	0.19	0.08

1. SdINF — The standard deviation of the inflation rate over all the observations 1960-88 (time series) on inflation for a given country (source: Fischer 1993 dataset).
2. INF XX-XX — The average inflation rate for the period (source: World Development Report 1994).
3. SGOV XX-XX — Average share of government consumption in GDP for the period (Source Easterly etal. 1993 dataset).
4. BMP 60-85 — Average black market premium for the 1960-85 period (black market exchange rate/official exchange rate) -1 where the official exchange rate = local currency per US dollar (source: Barro and Lee 1994).
5. CAD 80 — Current account deficit/surplus as a percentage of GDP in 1980 (source: Social Indicators of Development 1994).
6. Debt 85 — Total external debt as a percentage of GDP in 1985 (source: as for 6.) .
7. Sur 80 — Government surplus/deficit as a percentage of GDP for the year 1980 (source: World Bank World Tables 1996).
8. REVC 60-85 — Average number of revolutions and coups per year for the 1960-85 period (source: Easterly and Rebelo 1993 dataset).
6. ASSASS — Number of assassinations per million population per year (source: Banks 1979 updated and extracted from Barro and Wolf 1989).
9. RIOT — Number of riots per year 1960-85 (source: Banks 1979 updated and extracted from Barro and Wolf 1989).
10. STRIKE — Number of strikes per year 1960-85 (source: Banks 1979 updated and extracted from Barro and Wolf 1989).

5. Indonesia's Historical Development and the Challenge of the Global Knowledge Economy

5.1 Introduction

Indonesia's development experience in the modern era represents an interesting case study for the development economist. Over the course of a 30 year period Indonesia moved from being a poor and under developed country strafed by economic and political instability in the mid-1960s[44] to a rapidly industrialising and highly dynamic economy in the first half of the 1990s. However it should be noted that Indonesia's economy faltered in the second half of 1997 (as indicated by significant falls in the local stock market and in the value of the Rupiah as well as the announcement of a US $ 33 billion assistance package by the IMF) and there are now expectations for lower-than-normal growth in the short term[45]. Nevertheless, these recent developments should not overshadow the country's impressive growth performance over the 1960-90 period which, as can be seen from Table 3-1, led to a trebling of real per capita income in that time.

The *first* objective of this chapter is to provide a broad overview of Indonesia's development experience, highlighting the role of policy and international trade in that development (section 5.2). Whilst it is generally acknowledged that Indonesia's development record over the period was impressive, it will be emphasised that this should provide no grounds for complacency. This is because changing economic circumstances in the international arena will bring with it a new set of challenges for future growth and development.

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[44] See Hill (1996) for a review of the literature describing the economic conditions within Indonesia in the early to mid 1960s.
[45] See for example *WSJ* (November 3 1997), *EBRI* (September 22 1997), *FEER* (November 13 1997) and the *Economist* (November 8 1997).

The *second* objective of the chapter is to explain the nature and economic implications of these changing global circumstances (section 5.3). Two key developments are identified, both of which threaten a fundamental change in consumption and production activities the world over. The first is the on-going revolution in information and communications technologies and the second is the general trend toward economic deregulation. The combined result of these two developments has been the emergence of what many authors including Sheehan et al (1995), OECD (1995b) and others refer to as the *global knowledge economy.* The implications to Indonesia of a globalised international economy driven by rising knowledge intensity will be considered in Chapter 6. Indonesia's response to the global knowledge economy will be reviewed in chapter 7 whilst the policy constraints to that response will be considered in chapter 8.

5.2 Growth of the Indonesian Economy

5.2.1 Economic Policy and Recent Development

When the present regime, termed the *New Order,* came to power in the mid 1960s it inherited an economy in tatters. Years of economic mismanagement under the Sukarno government had according to Arndt (1984, p 29) brought about a degree of 'economic breakdown with few parallels in modern history.' Economic growth for the 1950-65 period averaged 1.8% per annum which was exceeded by the average population growth rate of 2.5% per annum resulting in a per capita income in 1966 well below that of 1950 (Hobohm 1987). A clear indication that the previous government had lost control of the economy was the high rate of inflation which averaged 330 percent over the 1962-66 period (table 5-1). According to Woo, Glassburner and Nasution (1994) this was due mainly to the printing of money to finance the often extravagant and wasteful government spending programs which were characteristic of the Sukarno era.

The balance of payments were also in crisis. Despite being an essentially extractive and agrarian economy, Indonesia throughout the 1950-65 period was dependent upon imports for all its needs, including rice. By 1966 annual export earnings ($527 million) were insufficient to cover the country's annual debt service obligations ($530 million), let alone its annual import bill. Meanwhile foreign exchange reserves had fallen from a high of $267 million in 1959 (the equivalent of 6.7 months of imports) to a new low of $17 million in 1965 (the equivalent of 0.3 months of imports) (Woo et al. 1994, p. 29).

Furthermore, notwithstanding a few simple resource-based processing activities such as rice milling and rubber and a few footloose industries such as weaving the country in the mid 1960s had little if no industrial capacity to speak of. There were moves by the Dutch colonial government to develop a domestic industrial capacity in the 1930s. However such efforts were quickly abandoned with the outbreak of the Second World War and the subsequent occupation by Japanese forces. What remained of the country's economic and industrial infrastructure was later damaged or destroyed during the struggle for independence (1945-49). Subsequent efforts to rehabilitate the industry sector in the post independence years were hampered by the chaotic political climate, poor economic management and the various regional rebellions (Hill 1992).

A key factor contributing to the poor state of the Indonesian economy in the mid 1960s was the very nature of President Sukarno's leadership. Throughout the 1950-65 period, Sukarno increasingly neglected matters of economic policy and became more concerned with domestic political manoeverings and Indonesia's confrontationist stance toward the outside world (BIES February 1965, Mangkusuwondo 1973). This was particularly the case after Sukarno dissolved the representative parliament in 1957 declaring that Indonesia would thereafter become a 'Guided Democracy'. Compounding the problems associated with the general lack of economic prudence of the ruling elite was the dire shortage of qualified personnel in the bureaucracy necessary for the effective macro-management of the economy (Hobohm 1987).

The Sukarno era came to an end in 1965 with the failed (alleged) coup by the *Partai Komunis Indonesia* (the Indonesian Communist Party). One of the surviving senior army officers who played a leading role in putting down the uprising and restoring order was a little known general called Suharto. Whilst Sukarno was greatly weakened by the coup, Suharto was able to gradually take control of the administration, becoming President in 1968s with virtually dictatorial powers, although promising to hold elections by 1971 (Woo et al. 1994).

With an agenda for economic rehabilitation and stabilisation, the newly installed Suharto government embarked on a radically different approach to both internal and external policies. Domestically, prudent economic measures were introduced to balance the fiscal budget, restrain inflation, halt the depletion of foreign exchange reserves and to restore stability to the banking sector. Externally, the new regime adopted a more conciliatory, less confrontationist approach to foreign policy. This in turn enabled the country to successfully lobby for a moratorium on all outstanding debts and to benefit from the future injections of foreign investment and aid into the development process (Hardy 1982; Nasution 1983).

In response to the governments stabilisation and rehabilitation program the economy grew robustly over the 1967-72 period, averaging 7.9 percent per annum compared to the 2.1 percent average recorded over the 1960-66 period (table 5-1). The fastest growing sectors in the first five years of the New Order government were the construction, finance and utilities sectors reflecting the drive toward economic rehabilitation. The mining sector also grew robustly driven mainly by inflows of foreign investment and oil export revenues.

The industrialisation process also began in earnest in the early years of the New Order following important supply side reforms such as the new regulations which enabled manufacturers better access to imported raw and intermediate inputs and the liberalisation of the foreign investment regime (Thee 1995b). Moreover, Hill (1992a) notes that years of economic and political chaos had left a backlog in unmet consumer

Figure 5-1

Indonesian Oil and Non-oil Exports 1965-95

Figure 5-1a

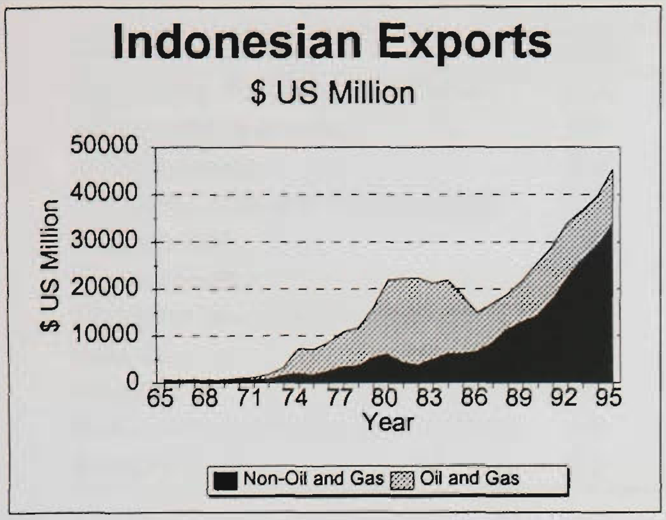
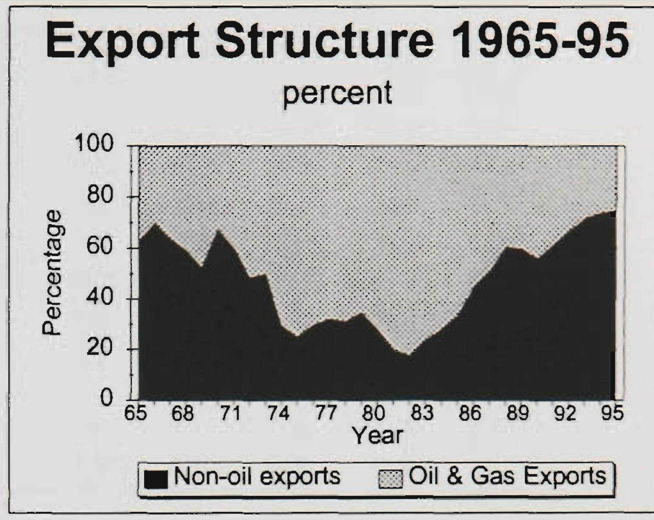


Figure 6-2b



	Exports ($ US Million)			Percentage	
Year	*Non-Oil & Gas*	*Oil & Gas*	*Total*	*Non-Oil*	*Oil & Gas*
1965	450.4	271.7	722.1	62.4	37.6
1966	474.2	203.4	677.6	70.0	30.0
1967	423.2	239.6	662.8	63.8	36.2
1968	431.2	296.8	728.1	59.2	40.8
1969	419.6	378.6	798.2	52.6	47.4
1970	706.6	346.3	1,052.9	67.1	32.9
1971	720.5	477.9	1,198.4	60.1	39.9
1972	862.3	913.1	1,775.4	48.6	51.4
1973	1,599.6	1,608.7	3,208.3	49.9	50.1
1974	2,211.5	5,211.4	7,422.8	29.8	70.2
1975	1,791.7	5,338.5	7,130.2	25.1	74.9
1976	2,542.2	6,014.1	8,556.3	29.7	70.3
1977	3,474.1	7,378.6	10,852.6	32.0	68.0
1978	3,657.0	7,986.2	11,643.2	31.4	68.6
1979	5,424.7	10,165.5	15,590.1	34.8	65.2
1980	6,165.7	15,743.1	21,908.9	28.1	71.9
1981	4,495.9	17,764.4	22,260.3	20.2	79.8
1982	3,920.4	18,372.9	22,293.3	17.6	82.4
1983	4,999.5	16,145.7	21,145.2	23.6	76.4
1984	6,204.7	15,683.1	21,887.8	28.3	71.7
1985	6,208.6	12,378.2	18,586.7	33.4	66.6
1986	6,689.7	8,097.0	14,786.8	45.2	54.8
1987	8,601.9	8,259.0	16,860.9	51.0	49.0
1988	11,434.4	7,466.6	18,901.0	60.5	39.5
1989	13,013.2	8,759.0	21,772.1	59.8	40.2
1990	14,313.9	11,239.3	25,553.2	56.0	44.0
1991	17,827.7	11,169.5	28,997.2	61.5	38.5
1992	22,541.9	11,273.6	33,815.5	66.7	33.3
1993	26,251.6	10,390.9	36,642.5	71.6	28.4
1994	29,383.6	10,523.5	39,907.1	73.6	26.4
1995	33,864.1	11,508.5	45,372.6	74.6	25.4

Note:
Oil and Gas exports - SITC (rev1) 3.
Non-Oil and Gas Exports - SITC (rev1) 1-2, 4-9.
Source: UN trade data accessed through IEDB, ANU.

Table 5-1 Sectoral Composition of Gross Domestic Product (%)

Share of GDP (%)	1960	1967	1973	1983	1989	1993	1996
Agriculture, Forestry, and Fishery	53.9	51.8	40.1	22.8	20.6	17.6	15.2
Mining and Quarrying	3.7	3.7	12.3	20.7	15.6	13.9	9.2
Manufacturing	8.4	8.4	9.6	12.7	18.5	21.1	24.6
Electricity, Gas and Water Supply	0.3	0.5	0.5	0.4	0.6	0.7	1.2
Construction	2	1.6	3.9	5.9	5.5	6.6	8.0
Trade & Hotels	14.3	15.8	16.6	14.9	16.1	16.4	16.6
Transport and Communication	3.7	3.5	3.8	5.3	5.3	5.9	1.2
Finance	1	0.8	1.2	3	4	5.1	9.2
Housing	2	2	2.1	3	2.7	2.4	-
Public Administration and Defence	4.5	5.5	6	7.4	7.8	6.8	8.8
Services	6.2	6.4	3.9	3.9	3.5	3.5	-

Average annual growth rate in period (%)	1960-66	1967-72	1973-81	1983-89	1990-93	1994-96
Agriculture, Forestry, and Fishery	1.9	4.3	3.6	3.8	3	3
Mining and Quarrying	1.1	19.7	3.2	0.6	4.1	6.9
Manufacturing	1.8	10.2	14.2	12.3	10.2	10.9
Electricity, Gas and Water Supply	7.5	12.7	14.5	11.9	13.3	14.1
Construction	1	24.7	13.5	4.2	11.4	12.6
Trade & Hotels	2.4	11.9	7.8	6.9	7.86	7.7
Transport and Communication	0.8	9.9	12.9	5.6	9.7	9.0
Finance	-2.3	27.9	13.7	10.5	13.5	10.9
Housing	2.1	8.1	12.2	3.4	4.3	-
Public administration and Defence	5.5	6	13	13	3.7	3.3
Services	2.3	2.1	2.4	2.4	6.5	-
Gross domestic product	2.1	7.9	7.5	7.5	6.9	5.3

Contribution to growth (percentage of total)	1960-66	1967-72	1973-81	1983-89	1990-93	1994-96
Agriculture, Forestry, and Fishery	49.7	26.7	16.7	14.8	8.85	6.2
Mining and Quarrying	1.9	11.8	4.5	2.1	8.75	8.1
Manufacturing	7.2	11.4	23.2	33.5	28.5	32.2
Electricity, Gas and Water Supply	1.2	0.9	1.1	1	1.2	1.9
Construction	1	7.1	8.6	4.3	10	11.8
Trade & Hotels	16.8	25.8	17.4	19.2	18.1	16.1
Transport and Communication	1.4	4.6	7.9	5.3	7.8	8.0
Finance	-1	4.1	2.8	6.5	8.4	12.0
Housing	1.9	2	4.1	1.8	1.6	-
Public Administration and Defence	13	4	12.7	9.1	4	3.9
Services	7	1.6	1	2.4	3.3	-

Source: Woo et al. (1994) for data 1960-1989. Data post 1989 calculated by author using BPS data.

Note: Calculated using constant prices. 1982 data was not used because of inconsistent base years. For the years 1994-96 Finance/ Housing have been merged into one category, as is the Public Administration and Defence/Services. Figures for the merged categories are in the Finance and Public Administration and Defence rows respectively.

demand, and as a result, investors in the manufacturing sector, both foreign and domestic, were able to find a ready market for much of their production.

Indonesia's economy continued to expand rapidly over the 1973-81 period, averaging 7.5 percent per annum growth (see table 5-1) and buoyed by the massive inflows of revenue associated with the OPEC induced fourfold increase in international oil prices in the second half of 1973. This price increase, accompanied by an expansion in output, caused the value of Indonesia's oil and gas exports to rise from $ 913 million in 1972 to $ 5.2 billion in 1974 (or from 51.4 to 70.2 percent of total exports). Oil and gas exports continued to increase throughout the following eight year period peaking at $ US 18.4 billion or 82.4 percent of exports in 1982 (see Figure 5-1).

Economists emphasise that the oil boom in the 1970s had both favourable and non-favourable influences upon Indonesia's development (eg Hill 1992a; Booth 1992; Asher and Booth 1992; Hobohm 1987). On the favourable side, the huge revenue inflows associated with the oil boom clearly enabled Indonesia to finance much of its social and economic development during the 1970s without recourse to excessive overseas borrowing[46]. According to Pangestu (1993) Indonesia, unlike many other oil exporters at the time, was able to utilise the resources associated with the oil boom relatively well. Booth (1992) for example, reports that much of these revenue inflows facilitated greater imports of intermediate and capital goods further fuelling the industrialisation process. This, combined with the government's sound macro management strategy[47] of the economy (which following the *Pertamina* crisis[48] of the mid-1970s included a conservative approach to external borrowing), enabled

[46]By the end of the 1980 fiscal year Indonesia's total stock of external debt stood at $ 20.9 billion - approximately 20% of current debt stocks. (World Bank 1991).

[47]A recurring theme in much of the historical literature has been the New Order administration's clear preoccupation with conservative macroeconomic management and international credit-worthiness. This is reflected in the government's continuing commitment to a number of macroeconomic fundamentals such as the successful restraint of inflationary and current account pressures, the pursuance of a free exchange rate with full convertibility, the maintenance of a high level of foreign exchange reserves and the allowance of budget deficits in so far that they can be financed overseas (and not from domestic sources or from the printing of money) (Soebiakto 1988, Woo et al 1994, Hobohm 1987).

[48]The Pertamina Crisis refers to the default on an external loan by the state oil company, Pertamina in February 1975.

Indonesia to finish the decade with a low current account deficit and with a low debt service ratio (Pangestu 1993, see also Figures 6-2b and 6-2d).

Less favourable influences of the oil boom upon Indonesia's long run development, were the effects upon efforts to mobilise domestic resources and to diversify and promote non-oil exports. Asher and Booth (1992) note that the higher oil revenues in the 1970s enabled a higher proportion of development expenditures to be funded domestically, but the rapid growth in oil export revenues meant there was little incentive to diversify the government's revenue base. By 1980 non-oil tax revenue accounted for a mere 29.2 percent of total taxation revenue (BPS data).

At that time there was also little incentive to diversify the export base. Given the high world demand for oil in the 1970s and early 1980s, pursuit of such a strategy was seen as a rational welfare enhancing exercise that enabled Indonesia to rise from the ranks of low income countries to the middle income category as determined by the World Bank (Siswanto and Budiarto 1987). This emphasis on oil and gas exports culminated in these exports commanding over 82 percent of the country's exports in 1982 (Figure 5-1). However as noted by Hobohm (1987), Thee (1995b) and others, it was also accompanied by an unfortunate neglect for a number of important non-oil export prospects. Notwithstanding the oil price effect, this neglect of non-oil exports was primarily a legacy of two factors.

First, Indonesia throughout the 1970s pursued a state-led industrialisation strategy characterised by a comprehensive import substitution program to develop a number of consumer, intermediate and capital good industries (Robison 1987, 1988; Kuyvenhoven, Puit and Van der Windt 1993; Poot, Kuyvenhoven and Jansen 1991; Hill 1992). Their establishment was fostered through various policy interventions including a restrictive foreign investment regime, a large scale public investment program and the provision of incentives to a select group of companies in the form of subsidised credits, protection against foreign and sometimes domestic competition and a host of other discretionary benefits (Hobohm 1987). Such a strategy was buttressed by both the strong nationalist sentiment that had re-emerged in policy making circles (particularly after the *Malari riots*[49] in 1974) and the oil export windfall which provided the necessary finance for the expanded role of the state (Robison 1987). As a result, notes Hobohm (1987), Indonesia did not fully exploit a number of market oriented export opportunities in labour intensive manufacturing (such as textiles, garments, electronics and footwear) until deregulation enabled export diversification in the mid 1980s.

Second, from August 1971 until devaluation in November 1978 Indonesia's exchange rate remained fixed at 415 rupiahs/dollar (Figure 6-2a). Throughout this period, particularly 1974-77, Indonesia experienced high domestic inflation induced by the massive inflows of oil money. The subsequent overvaluation of the rupiah meant that Indonesian producers of tradeable goods were experiencing a profit squeeze (the so called "Dutch Disease") as they had to reconcile output prices exogenously determined in the international marketplace against ever-increasing domestic input prices. The result was a re-allocation of resources from the tradeables to the non-tradeables (service) sector (Pangestu and Boediono 1986, Woo and Nasution 1989, Warr 1992).

With oil dominating both taxation and export revenues[50], the Indonesian economy was poorly prepared for the fall in international oil prices associated with the world-wide recession in 1982. The ensuing fiscal and balance of payments crises prompted the government to initiate a number of reforms to alleviate pressures on the current account and to diversify the export base. Important short term measures included a devaluation of the rupiah, the tightening of monetary policy, the postponement of a number of capital intensive public sector development projects and a strategy to maximise concessional loans from its western creditors (Nasution 1991; Woo et.al 1994). To improve the mobilisation of domestic resources important taxation and financial policy reforms were introduced in 1983 (Cole and Slade 1992).

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[49] According to Robison (1986) the *Malari* riots which followed the visit to Indonesia of the Japanese Prime Minister in January 1974 were a reflection of the deep rooted resentment toward foreign, particularly Japanese, capital at that time.

[50] In 1982 oil accounted for 68.20% of total government revenue and over 82% of the country's exports (BPS data).

Indonesia's Recent Macroeconomic Perfomance

Figure 5-2a

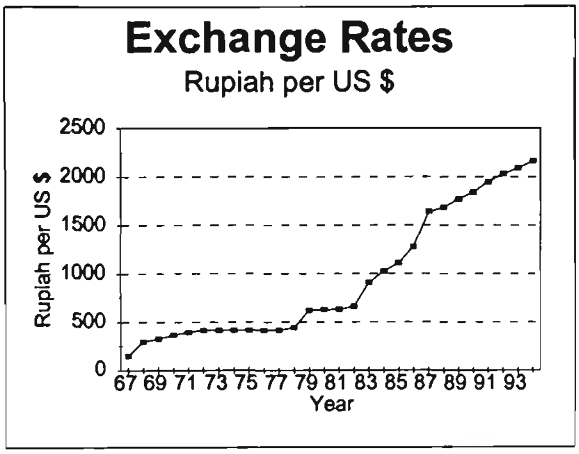


Figure 5-2b

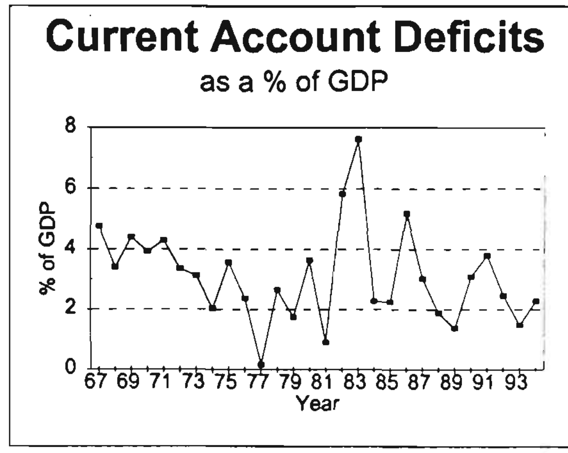


Figure 5-2c

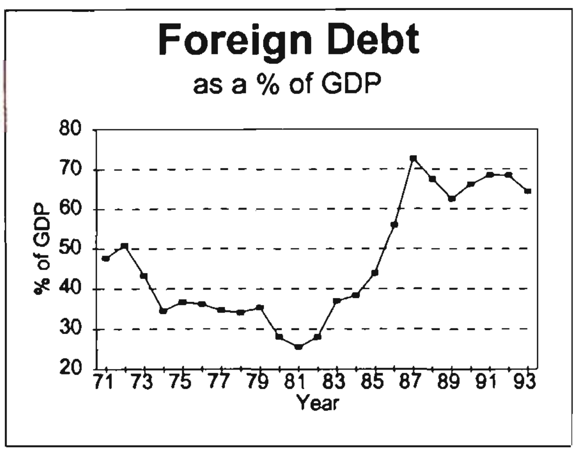


Figure 5-2d

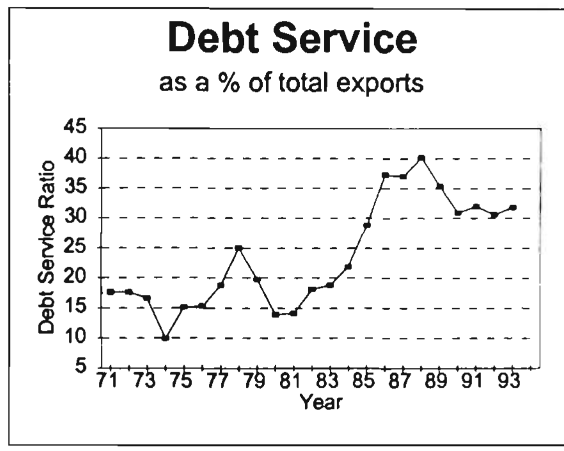


Figure 5-2e

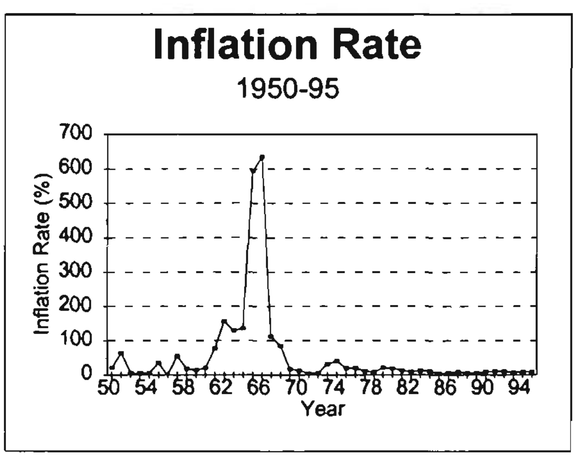


Figure 5-2f

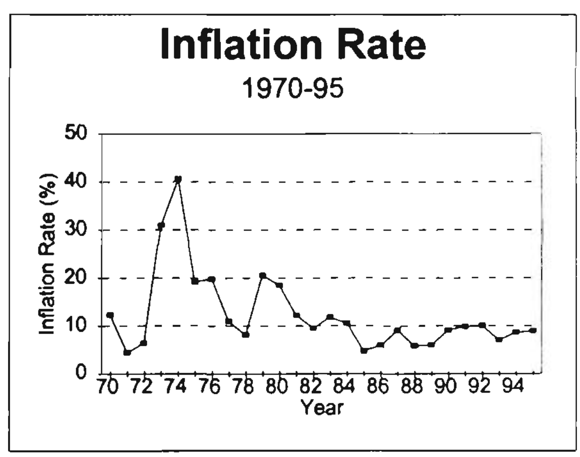
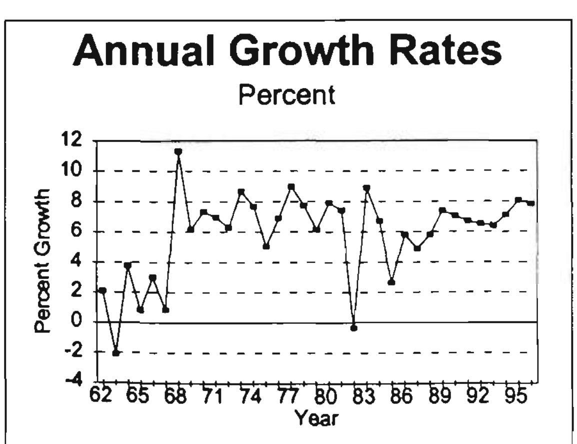


Figure 5-2g



Notes

Source: World Bank data accessed through IEDB, ANU.

In subsequent years various incentives for exporters and foreign investors were introduced, such as the March 1985 tariff rationalisation and the April 1985 shipping and customs reform (Pangestu 1991).

Total export growth remained relatively flat in the early 1980s and then fell sharply over the 1984-86 period (Table 5-1). Moreover, current account deficits remained persistently high in the early-mid 1980s (Figure 5-1), leading to a precipitous increase in the stock of external debt from US $20.9 billion in 1980 to US $52.7 billion in 1985: a 2.5 fold increase (World Bank 1991b). Whilst non-oil exports grew to 33.4 percent of total exports by the mid-1980s (figure 5.1), such growth was not sufficient to protect Indonesia's balance of payments from the adverse effects of the plunge in world oil prices in 1986.

Various authors have described how the efforts to restructure the export base through deregulation in the early-mid 1980s were frustrated by a number of policies and practices associated with the governments continued commitment to an inward-looking state led industrial strategy (Robison 1987, 1988; Woo et al. 1994, Thee 1994c)[51].Woo et al (1994) for example note the negative supply side effects upon the tradables sector of a continuation (and in some cases proliferation) of a number of restrictive trade practices and policies associated with countertrade measures, import licensing and quota restrictions. Thee (1994c) describes the government's ideological commitment to push ahead with its import substitution program at a time when a number of other countries in the region had already shifted to an export oriented pattern of industrialisation.

However as noted by Robison (1987, 1988), resistance to structural change and deregulation came not only from those supportive of the nationalist ideology underlying this inward looking development strategy but also from a number of other sources including: 1) those with vested political and bureaucratic interests who

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[51] New trade measures were announced in January 1982, for example, which led to the introduction of countertrade measures and a proliferation of import licensing and quota restrictions. By 1985 quantitative restrictions had become the dominant form of protection against imports with over 28 percent of import items requiring licenses and 6 percent under quotas (Woo et.al 1994 p.3).

benefited greatly from the existing industrial structure; 2) private and state-run enterprises in the upstream sector who feared they would be unable to compete without state protection and subsidy; and 3) politically well connected recipients of import licenses and other discretionary benefits who logically opposed any change that would threaten their privileged position in the economy

The external shocks of the mid-1980s injected a new urgency into the government's drive toward export oriented industrialisation. Various deregulation measures aimed at promoting non-oil exports were announced in three major reform packages in 1986, 1988 and 1990. These reforms saw import monopolies and NTBs removed, licensing procedures simplified, tariffs reduced and rationalised, duty drawbacks introduced for export industry, export procedures streamlined and the shipping, customs and port-handling systems completely overhauled (Soesastro and Drysdale 1990, Nasution 1991, Thee 1991). Moreover the 31% devaluation of the Rupiah in 1986 and its subsequent managed float which saw the currency depreciated by about 5 percent a year ensured improved competitiveness for Indonesian exports (Prasentiantono 1991). The investment regime was also refomed to enable export oriented manufacturing FDI better access to Indonesia's abundant supply of cheap labour (Mihira 1990, Hill 1992b).

Indonesia's non-oil exports remained fairly flat over the 1979-86 period, but accelerated sharply after the deregulation packages of the mid-late 1980s (Figure 5-1). In 1985 non-oil exports represented only 33 percent of total exports. However after a decade of strong growth averaging 18.8 percent annual growth, non-oil exports accounted for almost 75 percent of total exports (Figure 5-1). Driving Indonesia's strong non-oil export performance over the 1985-95 period were a number of resource and labour intensive manufacturing industries, such as textile clothing and footwear (ISIC 32), wood (ISIC 33) and plastics and rubber (ISIC 355/6). Such Industries became increasingly popular destinations for export oriented foreign investment relocated from higher wage countries (particularly Japan and the first tier NICs) as the foreign regime was progressively liberalised over the course of the late 1980s and early 1990s (Thee 1994i). Electronics exports have also grown rapidly, albeit

Figure 5-3
Indonesian Manufacturing Exports 1975-95

Figure 5-3a

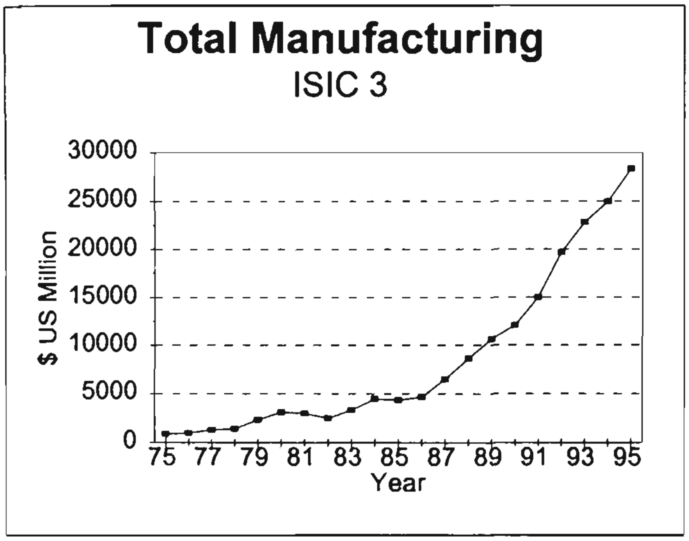


Figure 5-3b

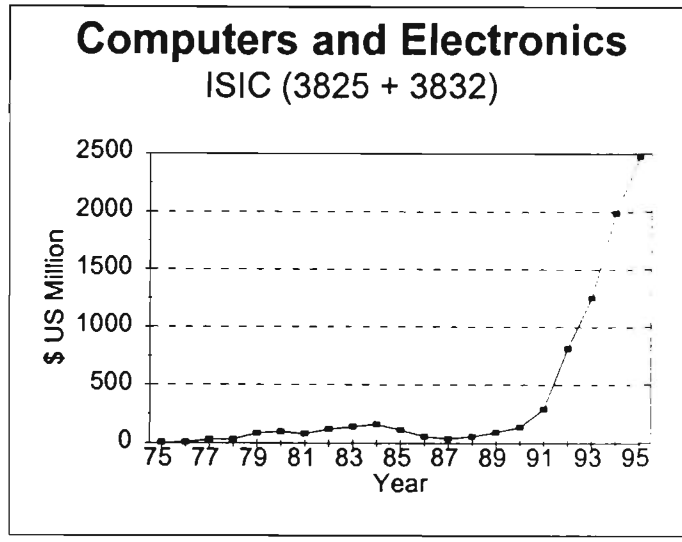


Figure 5-3c

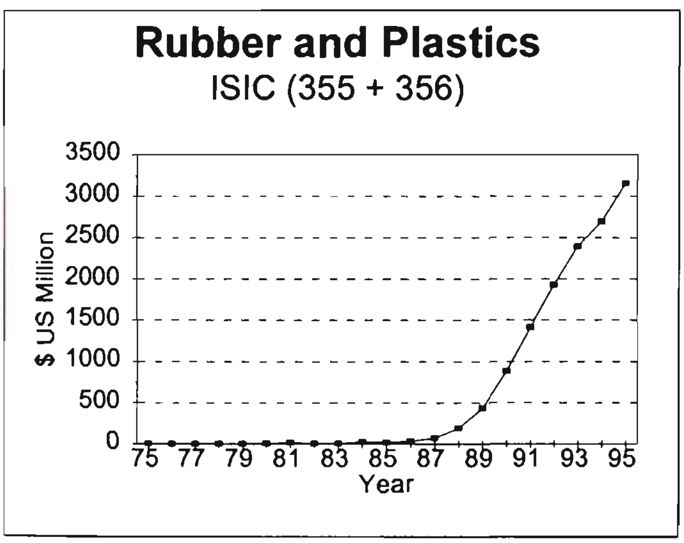


Figure 5-3d

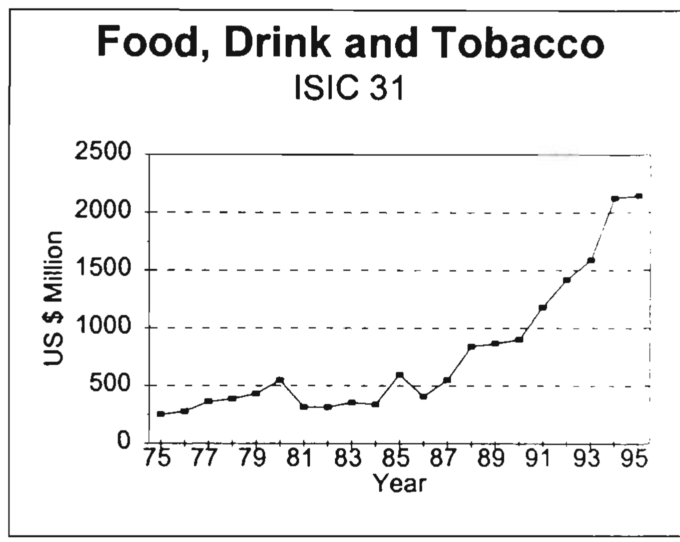


Figure 5-3e

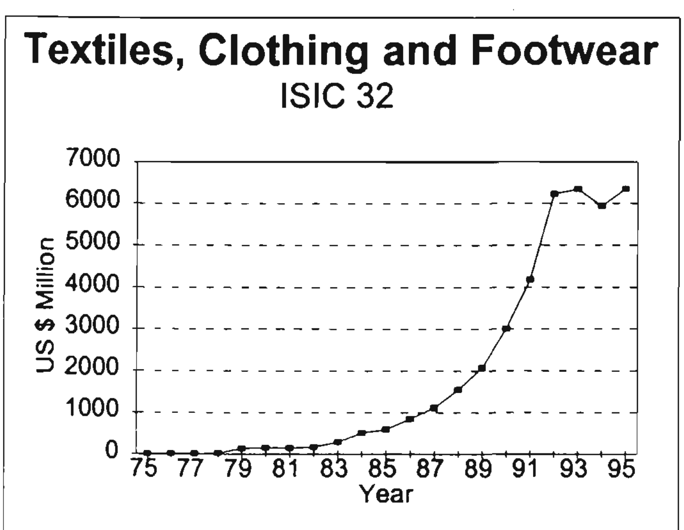
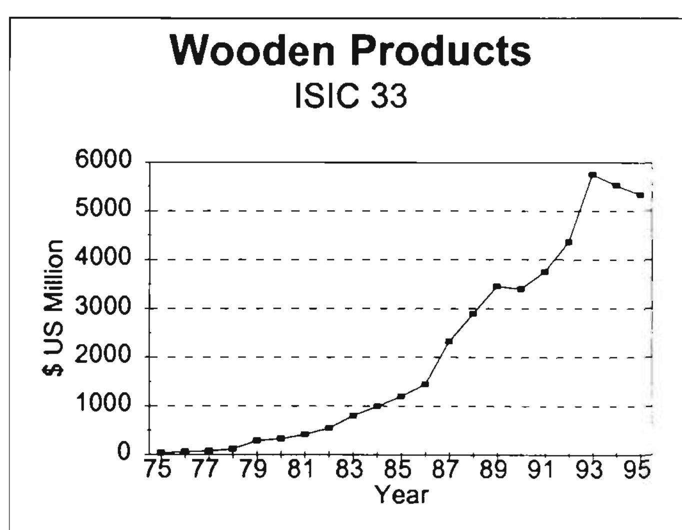


Figure 5-3f



Notes
Source: UN trade data concorded with ISIC codes and accessed through IEDB, ANU.

Indonesia's Comparative Growth Performance

Using Summers and Heston Constant Price Data (PWT 5.6)

Figure 5-4a

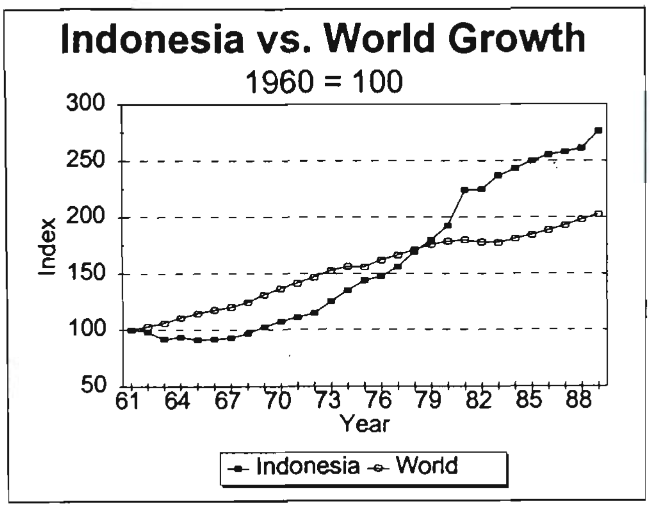


Figure 5-4b

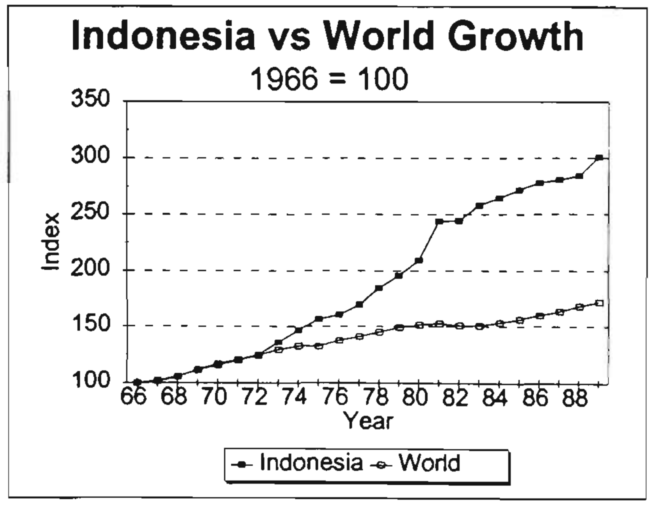


Figure 5-4c

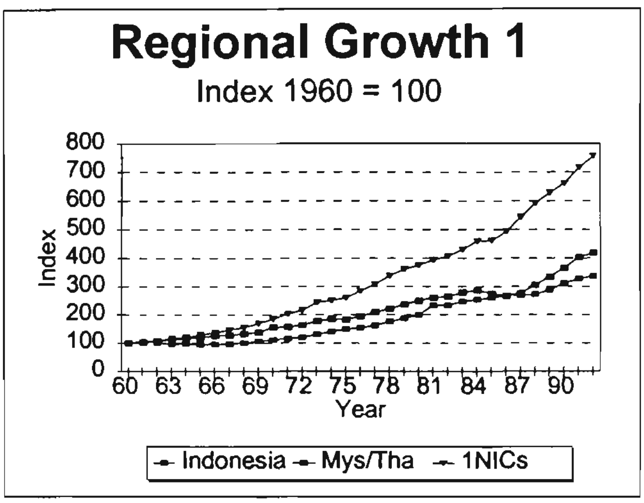


Figure 5-4d

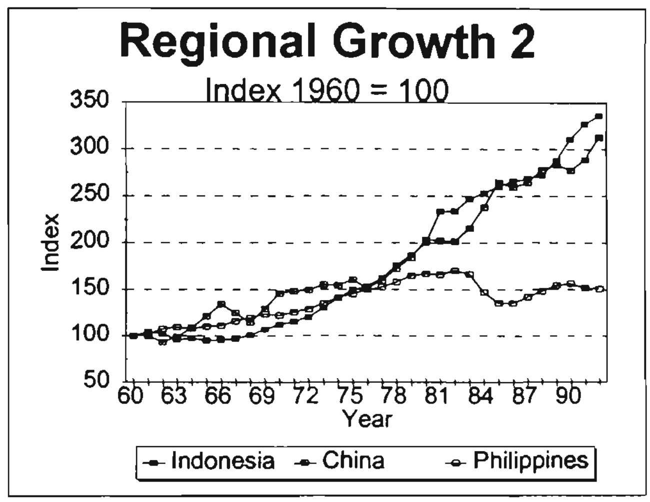
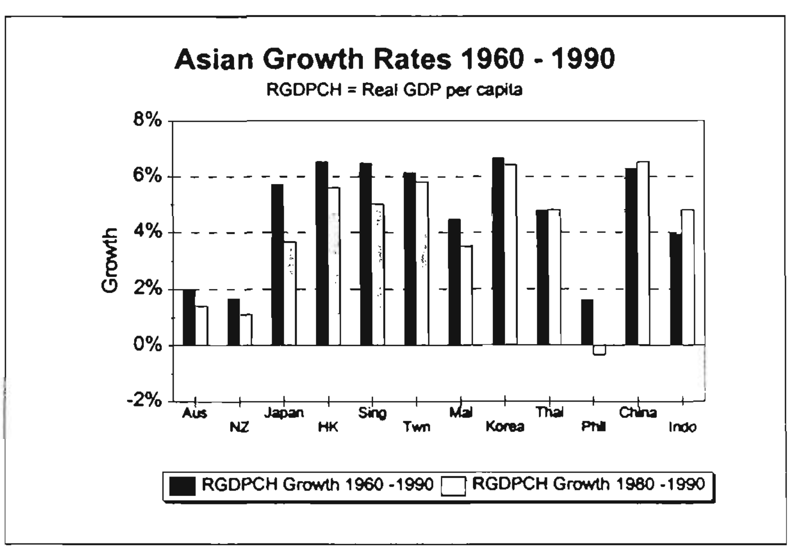


Figure 5-4e



Notes
1) The 'World' category in Figures 5-4a and 5-4b comprises 113 countries from the PWT 5.5 for which data exists for the years 1961-89
2) Estimated values are used for Taiwan (years 1991 & 1992) and Korea (year 1992) in Figure 5-4c
Source: Summers and Heston Penn World Table 5.6

belatedly, after important reforms were introduced in 1990 which significantly improved the incentive environment for export oriented FDI in this sector (Thee and Pangestu 1994).

Indonesia's economy grew rapidly after the deregulation program was initiated in 1985/86, averaging 6.68 percent annual growth over the 1986-96 period, or 7.1 percent growth from 1990-96 (Figure 5-2g). Indonesia's average annual growth over the 1968-86 period was also relatively high at 6.75 percent, but considerably less stable as the economy was far more exposed to the vicissitudes of international oil and commodity markets[52]. The diversification of the export base in the post deregulation period has clearly injected a degree of stability into the economy, as reflected in the relative consistency in growth rates (particularly in the 1990s) and also the stability in growth in total exports (see section 6.3).

5.2.2 Indonesia's Development Record 1960-92

Few economists would dispute that Indonesia's development record over the New Order has been impressive. In 1960 Indonesia's per capita income was US $625[53] and one of the lowest in the world at that time. However by 1990 per capita income had risen to just over US $2100. This dramatic jump in per capita income enables Indonesia to be categorised by UNIDO as a "Semi-Industrialised Country" and by the World Bank as a "Lower Middle Income Country" (Ikhsan et al. 1995; World Bank 1995).

Indonesia's impressive growth performance in relation to the rest of the world is illustrated clearly by the indexes found in Figure 5-4a. Per capita incomes are rebased at 1960=100 as a means to compare per capita growth paths for Indonesia and the rest of the world. Indonesia's growth faltered in the 1960s, reflecting the economic chaos

[52] Average deviation from the mean for growth rates for 1968-86 was 1.64, more than three times the estimated figure for 1986-96 (0.48) and 1990-96 (0.47).
[53] This section uses Summers and Heston 5.6 constant price data to enable cross country comparisons of real living standards (ie GDP per capita using purchasing power parity).

of the final years of the Sukarno administration and the transition period to the New Order government. Beginning in the early 1970s, however, Indonesia's growth outpaced the rest of the world as reflected in the steeper gradient of the country's indexed per capita growth path. This divergence in growth paths is made clearer by rebasing the index to 1966 - the effective beginning of the Suharto period (Figure 5-4b).

In a regional perspective Indonesia's growth over the past three decades appears to be less impressive. Figure 5-4c shows that the first tiered ANICs have clearly enjoyed higher per capita growth over the 1960-92 period compared with Indonesia, as evidenced by the diverging growth indices. The growth performance of Malaysia and Thailand over this period is more consistent with that of Indonesia, however both of these countries have been growing more rapidly than Indonesia since the mid-1980s. Finally, Figure 5-4d shows that Indonesia has recorded similar indexed per capita growth with China, and has clearly outperformed the Philippines where per capita incomes have remained quite flat over the period.

Table 5-2 Human Development Index 1960-92, Indonesia and Selected Regions

Country Group	1960	1970	1980	1992	Increase (1960-1992)
All Developing	0.260	0.347	0.428	0.541	0.281
Least Developed	0.165	0.209	0.251	0.307	0.142
Industrial	0.799	0.859	0.889	0.918	0.119
World	0.392	0.460	0.519	0.605	0.213
East Asia*	0.416	0.547	0.686	0.861	0.446
Indonesia	0.223	0.306	0.418	0.586	0.353

Source: Human Development Report 1994 (UNDP 1994)
Note: East Asia* excludes China.

An alternative way to represent Indonesia's rapid development over the past three decades is by considering other socio-economic indicators, such as education and health. One commonly used indicator of general development is the *Human*

Development Index (HDI) which incorporates life expectancy with education and standard of living measures[54]. Table 5-2 compares the development of Indonesia's HDI with HDI values by country group.

From the above table it can be seen that the improvement in the quality of life in Indonesia over the 1960-92 period (as measured by the increase in HDI) has been more rapid than in the developing and industrial country groups and for the world as a whole. Over this same period however, East Asia recorded a larger absolute increase in the HDI than Indonesia. Of a total sample of 174 countries Indonesia is now ranked 102nd in overall human development (UNDP 1996).

5.3 The Emergence of the Global Knowledge Economy and the Challenge to Indonesia

The previous section outlined the record of Indonesian development in the post-Sukarno period. As discussed, the achievements so far have been impressive. This is reflected *inter alia* by the increase in real per capita income as well as by a strong improvement in the Human Development Index. However as emphasised by Hill (1994 p. 56) Indonesia's economic achievements over the Suharto period must be qualified to a certain extent, and they should not provide any grounds for complacency about meeting new challenges for future development

> Viewed from a 1965 perspective Indonesia's performance has been better than most observers would have dared to hope for. But the record provides no grounds for complacency. Conditions were so disastrous in 1965 that any return to normalcy would have resulted in significant improvements. And although domestic policies have been the critical ingredient, the international environment has generally been supportive.....[However] for a new generation of Indonesians entering the work force, the universities and the political process, a comparison with the 1960s is

[54] The HDI is a composite of three basic components of human development: *longevity* (measured by life expectancy), *knowledge* (measured by a combination of adult literacy and mean years of schooling) and *standard of living* (measured by real GDP per capita using purchasing power parity) (UNDP 1994).

irrelevant. Their future options are defined by what is on offer in the booming East Asian economies, not the stagnation which was present in Indonesia before 1966 and is evident in so many parts of the Third World. Thus, while economic circumstances are no longer as desperate as they were in the 1960s, the challenges to policy-makers in the 1990s are in many respects just as formidable (Hill 1994 p. 56).

There is broad consensus in the modern literature that the global economic context within which countries like Indonesia could rapidly develop over the past 25-30 will be significantly different to that which is expected in the next 25-30 years. The edited volumes by the National Research Council (1995), Simon (1995) and Soesastro and Pangestu (1990) for example provide a broad account of the economic challenges confronting developing countries in the foreseeable future, particularly those from the Asia Pacific region. A central theme to emerge from these and other studies has been the development of the global *knowledge economy*[55] and the challenges and opportunities it poses for future economic growth. Discussed below are two key factors which, amongst others, have given rise to the emergence of a globalised and knowledge driven economy, ie the on-going revolution in information and communication technologies and the rapid process of international deregulation.

5.3.1 The Information and Communications Revolution

As noted by Sheehan et al (1995), Hall and Greenberg (1995), Mayo (1995) and others, a key element in the emergence of the knowledge economy has been the continuing revolution in information and communication technologies. This on-going technological revolution has been the subject of a substantial academic and journalistic literature. However a complete and detailed survey of this literature is clearly an undertaking beyond the scope of this dissertation. Nevertheless, useful overviews of the new and emerging technologies in this area have been provided amongst others by Mayo (1994), Chaudhuri (1995), Sheehan et al (1995), Hall and

[55] According to the OECD (1996) the term *knowledge economy* 'results from a fuller recognition of the role of knowledge and technology in economic growth' whilst *knowledge based economies* are those 'which are directly based on the production and distribution and use of knowledge and information.'

Greenberg (1995), Dicken (1992), Miller (1993) and *Business Week* (June 13 1994). Drawing from this literature it is possible to highlight a number of the key technological advances driving this technological revolution.

- *Semiconductors.* Since the development of the microprocessor by Intel Corporation in 1971 the power of the semiconductor chip has doubled every 18 months [56] whilst prices have halved (*Economist* March 23 1996, Miller 1993). The power of a semiconductor is determined by how many transistors can be crammed onto a chip. Wellenius (1993) notes that the number of active elements per semiconductor chip increased from 1 in 1950 to 1000 in 1970 to over 4 million in 1990[57]. As a result, average price per function of integrated circuits has halved every year; from over $1 in 1965 to about 0.01 cents in 1990 (Dahmen 1993). By early next century, with transistors measuring as little as 400 atoms wide, it is expected that the number that can be crammed onto a chip will reach known physical limits (Mayo 1995). The availability of ever cheaper and more powerful semiconductors has in turn generated an application revolution that affects virtually all electronic products and elements and the products and services of which electronic components and systems are elements (Miller 1993).

- *Fibre-optics Communications.* Various technological developments have significantly enhanced communications technologies over the past few decades. Dicken (1992), for example highlights the economic importance of satellites, cables and faxes to the globalisation process. More recently however, attention has focussed on optoelectronics technologies: the use of sophisticated lasers to transform electronic representations of voice, fax or data into pulses of light which then travel through the optical fibre to their destinations, where they are converted back into their original form (*Business Week* June 13 1994, *Economist* September 30 1995). Further enhancing communication technologies has been various

[56] The original rule as expounded by Gordon Moore, a co-founder of Intel, was that the power of semiconductor chips would double every year (*Economist* March 23 1996).
[57] More recent analysis by Sematech (1995) in their *National Technology Roadmap* shows that the amount of transistors per chip is expected to increase from 64 million in 1995 to 64 gig in 2010, a 1000 fold increase (http://www.sematech.com).

breakthroughs in digitisation which enable all forms of information (eg audio, visual or data) to be transmitted and received in a standard form (Sheehan 1995, Mayo 1995). The consequence of these technological developments has been the ability to transmit ever larger volumes of information at an ever lower cost. Forge (1995) notes that this trend is likely to continue in the future as overall fibre optic transmission capacity is doubling annually (a rate of increase much higher than the demand for bandwidth) whilst the cost of international circuits is falling each year.

- *Software.* Complimenting the above developments in computer hardware and communications have been a number of major advancements in software technologies (Sheehan et al 1995). Mayo (1995) notes that software was once a 'bottleneck' technology because of quality and progammer-productivity problems but has been recently advancing rapidly in important areas such as telecommunications because of advanced programming languages and reuse of previously developed software modules. Today, the ratio of hardware to software cost in computers is 1:1, down from 5:1 in 1970, and whilst the electronics industry as a whole has been growing at 10-12 percent per annum, software production is expected to continue to grow at 30 percent per annum, at least for the short term (Miller 1993). Important developments in software technology include object programming (the practice of breaking computer programs into neat packages, called objects, which then serve as building blocks for larger programs to reduce duplication), the development of artificial intelligence and speech recognition (*Business Week* June 13 1994).

- *Other important technologies.* There are a host of other recent innovations which have complimented, enhanced or help facilitate the major technological developments discussed above. These include the development of parallel processing (the practice of linking together multiple processors and programming them to work in concert), new scanning and imaging technologies, new developments in data capture and storage as well as a new generation of display and copying technologies (Sheehan 1995, *Business Week* June 13 1994, Chaudhuri 1995).

The economic implications of the innovations associated with the information and communications revolution has also been the subject of a substantial literature (eg see Miller 1993, Mayo 1995, Dahmen 1993, Chaudhuri 1995, OECD 1996, Rischard 1995, Wellenius 1993). A common theme to emerge from this literature is that these innovations have generated a rapid and sustained improvement in the speed, capacity and cost of handling information electronically, which has led to a fundamental reshaping of global economic activities. In production systems Miller (1993, p.19) for example writes

> there is a continuing substitution of smaller, cheaper electronic devices for more expensive ones, replacement of electromechanical devices with less expensive electronic components, miniaturisation of equipment, a far broader functionality, and a corresponding expansion of industrial and consumer applications.

It has also been reported that the programmability of many of the new electronic devices has introduced a high degree of flexibility into the production process such as that associated with the development of production on a multiple shift basis and the reduction of product lead times. New advances in microelectronics have also enabled greater heterogeneity of output without any significant reduction in scale economies or product quality (Dicken 1992, Kaplinsky 1985, Hoffman 1985a). According to Rischard (1995) this should allow smaller production units with lower overheads and shorter feedback loops to gain the advantage over larger units.

Another implication of the innovations described above is that economic distances have now shrunk and coordination problems diminished to such an extent that it has, in many cases, become efficient for firms to locate different phases of production in different parts of the world (IMF 1997). A related development seen the rapid growth of remote or teleporting services which has resulted *inter alia* in the export of various jobs (particularly in clerical, administrative, accounting and software development activities) and services (such as education and health) from high wage to low wage countries (Forge 1995)[58].

Another important implication of the information and communications revolution is that there are now shorter lags in the innovation process (eg Jolley 1995, Rischard 1995, Ali 1994). Jolley (1995) for example reports that the major technological breakthroughs in the eighteenth and nineteenth century, such as steam power and electricity, took well over a half a century to reach its full potential. He notes that in more recent years the pace at which new innovations are utilised has increased rapidly. The computer mainframe for example was introduced in the 1960s and its utilisation spread within two decades whilst the personal computer was introduced in 1981 and spread rapidly since.

Shorter lags in the innovation process, has meant that product life cycles are also shortening[59]. As a result, the speed at which technologies are spreading overseas is now much faster (Kodama 1995, Ali 1994). Miller (1993) reports that product life cycles which were formerly 5-15 years are down to 3 years for instrumentation, 1-2 years for computer products and 1 year for consumer electronics. Similarly, the life of a new microprocessor in the early 1990s was down to 4 years, and for an ASIC (application specific integrated circuit) just over one year[60].

At the level of the firm, the information and communication revolution presents new opportunities for product improvements through cost reductions, improved quality, the use of cheaper or more sophisticated materials or components, better customer service, faster response to market requirements (eg through just-in-time inventory methods), the use of worldwide hyper-competitive purchasing practices and improved computer aided design and manufacturing systems. The new technologies have also

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[58] See Forge (1995) and recent surveys by the *Economist* (September 30 1995) for a complete review of the economic and social implications of near-zero telecommunications tariffs.

[59] The well known product cycle hypothesis by Vernon (1966) states that technological innovation takes place in wealthy (high wage) countries, and that product technology is gradually transferred to developing countries where wage levels are low, depending upon the maturity of the technology.

[60] According to Miller (1993) microprocessors and ASICs are both the 'drivers and victims of the shrinking product cycle.'

led to the introduction of new products (eg the PC, new telecommunications products, and a range of entertainment products) and the use of computer technology to transform existing products (scientific equipment, transport equipment and other capital equipment) (Rischard 1995, Jolley 1995).

Also at the firm level, Hall and Green (1995) note that as the pace of technological development and diffusion quickens so too does the rate of obsolescence of knowledge embodied within human and physical capital. Workers may find that the knowledge acquired at school or during the early years on the job are inadequate to deal with latest technologies, and would therefore require further training. They likewise note that equipment and machinery become obsolete more rapidly and a firm which fails to regularly upgrade its physical capital is likely to lose competitiveness.

A final aspect to be considered here relates to the fundamental changes which the new information and communication technologies are generating in the world labour markets. In the OECD economies for example, it has been noted that the development of information-based new technologies is expected to generate higher unemployment, weak overall employment growth and rising wage inequalities between high and low skilled workers (OECD 1996b). For developing countries telecommunications tariffs present new opportunities for the import of service sector jobs from high wage countries (Forge 1995), however this may be offset to a certain extent by the development of labour saving technologies which diminishes the advantage of cheap labour in manufacturing (Junne 1987, OECD 1992).

5.3.2 International Deregulation

Tegart, Johnston and Sheehan (1997) identify another important factor behind the emergence of the global knowledge economy as the rapid pace of economic deregulation experienced throughout the world since the early 1970s. They note that this process of deregulation has taken place across three broad fronts:

1. Through the deregulation of trade through the reduction of tariff and non-tariff barriers.
2. Through the freeing up of capital markets which has seen the general move toward floating exchange rates, the deregulation of finance and other service sectors and the reduction of impediments to foreign direct investment, portfolio capital flows and technology transfer.
3. Though the deregulation of internal markets for goods, services and capital.

Moves toward international deregulation began in the post war era as early as 1947 with the signing of the General Agreement on Tariffs and Trade (GATT) in that year. However progress toward an open world trading system remained slow until the mid 1960s (Pomfret 1995). With increased pressure for tariff reform in the Tokyo Round of GATT, effective tariff rates in the advanced countries fell from about 12 percent in the early 1960s to less than 3 percent in the early 1990s (IMF 1997). According to Tegart et al (1997), with the establishment of the World Trade Organisation in 1995 and a number of other regional developments (such as APEC and NAFTA), further global reductions in barriers to trade in goods and services are inevitable over the next decade.

A similar trend has occurred in world financial markets. Throughout the post war period prior to 1971, the Bretton Woods system ensured that global economic development took place within the context of inflexible exchange rates and limited capital flows (Tegart et al 1997). However, with the collapse of the Bretton Woods system in 1971, followed by further moves toward financial deregulation and the realignment of major currencies in the mid 1980s, there was a dramatic increase in the international flows of capital, particularly in the second half of the 1980s. Large flows of capital across national borders continues to be a key feature of the global economy in the 1990s.

5.3.3 Ideas and Indonesia's Response to the Global Knowledge Economy

An important implication of this process of international deregulation has been a dramatic increase in quantity and speed of global flows of traded goods and services, financial capital and technology. This in turn has contributed to the on-going process of economic globalisation where countries are increasingly integrated into a single international economy. The interconnectivity and interrelatedness across individual economies which characterises the global economy, makes it difficult for countries seeking rapid growth and development to do so in an entirely isolated manner (IMF 1997). More importantly, changes in economic conditions, both adverse and favourable, which are experienced in one country and/or set of countries, are likely to generate changes in other countries depending upon the degree of interconnectivity. A recent example is the turmoil experienced by equity and financial markets the world over in October 1997 which was precipitated by adverse developments in a number of South East Asian economies. The Indonesian economy fared badly as a result and expectations for economic growth have been significantly downgraded for the 1997/98 years (*Economist* November 8 1997)[61].

Indonesia has thus recently felt the full impact of the type of pressures which a globalised economy can place upon a single economy. One of the lessons that can be drawn from recent experiences is that there are clearly a broad range of issues relating to the nature of an increasingly globalised international economy and its implications for Indonesia which deserve further research. The central focus of this thesis however is importance of new ideas and innovation to Indonesian industry with the context of the emerging global knowledge economy

In the above discussion, the emergence of the global knowledge economy was reported to be driven in large part by new innovations in information and communications technologies and the process of international economic deregulation. The fundamental changes which these developments confer upon economic systems

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[61] See references in footnote #2.

suggests that supply and demand conditions confronting both developed and developing countries will be changing rapidly in the future. This raises important questions to be considered in subsequent chapters of the dissertation: *Firstly*, does the emergence of the international knowledge economy present new demand side challenges for Indonesia, or can it continue to develop as it has for the past three decades? *Secondly*, from both an industry and policy perspective what has Indonesia's response to-date been to these new technological developments; and *thirdly,* what role does policy play in constraining or facilitating growth within the context of the international knowledge economy. These questions will be considered respectively in subsequent chapters.

6. Indonesian Exports in the Global Knowledge Economy: Demand Side Pressures to Upgrade

6.1 Introduction

In the previous chapter it was shown that Indonesia's development and growth record over the past quarter of a century has been impressive. This is evidenced by rapid increases in per capita income and a substantial improvement in a number of social indicators.

Whilst it is important to acknowledge the country's development achievements thus far, it is equally important to consider whether this rapid pace of development will be able to continue in the future. This is because it has become increasingly clear that the global economic context within which Indonesia has been able to grow rapidly over the past 30 year period will be significantly different to that expected in the next 30 years.

Whilst there are a host of factors expected to contribute to this change, there is perhaps none more fundamental than the combined effect of the trend toward international economic deregulation and the ongoing revolution in information and communications technologies, leading to the emergence of what many refer to as the *global knowledge economy*. As noted in Chapter 5 an important implication of the emergence of the global knowledge economy is a fundamental transformation in consumption and production activities the world over. This suggests that demand conditions in international trade should be changing rapidly in favour of more knowledge intensive products and industries. Thus, orientation to world demand growth can represent a useful indicator of a particular country's ability to participate in the global knowledge economy.

Section 6.2 in this chapter will measure Indonesian export orientation to world demand growth as a means to assess the challenge posed by changing global conditions to the Indonesian economy, and also to assess Indonesia's comparative performance within those changing circumstances over the 1980-95 period. The results of the empirical analysis in this section suggest that Indonesia has been improving its orientation toward high growth industries, particularly in the post-deregulation period, but nevertheless continues to exhibit a less dynamic export structure than most other countries in the region.

Section 6.3 provides a more qualitative analysis of those demand side pressures which compel low wage and commodity exporting countries such as Indonesia to upgrade to more knowledge intensive activities. These include international trends which affect demand for agriculture and other primary products as well as recent trends within manufacturing which adversely affect low technology and labour intensive producers.

6.2 Measuring Indonesia's Orientation to World Demand Growth

Two separate data sets are used to assess the orientation of Indonesian exports to world demand growth. The first is SITC three digit export data for 181 product groups from seven countries: Indonesia, Malaysia, Thailand, China, Singapore, Korea and Taiwan, Hong Kong, as well as export data for the world as a whole. In many cases the data are separated into the following industry classifications.

Table 6-1 Industry Categories using 3 digit SITC (rev1) Trade Data

Industry Category	SITC (rev1) Code
Manufacturing	SITC 5 to 8 (excluding 68)
Primary	
Agriculture	SITC 001 to 271, 291, 292, 4
Oil and Gas	SITC 3
Mining and Metals	SITC 272 to 286, 68
Other	SITC 9

These categories should be considered as broad representations of the respective industries, as a more accurate categorisation would require a much higher degree of disaggregation. It should be noted that there are a number of manufacturing activities contained within the agriculture category, such as the processed food, drink, animal and vegetable oils. Also, following UNCTAD (1996a) and others, non-ferrous metals (SITC 68) are not included within the manufacturing category due to their low value added content and price volatility, characteristics more commonly associated with primary commodities.

The second export data set uses manufacturing export data concorded with ISIC 3 industry data. Following an approach developed by the OECD Secretariat, the manufacturing data is divided into 22 industries in order of decreasing knowledge intensity (see OECD 1994). The knowledge intensity of an industry is represented by the average level of business expenditure on R&D per unit of production in that industry as measured across 13 of the largest economies in the OECD (which account for more than 95 percent of industrial R&D performed in the OECD). It can be seen from Table 6-2 that *aerospace* (1) is the most knowledge intensive manufacturing activity whilst the lowest is *furniture and wood* (22). The industries are also categorised into four sub-groupings according to knowledge intensiveness: ie high, medium-high, medium low and low.

6.2.1 Regional Comparison

A recent report released by UNCTAD (1996a) assesses the performance of the first tiered NICs (Hong Kong, Taiwan, Singapore and Korea), the second tiered NICs (Thailand, Malaysia and Indonesia) as well as a number of Latin American countries

Table 6-2 OECD Industry Groups by Technology Intensity (22 Manufacturing Industries)

Tech. Group	R&D Ratio (%)	Industry Group	ISIC Codes	Avg. Annual World Demand Growth 1980-95	Growth Ranking 1970-95	Expanding OECD Imports 1970 - 95
High						
1	20.2	Aerospace	3845	6.7%	13	
2	12.4	Computers	3825	15.2%	1	X
3	10.8	Electronics	3832	13.0%	2	X
4	10.3	Pharmaceuticals	3522	10.3%	3	X
Medium-high						
5	4.8	Instruments	385	8.4%	6	X
6	3.5	Motor Vehicles	3843	7.9%	7	X
7	3.4	Chemicals	351, 3521, 3523, 3529	7.0%	12	X
8	3.2	Electrical Machinery	3831, 3833, 3839	10.0%	4	X
Medium-low						
9	2.1	Machinery	3821-4, 3929	6.2%	15	
10	1.9	Other transport equipment	3842	5.0%	18	X
11	1.4	Shipbuilding	3841	6.0%	16	
12	1.1	Petroleum Refining	353, 354	-0.5%	22	
13	1.1	Stone, Clay and Glass	36	6.4%	14	
14	1	Other Manufacturing	39	7.3%	10	X
15	1	Rubber and Plastics	355, 356	9.8%	5	
16	0.9	Non-ferrous Metals	372	4.0%	21	
Low						
17	0.7	Ferrous Metals	371	4.2%	20	
18	0.6	Fabricated Metals	381	5.9%	17	X
19	0.3	Food, Drink and Tobacco	31	5%	19	
20	0.2	Paper and Printing	34	7.7%	8	
21	0.2	Textiles and Clothing	32	7.3%	9	
22	0.2	Wood and Furniture	33	7.0%	11	

Notes
Column 1: percentages indicate the average level of business expenditure on R&D per unit of production in that industry for the OECD taken as a whole (following OECD 1994).
Column 2: the average annual growth for the World's manufactured exports (imports) over the 1980-1995 period
Column 3: the rankings of the 22 industries as per world demand growth in column 2
Column 4: industry groups marked with an X have been expanding as a share of OECD imports (USA, Canada, Japan and the EEC7) over the 1970-1995 period.

Table 6-3 Sectoral Orientation of Exports of the First and Second Tiered Asian NICs in 1990 (share of exports in fast growing OECD import sectors)

Country	Share of Exports in Expanding OECD Import Sectors
Hong Kong	91.0
Taiwan	83.9
Singapore	83.3
Korea	82.0
Thailand	66.7
Malaysia	60.8
Indonesia	39.5

Source: UNCTAD (1996a)
Note: A fast growing OECD import sector is defined as one in which imports into OECD countries as a proportion of total OECD imports increased over the 1963 to 1990 period.

in their efforts to upgrade export competitiveness[62]. According to the report 'entering and adapting to markets in the more advanced countries is crucial for establishing competitive industries and for successful upgrading.' Country (or regional) performance is thus determined by orientation to expanding OECD import markets. In this respect, the report found that the first and second tiered Asian NICs were the only developing regions to consistently increase their market shares in expanding OECD import sectors over the 1963-90 period, despite beginning the period with factor endowments similar to all other developing regions.

Table 6-3 shows that by 1990 the first tiered NICs structured over 80 percent of their export industries in favour of fast growing OECD import sectors. All second tiered NICs commanded less than 70 percent of expanding OECD import markets. Indonesia's share, which was less than 40 percent, resembled that recorded by other developing countries, particularly those from Latin America (UNCTAD 1996a).

[62]The report received considerable attention in Indonesia as it explicitly considered Indonesia's competitiveness *vis a vis* a number of other countries in the region - see for example articles discussing Indonesia's relative export performance in *Kompas* (20, 24 & 26 September 1996).

A similar exercise was carried out by the author using the 22 industry manufacturing data described above. In contrast to the UNCTAD (1996a) study, orientation to expanding OECD import markets was measured over a 25 year period (ie 1970-95) and limited to the manufacturing sector. An import market is considered to be expanding if that sector's share of total imports increased over the 1970-95 period. Those sectors are indicated in the seventh column of Table 6-2. Orientation to expanding OECD import markets is the share of a particular country's exports which fall within those expanding OECD import markets.

The results of this analysis are presented in Figures 6-1 which compare the orientation of Indonesia's manufacturing exports to expanding OECD manufacturing import sectors with that of Malaysia, Thailand, China, first tiered ANICs and the world. Throughout the period Indonesia lagged all other sample countries in penetrating expanding OECD manufactured import markets. During the 1984-87 period Indonesia's orientation to these markets was actually declining whilst most other countries were rapidly increasing their penetration. After the deregulation measures described in the previous chapter were carried out in 1985/86, Indonesia's penetration of OECD import markets improved substantially: increasing from 6.8 percent in 1987 to 34.2 percent in 1995. The results are therefore consistent with the view that the restrictive trade policy environment prior to the mid 1980s constrained Indonesia's ability to compete in the more dynamic export industries.

An alternative method to assess the sectoral orientation of East Asian exports is to consider each country's penetration of rapidly growing world markets rather than just the dynamic or expanding import markets in the OECD. This is particularly relevant for Indonesia, as exports to OECD destinations as a proportion of total exports declined over the 1987-95 period. In 1987 over 75 percent of Indonesia's exports were sold in OECD countries. By 1995 this figure had fallen to less than 59 percent (BPS data).

From the 22 manufacturing industries outlined in Table 6-2 it is possible to identify a group of 'high demand growth industries' which comprises the five fastest growing manufacturing industries in world trade over the 1980-95 period: *computers, electronics, pharmaceuticals, electrical machinery* and *rubber and plastics*. Determining the number of industries to include with the high growth category is somewhat arbitrary. However, as can be seen from Table 6-4 an obvious lower boundary to this grouping appears under *rubber and plastics*.

Table 6-4 OECD 22 Industry Groups by World Demand Growth

Industry No.	Industry Group	Avg Annual World Demand Growth 1980-95	R&D Ratio
2	Computers	15.2%	12.4
3	Electronics	13.0%	10.8
4	Pharmaceuticals	10.3%	10.3
8	Electrical Machinery	10.0%	3.2
15	Rubber and Plastics	9.8%	1
5	Instruments	8.4%	4.8
6	Motor Vehicles	7.9%	3.5
20	Paper and Printing	7.7%	0.2
21	Textiles and Clothing	7.3%	0.2
14	Other Manufacturing	7.3%	1
7	Chemicals	7.0%	3.4
22	Wood and Furniture	7.0%	0.2
1	Aerospace	6.7%	20.2
13	Stone, Clay and Glass	6.4%	1.1
9	Machinery	6.2%	2.1
11	Shipbuilding	6.0%	1.4
18	Fabricated Metals	5.9%	0.6
10	Other transport equipment	5.0%	1.9
19	Food, Drink and Tobacco	5.0%	0.3
17	Ferrous Metals	4.2%	0.7
16	Non-ferrous Metals	4.0%	0.9
12	Petroleum Refining	-0.5%	1.1

Note: Column definitions as per Table 6-2

The sectoral allocation of manufactured exports in this category provides a measure of orientation to the most dynamic industries in world trade as illustrated in Figure 6-2. Clearly apparent from both figures is the relatively small orientation of Indonesian manufactured exports toward the high demand growth category over the sample period. By 1990 less than 10 percent of Indonesia's manufactured exports were from this category, whereas other countries such as Malaysia and Thailand were clearly more established in these industries at this time. Indonesia was able to improve its orientation to the high growth category rapidly in the first half of the 1990s, but was still the lowest in the sample in 1995.

Table 6-4 shows that *rubber and plastics* is a an industry with a relatively low knowledge intensity but has enjoyed rapid world export growth over the 1980-85. If excluded from the high growth category, Indonesia's sectoral allocation in 1995 to these exports falls from 21.6 to 10.4, further highlighting the country's relatively low orientation to dynamic export industries.

Table 6-5 Computer and Electronics as a proportion of total manufactured exports (percentage)

	1980	1985	1990	1995
Hong Kong	13.9	14.7	17.1	19.7
Taiwan	14.2	15.0	22.1	33.0
Singapore	19.3	24.5	40.8	57.3
Korea	11.7	13.9	24.6	31.0
China	0.6	2.1	9.5	14.2
Thailand	2.2	2.8	19.0	24.1
Malaysia	19.3	27.7	39.8	51.1
Indonesia	3.3	2.6	1.1	8.7

Source: Processed CSES estimates using data from IEDB, ANU.

As noted above, the two most dynamic export industries in world trade over the 1980-95 period were *computers* (15.2 percent) and *electronics* (13.0 percent). These two industries have clearly dominated East Asian exports over the 15 year period (Table 6.3). In all eight sample countries listed the share of computers and electronics increased significantly; in most cases more than doubling. By contrast the share of computer and electronics in Indonesian manufactured exports declined during the 1980s. However, robust growth in electronics exports in the early 1990s enabled the share to increase to more than 8.7 percent in 1995. Despite this rapid growth, the share of computers and electronics in manufacturing exports in 1995 was still low by regional standards, particularly when compared with Singapore and Malaysia (Table 6-5).

Figure 6-1
Sectoral Orientation of Manufactured Exports in Expanding OECD Manufacturing Import Sectors 1970-95

Figure 6-1a

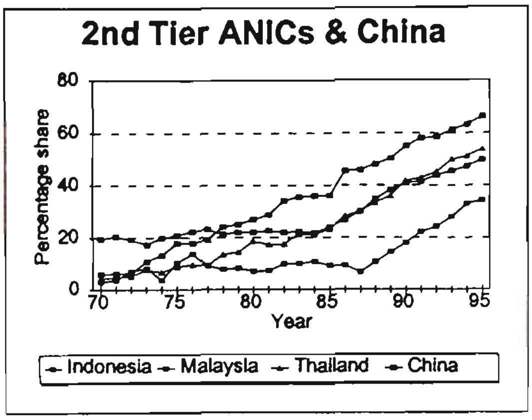
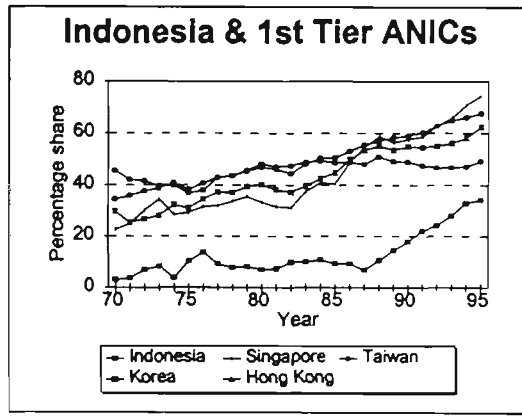


Figure 6-1a



Summary

Year	Indonesia	Malaysia	Thailand	China	Singapore	Taiwan	Korea	Hong Kong	World
1970	3.0	5.9	4.2	19.4	22.6	34.5	29.8	45.6	43.2
1975	10.3	17.8	8.9	20.8	29.2	38.3	31.1	36.8	41.9
1980	7.0	26.9	18.6	22.0	33.4	47.0	40.2	48.2	45.7
1985	9.3	36.2	23.3	23.9	40.5	50.6	44.7	48.7	50.6
1990	17.9	55.1	41.8	41.0	57.6	59.0	55.0	49.0	51.7
1995	34.2	66.2	53.9	49.8	74.5	67.8	62.5	49.2	57.5

Note:
1) Expanding OECD manufacturing import sectors are those that increased their share of total OECD imports over the 1970-95 period - as indicated in table 6
2) OECD here is defined as USA, Canada, Japan and the EEC7.
Source: Processed CSES estimates using IEDB, ANU.

Figure 6-2
Sectoral Orientation of Manufactured Exports in High Demand Growth Industries 1970-95

Figure 6-2a

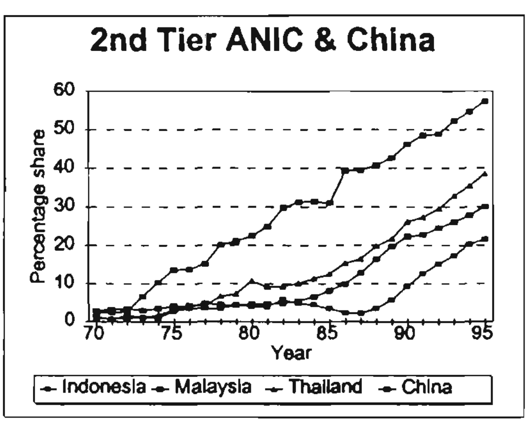
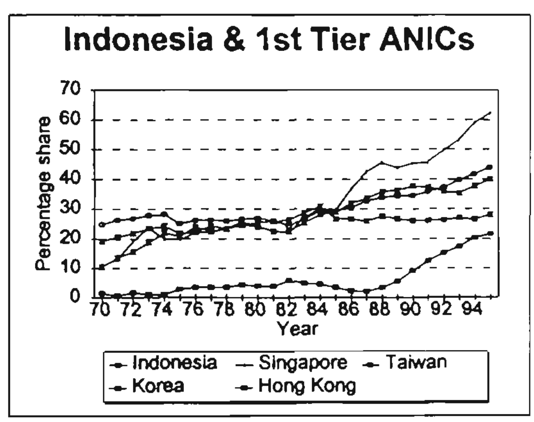


Figure 6-2b



	Indonesia	Malaysia	Thailand	China	Singapore	Taiwan	Korea	Hong Kong	World
1970	1.5	2.3	0.9	2.9	10.8	24.8	10.5	19.2	11.2
1976	2.8	13.6	3.2	4.1	19.7	25.0	20.8	21.8	11.3
1980	4.0	22.5	10.7	4.6	24.4	27.0	24.0	25.4	12.7
1985	3.5	31.0	12.5	8.1	29.5	29.1	29.0	26.6	15.9
1990	9.2	46.2	26.1	22.3	45.4	34.6	37.8	26.1	18.8
1995	21.6	57.3	38.5	30.0	62.3	43.9	40.0	28.1	24.8

Excluding Rubber and Plastics

1970	1.5	1.1	0.3	2.0	8.2	16.3	7.1	11.2	9.6
1976	2.5	7.4	2.5	2.9	17.8	16.6	12.2	14.8	9.5
1980	3.8	21.2	8.8	3.5	22.0	18.3	12.9	18.0	10.8
1985	3.0	29.8	10.1	4.6	27.9	19.7	15.4	20.5	14.0
1990	1.9	43.9	22.4	14.6	43.3	28.2	26.5	22.6	16.3
1995	10.4	55.7	30.7	21.1	60.4	40.5	34.5	26.0	22.1

Note
1) See text for definition of high demand growth industries.
Source: Processed CSES estimates using IEDB, ANU.

An important problem with the two approaches outlined above is that there may be considerable differences of values within categories and/or closeness in values for industries either side of category boundaries. For example, in the analysis underlying figures 6-2a and 6-2b, those markets which increased their share in total OECD import markets included those with a strong increase in market share (eg *computers* and *electronics*) and those with just a marginal increase (eg *other transport equipment* and *fabricated metals*). Moreover, as noted above the choice of how many industries to include in the high demand growth category used in Figure 6-2 is necessarily arbitrary. Including *rubber and plastics*, the fifth most rapidly growing industry in world trade in this high growth category (growing on average only 0.2 percent less than *electrical machinery*) significantly alters the high growth orientation for Indonesia (a major exporter of rubber). Developed in the next section are a number of weighted indexes which avoid such categorisation problems and enable a more continual assessment of a country's export performance over time.

6.2.2 Index of Growth Intensity (GI)

The index of growth intensity (GI) developed in this section measures growth orientation for a complete set of exports whereby a country i's exports by industry or commodity classification j are weighted by the average growth in world exports for the period 1980-95. The index of growth intensity can be formally expressed as

$$GI^i = \frac{\sum_j^n \left(X_j^i . G_j\right)}{\left(\sum_j^n X_j^i\right) . G_0} \qquad (1)$$

where i is the country, j is the industry, G is the rate of growth in world demand (average 1980-94) for the specific industry, product or product group whilst n is the total number of industries included. G_0 is the average growth rate across all n industries

$$G_0 = \frac{\sum_{j}^{n} G_j}{n} \qquad (2)$$

The index is influenced not by increasing overall value or quantity of exports but by the changing structure of exports. An index value greater than one indicates that country i's exports are concentrated in industries with a high growth in world demand whilst a value less than one indicates a concentration in lower growth industries. An upward sloping index thus indicates that country i is changing its export structure in favour of higher growth industries. The index would be constant in the unlikely event that country i's export structure remains unchanged throughout the period.

The two different data sets described earlier are used to generate growth intensity indexes for the seven ANICs (Table 6-1) and China. The first dataset uses 3 digit SITC export data across 181 categories (n) for all exports from the sample countries. Average world growth rates over the 1980-95 period for each of the 181 categories are used as weights (G) in the above formula. The second dataset uses the 22 manufacturing industries data, with average world growth rates for the exports for each of these industries used as weights.

The four graphs in Figure 6-3 show the estimated indexes comparing Indonesia's exports performance with seven other East Asian countries, the region and the world. All graphs show upward sloping indexes suggesting a general move into more dynamic export industries. By the early 1990s all sample countries, except Indonesia, had an index value exceeding unity indicating an export concentration in favour of high growth industries. Indonesia's GI index had increased for most of the period, however by the end of the period it had yet to exceed unity indicating that the country still exhibited (albeit marginally) an export concentration in favour of less dynamic industries.

Figure 6-3a compares Indonesia's GI index with the first tiered Asian NICs (Singapore, Korea, Hong Kong and Taiwan). The indexes for both Korea and Taiwan began the period well above one, suggesting that these two countries were well structured to meet world demand growth over the subsequent fifteen year period. The slight increase in their GI indexes over the period shows that they were able to further restructure in favour of high growth industries. Singapore began the period much lower than Korea or Taiwan but was able to restructure its exports at such a rapid rate that by 1995 it had an index value exceeding the other two. Throughout the period, the GI index for Hong Kong was relatively flat suggesting that the colony did not restructure in favour of more dynamic export industries. As expected Indonesia was positioned well behind the first tiered NICs throughout the period but by 1995 had almost caught-up with Hong Kong and was also able to converge slightly with Korea and Taiwan.

Using the world GI index as a benchmark, Korea, Taiwan and Singapore continue to exhibit an above-average export performance. However, since 1985 Hong Kong's growth orientation has clearly been below world average. Over the 15 year period Indonesia remained clearly behind, although converging slightly with, the world average.

Figure 6-3b compares Indonesia with Malaysia and Thailand, the two other second tier NICs with endowments more directly comparable with that of Indonesia. The indexes for Malaysia and Thailand have been clearly higher than Indonesia's over the period suggesting a better export orientation to world demand growth. The Indonesian index has converged to certain degree with that of Thailand but has clearly diverged with that of Malaysia since 1987. Since the late 1980s/early 1990s both Malaysia and Thailand have enjoyed better-than-average orientation to world demand growth.

Figure 6-3c also shows that the GI index for China has been higher than the Indonesian index throughout the 1980-95 period. Although converging with Indonesia in the first half of the 1980s, China's index since 1985 has grown more rapidly. Moreover since 1989 China has enjoyed an increasingly better-than-average orientation to world demand growth. The final graph, Figure 6-3d, shows that Indonesia's GI index has converged with the world average, but only slightly with an average of the seven other sample Asian economies.

The second dataset uses manufacturing exports (ISIC 3) as categorised into 22 industry groups by the OECD. As found above, Indonesia lagged all other countries in the region in the move toward more dynamic export markets over the 1980-95 period (Figure 6-4a and 6-4b). Indonesia was able, however, to exhibit a degree of convergence or 'catch-up' with the world average and, to a lesser extent, the region (Figure 6-4c) However, by excluding computer and electronics, the world's most rapidly growing export markets over the 1980-95 period, it can be seen in Figure 6-4d that the GI indexes for Indonesia, East Asia and the World had all converged by the early 1990s. The significant fall in the East Asian index with the exclusion of computers and electronics suggests that these two industries played a critical role in the region's export success. Conversely, with little change occurring in the Indonesian index it can be concluded that these two industries have played a relatively minor role in that country's export performance.

Combined with the observation that the Indonesian GI index continues to lag other countries in the region, such results are consistent with the view that Indonesia has been relatively slow in exploiting new export opportunities associated with changing global economic circumstances due to its inability to better compete in the computers and electronics industries - two industries described earlier in section 5.3 to have played a critical role in the development of the global knowledge economy.

Figure 6-3

Index of Growth Intensity (All Exports) 1980-95

Using SITC 3 digit data - 181 Product Groups

Figure 6-3a

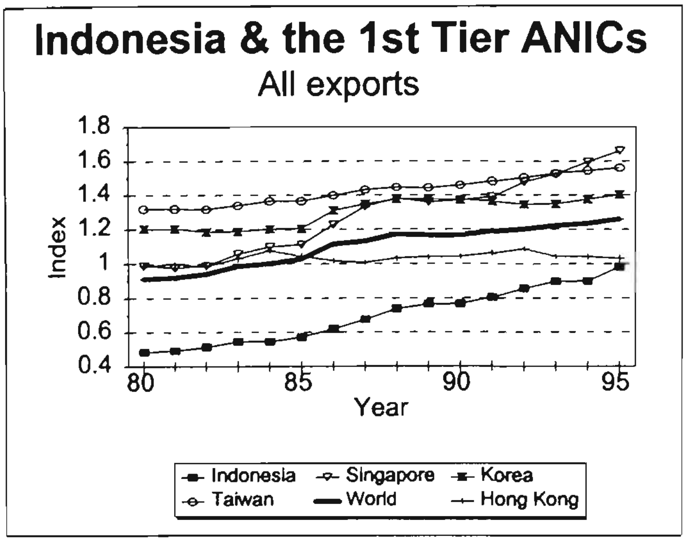


Figure 6-3b

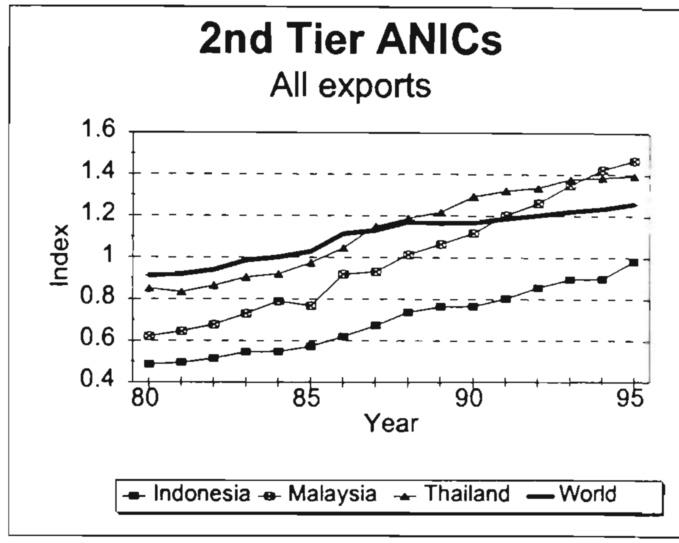


Figure 6-3c

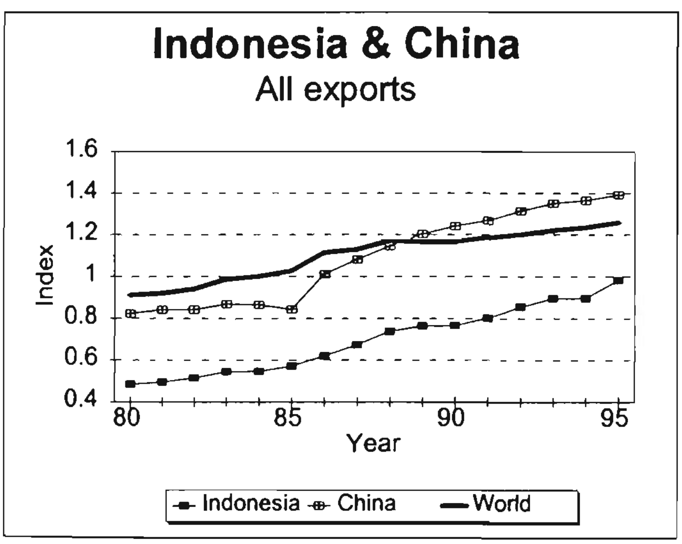
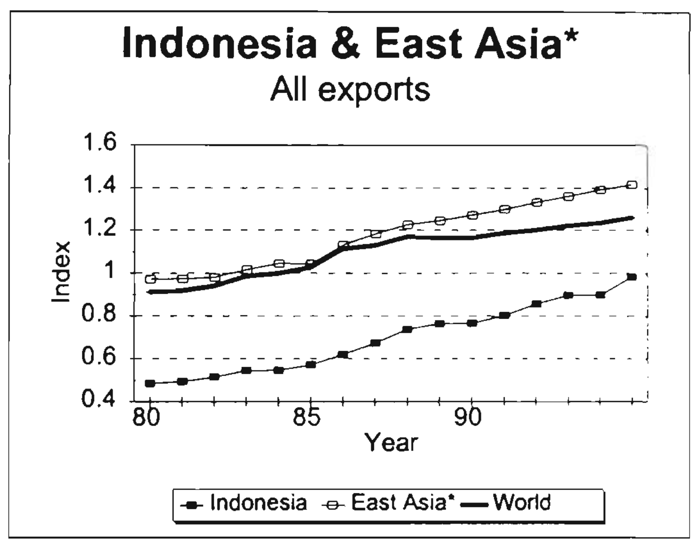


Figure 6-3d



Note:

'East Asia* is defined here to include Singapore, Taiwan, Hong Kong, Korea, China, Malaysia, Thailand but in this instance excludes Indonesia.

Source: Processed SITC (rev1) trade data from IEDB, ANU.

Table 6-6 Summary of Indices of Growth Intensity

	All Exports		Manufacturing Exports		
	1980	1995	1980	1995	1995 (excl. C&E)
Indonesia	0.48	0.98	0.46	1.02	1.03
Malaysia	0.62	1.47	0.96	1.39	1.01
Thailand	0.85	1.39	0.83	1.21	1.08
China	0.82	1.39	0.84	1.15	1.14
Singapore	0.99	1.66	0.74	1.43	0.85
Korea	1.20	1.40	1.07	1.22	1.05
Taiwan	1.32	1.56	1.10	1.30	1.08
Hong Kong	0.99	1.03	1.18	1.21	1.15
East Asia*	0.91	1.36	0.90	1.24	1.05
World	0.91	1.26	0.91	1.09	1.03

Note: East Asia* excludes Indonesia
C&E refers to electronics and computers (as defined in Table 6-2)

6.2.3 Summary

The empirical analyses carried out in this section shows that Indonesia lags all other countries in the region in the move toward a more dynamic export structure, as determined by the demand trends in both the OECD and international import markets. As expected Indonesia's export structure is significantly less oriented to world demand growth than the first tiered NICs, but is also lagging the more similarly endowed economies of Thailand, Malaysia and China. Nevertheless, some measures of growth orientation exhibit a limited degree of convergence between Indonesia and the other sample countries over the 1980-95 period. This was particularly the case after 1985 for manufacturing exports. There is, however, little indication of convergence between Indonesia and East Asia using total exports.

An important observation to make is that the most dynamic industries in world trade tend also to be the most knowledge intensive. The role of computers and electronics as key elements in the information and communications revolution is reflected by the high demand growth for products from these two industries. Computers and electronics also represent the key element differentiating the manufacturing export performance of Indonesia and other East Asian countries. Excluding computers and electronics enables Indonesia's growth intensity index to converge with an East Asian/World average. This suggests that a critical factor behind Indonesia's inability to develop a more dynamic export structure is its relatively small international presence in computers and electronics.

6.3 Demand Side Pressures to Upgrade Indonesian Exports

In the previous section it was shown that Indonesia lags a number of other countries in the region in the move toward more dynamic export industries. This was reflected in the various measures of export orientation to areas of high demand growth in both OECD and world import markets. Whilst it should be acknowledged that there are a broad range of factors influencing the level of demand for Indonesia's exports, it is nevertheless useful to highlight two key international trends which help explain Indonesia's lack of export dynamism, and why exports must be upgraded if the country is it to maintain and improve competitiveness in the future. Discussed below are two such important trends. The first relates to pressures to move away from primary export activities in favour of manufacturing, whilst the second include a number of developments within manufacturing which compel labour and resource intensive manufacturers to upgrade in favour of more knowledge intensive activities.

6.3.1 Lagging Industry Adjustment

Throughout the 1970s and early 1980s Indonesian economic development was heavily dependant upon natural resources. Agriculture and mining not only provided the bulk of employment and output but also most of the foreign exchange and budget revenues (Hobohm 1987). This dependence upon natural resources can be seen in the sectoral share of GDP for agriculture and mining in Table 5-1. In 1973 the combined share of these two sectors was 52.4 percent falling to 43.5 percent in 1983. The dependence upon natural resources at that time is also reflected in export figures which show the non-manufacturing share of exports exceeding 97 percent in throughout the 1967 to 1981 period (Table 6-7).

A recurrent theme in the literature on Indonesia's development in the New Order period has been the process of rapid structural change away agriculture, mining and oil and into manufacturing[63]. Various data highlight this rapid change in industry structure. From Table 5-1, it can seen that manufacturing as a percentage of GDP, increased from 8.4 percent in 1973 to over 24 percent in 1996. Moreover, from Table 6-8 it can be seen that Indonesia had the fastest growing manufactured exports over the 1980-95 period of the eight sample East Asian countries. In 1980 manufacturing commanded only 2.2 percent of total exports, however by 1995 this share had increased to 49.8 percent[64]. It should be noted that the rapid decline in the export share of oil and gas, particularly in the mid-late 1980s, exaggerates the growth in the manufacturing share. However, even within the non-oil export category, the growth in the manufacturing share has been remarkable, rising from 7.8 percent in 1980 to just under 65 percent in 1995 (Table 6-7)

Despite the rapid growth in manufacturing activities over the period, Table 6-8 shows that Indonesia by 1995 still exhibited the highest dependence upon primary exports (as reflected in the percentage share of primary exports in total exports) of the sample East Asian countries, including China and the other second tier ANICs, Malaysia and Thailand. Indonesia's primary export share of 50.2 percent far exceeds the average for

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[63]See for example the various accounts of Indonesia's recent economic development provided by Hobohm (1987), Woo et.al (1994) and Hill (1996) and others.

[64] This theme that Indonesia underwent more rapid rates of structural change than other developing countries was explored empirically by Ikhsan, Basri and Saleh (1995) who compared the country's "actual" pattern of structural change with the "normal" international pattern as determined by Chennery and Syrquin (1988) in their empirical study of structural change for 118 countries over the period 1950-83. They find that the fall in the agriculture sector's share of Indonesia's GDP over the same period was far more pronounced than the normal international pattern. This was accompanied by a higher than average growth in the manufacturing share.

Table 6-4

Indonesian Export Structure 1965 - 1995

Year	Total Exports (US $,000)					Share of Total Exports					Share of Non-Oil Exports		
	Manuf.	Agric.	Minerals & Mining	Oil & Gas	Total	Manuf.	Agric.	Minerals & Mining	Oil & Gas	Total Primary	Manuf.	Agric.	Minerals & Mining
1965	26,649	381,398	42,267	271,744	722,100	3.7	52.8	5.9	37.6	96.3	5.9	84.7	9.4
1966	30,496	407,855	35,728	203,420	677,601	4.5	60.2	5.3	30.0	95.5	6.4	86.0	7.5
1967	11,214	340,689	60,171	239,602	662,815	1.7	51.4	9.1	36.1	96.6	2.6	80.5	14.2
1968	8,562	371,025	50,311	296,797	728,075	1.2	51.0	6.9	40.8	98.6	2.0	86.0	11.7
1969	9,636	360,692	44,651	378,595	798,189	1.2	45.2	5.6	47.4	98.2	2.3	86.0	10.6
1970	9,992	569,712	124,151	346,335	1,052,914	0.9	54.1	11.8	32.9	98.8	1.4	80.6	17.6
1971	15,787	640,097	59,849	477,913	1,198,367	1.3	53.4	5.0	39.9	98.3	2.2	88.8	8.3
1972	28,456	738,248	88,961	913,094	1,775,428	1.6	41.6	5.0	51.4	98.0	3.3	85.6	10.3
1973	58,042	1,393,071	140,123	1,608,698	3,208,304	1.8	43.4	4.4	50.1	97.9	3.6	87.1	8.8
1974	57,298	1,823,542	322,097	5,211,364	7,422,842	0.8	24.6	4.3	70.2	99.1	2.6	82.5	14.6
1975	84,991	1,452,101	252,051	5,338,499	7,130,205	1.2	20.4	3.5	74.9	98.8	4.7	81.0	14.1
1976	118,672	2,125,551	293,603	6,013,932	8,556,315	1.4	24.8	3.4	70.3	98.6	4.7	83.6	11.5
1977	173,994	2,906,905	380,383	7,378,105	10,852,621	1.6	26.8	3.5	68.0	98.3	5.0	83.7	10.9
1978	196,231	3,028,593	413,915	7,985,436	11,643,172	1.7	26.0	3.6	68.6	98.2	5.4	82.8	11.3
1979	399,731	4,352,320	634,129	10,163,762	15,590,149	2.6	27.9	4.1	65.2	97.2	7.4	80.2	11.7
1980	481,857	4,773,301	881,217	15,740,009	21,908,885	2.2	21.8	4.0	71.8	97.7	7.8	77.4	14.3
1981	656,035	2,960,750	824,355	17,759,026	22,260,342	2.9	13.3	3.7	79.8	96.8	14.6	65.8	18.3
1982	798,698	2,368,541	702,730	18,364,127	22,293,340	3.6	10.6	3.2	82.4	96.2	20.3	60.3	17.9
1983	1,372,453	2,623,782	777,738	16,133,459	21,145,205	6.5	12.4	3.7	76.3	92.4	27.4	52.4	15.5
1984	2,191,310	3,077,951	797,868	15,656,597	21,887,766	10.0	14.1	3.6	71.5	89.2	35.2	49.4	12.8
1985	2,389,857	2,995,208	831,201	12,338,798	18,586,716	12.9	16.1	4.5	66.4	87.0	38.3	47.9	13.3
1986	2,784,116	3,175,874	750,869	8,064,067	14,786,754	18.8	21.5	5.1	54.5	81.1	41.4	47.2	11.2
1987	4,030,014	3,647,239	950,421	8,233,138	16,860,889	23.9	21.6	5.6	48.8	76.1	46.7	42.3	11.0
1988	5,350,941	4,624,309	1,500,186	7,425,047	18,901,022	28.3	24.5	7.9	39.3	71.7	46.6	40.3	13.1
1989	6,547,777	4,705,359	1,839,388	8,677,745	21,772,132	30.1	21.6	8.4	39.9	69.9	50.0	35.9	14.0
1990	8,822,137	4,290,194	1,367,650	11,071,165	25,553,187	34.5	16.8	5.4	43.3	65.5	60.9	29.6	9.4
1991	11,540,305	5,040,157	1,518,138	10,894,860	28,997,165	39.8	17.4	5.2	37.6	60.2	63.8	27.8	8.4
1992	15,799,617	5,629,044	1,712,847	10,670,892	33,815,478	46.7	16.6	5.1	31.6	53.3	68.3	24.3	7.4
1993	19,141,484	6,139,300	1,613,764	9,745,810	36,642,532	52.2	16.8	4.4	26.6	47.8	71.2	22.8	6.0
1994	20,374,836	7,856,868	1,977,284	9,693,820	39,907,110	51.1	19.7	5.0	24.3	48.9	67.4	26.0	6.5
1995	22,585,290	9,219,893	3,098,096	10,464,737	45,372,563	49.8	20.3	6.8	23.1	50.2	64.7	26.4	8.9

Notes
Industry Classification as per table 6-1
Source: Processed SITC (rev1) data from the IEDB, ANU.

Structure of East Asian Exports 1980-95

Percentage Share, Growth Rates and Specialisation

	Manufacturing Exports	Primary Exports: Agriculture	Mining	Oil & Gas	Total Primary	Other	Total Exports
Indonesia							
1980	2.2	21.8	4.0	71.9	97.7	0.1	100
1985	12.9	15.9	4.5	66.6	87.0	0.2	100
1990	34.5	16.2	5.4	44.0	65.5	0.0	100
1995	49.8	20.3	6.8	23.1	50.2	0.0	100
Growth (1980-95)	29.2	4.5	8.7	-2.7	0.4		5.0
RCA (1995)	0.7	1.7	2.1	3.4	2.3		
Singapore							
1980	46.7	18.4	2.4	25.2	46.1	7.2	100
1985	50.3	12.5	3.1	27.0	42.5	7.2	100
1990	70.8	7.8	2.4	17.9	28.0	1.1	100
1995	83.3	5.0	2.7	6.7	14.5	2.2	100
Growth (1980-95)	17.2	3.5	13.7	3.3	4.4		12.8
RCA (1995)	1.1	0.4	0.8	1.0	0.7		
Malaysia							
1980	18.8	46.0	10.2	24.7	81.0	0.3	100
1985	26.8	35.8	5.7	31.5	73.0	0.1	100
1990	53.0	25.4	2.8	18.3	46.6	0.4	100
1995	74.0	15.7	2.0	7.0	24.7	1.3	100
Growth (1980-95)	23.1	4.5	0.8	3.2	3.8		12.3
RCA (1995)	1.0	1.3	0.6	1.0	1.1		
Taiwan							
1980	87.9	10.2	0.5	1.4	12.1	0.1	100
1985	88.4	7.2	2.7	1.6	11.6	0.0	100
1990	91.0	5.6	2.7	0.6	8.9	0.1	100
1995	89.8	5.6	3.5	0.2	9.3	0.9	100
Growth (1980-95)	11.3	6.9	27.3	-2.5	9.3		11.2
RCA (1995)	1.2	0.5	1.1	0.0	0.4		
Hong Kong							
1980	91.2	1.7	6.4	0.0	8.1	0.7	100
1985	89.1	2.0	7.9	0.0	9.9	1.1	100
1990	87.2	2.8	8.8	0.1	11.6	1.1	100
1995	86.1	3.3	8.9	0.1	12.3	1.6	100
Growth (1980-95)	4.6	9.6	7.4	17.3	7.9		5.0
RCA (1995)	1.1	0.3	2.7	0.0	0.6		

	Manufacturing Exports	Primary Exports: Agriculture	Mining	Oil & Gas	Total Primary	Other	Total Exports
Thailand							
1980	25.2	58.3	13.6	0.1	71.9	2.9	100
1985	37.1	55.4	5.4	1.3	62.1	0.8	100
1990	62.5	33.8	1.6	0.8	36.3	1.2	100
1995	72.2	24.7	1.5	0.7	26.9	0.9	100
Growth (1980-95)	24.0	9.2	-0.2	35.2	8.3		15.6
RCA (1995)	1.0	2.0	0.5	0.1	1.2		
Korea							
1980	89.5	8.8	1.1	0.2	10.1	0.4	100
1985	85.3	4.9	6.7	3.1	14.7	0.1	100
1990	87.8	4.6	6.6	1.0	12.2	0.1	100
1995	88.8	3.6	5.6	2.0	11.2	0.0	100
Growth (1980-95)	13.8	7.4	26.7	33.1	14.7		13.9
RCA (1995)	1.2	0.3	1.7	0.3	0.5		
China							
1980	48.4	25.3	3.2	22.8	51.3	0.3	100
1985	49.3	21.3	2.7	25.7	49.7	1.0	100
1990	79.4	11.6	1.9	6.4	19.9	0.6	100
1995	88.9	6.7	1.8	2.2	10.6	0.5	100
Growth (1980-95)	22.5	7.7	13.1	0.7	6.0		17.7
RCA (1995)	1.2	0.6	0.5	0.3	0.5		
World							
1980	50.7	14.8	8.4	24.0	47.3	2.0	100
1985	59.5	13.8	7.5	17.6	38.9	1.6	100
1990	68.6	12.4	6.9	10.1	29.3	2.1	100
1995	75.6	12.1	3.3	6.8	22.2	2.2	100
Growth (1980-95)	8.5	4.2	-0.6	-2.8	0.5	6.3	5.7

Notes:
Industry categories as defined table 6-1.
RCA (revealed comparative advantage) is a measure of specialisation - see text.
Source: Processed SITC (rev1) data from IEDB, ANU.

the first tier ANICs (11.8 percent) as well as that for Malaysia, Thailand and China (20.7 percent). Table 6-8 also provides a measure of industry specialisation known as revealed comparative advantage. Following Balassa (1965) revealed comparative advantage (RCA) is defined as the ratio of the share of a certain product (or industry) in total manufactured exports for a particular country to the share of that product's exports in total world manufactured exports. That is

$$\text{RCA} = \frac{X_j^i / X_t^i}{X_j^w / X_t^w} \qquad (3)$$

where superscripts i and w refer to the particular country and the world respectively and the subscripts j and t refer to the exported product(s) and to all manufactured exports respectively. An RCA value greater (lesser) than one indicates that the country a has a greater (smaller) specialisation in the export of product(s) i than the rest of the world w as a whole.

From Table 6-8 it can be seen that of the eight sample countries Indonesia had the lowest specialisation in manufacturing in 1995 with a RCA value of 0.7. All other countries had a RCA value exceeding unity indicating a better-than-average specialisation in export manufacturing. Conversely, Indonesia had the highest specialisation in primary products (agriculture, mining and metals, oil and gas) as indicated by the 1995 RCA value of 2.3. This was driven in large part by Indonesia's continued strong specialisation in oil and gas and mining and metals. All other sample countries had much lower 1995 RCA values. China and the first tier ANICs all had less-than-average specialisations in primary exports, whilst the RCA values for Malaysia and Thailand were slightly above world average but less than half that for

Indonesia. Indonesia's continued specialisation and dependence upon primary exports makes it unique within the eight country sample.

The key problem with this continued strong focus on primary exports is that since the early 1980s global demand for primary commodities has remained relatively flat whilst growth in manufacturing has accelerated (Figure 6-5a). Over the 1980-95 period world manufacturing exports grew at an average of 8.6 percent per annum compared to just 0.85 percent for primary commodities (ie. 4.2 percent for agriculture, -0.64 percent for mining and metals, and -2.8 percent for oil and gas) (Table 6-8).

Stagnant or declining commodity prices play a key role in the low growth of world primary exports during the 1980s and early 1990s (World Bank 1994, Maizels 1992). Table 6-9 shows that for many important commodities, real prices more than halved over the 1980-93 period. According to the World Bank (1994b) such price drops represent a sharp departure from the long run trend decline in commodity prices[65]

Table 6-9 Trends in Real Non-oil Commodity Prices

Commodity Group	Percentage Change in Real Prices 1980-93
Metals and Minerals	-55
Timber	34
Nonfood Agriculture	-55
Other Food	-53
Fats and Oils	-51
Cereals	-51
Beverages	-68

Source: World Bank (1994b)

[65] It is important to note that since the celebrated works of Prebisch (1950) and Singer (1950) there has been on on-going debate in the literature regarding the long-term behaviour of commodity prices (see Nguyen 1981 and Ziesemer 1996 for a brief survey). According to the so-called Prebisch-Singer hypothesis the terms of trade between primary products and manufactures are on a downward trend. However as noted by the World Bank (1994b) a number of subsequent studies have questioned the validity of this hypothesis by considering quality improvements in manufactured products and other complicating factors. Despite the unresolved nature of the debate, the ODI (1995) note that most recent studies have concluded that either real commodity prices do exhibit a downward secular trend, or that the trend is stationary but subject to a one-off downward step in certain years. Moreover they note that most estimates of the long-term downward trend are generally around 0.5 percent a year, in real terms.

Figure 6-5

Trends in World Exports

Figure 6-4a

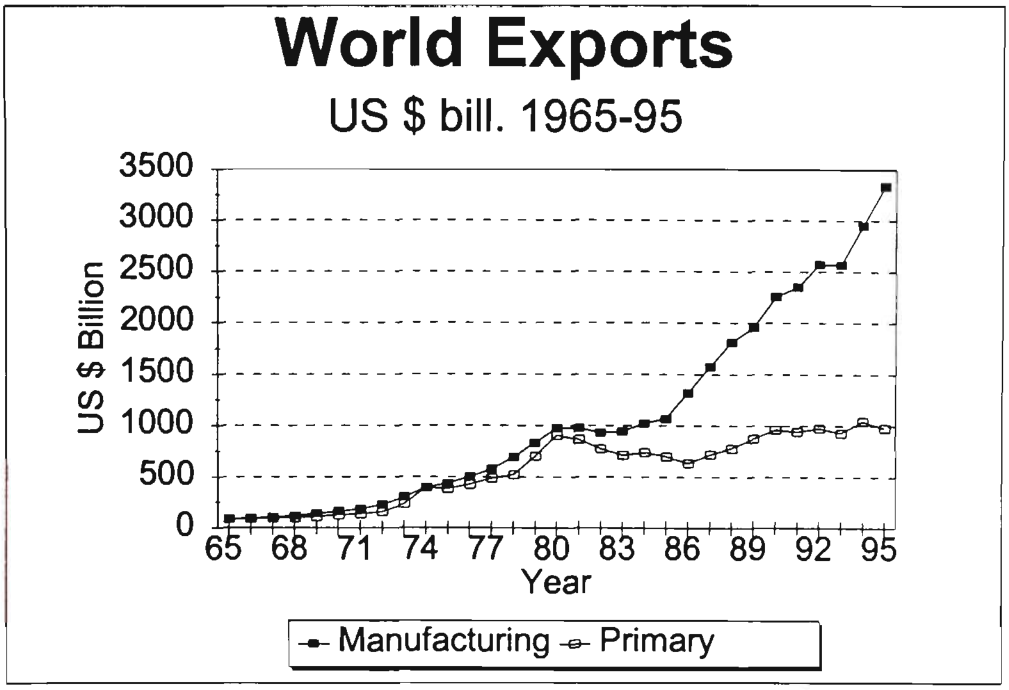


Figure 6-4b

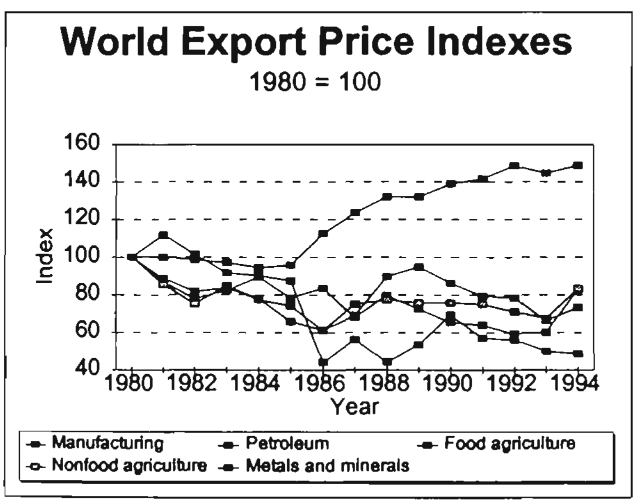


Figure 6-4c

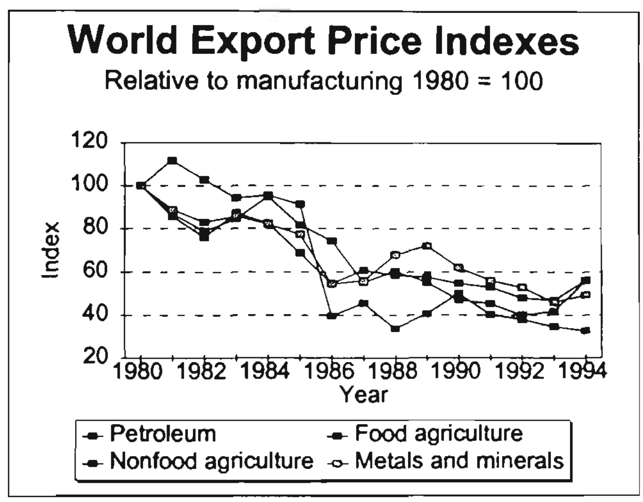


Figure 6-4d

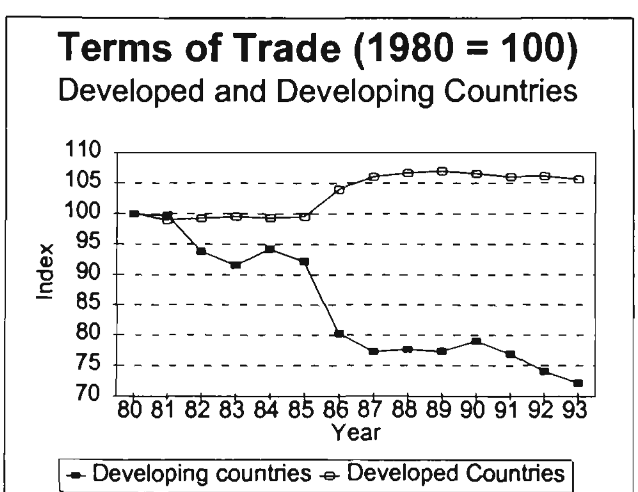
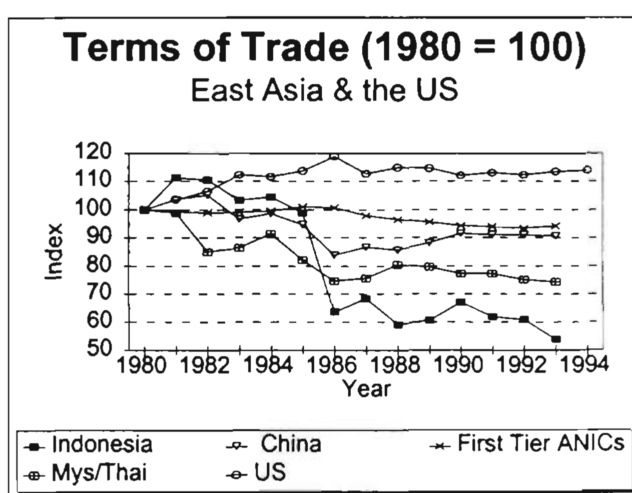


Figure 6-4e



Notes
1) Figure 6-4a: industry clasification as per Table 6-1.
1) Figure 6-4b and 6-4c uses a unit value index for manufacturing as used by the World Bank (1994, 1995).
Sources: Figures 6-4a, 6-4d and 6-4e - IEDB data.
Figure 6-4c and 6-4d - World Bank (1994).

Figures 6-4b and 6-4c compare trends in commodity price indexes with a unit value of manufactures over the 1980-94 period[66]. The figures show that prices on major commodity groups (food agriculture, non-food agriculture, metals and minerals) have been declining in both an absolute sense, and relative to manufacturing over the 14 year period. The unit value index for manufactures declined marginally in the first half of the 1980s but has exhibited strong positive growth since 1985.

A direct result of the decline in commodity prices relative to manufacturing prices is that the terms of trade for developing countries, which in most part rely on commodities for exports whilst importing a significant share of their manufacturing needs, have been declining in both an absolute sense and also relative to the terms of trade for developed countries (Figure 6-4d). In East Asia, there appears to be a clear relationship between specialisation in primary exports and declining terms of trade (Figure 6-4e and Table 6-6). Indonesia with the strongest specialisation in primary exports, suffered the greatest fall in terms of trade over the 1980-94 period, whilst the first tier NICs with a more established and more sophisticated manufacturing export base, on average experienced only a marginal decrease in their terms of trade.

There is a substantial literature suggesting a broad range of explanatory factors which have contributed to the long and short term weakness of commodity prices[67]. Although not attempting to provide a complete account of this literature it is nevertheless possible to identify a number of important long run trends which with no foreseeable change in the future, will continue to put downward pressure on the terms of trade for commodity exporting developing countries. These include

1. *A general slowdown in industrial development in the OECD.* Sluggish growth in the developed economies throughout the 1980s/early 1990s has restricted the demand for a number of important commodities (Maizels 1992). Industrial production in the OECD grew at 6.3 percent per annum during the 1960s but fell

[66] The unit value index of manufactures is calculated using manufacturing export data from the G-5 countries (France, Germany, Japan, UK and USA) weighted by the country's exports to developing countries (World bank 1994).
[67] For surveys and summaries of the literature see Maizels (1992) and the World Bank (1994b).

2.5 percent during the 1970-94 period (IMF 1997 p. 52) A major factor contributing to this downturn in industrial production has been the general shift toward service based industries in the OECD (Maizels 1992, Overseas Development Institute 1995, IMF 1997)

2. *The low income elasticities of demand for commodities* (implying that an increase in income has only a small effect on demand[68]). The growth in steel consumption, for example, will be much higher than GDP growth when a country "takes off" as during the early stages of industrialisation equipment and infrastructure need to be installed. However, once the domestic market for industrial equipment is saturated, the growth in steel consumption falls below GDP growth as the economy in question moves into more sophisticated production and service industries which are less intensive users of steel (Keeling 1992). Similarly, the International Iron and Steel Institute (1989), found that the relative consumption of cement, timber and cast iron declined as countries developed.

3. *Technological developments leading to increased efficiency in the use of commodities in manufacturing processes.* Since the dramatic jumps in international oil prices in the mid-1970s, technological advancement in manufacturing has been directed primarily toward making production more efficient in terms of its use of energy and natural resources. This has included the development of production technologies that use less materials, the downsizing of products using new micro-electronic based innovations as well as reductions in materials wastage (Maizels 1992). Supporting this move away from resource and energy intensive industries is the trend towards more knowledge/R&D intensive production which tends to be cleaner, less dependent upon energy and less resource intensive (UN 1992). In addition, new technologies have enabled greater

[68]This is consistent with what economists often refer to as *Engel's Law* - the idea that the proportion of a nation's income spent on food will diminish as overall income increases. It is often tested by estimating the income elasticity of demand (the percentage increase in demand as a result of a one percentage increase in income) most commonly for a number of food-commodities and manufactures. The World Bank (1994b) reviews a number of recent studies that use differing methodologies and data sources but arrive at the common result that the income elasticity for manufactures is on average much higher than that of commodities.

substitution of raw materials by synthetics and other non-traditional materials. This has been most apparent in non-food agriculture (eg cotton and wool replaced by synthetic fibres), metals (eg copper wire replaced by optic fibre) and foods (eg synthetic sugars replacing sugar). Furthermore the increased use of scrap and secondary metals has reduced demand for metal imports from developing countries (Maizels 1992; Rowlatt and Black 1959; World Bank 1994).

4. *A rapid expansion in the global supply of commodities.* As noted by the World Bank (1994b) the rate of growth of supply of a number of major commodities (such as those listed in Table 6-7) in the 1980s and early 1990s has been approximately four times that recorded in the 1970s. According to Reinhart and Wickham (1994) about three quarters of this increase can be sourced to the rapidly increasing agricultural exports from Western Europe and the East Asian NICs

Further reason for the move away from resource based activities in favour of manufacturing relates to the traditionally high degree of instability of in commodity exports vis a vis manufacturing exports in international trade. This can be seen from Figure 6-5 which summarises empirical work by the World Bank (1994b) that shows the percent deviation from trend for all decades over the 1900-92 period for all manufacturing and agricultural exports. For each period it can be seen that the instability measure for manufacturing exports is consistently lower than that for commodity exports

A similar measure used for Indonesian data (summarised in Figure 6-5b) also illustrates that primary exports have tended to be more volatile than manufacturing exports. In this instance, manufacturing and primary exports were regressed against time over the 1965-95 period to determine a trend for each series. A log-linear form was chosen as it provided a much better fit for each series. This was particularly the case for manufacturing exports which accelerated rapidly in the mid-late 1980s and early 1990s. Standard deviation from trend was then calculated by comparing actual and predicted values. Thus 'instability' is calculated by measuring the variation from the predicted trend line for each of the series. Figure 6-5b presents five-year averages

Figure 6-6

Commodity Export Instability

Figure 6-6a

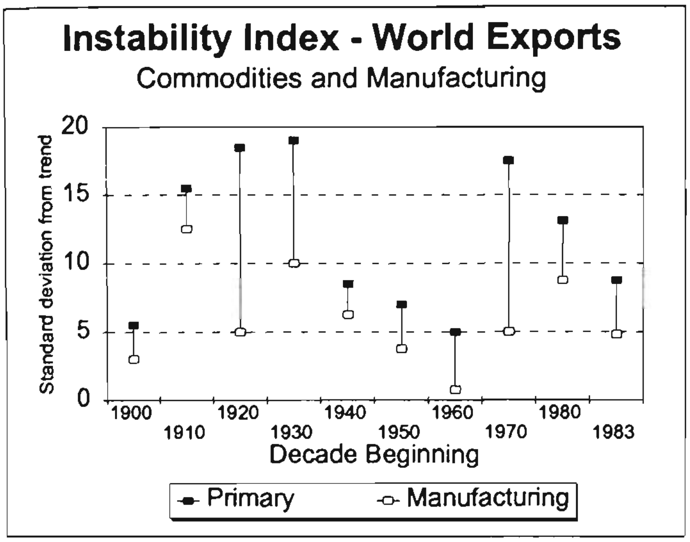


Figure 6-6b

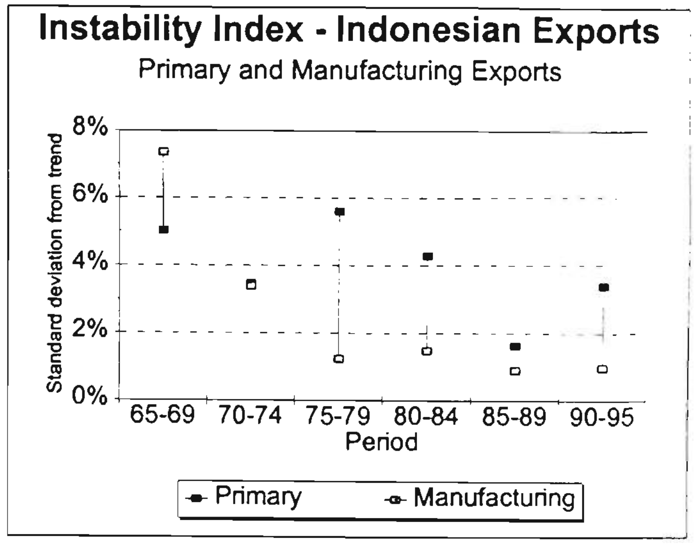
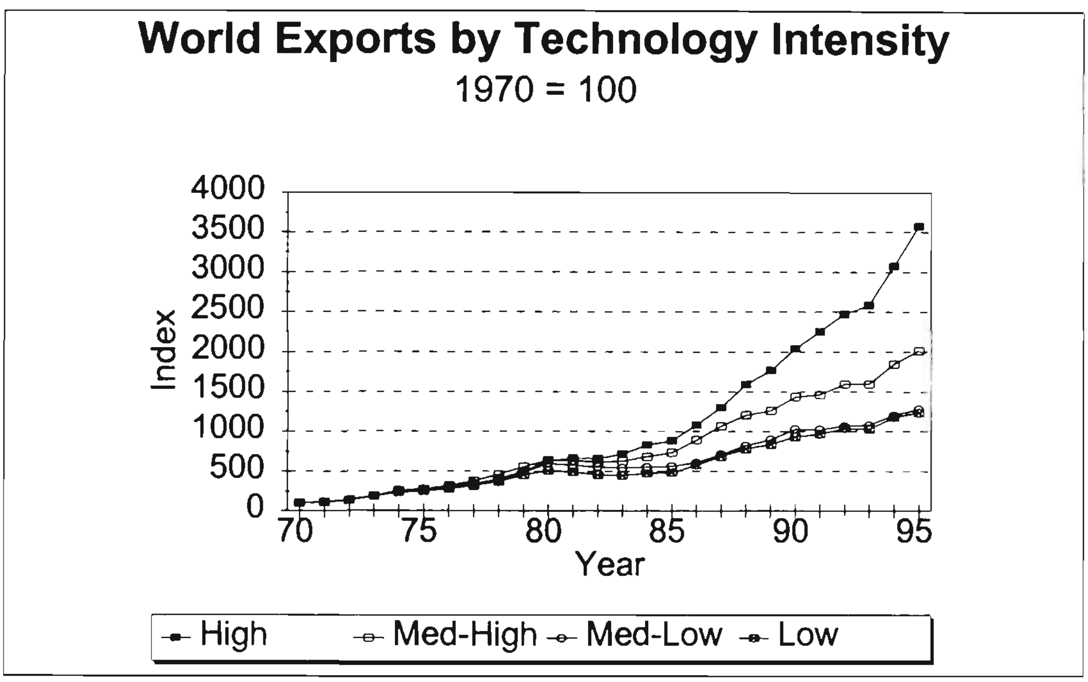


Figure 6-7



Notes

Source: Figure 6-6a: World Bank (1994).
Figure 6-6b: Instability index calculated by author - see text.
Figure 6-6c: Processed CSES estimates using IEDB data.

of the instability measure for both commodity and manufacturing exports[69] over the 1965-95 period. It can be seen that since the mid-1970s manufacturing exports have recorded a much lower instability measure than primary exports. This in turn provides further reason to restructure export activities in favour of manufacturing.

6.3.2 Trends Within International Manufacturing

The previous section discussed a number of factors compelling Indonesia to move away from exporting primary products and into more manufacturing export activities. In this section, it will be shown that within manufacturing there are a number of important international trends to emerge in recent decades which suggest that newly industrialising countries such as Indonesia need to upgrade to more knowledge and skill intensive activities to maintain and improve competitiveness in the future.

The *first* trend relates to the rapid growth in demand for more knowledge intensive products in international trade. In section 5.3 it was emphasised that technological developments associated with the information and communications revolution has generated a fundamental change in production and consumption activities the world over. It was argued that firms wishing to use more sophisticated process and product technologies to remain competitive have had to continually upgrade in favour of more sophisticated equipment and machinery, whilst consumers have been increasingly demanding those goods and services which embody the latest information technologies. This has resulted in a more rapid rate of growth in demand for high technology products (such as those from the electronics, computers and pharmaceutical industries) than that recorded for more traditional manufacturing activities. This is reflected in Figure 6-7 which shows that since the early 1980s the most rapid growing industry group in world trade has been the high technology

[69] Using industry classification as per Table 6-1.

category[70] which has as its key components, computers and electronics - the key enabling technologies of the information and communications revolution.

Table 6.10 summarises the average annual growth rates over the 1980-95 period for all four technology categories defined in Table 6-2. World high technology exports have clearly grown rapidly over the 1980-95 with an annual average annual growth rate more than twice that of the medium-low and low technology categories. In 1980 exports of high technology manufacturing products commanded 9.6 percent of international trade in manufacturing. By 1995 this share had doubled to 19.2 percent. Meanwhile the share of medium-high technology exports had increased slightly whilst that for the lower technology categories had declined. The growth in high technology exports has been particularly impressive in East Asia, more than doubling that from the USA or the EEC7. The growth of Indonesian high technology manufacturing exports over the 1980-95 period has also been high, but from a much lower base than other East Asian countries..

Table 6-10 Growth in Merchandise Exports, 1980-95 by Technology Intensity: Selected Countries and Regions.
(average percentage rates of growth)

	Technology Grouping				Total
	High	*Med-High*	*Med-Low*	*Low*	**Manufacturing**
USA	9.1	7.6	5.6	6.9	7.3
EEC7	9.3	6.0	3.4	5.0	5.4
East Asia	23.9	19.4	9.4	12.3	15.3
ASEAN	19.6	17.1	13.8	11.1	14.0
Japan	12.7	8.5	8.6	3.3	8.5
Indonesia	23.0	25.2	9.4	20.1	16.0
World	12.3	8.0	5.2	6.1	7.2

Source: CSES estimates using data from the IEDB

A *second*, and not unrelated trend is the on-going fall in the manufacturing terms of trade (MToT) for developing countries. Various empirical studies including Maizels,

[70] As defined in Table 6-2.

Palaskas and Crowe (1996), Sarker and Singer (1991), Minford, Riley and Nowell (1995) and Prasad (1996) have shown that in recent decades the unit prices for manufacturing exports from developing countries have on average fallen both in an absolute sense and also in relation to the unit prices for manufacturing exports from developed countries. For many developing countries, lower unit prices for manufactured exports coupled with relatively higher unit prices for manufactured goods imported from developed countries has resulted in downward pressure on the MToT. However rapid expansion in the volume of developing country manufacturing exports has enabled these countries, on average, to improve their income terms of trade[71], and therefore to increase the purchasing power of their exports (UNCTAD 1996a)

An important theme to emerge from the literature on manufacturing terms of trade is that there appears to be much variation in relative price declines across industry categories, with large declines in resource and labour intensive exports, but with little evidence of a downward trend in the more knowledge or skill intensive goods. Given the significant variation in knowledge intensity for manufactured exports across developing countries, it is unsurprising to find that some regions have suffered far greater declines in the MToT than others. Using data on the trade flows between the European Union and developing countries, Maizels et al (1996) for example found that of the major developing regions, the smallest decline in MToT was in East Asia - the developing region which they identify as having the highest proportion of technology and skill intensive manufactures and the lowest proportion of labour and skill intensive manufacturing exports. Within East Asia, given the differences in export structures across countries it would be expected there would be considerable diversity with regards to movements in the MToT. Unfortunately, there is limited data on MToT across countries in East Asia to support or dispute this argument. Prasad (1996) however was able to show that the decline the MToT was far more significant for Indonesia than Korea (where if anything the movements in the MToT were

[71] The income terms of trade is the terms of trade weighted by the volume of exports, to give an indication of the purchasing power of exports.

slightly favourable), which is consistent with the argument that knowledge intensity favourably influences the terms of trade for developing country manufactures.

A *third* important trend, which may contribute in part to the second trend described above, relates to the increased competition to produce and export manufacturing products in the global economy. In the previous section it was argued that the terms of trade between primary products and manufactures are on a downward trend. Thus, to boost export earnings developing countries should move away from primary products and into manufacturing, for which price and income elasticities are higher. Table 6-11 shows that such a diversification has already taken place. Throughout the 1960s and 1970s the export share of primary exports from developing countries exceeded those of manufactures. However, as a direct result of rapid expansion of developing country manufactured exports over the 1980-95, the latter was able to command over 68 percent of total developing country exports in 1995 as opposed to 30.9 percent for primary products. Contributing to this general transformation in the structure of developing country exports has been the arrival of new entrants emerging from previously closed transitional and developing economies (UNCTAD 1996b)

Table 6-11 Structure of Developing Country Exports

	1965	1980	1995
Primary	81.3%	78.6%	30.9%
Manufacturing	18.3%	20.5%	68.3%
Other	0.4%	0.8%	0.8%

Note:
1)Developing country group as defined by the IEDB, ANU is the aggregate of 139 developing countries
2) Industry groups as defined in Table 6-1
Source: Processed IEDB data.

To illustrate an important aspect of the increasingly competitive environment for export manufactures in world trade, Table 6-12 describes the participation by developing countries in world trade for two broad categories of manufactured exports.

Limited cross country data prevents the use of the 22 industry data for this analysis, hence the use of SITC (rev1) three digit trade dataset which provides data for 139 developing countries. It is important to note however, that this latter dataset cannot easily be categorised by the usual aggregation schemes for classifying industries (eg by technology intensity, resource or labour intensity etc) as is commonly the case with the 22 industry data[72]. Given that an important objective in this section is to show that there is increased international competition (as represented by increased participants) particularly at the lower end of export manufacturing, it is therefore necessary to aggregate those manufactured products with a low technology intensity into what is termed below as 'basic manufactures.' This category of manufactures is defined as an aggregate of SITC 6, 82, 83 and 84 and includes a number of labour and resource intensive activities such textiles, clothing and footwear, furniture, basic metals, as well as paper, rubber and wooden products. Although this category does not provide an exhaustive account of low technology manufactured exports, it nevertheless captures the key industries which represent the core of export manufacturing activities for newly industrialising countries such as Indonesia. In Indonesia's case, this group of manufactures commanded between 70-80 percent of total manufactured exports over the past two decades (79 percent in 1980 falling to 73 percent in 1995).

From Table 6-12 it can be seen that there has been an increase in the number of countries exporting basic manufactures in world trade. This upward trend is consistent across all three categories as determined by the number of developing countries with a world market share in excess of a critical level. Such results are consistent with the view that there is increased competition in lower value added export manufacturing. For the other category considered, total manufacturing, there is a similar increase in the number of developing countries with a world market share above the three critical levels. However, as expected the degree of participation of developing countries in this market is less than that recorded for the first category. Also shown in Table 6-10 is the share of the developing country group in world trade for each of the

[72] See for example the OECD (1995 chapter 4 p. 25) for a description of four common aggregation schemes: one based on technology, one based on wages, one based on orientation and one on skills.

manufacturing category. In can be seen that in both instances that developing countries as a group have been able to increase their share of world export markets.

Table 6-12 Participation by Developing Countries in World Manufacturing Trade by Market Share (no. of developing countries from a total 133)

	Basic Manufacturing			Total Manufacturing		
Market Share	*1965*	*1980*	*1995*	*1965*	*1980*	*1995*
>1%	4	3	9	0	3	6
>0.5%	7	10	14	4	6	10
>0.25%	13	17	19	8	10	13
Total Market Share	13.9%	18.2%	32.2%	5.4%	10.6%	24.4%

Note:
1) *Basic Manufactures* is defined as the aggregate of SITC (rev1) 6, 82, 83, 84 (see text).
2) *Total Manufacturing* is defined as per Table 6-1.
3) Developing Country group as defined in Table 6-9.
Source: Processed IEDB data

Whilst the results summarised in Table 6-10 provide only a crude measure of global competition, it is nevertheless suggestive that there is now increased competition for Indonesia from other emerging manufacturers in global export markets, particularly at the lower end of manufacturing. It is also consistent with concerns commonly expressed in the literature regarding the emergence of regional competitors to Indonesia such as China, India, Vietnam and Bangladesh.

6.4 Conclusion

This chapter has explored a number of key demand trends associated with the emergence of the global knowledge economy which compel Indonesia to upgrade to more sophisticated or knowledge intensive products. In the first section a number of empirical measures were used which illustrate Indonesia's comparative performance in competing in the more dynamic areas of global production and trade. In most cases it can be shown using export data that Indonesia's performance has been improving but lagging all other countries in the region. This is due to a number of factors including a continuing dependence upon resource and labour intensive exports for which income and price elasticities are low, and a relatively low specialisation in the more dynamic and knowledge intensive activities such as computers and electronics.

The central conclusion to be drawn from this chapter is that changing global demand conditions associated with the emergence of the global knowledge economy present new challenges for the Indonesian economy. The nature and extent of Indonesia's response to these demand-side challenges will be considered in the next chapter.

7. Using and Producing Ideas in the Manufacturing Sector: Indonesia's Response to the Emerging Global Knowledge Economy

7.1 Introduction

In the previous two chapters it was shown that Indonesia's development record in recent decades has been impressive, but that new circumstances associated with the emergence of the global knowledge economy suggest a new set of challenges for future growth and development. It was argued that to meet these challenges, Indonesia must move into more dynamic areas of global trade and production. The primary objective of this chapter is to describe and review Indonesia's supply-side response to date to these demand-side challenges, or in other words, to review the efforts by Indonesian industry to become more knowledge intensive as a means to better compete in a global economy characterised by increasingly sophisticated production and consumption activities.

Three key aspects of this response will be considered. The first and second aspects consider the roles played the public and private sector respectively (section 7.2 and 7.3), whilst the third is an assessment of Indonesia's comparative performance using a number of aggregate empirical measures (section 7.4). An important theme to emerge from the analysis is the dominant position of the government in promoting national technological development. This position will be explained in the wider context of the traditionally interventionist role of the Indonesian state in the modern era. The current approach to technology policy, as represented by the programs and policies of the Minister for Research and Technology Habibie, will be seen as a continuation of this on-going tradition.

Despite this emphasis by the state on science and technology matters, another important theme to emerge from the analysis is the relative technological backwardness of Indonesian industry. This will be represented in two ways. The first approach, as outlined in section 7.2, is through a survey a number of industry and firm level studies which commonly report a low level of technological and innovatory capability in the private sector, resulting in a strong dependence upon foreign sources for technology inputs. The second approach, which is considered in section 7.3, is to use a number of empirical tools to assess the knowledge intensity of Indonesian manufacturing using mainly export data. The key conclusion drawn from this section is consistent with that of the industry surveys reviewed in section 7.2, namely that Indonesian industry is lagging other countries in the region to move into more knowledge intensive activities.

7.2 Policy Approach to the Knowledge Economy

According to Scherer (1993) an essential feature of Indonesia's recent efforts toward national technological advancement has been the dominant role played by the state. Table 7.1 compares the relative role of the state in the science and technology effort for a number of Asian countries. In 1991 eighty percent of all Indonesian R&D funding originated from government sources and 62 percent of R&D activity was performed by government institutions. In both instances, the distribution of R&D activity is considerably more biased toward the public sector than in the other sample countries.

STAID (1993) also reports that in 1991 that only 15 percent of Indonesia's engineers and scientists were employed in the private sector. Moreover the distribution of higher education degrees (diploma, bachelor, masters and PhD) among the government, higher education and industry sectors were strongly biased in favour of the first two. The high degree of state involvement in the country's technology based activities is also evidenced by the significant amount of human and financial resources channelled into the state owned strategic industries program (see section 7.2.2). As discussed later, this enlarged role for the state has important implications for the incentive environment for the use and production of ideas, particularly in private sector manufacturing.

Table 7-1 The Role of Government in R&D Activities in 1991 - Selected Countries

	Source of R&D Funds (%)		
	Government	Industry	Other
Indonesia	80	19	1
Japan	16.4	77.4	6
Korea	19.6	80.4	-
Singapore	41.6	58.4	-
Taiwan	52.1	45.5	-
India	75	25	-
	Performers of R&D (%)		
	Government	Industry	Other
Indonesia	62	33	5
Japan	8.1	75.4	16.5
Korea	3.7	71.3	25.4
Singapore	22.1	58.4	19.4
Taiwan	9.1	53.6	37.3
India	75	25	-

Source: US National Science Foundation cited in STAID (1993).
For Indonesia data is based upon a special survey for STAID (1993).

The primary objective of this section is to outline broadly the present Indonesian Government's approach to technology policy and the economic philosophy underlying that approach. Given the highly interventionist approach of the Indonesian government in this regard, it is appropriate to preface this discussion by considering the economic policy making process in a broader historical and political context. To this end, Section 7.2.1 below provides a broad account of the nature and role of the state in Indonesian economic development.

7.2.1 The Nature and Role of the State in the Indonesian Economy

An essential feature of Indonesia's post-independence development has been the extremely active role played by the state in the economy. According to Hobohm (1987) explanations of this expanded role of the state cover a number of ideological, historical, political and cultural factors. Providing a full account of these factors is clearly an undertaking beyond the scope of this dissertation. Accordingly the approach taken in this section is to briefly outline a number of key themes from the literature as a useful background to the later discussion on Indonesian technology policy.

Economists and other commentators have long emphasised the traditional aversion to liberal economic thought in Indonesia (eg Castles 1965; Sadli 1988; Rice 1983; Robison 1986, 1987). Castles (1965 p.13) for example, writing toward the end of the Sukarno period reports that the 'rejection of capitalism and espousal of socialism as the preferred pattern of economic organisation has been an almost universal element in Indonesian political ideology since independence.' McCawley (1982) and Liddle (1982) note the justification for an active state found within a number of interpretations of the theoretical concept *Ekonomi Pancasila,*[73] which in essence call for a non-market economy based upon an incentive system driven by social or religious values rather than the pursuit of profit (eg see Mubyarto and Boediono 1981). Others such as Woo et al. (1994) and Rice (1983) stress that state participation in the economy is actually enshrined in the Indonesian 1945 constitution.[74]

History plays an important part in explaining Indonesia's traditional ideological aversion to free enterprise. According to Sadli (1965)[75] a tendency toward interventionism 'emerges naturally if it is remembered how greatly the Indonesian people have suffered from economic liberalism in colonial times.' For almost 350

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[73] *Pancasila* is the official state ideology based on five principles: 1) belief in one God; 2) justice and civility among peoples; 3) the unity of Indonesia; 4) democracy through deliberation and consensus among representatives; and 5) social justice for all.

[74] Article 33 of the constitution includes the following statements: (1) Economic affairs are to be organised as a joint effort based on family principles; and (2) Branches of production which are important for the state and which control (the supply of) the basic needs of the masses are to be controlled by the State (see Rice 1983).

[75] Cited in Glassburner (1978 p. 30).

years Indonesia had, to varying degrees been under the control of the Dutch. As noted by Hobohm (1987) the reality of colonialism for many Indonesians was that it led to the transfer of much of the country's wealth to the large Dutch (and other European) enterprises and the thriving overseas Chinese business community which had been brought in by the Dutch and according to Adicondo (1979) given better business opportunities by the colonial government.

An important element behind Sukarno's broad popularity in the 1950s and 1960s was that he was able to nurture and exploit the widespread feelings of resentment toward foreign capitalists and more generally, suspicion toward (what he termed) western styled 'free-fight' capitalism. This was particularly evident in his populist speeches whereby he argued that capitalism was synonymous with exploitation and was therefore inconsistent with traditional Indonesian communitarian values which emphasise peaceful coexistence through mutual help (Hobohm 1987).

In recent years, economists have acknowledged the more market oriented approach to policy employed after 1966, but emphasise the lingering attachment to interventionist styled thinking that has persisted throughout the Suharto period (Hill 1996, Sadli 1988, Glassburner 1978). Hill (1996, p. 93) for example writes

> It is...a mistake to view the change in regime in 1966 as a switch from a "socialist' to a "capitalist" or free market regime. There remains a deep-seated mistrust of market forces, economic liberalism and private (especially Chinese) ownership in many influential quarters.

One indication of a continuing interventionist approach to economic management throughout the New Order period has been the widespread activities of a large number of state-owned enterprises (BUMN). In 1995 there were 182 BUMN[76] (reduced from 214 in 1987) involved in a broad range of activities including transport, telecommunication, public utilities, manufacturing, mining, logging, plantation

[76] Of the 182 BUMN, 62 were considered financial unsound according to 1994 financial statements while around 21 suffered losses. Of the ten strategic industries under the control of Research and Technology Minister Habibie only three were rated by the Department of Finance as being financially sound (see *Warta Ekonomi* 27 November 1995, p. 18-34; *EBRI* September 30 1995, p. 18).

agriculture, trade and insurance[77]. In the same year it was reported by the PDBI (the Indonesian Business Data Centre) that the output of BUMN accounted for almost 25 percent of GDP in 1994 (*Jakarta Post* October 9 1995). Other important channels by which the New Order government has maintained a strong hand in the economy include the activities of the National Logistics Board (*BULOG*)[78] which controls the price and supply of rice and other agricultural commodities as well as the activities of the Investment Coordinating Board which screens all foreign and domestic investment projects (Glassburner 1978, Hobohm 1987).

Industry and trade policy is another area where interventionism has been clearly apparent in the Suharto period. As noted by Thee (1994), Robison (1987), Hobohm (1987) and others, Indonesia's process of industrialisation in the 1970s and early 1980s was supported by a host of protectionist trade, industrial and foreign investment policies as well as high levels of direct state investment in a number of upstream industries. According to Robison (1988) the rationale behind this level of state involvement in the economy was to build a strong and independent industrial base that could not have otherwise been produced were it left to the free market. Soehoed (1988) for example, argued that the private sector was considered unprepared or incapable of undertaking such large scale industrial projects for which considerable amounts of capital would be needed, gestation periods would be long, physical infrastructure would first have to be laid out, and profit margins were generally low. This, he maintains, provided a strong justification for a direct role to be played by the state in the industrialisation process during his time as Industry Minister over the 1978-83 period.

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[77] Woo et al (1994) provide four reasons behind this diverse range of activities. Firstly, many of the BUMN were Dutch companies nationalised in late 1950s as part of Sukarno's so-called 'guided economy' approach to economic management. Second, many of the BUMN were established to prevent Chinese domination of the corporate sector. Third some were set up to support an infant industry, eg PT IPTN and PT PAL - the aerospace and shipbuilding industries respectively; and fourth, others were created when the State took over failed private enterprises (eg, PT Indocement, PT CRMI - a cold rolling steel mill).

[78] The activities of BULOG, however, are expected to be significantly downgraded when it loses its monopoly on imports of wheat, garlic and soybeans after January 1 1998, as part of the IMF imposed deregulation program announced in late October 1997 (see *WSJ* November 3 1997).

Economic Nationalism is a term often used in the literature to describe the ideology underlying the interventionist role of the state in the Indonesian economy in the post war period (see for example Robison 1987, Thee 1994c, Schwarz 1994, Hobohm 1987, Liddle 1991, Chalmers and Hadiz 1997). As noted by Woo et al. (1994), Robison (1987) and others, economic nationalism in Indonesia builds upon the widespread feelings of suspicion toward foreign and ethnic-Chinese capitalists and more generally toward the free market mechanism as well as the general desire to see Indonesia as an industrialised and internationally powerful nation. It manifests itself within the policy context in a variety of ways: from the above-mentioned state-led industrial strategy of the 1970s/early 1980s, to the various measures used by the government to help indigenous (*pribumi*) business people to catch-up with the economically dominant ethnic-Chinese (Thee 1994c), to the restrictive policies imposed upon foreign investment particularly over the 1974-86 period (Hobohm 1987), to the efforts by Ibnu Sutowo to build a business empire from the state oil monopoly *Pertamina* in the 1970s (Robison 1987), and to the more recent efforts by Technology Minister Habibie and his supporters to develop a number of ambitious and expensive high technology projects within the state-owned and run strategic industries program (Thee 1994c, see below).

Generally included within the 'economic nationalist' camp in the Suharto period are a number of high profile politicians (such as former Industry Minister Soehoed and current ministers Habibie, Ginandjar Kartasasmita and Hartarto) as well as a large number of engineers-turned-managers, (ex)military officers, economists with structuralist inclinations and senior bureaucrats all united in their belief that the market must be supervised to an extent[79] (Chalmers and Vadiz 1997, Woo et al 1994, Mackie and Macintyre 1994). Collectively this group has been able to influence policy through the control of key government bodies, such as the Ministries of Trade and

[79] It should be noted that within this broad grouping there can be found considerable divergence of opinion on the extent or degree to which the market should be controlled. Mackie and Macintyre (1994) for example highlight as one of the key differences between 'old-style' economic nationalists and the more modern interventionists as the preparedness of the latter to accept some forms of deregulation. Likewise, within the group of modern interventionists, there is some dispute over the role of global market forces, ie Habibie considers the role of economic globalisation to have generated new opportunities for Indonesia, whilst Ginandjar believes that globalisation may constitute a threat to the nation, undermining the effort toward a self-reliant economy (Chalmers and Vadiz 1997).

Industry (now merged), the BKPM, BULOG, BPPT and in the 1970s, the state oil company, Pertamina (Woo et al. 1994, Scherer 1993, Mackie and Macintyre 1994). Liddle (1991) notes that this group has frequently found favour with the President due to their ability to represent their ideas and programs as the 'embodiment of his dream for more rapid progress toward an industrialised, internationally powerful Indonesia.' Moreover, as noted by Woo et al. (1994) their support for an interventionist state has won them the support of the 'rent-seeking coalition' composed of indigenous capitalists, army officials, civilian bureaucrats and others who generally benefit from government regulation and control of the market.

Opposing the economic nationalists in the policy debate are a group of US trained neoclassical economists known as the *technocrats*. From their positions of influence as advisers to the president or within government bodies such as Bappenas, the Ministry of Finance, Bank Indonesia and a number of the larger universities, this group has, throughout the Suharto period, vigorously opposed the interventionist agenda of the economic nationalists.(Robison 1987, Schwarz 1994, Mackie and Macintyre 1994). They instead posit a number of key macroeconomic fundamentals such as minimal budget deficits, low inflation and realistic exchange rates (Thee 1994c, Mackie and Macintyre 1994). In addition notes Woo et al (1994), their general acceptance of the principal of comparative advantage has led them to emphasise, through a general process of trade and investment deregulation, the development of a number of resource and labour intensive industries, such as agricultural commodities and low technology manufacturing.

Throughout the previous three decades the dynamics of the economic policy debate is often seen as analogous to a pendulum swinging back and forth between the two competing ideologies described above (eg Hill 1994, Mackie and Macintyre 1994, Robison 1986). Various authors including Robison (1987), Schwarz (1994), Mackie and Macintyre (1994) and others, have noted that the ability of the technocrats to influence policy appears to be inversely related to the general well being of the economy[80].

Amid the economic chaos of the mid-late 1960s the technocrats found favour with their free market approach by virtue of their credentials as sound economic managers. However with the return of economic stability and growth (as well as the revenue windfall from the OPEC induced oil boom) in the early-mid 1970s the pendulum once again swung in favour of economic nationalists. The economic downturn resulting from the fall in international oil prices in the mid 1980s brought the technocrats back to a more influential position within economic policy making circles, as the promotion of non-oil exports required a fundamental restructuring and deregulation of Indonesian economy (Hill 1996, Schwarz 1994). In the 1990s their influence has been checked by the rising industrial nationalism associated with Technology Minister Habibie and his supporters (Thee 1994c, Macleod 1993). However, more recently there are indications that the technocrats may have the ascendancy through the formation of a 'crisis management team' set up by the President to oversee austerity measures as a response to the current problems confronting the Indonesian economy (see for example *EBRI* September 22 1997).

7.2.2 Approach to Technology Policy

In a study of technology policies across seven industrialised countries Ergas (1987) notes two major approaches to technology development: the *mission oriented* approach and the *diffusion oriented* approach. The former is defined as 'big science deployed to meet big problems (Weinberg 1967) and is most prevalent in the United States, the United Kingdom and France. The defining feature of the first approach is *concentration*. This refers to the centralisation in the decision making process, as well

[80] This observation has led to what is commonly known as 'Sadli's Law' - the idea that during times of economic austerity the technocrats can force through important reforms which are to the long term betterment of the economy, whilst during times of economic prosperity, it is often politicians and other non-economists who dominate decision-making, often to the detriment of sound economic principles (EBRI September 22 1997).

as the limited range of technologies covered, and the small number of participants and projects which command a significant share of the research budget. The approach is therefore an attempt to pick *winners*, or as Ergas (1987 p. 194) notes

> ...a few bets are placed on a small number of races; but together, these bets are large enough to account for a high share of each country's total technology development program.

In contrast, the *diffusion oriented* approach emphasises the diffusion of a broad range technological capabilities throughout the entire industrial structure, rather than concentrating on a few selected technologies or industries. The defining feature of this second approach is *decentralisation.* This refers to the emphasis given to technology development across a large number of small to medium enterprises, the more significant role played at the implementation stage at the industry level (eg industry associations and cooperative research organisations) and the broad range of policies used to improve overall technological capabilities such as education, basic research and product standardisation measures (Ergas 1987)[81].

Although the above study was carried out within the context of developed countries the two approaches to technology development - mission and diffusion oriented - broadly represent the differing approaches employed by Prof Sumitro Djojohadikosumo and Prof. Ing B.J. Habibie, respectively the first and second Ministers for Research (and Technology) in the Suharto administration. Habibie has had a distinctly mission oriented approach to technology development, ambitiously emphasising a small number of high technology 'vehicles' as a means to ensure Indonesia's long run industrial development. Sumitro, by contrast, emphasised more basic research relevant to Indonesia's immediate needs in agriculture, natural resource use and employment creation (Rice 1990).

[81]The World Bank (1992) makes a similar definition between a 'selective' (mission oriented) approach and a 'functional' (diffusion oriented) approach to technology policy.

The following discussion is a broad outline of the Habibie approach to industrial development that draws upon a considerable literature which includes articles and speeches by Habibie (1982, 1983, 1986, 1993) or those generally supportive or sympathetic to the Habibie agenda (eg Raillon 1990; Soesilo 1995; Ridwan 1995; Juoro 1993a, 1993b; Alam 1995), local press reports such as those in *Warta Ekonomi*, *Republika*, *Kompas*, *Bursa* and *Gatra* as well as critical analysis of his policies by others (Hill 1988, 1995, 1996; Rice 1990; Schwarz 1994; Cliffford 1993; Crouch 1994; World Bank 1993).

7.2.2.1 ***Habibienomics***

Habibienomics is a term originally coined by economist Kwik Kian Gie (1993) which describes the industrialisation strategy of Indonesia's current Minister for Research and Technology, Professor Dr. Ing B.J. Habibie. A long time close associate of President Suharto and his family, Habibie was recalled back to Indonesia from his position as Vice President and Director of Technology at the leading German aircraft manufacturer Messerschmidt Boelkow Blohm in 1974 to become Presidential Adviser for Advanced Technology and Aeronautics and in 1978 was appointed as Minister for Research and Technology (Hill 1988).

At the core of Habibie's technology program has been the establishment of a number of strategic high-technology enterprises which are state owned and run and include such activities as aerospace, ship building, telecommunications, electronics, steel, weapons and munitions, nuclear power and the manufacture of various capital goods. According to Raillon (1990) these industries are strategic in an economic sense in that they a) provide an effective 'vehicle' for the transfer and diffusion of advanced technologies, b) provide key transport and telecommunication infrastructure to an archipelago nation of more than 13000 islands and c) help establish a capital goods industry in a capital scarce country. They are also significant in a military sense in that they are required to devote 20 percent of their production to military purposes (or 80 percent in the event of a threat to either national sovereignty or unity). Providing technological support for the strategic industries are the two major government research institutes: LIPI and BPPT (Thee 1994a).

The rationale used by Habibie for this style of capital and skills intensive investment in a developing country such as Indonesia is to promote the eventual development of a self-sustaining high technology manufacturing capability. This, he maintains, will ensure the long run *competitive advantage* of Indonesian industry. By contrast, he doubts whether development based upon Indonesia's *comparative advantage* in low technology labour intensive manufacturing such as textiles, clothing, shoes and furniture will generate significant improvements in living standards in the long run due to the inherently 'footloose' nature of these type of industries, their typically low value added content and the downward pressure on prices through the competitive behaviour of other low wage producers. By actively and selectively promoting the technological development of Indonesian industry now, Habibie maintains that Indonesia can take charge of its own long run economic destiny as opposed to it being determined solely by the international division of labour (Habibie 1982, 1993).

The key element in Habibie's economic philosophy is that high technology activities is the key to future economic success. Like many others, he sees the diffusion and development of both indigenous and foreign technologies as the most critical element in overcoming poverty and low living standards in developing countries. What differentiates Habibie's approach from more conventional thinking is his insistence that any developing country, given adequate planning and management, should be able to absorb and adapt for its own purposes any form of technology whatever its degree of sophistication. Advanced country technology is therefore seen not as a 'special right for the exclusive use by advanced nations' (Habibie 1986 p.95) but as something all developing nations can benefit from. Transferring only 'appropriate' (or what he terms *primitive*) technology is therefore

> to sentence [less developed] countries to continue being primitive....and to strengthen the vicious circle between ignorance and poverty (Habibie 1986 p. 94).

To leapfrog the Indonesian economy to a higher technological paradigm, Habibie emphasises eight[82] 'vehicles' (*wahana*[83]) for industrial transformation. The activities of these industry vehicles up to now have included the following:

1. **Aerospace.** Component production, maintenance and overhaul, production under license of various fixed wing and wing aircraft, design and production of the N250 (a 64 seat commuter aircraft) and the planning and design of the N1230 (a 100 seater regional jet).
2. **Maritime and Shipbuilding.** Production under license (and in some cases design and production) of naval and commercial vessels as well as maintenance and overhaul.
3. **Land transportation.** Manufacture of heavy equipment, manufacture of railway rolling stock and the planning and co-design of the 'national' Maleo car.
4. **Telecommunications and Electronics.** R&D and production activities associated with component production and equipment manufacture in number of areas including broadcast equipment, control systems, avionics, marine and automotive electronics, digital telephone systems and advanced fibre optic systems.
5. **Energy Generation.** Manufacture of power generation equipment, operation of nuclear powered experimental reactors, overseeing the establishment of a commercial nuclear power industry and the management of the Natuna gas field.
6. **Engineering**. Steel Production, production of industrial machinery, as well as industrial and engineering services.
7. **Agricultural equipment.** Production of agro industry equipment.
8. **Defence.** Explosives and weapons manufacture.

According to Habibie (1982) the economic activity in these selected industries generates activity in other sectors of the economy through various forward and

[82] Habibie also notes a ninth 'vehicle' which represents a number of industries connected through forward and backward linkages with the other vehicles mentioned above (Rice 1990).
[83] *Wahana* is a Javanese word of Sanskrit origin used originally to describe the god Vishnu's vehicle, the mythical Garuda bird but in modern language refers in a literary sense a mode or vehicle for conveying thoughts, ideas or for realising ideas (Echols and Shadily 1989).

backward linkages. Such linkages allow for the diffusion of technology from the *strategic* industry to associated or connected industries[84]. According to Rice (1990), Habibie places two important preconditions on the success of these industry vehicles, both as individual economic units and as agents for the diffusion of knowledge. The *first* is that their production must follow a 'progressive manufacturing plan' (PMP) This plan, consisting of four stages, beginning with final assembly activities and ending with research and design work. These stages are as follows,

1. The first or the *technology introduction stage,* sees the acquisition of existing technologies through the assembling and manufacturing of products under license from abroad. Technological capabilities are enhanced through improved understanding of more advanced foreign design and manufacturing processes. Better manufacturing skills as well as organisational and management capabilities are developed and quality and work discipline standards are improved.
2. The second or *technology integration stage* sees the integration of existing technologies in the design and manufacture of new products. Basic research and design capabilities emerge during this second stage as existing technologies are adapted to local circumstances. New skills also emerge in the selection, integration and optimisation of existing components into new systems (or products). With the development of new products, testing capabilities and facilities are also developed.
3. In the third, or *technology development stage,* existing technologies are enhanced and developed into modified technologies, through production engineering. The new technologies employed at this stage enable the design and production of internationally competitive products
4. In the final, or *basic research stage,* R&D capabilities are enhanced to foster innovations and the development of entirely new technologies. Products designed and produced in this final stage push out the international frontier of industrial knowledge.

[84]Habibie often refers to a required critical mass of highly skilled engineers and technicians representing one percent of the population acting as agents for the diffusion of advanced technologies throughout the country (eg Habibie 1993).

The *second* important condition for the success of the vehicle industries is that they are protected from international competition and can therefore service a captive domestic market. When scale is achieved and the necessary technologies are acquired and developed, protection is then lowered to enable competition without assistance in both domestic and international markets (Rice 1990). Habibie acknowledges that many of his strategic industries, due to their capital and technology intensive nature do not concord with Indonesia's comparative advantage in labour and resource intensive industries and as a result may be technically inefficient and unable to immediately compete with foreign producers. He thus expresses a willingness to accept a lower rate of growth in the short run, as this will be more than compensated for in the long run when technology intensive industries will be able to generate higher growth and income levels (Habibie 1993).

Habibie's industrial development efforts are centred on the ten state-owned strategic enterprises under the aegis of the Coordinating Agency for Strategic Industries (BPIS - *Badan Pengelola Industri Strategis*). The biggest of the strategic industries are the aircraft manufacturer (IPTN), the shipbuilder PT PAL and the Krakatau steel works, all of which benefit from direct and indirect government subsidies, but as yet show few signs of becoming internationally competitive, or at least profitable within a protected domestic market. Habibie is, to a certain extent, able to generate business for these firms by selling their products to government departments and state-owned enterprises and also through various 'offset' arrangements negotiated with foreign companies who sell technologically advanced equipment to Indonesia (Schwarz 1994).

Discussed below is a brief account of the technological activities of the three largest state-owned enterprises within the strategic industries program as listed above.

1. IPTN (*Industri Pesawat Terbang Indonesia* - the Indonesian Aircraft Industry) is clearly the largest and most ambitious and expensive of the strategic industries program (Clifford 1993). According to CSES (1995) the prominence of aerospace within the strategic industries reflects the influence and background of Habibie, who

as noted earlier, had a distinguished career in the German aerospace industry before being recalled back to Indonesian in 1974. As with all the strategic industries, Habibie's approach is to follow the PMP, ie to 'start with the end and end with the beginning.' Thus, rather than gradually developing technological capability through components manufacture and aeromaintenance - a strategy successfully employed by other developing countries such China, Korea, Brazil and Singapore - Indonesia instead opted to more immediately into final assembly operations, despite the obvious lack of skills and technical knowhow and the absence of an adequate machinery and capital goods base (CSES 1995).

IPTN had its origins as a division of Pertamina (the state oil company) in 1974. It began production operations later in the decade assembling a number of aircraft for European manufacturers[85]. During this early phase (the technology introduction stage) IPTN developed the knowhow for final assembly operations and was able to significantly increase the proportion of components made locally (Raillon 1990) although by value foreign content was as much as 70-80% during the early-mid 1980s (McKendrick 1992). IPTN entered the second phase of the progressive manufacturing plan, (*the technology integration* stage) when in the early 1980s it began to jointly design and produce a completely new aircraft, the CN 235[86], with the Spanish aerospace company CASA. According to the CSES (1995) the CN 235 was a commercial failure, with only a few sales outside of Indonesia, due in part to corrosion and cracking problems and high maintenance costs.

In 1987 IPTN entered the third phase of the PMP (the technology development phase) when it began work on a new aircraft, the N-250[87] (Raillon 1990). IPTN has since

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[85]These included the 212 Aviocar, a 19-seater turboprop from CASA, Spain; the NBO-105 helicopter from Messerschmitt, Germany and the SA 330J Puma helicopters from the Aerospatiale Company, Germany.

[86]The CN-235 was a 35 seat twin turboprop designed specifically for Indonesian conditions, ie to take off and land on short airstrips and to operate in mountain or rough areas. The aircraft was designed with a rear ramp door to facilitate use for military or freight purposes.

[87]The N-250 is a fixed wing turboprop aircraft that has been specifically designed for short haul commuter flights carrying 64-68 passengers at speeds of up to 330 knots over a 800 nautical mile distance (BPIS 1995). Due to the incorporation of an advanced "fly-by-wire" flight control system the N-250 has been touted by Technology Minister Habibie, IPTN and the local media as the most

fully designed and produced a prototype of the aircraft which had its maiden flight in Bandung in August 1995. Although not publicly acknowledged, a significant component of the design and research work for the N-250 was carried out by subcontracted foreign engineers, technicians and pilots mainly from the USA, UK and Germany and numbering usually 200-300 at any one time. Production of the aircraft is expected to begin within a few years (ie upon accreditation by necessary authorities such as the US Federal Aviation Authority, this appears to be still a long way off), with production and marketing facilities planned also in the USA and Germany (*Warta Ekonomi* 6 May 1996, *Gatra* 24 June 1995, *Jakarta Post* April 4 1995). The break-even point for the aircraft is 259, however by July 1996 the N-250 program office reported only 26 firm orders and 187 options. All of the firm orders are from Indonesian operators and 33 of the options are from foreign carriers (*Aviation Week and Space Technology* July 1 1996).

IPTN is now planning on entering the fourth stage of the PMP - basic research - by designing and producing a 80-130 seat jetliner, the N-2130. It is envisaged that the fly-by-wire flight control technology applied on the N250 will also be featured in the transonic jet (IPTN 1995). Initial moves have seen the establishment of a company, (PT Dua Satu Tiga Puluh) to generate funds for the project. (*Kompas* 7 and 22 February 1996), a new research program was initiated late 1995 to develop additional transonic aviation technologies and an ambitious schedule[88] for the aircraft's ultimate production and sale was announced in February 1997 (*Kompas* 7 February 1997).

Whilst designing and producing final aircraft has increasingly become IPTN's major focus, the company has also continue to pursue a number of international collaborative ventures which includes co-production, subcontracting and maintenance,

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technologically sophisticated aircraft in its class (see for example BPIS 1995, IPTN 1995, and media reports such as *Gatra* 24 June 1995, *Media Indonesia* 15 August 1995).

[88]The schedule sees the feasibility study finalised in 1997, the aircraft configuration completed in 1999, design of the aircraft commenced in 2001, prototype production, roll-out and certification in 2002 and the maiden flight scheduled for 2002-2003. Commercial sales of the aircraft are planned to commence in 2005 and by 2013 the 326th unit sold should allow IPTN to reach the break even point (*Kompas* 7 February 1997).

repair and overhaul work[89]. For example the NBELL-412 and the Eurocopter NBO-105 helicopters are continued to be made under license with recent sales to the Indonesian Navy and the Defence Department (*Kompas* 27 March 1997), however the entire helicopter program is reported to be winding down (*Aviation Week and Space Technology* 1 July 1997). The company has also benefited through offset arrangements negotiated through the purchase of aircraft by Garuda Airlines and the Indonesian Airforce. In December 1995 for example IPTN was awarded a contract to produce components for the Airbus A-330 and A-340. Prior to this similar arrangements enabled IPTN to produce components for Boeing, Fokker, General Dynamics and British Aerospace (*Republika* 1 May 1996).

2. PT. PAL. Established in the Naval Base at Surabaya in 1980 PT PAL inherited the Navy's existing facilities, docks and personnel. According to STMIS[90] (1993) PAL is active across the first three stages of the PMP. In the first stage PAL has been producing various craft under licence such as patrol boats and jetfoils in the warship division and tankers, utility vessels, tugboats and a general cargo carrier in the commercial ship division. In the second phase of the PMP PAL has been producing entirely new products such as bulk carriers, jetfoils, tugboats and sailing yachts either with and without foreign collaboration[91]. In the third stage - the technology development stage PT.PAL has been able to design and produce tuna fish long ships and steel sailing boats.

3. PT Krakatau Steel (PTKS) is ASEAN's largest integrated steel production plant and Indonesia's largest heavy industry complex. The plant had its beginnings as a steel project developed with Soviet assistance in the Sukarno era. The central

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[89]See *Aviation Week and Space Technology* (1 July 1997) for a description of recent international collaborative ventures.
[90]The Science and Technology Management Information System is a UNDP-UNESCO funded project where the Centre for Analysis of Science and Technology Development in PAPIPTEK-LIPI assesses the development of technology capacity in the BPIS. According to one official from LIPI involved in the project there were two different reports produced: an unpublished more critical report and a "sterilised" more positive report that was released to the public.
[91]One ship given much recent attention in the media was the *Palindo Jaya 500-1* - a 400 ton, 500 passenger ship designed to cruise large rivers and dock in small harbours and produced in collaboration with Germany's Meyer Werft shipyard. The ship was launched in July 1995 with attendance by the President and Technology Minister Habibie. (*Jakarta Post* July 21 1995).

objective of the steel works is to provide Indonesia with self-sufficiency in steel (a crucial material for a rapidly industrialising country) and to stabilise the price and supply of steel so that downstream industries can grow (BPIS 1995). However Clifford (1993) reports that the track record of Krakatau Steel over the past two and a half decades is unimpressive. Despite substantial government subsidies and assistance the plant is yet to become internationally competitive[92]. Moreover, STMIS (1993) notes that Krakatau Steel has yet to develop any significant innovatory capacity and is still heavily dependant upon foreign technology.

7.2.2.2 Assessment of Habibie's Approach

Various authors describe the popular support which can be found throughout virtually all levels of Indonesian society for Habibie's ideas and programs (eg Thee 1994c, Crouch 1994, Schwarz 1994). As noted by Crouch (1994), an important factor behind this widespread support is Habibie's ability to tap into popular nationalist sentiment. Clifford (1993) for example notes that many Indonesians are clearly proud of the fact that Indonesia now has Southeast Asia's only aircraft assembly plant, its largest steel mill and largest shipyard and may eventually have its own nuclear plants[93]. According to Thee (1994c) the popular acceptance of Habibie and his ideas has given him a clear advantage over his technocrat rivals in the policy debate.

> While the economic technocrats have rightly been credited with the speedy recovery of the Indonesian economy after the economic chaos left by the Old Order [Sukarno] Government , and again with taking appropriate adjustment measures after the end of the oil boom in 1982 to restore macroeconomic stability and promote non-oil exports, they have not been able to offer a vision of Indonesia's economic future to capture the imagination of the very same people who now support the high-tech drive of Professor Habibie...Perhaps it could not have been otherwise, as the economic technocrats, exhausted from their protracted battles to have the government pursue prudent macro-economic policies, were only able to offer what must have sounded like bland

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[92] Clifford (1993) notes that in the early 1990s prices remained at 20% above international levels and the plant was grossly over-staffed.

[93] However, it has been reported recently in the press that Habibie has had to postpone his plans for the establishment of nuclear power in Indonesia, after widespread opposition to the program.

prescriptions for macro-economic stability, including low inflation, low current-account deficits and sensible exchange rate management instead of offering a blueprint for Indonesia's industrial development (Thee 1994c p. 18).

Further strengthening Habibie's position vis-a-vis his rivals is his high profile in the local media. Macleod (1993) reports that in the public debate over Indonesia's industry or technology policy, Habibie has clearly been making a stronger impact upon the local media than his technocrat rivals. The latter, he notes, appear to lack a spokesman willing and able to match Habibie's public relations drive.

In the political arena, Habibie has been able since 1990 to considerably broaden the political support for his economic ideas, through his chairmanship of the newly formed Association of Moslem Intellectuals (ICMI) (Schwarz 1994). In the first half of the 1990s he was also able to enjoy the support of an increasing number of cabinet members sympathetic to his approach to development[94]. However it is at the highest level of government where Habibie engenders his strongest and most powerful support. As noted earlier, Habibie has enjoyed a long and close personal relationship with the President and according to many observers including Schwarz (1994), Crouch (1994), Hill (1988) and others, this relationship plays a crucial role in explaining Habibie's political influence[95].

Despite enjoying such strong support and influence, the policy agenda of Habibie has been criticised on a number of fronts. The first and most obvious criticism is that the billions of dollars invested in his projects annually are a waste of money and these funds would be better used elsewhere. Schwarz (1994) notes that while the Indonesian fiscal budget is not large, the demands of Habibie's programs are substantial. Continued government support for Habibie's projects - at least while they are recording losses - will mean either an increase in foreign debt or fewer budget allocations for other uses.

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[94] See Macleod (1993) and Schwarz (1994) for an account of Habibie's rising political fortunes in the early 1990s.

[95] It is important to note that in the latter half of 1997 there were a number of journalistic and other less formal reports that Habibie's political influence was waning. However this has yet to be formally documented.

The standard technocrat position on Habibie, as represented by Wardhana (1995) and Djodjohadikosumo[96], dismisses the notion of 'picking winners' to create *competitive advantage* and instead posits a gradual progression towards value added industries commensurate with the development of the domestic resource base. Wardhana (1995) for example, writes that policy makers should not prematurely reject natural and labour intensive industries as a basis for the skill- and capital-intensive industries of the future. He maintains that the government should continue to support Indonesia's present comparative advantage in these industries for two reasons. First, because they are an important source of foreign exchange (accounting for almost one-half of non-oil exports, and for nearly two-thirds of export growth during Repelita V), whilst high technology industries have so far generated very little export earnings. Second, because high technology industries provide few work opportunities for Indonesia's predominantly low skilled and abundant workforce[97].

As noted by Schwarz (1994) the technocrats typically dismiss the argument commonly made by Habibie and his supporters that the current approach of picking high technology winners had its antecedents in the successful industrial targeting experiences in Japan, Korea and Taiwan. Wardhana (1995) notes that even if the on-going debate in the development literature was resolved in favour of those who support selective targeting, he doubts whether Indonesia could emulate the success of these countries for two reasons. First, because Habibie's strategic industries would not be expected to meet similar performance requirements (usually in the form of strong export performance) which the governments in these countries typically demanded from firms in return for government subsidies or protection; and secondly, because the

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[96] A speech delivered at the Economics Faculty at the University of Indonesia, 20 September 1995, as summarised in the *Jakarta Post* September 25 1995.

[97] Many others have voiced their concerns about the distributional implications of Habibie's programs (eg Manurung 1993, Budiman 1993, Macleod 1993, Simarmata 1993). Most question the logic of imbuing a small subset of the population with high technology skills and comparatively high wages, at the expense of work and educational opportunities for the low income majority. One observer, (Simarmata 1993) invokes the *Demokrasi Ekonomi* concept (a democratic economy) as enshrined in paragraphs 33 and 27 of the Indonesian constitution which emphasises that the economy should be managed in such a way as to ensure participation by all Indonesians. The Habibie programs he argues belies such a concept by concentrating a disproportionate share of the country's resources into a small sector of the economy, whilst generating higher unemployment elsewhere.

international context has changed in favour of less regulated trade and it is now more difficult for governments to actively promote selected sectors.

Other reasons proposed in the literature to reject the practice of picking winners relate to the problem of government failure in Indonesia. Various authors including Thee (1995a) and the World Bank (1992) have suggested that the Indonesian government does not have the administrative capability to effectively handle the many complexities associated with an industry policy which selectively assists a few industries or firms. More explicitly, Schwarz (1994) notes that interventions in Indonesian industry in the past had often resulted in politically motivated government-business collusion, widespread corruption and the entrenchment of vested interests. Moreover given that the political setting had not significantly changed over the past two decades, he argues there is little reason to expect that the current round of industrial targeting under Habibie would not meet the same fate.

Another important criticism relates to the capacity of Indonesian industry to absorb sophisticated forms of technology (eg World Bank 1993, Clifford 1993). The World Bank (1993) maintains that Indonesia is yet to develop sufficient technical know-how to independently carry out even part of Habibie's plans. Out of the 40,000 workers employed in the Indonesian electronics industry it was found that only 320 had university degrees. Moreover in order for Indonesia to simply reach the level of electronics capability South Korea had achieved by the early 1980s another 17-18,000 engineers are required (World Bank 1993). Thus the continuing advancement of Habibie's programs may require a substantial inflow of expensive foreign expertise which, as noted earlier, was the case for the IPTN's N-250 program.

Other concerns within the literature focus on the ability of Habibie's industries to develop meaningful economic linkages with other sectors of the Indonesian economy and therefore to diffuse new technologies. Whilst there is general agreement that projects such as the IPTN appear to have imported and developed high levels of technology, there is little evidence to suggest that such skills and know-how have been spread to other sectors of the economy. One study of the development of the

Indonesian aircraft industry found that there were opportunities to develop linkages with other sectors of the economy, but due to the inability or unwillingness of management to draw other firms into the *IPTN* circle of activities, such inter-firm linkages had yet to be developed (McKendrick 1992). Moreover, it may be the case that the technology developed within Habibie's vehicle firms is too sophisticated to be applied to local manufacturing industries. As a Jakarta Post editorial diplomatically stated

> The problem is that IPTN has advanced so much faster than the other sectors of the economy that it virtually operates as an island without the support of local vendors or parts suppliers which in foreign countries are the strategic partners of aerospace companies (Jakarta Post February 1995).

Other reasons cited for the lack of linkages relate to the choice of industry vehicles. Noting the general lack of 'trickle-down' benefits for the private sector, Kwik Kian Gie (1993) suggests that the public science and technology effort would be better directed to the fields of genetic and bio-engineering which would generate considerable benefits for farmers, cattle breeders and fisherman who in large part belong to the poorer segments of society[98].

A final criticism considered here relates to the problem of inefficient production leading to higher input costs for downstream industries. Rice (1990) writes that the development of Habibie's vehicle industries helps lessen Indonesia's dependence on the rest of the world for high technology goods and services, but notes that there is a conflict between this and efficiency. Efficient production of aircraft, ships and industrial machinery and their many component parts requires a certain quantum of output to cover fixed costs. For many of these final products and component parts there is not sufficient demand in Indonesia to generate such economies of scale (Rice 1990, World Bank 1993). Higher costs of production are then transferred through

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[98]Gede Raka, the Director at the *Pusat Penilitian Teknologi* (Technology Research Centre) ITB likewise questions the appropriateness of Habibie's choice of industry vehicles. He singles out the pharmaceutical sector as a more appropriate recipient of policy assistance due to Indonesia's considerable supply of raw materials in this area and strong local demand for pharmaceutical products (Interview with Dr. Ing Gede Raka at the Technology Research Centre, ITB Bandung, September 1995).

forward linkages to downstream industries, which are restricted to using the protected locally produced capital goods.

Examples of such negative forward linkages can be sourced to the shipping and aircraft industry. Rice (1990) notes that the protection of local shipbuilding activities in the 1980s resulted in high cost inter-island shipping, generating further costs for farmers and consumers. More recent evidence of negative forward linkages was revealed when the local airline Merpati caused a major political controversy in October 1995 when it refused to lease 16 IPTN produced CN-235 aircraft. The company's director Mr Ridwan Fatarudin, who was later dismissed by the Transport Minister, explained in local media reports that the aircraft had unusually high operating costs which makes them commercially unviable (*Jakarta Post* October 18 & 19 1995; Warta Ekonomi November 6 1995).

Making an accurate and full assessment of the financial viability of Habibie's strategic industries program is a difficult task and will not be attempted here. This is because financial information on the BPIS is sparse and generally unreliable (Hill 1988, 1996; Schwarz 1994) [99]. Hill (1996) writes that even when profitability figures are released they do not take into account a number of implicit and explicit subsidies. In the case of IPTN in Bandung for example, the land has been provided at no cost to the firm, local airlines are obliged to purchase the company's aircraft and increasingly IPTN is the beneficiary of various offset arrangements through foreign purchases of the National airline, Garuda and the Indonesian Airforce (Hill 1996; Crouch 1995). More explicitly the government has recently converted a loan from the Forest Ministry's reforestation fund to the IPTN aircraft plant into government equity in the project thereby releasing IPTN of any obligation to pay back the loan [100] (*Warta Ekonomi* 17 February 1997).

[99] Any sort of critical analysis of the BPIS program is also difficult in a political sense. One business magazine (*Bursa* 19 September 1995) for example notes that Habibie's strong personal and political ties with the President, his chairmanship of ICMI and the fact that IPTN is increasingly identified with Habibie make it extremely difficult to criticise the BPIS program in the present political climate without it being interpreted as an attack on the President, Habibie himself or certain Moslem groups (See also the interview with Farid Gaban in the same issue).

[100] Based upon *Keppres* (Presidential Decision) No. 42/1994, the government was authorised to lend money from the forestry budget to IPTN on the understanding that IPTN would pay back the loan

Despite such assistance, most of the BPIS companies are yet to become profitable. In February 1995 Habibie acknowledged to a government commission that around five of the companies (particularly the large high technology ventures) were making losses (*Kompas* 21 February 1995, *Sinar* 4 March). In November 1995 the Finance Department released a listing of the most 'healthy' of the BUMN, of which only three of the smaller BPIS were included (*Warta Ekonomi* 27 November 1995). According to Finance Minister Mar'ie Muhammad, who is seen to be aligned more in the technocrats camp, the financial performance of the BPIS was the worst of the BUMN (*Kompas* 21 February 1995).

In reply, Habibie cites as the major problem affecting financial performance the lack of export credit facilities made available to his companies. Without such facilities he argues it is extremely difficult to export expensive items such aircraft, ships and railway carriages (*Sinar* 4 March 1995; *Kompas* 21 February 1995; *Forum Keadilan* 28 August 1995). The Finance Ministry has declined to provide export credits for BPIS products arguing that the government simply does not have the necessary financial resources to fund such a scheme (Jakarta Post February 22 & 23 1995, *Sinar* 4 March 1995)[101]. One creative alternative explored by Habibie is to sell IPTN (or other BPIS) products through barter arrangements such as that seen recently with Malaysia for cars and with Thailand for rice (*Suara Pembaruan* 29 April 1996, *Warta Ekonomi* 6 May 1996).

It is clearly too premature to make a full assessment of the economic benefits of the strategic industries program to the Indonesian economy. Such an assessment will only come with the fullness of time. However, the wide range of criticisms and problems associated with the program noted above suggests that any long run benefits will also be accompanied by high socio-economic costs. This makes the strategic industries a

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when it has sold 707 aircraft, at a marginal rate of 5 percent per unit sold (*Warta Ekonomi* 17 February 1997).

[101] See also Wijaya, K (1995) who presents a number of alternative methods for financing export credits for the BPIS products.

very risky project, as it may be the case that the on-going costs of the program to the rest of the economy, and to society in general may outweigh the long run benefits.

A less risky approach, is to follow the model set by a number of other countries in the region whereby technological advancement has been driven mainly by the profit seeking activities of private firms. From both the theory and practice of growth reviewed in the first section of the thesis (Chapters 2-4), it can be seen that market incentives are a crucial determinant of innovation and technological progress. However, the dominance of the state in Indonesia's drive toward technological development has not only crowded out the private sector by commanding a substantial share of the country's scarce financial and human resources, but it has also clearly distorted the overall incentive environment for innovation. Thus Indonesia's current approach to technological development is contrary to the successful practice of other East Asian countries where the private sector played a leading role.

7.3 R&D and other Innovative activities in the Private Manufacturing Sector

7.3.1 Recent Surveys

There have been a number of studies on the innovatory or technological capacity of the Indonesian manufacturing sector. These include STAID (1993), Scherer (1993), Thee (1990, 1994), Thee and Pangestu (1994), Harianto and Safarian (1995), SRI (1992) and Hill (1991). A central theme to emerge from the literature is that local manufacturing firms have low innovatory and technological capacity.

Most studies are based upon interviews or case studies. The only quantitative study was that carried out by the STAID[102] program when it attempted to measure the

[102] The Science and Technology for Industry Development project funded by the World Bank involving both LIPI and BPPT.

degree of R&D activity and production engineering (PE)[103] in the manufacturing sector using a special survey conducted by the Central Bureau of Statistics. STAID (1993) reports that many of the larger enterprises were unable to accurately report the amount of funds channelled into both R&D and PE. Of those firms that did respond it was found that approximately 0.2% of total output was spent on R&D and about 0.8% for PE with the chemicals and fabricated metals industries the largest spenders on both R&D and PE. Total R&D expenditures of the public sector (ie government departments, universities and state-owned enterprises) and the private sector combined was crudely estimated to represent 0.7 percent of GDP. Scherer (1993) notes that this is low compared to its neighbours, but about average for an economy with a similar per capita income as Indonesia.

A broad overview of the technological capacity of Indonesian private industry was provided by Scherer (1993) who divided it into three distinct categories:

1) Small scale enterprises that use traditional skills to produce mainly for the domestic market. Such firms show low levels of operational capability and poor quality control and have little or no capability or awareness of how to innovate or access modern technologies. There is very little standardisation of their products and due to their technological backwardness have few linkages with modern industry.

2) Modern small and medium sized firms that produce for the domestic market but with a large number that produce for the export market. Export oriented firms show good quality control and maintenance procedures as well as competitive production in low technology manufacturing but must depend on overseas contacts (such as joint venture partners or foreign licensors) for technological inputs. Domestic oriented firms lack quality control and standardisation as well as the technology to

[103]Production engineering includes quality control, problem solving and other technical services associated with the production process. According to STAID (1993) production engineering is considered important to Indonesia as it represents the country's main technical activity and acts as a prelude to more innovative or knowledge based activity.

design or develop new products, but some firms however have acquired modern process technologies.

3) Large scale firms that tend to be under the control of the conglomerates or are foreign owned. In this category firms generally have good operating capability and command of existing process technologies as well as some minor adaptation and improvement abilities. Many firms however are limited to assembly and other low technology activities with poor quality control and little design and innovation capabilities. There appears to be little standardisation except when provided by foreign or local buyers.

Thee (1990) in his study of the technological capability of the manufacturing sector focused more on the issues of foreign investment, licensing agreements with foreign companies and technology transfer. His study examined to what extent technology transfer through transnational corporation (TNC) activity (ie. joint venture or licensing) promoted or inhibited the technological development of local firms[104] centring on four aspects of technology transfer: the adaptation of products and processes to Indonesian conditions; the training of local employees; the development of local R&D capability; and the transfer of technology through linkages with the local economy.

The key finding of Thee's (1990) study was that it was the type of arrangement with the TNC that determined the degree of technological capability attained by local firms. More specifically, he found that those firms that produced under licence extracted greater technological benefit through their association with foreign partners than those in joint ventures arrangements.

To assess the technological capabilities of the firms surveyed Thee (1990) refers to Dahlman and Westphal's (1982) stages of technological development, which consist of 1) Production engineering (the operation of existing plants); 2) Project execution

[104]Based on 12 case studies - 3 firms from each of the food processing, pharmaceutical, chemical and automotive industries.

(setting up new production capacity); 3) Capital goods manufacture (embodying new ideas into process and product technologies) and 4) R&D - generating and developing new ideas.

In general Thee found little evidence of firms engaging in capital goods manufacture and /or R&D. However, those firms which chose to purchase their technology through licensing arrangements were active in both production engineering and project execution. Conversely those firms involved in a joint venture arrangement found that the technology transferred from the foreign partner was limited to production engineering.

> Insofar as process and product adaptations to local conditions, training of local employees, establishment of local linkages, establishment of local linkages and the establishment of small laboratories for testing and quality control (not R&D facilities) were carried out by the TNC, they were primarily done with a view to ensure the smooth operation of these joint ventures (Thee 1994 p.11).

Furthermore, providing there was an adequate flow of profits and smooth operation of production facilities local partners appeared to have little concern with the issue of technology transfer. Of the firms that chose not to have equity participation by a foreign partner, there was far greater pressure to improve technological capacity among those that purchased off-the-shelf technology (OTST) vis a vis those that continued to produce under licence. Firms using OTST were able to be more innovative in labour intensive industries, producing standardised products such as food and generic drugs.

Kakazu (1990) likewise emphasised the role of foreign direct investment in his study of industrial technological capabilities in a number of East Asian economies. Although noting a general improvement in capabilities over the 1970/80s, the author found that the Indonesian industry sector in the late 1980s was still driven largely by labour and resource intensive activities and as a result was lagging behind the other sample countries in the move toward more knowledge intensive activities. He cites as one of the major reasons for Indonesia's industrial technological backwardness the inability to diffuse and effectively use the many foreign technologies introduced in the late 1960s and 1970s. In particular, the capital intensive and resource based technologies transferred at that time were not suitable for more broad based industrial development appropriate to local factor endowments.

Thee and Pangestu (1994) in a more recent study explored the link between technological capabilities and export performance in the textile, garment and electronics industry. A key conclusion drawn from their survey is that most firms were found to have already developed skills and knowhow necessary for production operations. Some firms could make minor changes, few firms however, had developed the ability to undertake major changes or innovations to their production systems. Moreover, they found that there were few if any linkages apparent between private firms and government research institutes.

7.3.2 Industry Studies

Electronics. There have been numerous surveys of the Indonesian electronics industry (eg Safarian and Harianto 1995, SRI 1992, Thee and Pangestu 1994, Reed Electronics Research 1997). A dominant theme to emerge from this literature is that the industry is characterised by low skill and low technology intensive activities. Assembly operations represent the major activity, although component production has in recent years grown rapidly, albeit from a very low base[105]. Indonesia has been a minor player in the semiconductor industry but with leading semiconductor manufacturers recently announcing production plans[106] there are expectations that Indonesia could become a significant supplier (Reed Electronics Research 1997).

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[105]As discussed in Chapter 8, Indonesia was producing components in the early-mid 1980s through the operations of two TNCs: *Fairchild* and *National Semiconductor*. Due to a world wide slump and the restrictive policy environment at the time that discouraged automation both companies ceased component production operations in Indonesia in the mid 1980s and relocated elsewhere. As a result, active components as a percentage of total electronic exports fell from 60.1% in 1985 to a mere 7% in 1992 (Thee and Pangestu 1994).

[106]For example the joint venture between PT Humpuss Elektronika (Chaired by Hutomo Mandala Putera "Tommy" - the son of President Soeharto) and the NEC Corporation of Japan announced in October 1995 - see *Warta Ekonomi* (16 October 1995 p. 69) and *Jakarta Post* (September 30 1995

The predominance of assembly operations in Indonesian electronics is reflected by the industry's high degree of dependence on imported parts and components. Estimates of the dependence upon foreign components range from 70 to 85 percent[107]. More formally, this dependence upon component imports is indicated by the production-demand ratios as shown in table 7-2. During the late 1980s and early 1990s the production-demand ratio has remained very low indicating that the Indonesian electronics industry could, at most, meet only half of total domestic demand for electronics parts, components and final products. The domestic supply of consumer goods exceeded domestic demand in 1993. However, both the industrial and parts/components sector could supply only about 30% of domestic needs in that year.

Contributing to high dependence upon imported components is the low quality and standard of available domestic components (Thee and Pangestu 1994). Those components that are sourced domestically tend to be less technology intensive materials such as plastic and metal parts, packaging and passive components, whilst the imported components tend to be more technology intensive components such as cathode ray TV tubes and integrated circuits (Harianto and Safarian 1995).

Table 7-2 Ratio of Domestic Production to Domestic Demand (%) - Electronics

	1985	1993
Total	45.2	52.2
Consumer	83.2	179.8
Industrial	29.1	28.1
Parts/Components	59.7	29.1

Source: Ministry of Industry data cited in Harianto and Safarian (1995).

p.12). Another important joint venture recently announced is that between PT Tabung Gambar Indonesia and the Toshiba Corp., Sumitomo Corp. (Japan) and the Orion Electric Co. Ltd. (South Korea) to produce colour television picture tubes in Bekasi, West Java - see *Jakarta Post* (March 11 1995 p. 9). Also Matsushita of Japan has recently established an assembly plant for semiconductors in West Java which began operation in early 1997, and a joint venture to produce coin-format lithium batteries (Reed Electronics Research 1997).

[107]For example see *Bisnis Indonesia* (4 August 1994, 30 November 1995) *Suara Pembaruan* (6 June 1994), *Warta Ekonomi* (8 May 1989).

As emphasised in Chapter 3, contact with foreign partners has been an important mechanism for technology acquisition in East Asia's electronics firms. However industry surveys by Thee and Pangestu (1994) and Harianto and Safarian (1995) showed that Indonesian companies participating in a joint venture arrangements with a foreign partner were given little opportunity to learn new technologies beyond that necessary for efficient production operations. Furthermore, the firm(s) that did not enter into a formal production arrangement with a foreign manufacturer were forced to develop their own in-house research and design capabilities. These firms were also able to access modern technologies through less formal arrangements, such as sending personnel overseas or receiving foreign consultants.

Journalistic accounts of innovative behaviour in the electronics sector typically highlight only a small number of firms: eg. PT Hartono Istana Teknologi (Polytron) is a wholly owned Indonesian company that has from the start conducted its own research and development and has not been bound to a foreign principal. Where necessary the company has imported technology through less formal means, such as independent engineering consultants. A number of the company's products, such as TVs and VCRs have already penetrated OECD markets (*SWA Sembada* July 1993). Another company PT Panggung Electronics Industries, carries out OEM work for its foreign partners but by developing research and development it has the ability to carry out own-design and own-brand manufacture (*Business News* no. 184 1991).

Pharmaceuticals. The activities of the Indonesian pharmaceutical industry consists essentially of assembling and mixing the active ingredients as well and some packaging and repackaging (Thee 1990, Afdal 1994) According to informal estimations, approximately 90-95% of all active ingredients (raw materials) are imported (*Warta Ekonomi* 5 December 1994, *Jakarta Post* June 1 1995, *Eksekutif* September 1994). Contributing to this high rate of dependence upon imported components is the high costs and low quality of domestic production (Sudarwanto 1995). The small number of active ingredients that are produced domestically tend to be restricted to the last stage of the manufacturing process leaving little opportunity for any significant value adding (Thee 1990). Recent government policy measures are reported have improved both the quality and cost of locally produced components through tariff reduction packages (May 1990 October 1993 and May 1995) and industry standards legislation (EBRI September 30 1995, *Eksekutif* September 1994)

The smallness of domestic demand and the high cost of R&D severely limits the scope for genuine innovative activity in the Indonesian pharmaceuticals sector (Afdal 1994). What R&D is carried tends to be limited to testing or mixing of known formulations (Sudarwanto 1995). Journalistic accounts of innovation in this sector highlight the activities of two firms: the state owned Bio Farma for its work on vaccines for polio and hepatitis and PT Kalbe Farma which since establishing R&D facilities in the early 1970s has continued to bring out new formulations and product brands each year using imported active ingredients (*Eksekutif* September 1995, *SWA Sembada* July 1993).

Automotives. The Indonesian automotive industry is dominated by foreign companies. Although the domestic market is relatively small there are a large number of makes competing within that market. In 1994, for example, there were 27 different makes for a total market of 320,000 units. Of the 320,000 units 60% was dominated by just three manufacturers, Toyota, Mitsibushi and Suzuki, leaving the 24 other producers to compete for the remaining 40%, or approximately 128,000 units (*Warta Ekonomi* 13 May 1995). Since 1994, other makes have entered the market including Hyundai and the controversial 'national car' of Timor Putra Nasional (a company headed by the youngest son of President Suharto, Hutomo Mandela Putra). The low-cost 'Maleo' car from the Technology Minister Habibie's Strategic Industry Program (BPIS) is also expected to enter the market in the next few years further crowding the local market (*FEER* February 27 1997).

Given the fragmented nature and the smallness of the Indonesian market there is very little opportunity to develop profitable scale economies. The poor scale economies also ensure that the foreign manufacturers undertake mainly assembling activities in Indonesia (Sargo 1995). Component production has been growing steadily over the past decade and a half, due largely to the government's deletion (increased local content) program initiated in 1976/77 (Thee 1990) and the various tariff reductions on imported components introduced over the years such as the May 1995 package (EBRI July 22 1995). More recently the extension of tax concessions to competitors of the Timor national car project, on the condition of meeting a 60 percent local content requirement by 1998, has given a clear incentive for these firms to upgrade local capabilities and to reduce their dependence on imports (*FEER* February 27 1997). Nevertheless, there is little indication in the literature that the industry has developed any significant research or design capability.

Textiles, Clothing and Footwear. Indonesia has produced textiles for over 80 years and in that time it has developed some ability to make minor changes to the production process. However, as noted by Thee and Pangestu (1994), the need to develop indigenous technical knowhow is diminished to an extent by the willingness of Japanese partners to supply the necessary technology to ensure efficient production operations. Similarly, in the garment industry, most Indonesian manufacturers produce under OEM arrangements for foreign clients or partners which allows little opportunity to develop inhouse research or design capability (Thee and Pangestu 1994).

Footwear. There is very little local content in the shoes produced in Indonesia. Approximately 70-80 percent of all materials and parts imported whilst the materials supplied locally tend to be restricted to packaging materials, shoe laces, zippers and other non-primary components (*IBW* February 26 1993). In most case the Indonesian producer simply responds to original equipment manufacturing (OEM) orders from the foreign client or partner. This leaves little opportunity for the Indonesian producer to develop technical skills beyond that of investment and operation capabilities.

By way of conclusion to this section it is useful to emphasise a number of important themes which emerge from the above surveys. The *first* is that the technological capability of private sector manufacturers is typically low. *Second*, and relatedly, the manufacturing sector is largely import driven, with low value added assembling activities representing the primary activity. *Third*, most domestic manufacturers are dependent upon foreigners for their technology inputs which are typically imported through OEM, FDI or subcontracting arrangements. However it appears that local manufacturers have been largely unable to learn from their foreign partners to graduate to more technology intensive activities such as ODM, OBM or even collaborative R&D work, as is increasingly occurring in a number of other countries in the region (see Chapter 3).

7.4 Measuring the role of Technology in Indonesia's Industrial Development: New and Old Approaches

An important theme which emerges from the first section of this dissertation is that rapid growers in the developing world have been those countries best equipped to import and effectively use modern forms of foreign technology; and in some cases to develop indigenous technologies.

Given the importance of technology to economic development it is clearly important for the economist to be able to quantitatively assess both the level and growth of technological capacity. There is, however, no clear cut method of quantitatively measuring technology capacity. Analytical tools available to economists today provide only illustrative and not precise or accurate assessments of a country's technological capacity.

In this section a number of quantitative methods and indicators are used as a means to measure the growth and level of Indonesian industrial technology capacity. This includes the traditional growth accounting approach and a number of alternative approaches using manufacturing export data.

7.4.1 The Growth Accounting Approach

The traditional method of measuring the rate of technological progress is the growth accounting approach which is built upon the standard neoclassical production function with exogenous technology. This approach, first carried out by Abramovitz (1956) and Solow (1957) and continued and developed amongst others by, Kendrick (1961) Denison (1967, 1985), Maddison (1987), Jorgenson, Gollop and Fraumeni (1987) and Mankiw, Romer and Weil (1992), disaggregates the determinants of output into physical capital (and sometimes human capital) and labour. The part of output growth that cannot be attributed to the accumulation of any input - the so called 'Solow residual' or TFP (total factor productivity) - is taken to represent disembodied technical change (ie not embodied in goods or people but instead representing new ideas or blueprints).

The basic growth accounting approach assumes a standard Cobb-Douglas production function of the form

$$Y = A(t).\, K^{\alpha} L^{1-\alpha} \qquad (1)$$

where A is disembodied exogenous technology and the exponents on capital and labour sum to unity to ensure constant returns to scale. By differentiating with respect to time to find growth rates and then taking logs we get

$$y = a + \alpha k + (1-\alpha)\, l \qquad (2)$$

where lower case represent logs. If we assume competitive markets with factors being paid their marginal products then the capital and labour shares correspond with the exponents α and $1-\alpha$ from (1) respectively, or the coefficients from (2). Most studies including Fischer (1993), Maddison (1987), Solow (1956) and Denison (1985) estimate the capital share at around 0.3 to 0.4[108]. Maddison (1987) for example

[108]When incorporated into the production function, this implies sharply diminishing returns to labour and therefore downplays the role of capital in the growth process.

estimates the average capital share for six OECD countries (France, Germany, Japan, Netherlands, United Kingdom and the United States) over the 1973-82 period to be approximately 0.3.

Using this information the growth equation can be written

$$y = a + 0.3\,k + 0.7\,l \qquad (3)$$

and rearranging to get 'a' over to the left hand side to get

$$a = y - 0.3\,k - 0.7\,l \qquad (4)$$

The residual term "a" is often referred to as a measure of total factor productivity (TFP)[109], ie. that portion of income growth that cannot be explained by growth in the capital and labour stocks.

Using the above methodology Solow (1957) concluded from US time series data over the period 1909 to 1949 that output per worker had doubled with 87.5 percent of the increase attributable technological progress (ie. the 'Solow residual') and the remaining 12.5 percent due to the increased use of capital. Similar emphasis upon technological progress were found in other early growth accounting studies by Kendrick (1961) and Denison (1967). Grossman and Helpman (1991) note that more recent studies have significantly reduced the size of the residual by incorporating estimated changes in the quality of factor inputs (eg Denison and Chung 1976, Maddison 1987, Jorgenson et.al 1987)[110]. The contribution of the technology residual was likewise substantially reduced in Mankiw, Romer and Weil (1992) whereby the constant returns production function (1) is redefined to include human capital with

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[109]Sometimes referred to as Multi-factor productivity.

[110]Maddison (1987) for example incorporates ATFP (augmented total factor productivity) which is defined as TFP minus the imputed the contributions of increases in labour quality and capital quality. For a sample of six OECD countries (listed above) over three time periods (1913-50, 1950-73 and 1973-84) estimated ATFP was in most cases 100 percent smaller than TFP.

shared equal weights with physical capital and labour as represented in the following the production function

$$Y = A(t).\, K^{\alpha} E^{\beta} L^{\gamma} \qquad (5)$$

where E is human capital and $\alpha = \beta = \gamma = 1/3$. As above logs are taken and the equation is rearranged so that the residual is on the left hand side.

$$a = y - 0.333\, k - 0.333\, e - 0.333\, l \qquad (6)$$

Table 7-3 summarises the estimated TFP growth rates over given years from a sample of published studies. The first column summarises the results from Fischer (1993) which employs a similar approach to that as outlined in equations (1) to (4) above. However due to the higher estimated capital share in developing countries, Fischer increases the assumed value of the capital coefficient to 0.4, whilst reducing the labour share to 0.6 to ensure constant returns to scale. The second column summarises the results from Mankiw et al (1992) which uses the coefficient weights as described above ie following equations (5) and (6) . In this approach years of educational attainment is used as a proxy for human capital.

The third and fourth columns in table 7-3 summarise the results from two alternative approaches employed by the World Bank (1993). In each case, the familiar Cobb-Douglas production function is used with the coefficients on log capital growth, log human capital growth and log labour growth constrained to sum to unity. The coefficients for approaches A and B are based upon output elasticities estimated for a complete sample of developing and developed countries (ie 2093 observations) and on a smaller sample of high income countries (ie 460 observations) respectively.

From Table 7-3 it can be seen that changing the assumed coefficient values generates quite diverse results (as indicated in differences across columns 3 and 4). For example, Singapore records positive TFP growth in the third column but strongly negative growth in the fourth. Similarly Malaysia's TFP growth is positive in the first and third approaches but negative in the second and fourth. However, rankings of average TFP growth across the sample countries appears to be more or less constant. Japan consistently records the highest TFP growth which is surprising given Japan's role as a technological leader in the region. The relocation of many Japanese industries in the 1970s and 1980s to the other sample countries should have facilitated a degree of technological convergence in the region, but is not reflected in these figures. Also surprising is the low, and often negative TFP growth rates for Singapore and Malaysia which have both moved rapidly into more knowledge intensive manufacturing over the past three decades, whilst Indonesia has lagged all other countries in this respect but recorded relatively high TFP growth.

Table 7-3 Technology Residuals - Average Growth Rates (various studies)

Country	Solow Residual	Mankiw et al. Residual	World Bank (1993) A	World Bank (1993) B
Singapore	-0.38%	-0.10%	1.19%	-3.01%
Malaysia	0.12%	-0.21%	1.07%	-1.35%
Japan	1.31%	1.64%	3.47%	1.42%
Indonesia	1.13%	0.21%	1.25%	-0.79%
Thailand	0.62%	0.45%	2.50%	0.54%
Korea	0.60%	0.41%	3.10%	0.24%
Hong Kong	NA	NA	3.64%	2.41%
Years	1965-85	1965-85	1960-90	1960-90

Note: 1) Columns one and two are calculated using the Fischer (1993) data set.
2) Columns three and four calculated using World Bank data.

Other studies of TFP growth using similar a methodology generate equally surprising results. Young (1994) for example found that Egypt, the Congo and Bangladesh had higher TFP growth than Korea, Taiwan or Singapore. Similarly, Lau and Kim's (1992) econometric analysis of 'meta production functions' across countries shows that Korea and Taiwan have experienced very little technical progress at all over the past few decades. Also surprising were the results from an earlier World Bank (1991) study which shows an almost universal fall in TFP growth in the developing world over the 1960-87 period. According to Singh (1995) the causal model underlying this analysis is that the recent fall in TFP growth rates is due to policy mismanagement, ie low rates of technical progress caused by distortions, lack of competition, lack of integration with the world economy etc. He maintains that the evidence is not compatible with such an analysis as there is general agreement among economists, including those from the World Bank, that there has been more competition, greater openness and fewer distortions in most developing countries in the latter period.

However, as noted by Grossman and Helpman (1992), Singh (1995), Sheehan (1994) and others, the problems that arise in interpreting results from growth accounting exercises relate to a number of fundamental weaknesses in the model, as described below.

1. *Unrealistic assumptions underlying the model.* Singh (1995) for example writes that the model assumes full employment of resources and perfect competition, none of which obtains in the real world. The approach, therefore, will only accurately measure each factors contribution to output growth in the case that factors are paid their value marginal product. However if factors markets are imperfectly competitive or production generates increasing returns and/or externalities, then the Solow residuals will be biased measures of productivity growth (Grossman and Helpman 1992). Ito (1995) sees the existence of large residuals in growth accounting as showing a 'failure of the assumptions that underlie the regression...and may be suggestive of an alternative (such as increasing returns).' As noted by Sheehan (1994) the inability of the growth accounting work to provide some kind of theoretical basis for determining the weights applied to factors in the production function seriously undermines any economic meaning that can be drawn from the TFP concept.

2. *The inability of national accounts to capture the full effect of new ideas on output.* A number of studies emphasise that consumer price indexes cannot effectively account for quality improvements and due to the lateness for inclusion of many new products, are unable to capture the price reduction effect which typically follows the introduction of new (usually higher technology) products (Gordon 1996; Bresnahan 1986; Tratjenburg 1990). According to Grossman and Helpman (1992) it is now generally believed that reported price indexes often underestimate the economic

benefits from product innovation, and as a result growth accounting exercises will understate the contribution of new ideas to output growth. Griliches (1992) and Gordon (1996) note that those countries with a high service sector share of the economy are more likely to underestimate overall GDP as it is more difficult to measure technology related productivity increases in this sector.

3. *The assumed exogenous nature of the TFP residual* (ie those unexplained factors which push out the production function). As noted by Sheehan (1994) and Hall (1990), in order for the growth accounting analysis to generate an economically meaningful concept of TFP, a necessary condition is that there must be reasons for believing that the factors generating the shifts in the production function are independent of movements along the production function. Thus technological advances, as supposedly captured by the TFP residual, should be totally independent of human and physical capital accumulation. The model is therefore incompatible with more modern theoretical perspectives on growth which hold the determinants of technological progress as endogenous.

Given the difficulties of drawing any economically meaningful interpretation from the results of growth accounting exercises, the approach in this chapter is to disregard TFP as a potential indicator of technological progress, and to instead consider a number of alternative means as outlined in the next section.

7.4.2 Alternative Approaches using Export Data

In this section, three alternative methods are used to assess technological development according to the type of manufactured products it is exporting. According to this approach, a country is assumed to develop technologically as it structures its export manufacturing in favour of more knowledge intensive activities.

The analysis uses 22 industry manufacturing export data ranked by knowledge intensity as described in section 6.2 for the seven ANICs and China. Knowledge intensity is determined by R&D/production ratios for those industry groups for the OECD countries taken as a whole. The highest R&D-production ratios are found in industries such as aerospace (20.2%), computers (12.4%) and electronics (10.8%) whilst the lowest are in the wood and furniture (0.1%), paper and printing (0.2%) and textiles and clothing (0.2%) industries. The 22 industries are also separated into four technology categories: high, medium-high, medium-low and low (Table 6-1).

There are three reasons why the analysis uses mainly manufacturing export data. First, as emphasised earlier in chapter 3, export manufacturing has been a key vehicle for technological advancement in the East Asian region over the past three to four decades. Second, export data is generally regarded to be more reliable than industry data[111]. Third, competitive demand side pressures suggests similar quality standards across countries for similar products (ie it is more difficult to market a manufactured product internationally that has obsolete embodied technology).

The first method used to measure Indonesian technological development is an index of technology composition of exports as developed by Sheehan, Pappas, Tikhomirova and Sinclair (1995). By this approach, export values for the 22 industry groupings are weighted using their respective OECD R&D ratios (described above), summed and rebased to produce an index of technology composition whereby an index value greater than one indicates that a country's exports are concentrated in industries with a high knowledge intensity whilst a value less than one indicates a concentration in industries with low knowledge intensities.

The index of technology composition can be formally expressed as

[111]In Indonesia, for example, industry data is based upon surveys of companies from a subset of the industry sector. Moreover, those firms included within surveys must have 20 employees or less. Inaccurate estimation of past industry data led to a substantial modification for all data prior to 1985. This modified dataset is known as the 'backcasting data' (BPS 1995).

$$TC^{i} = \frac{\sum_{j}^{n}\left(X_{j}^{i}.I_{j}\right)}{\left(\sum_{j}^{n}X_{j}^{i}\right).I_{0}} \qquad (7)$$

where X is the export value, I is the knowledge intensity as proxied by OECD R&D/production ratios, I_0 is the average knowledge intensity, i is the country and j is the industry grouping.

It is important to note that the ITC cannot be regarded as an absolute indicator of a country's technological development. It is constructed using R&D-production ratios from the OECD countries from the late 1980s. However for any specific country, be it developed or developing, the knowledge intensity of export production might be quite different to that of the OECD average reflecting the unique conditions of that country at that time. It therefore may overstate the knowledge intensity of manufactured exports from assembling or platform activities[112]. However, the advantage of using the ITC is that it allows manufacturing activities in particular countries to be classified in an international framework, and therefore enables cross-country comparisons to be made. Moreover, as can be seen below, the ITC generates results which are consistent with a broad conclusions drawn from this chapter, ie that Indonesia is lagging most other countries in the region in the move toward more knowledge intensive activities.

Table 7-4 and Figures 7-1 and 7-2 provide a summary of results using the ITC for a number of East Asian countries.

[112]The clearest example in this regard is computers and electronics (X2 and X3 in the high technology category) which includes world class R&D work such as that carried out in Korea and Taiwan on semiconductors, superconductor technologies, telecommunications, computer storage and display and other information technologies (National Science Foundation 1993, 1996; Hobohm 1995) but also simple labour intensive assembling activities such as that found throughout electronics plants in Indonesia and China (Safarian and Harianto 1995, Thee and Pangestu 1994, Shirk 1990, Ding Fing Ping 1990).

Table 7-4 Index of Technology Composition for East Asian Manufacturing Exports 1970 & 1995

	1970	1995	1995 (Excluding Computers and Electronics)
Indonesia	0.19	0.45	0.27
Malaysia	0.24	1.82	0.73
Thailand	0.15	1.05	0.51
China	0.22	0.70	0.39
Korea	0.37	1.27	0.63
Taiwan	0.57	1.33	0.54
Singapore	0.47	2.02	0.69
Hong Kong	0.41	0.90	0.47

Source: CSES estimates using IEDB.

Clearly evident in these figures is the rapid move into more technology intensive export manufacturing for all sample economies. Due to its emphasis upon less knowledge intensive manufacturing Indonesia records the lowest sample index value in 1995. Conversely, Singapore and Malaysia were able to record the highest index value for the sample in 1995 due mainly to their strong export focus in computers and electronics (see Table 3-2).

Figure 7-1 shows Indonesia's ITC remained low throughout the 1970-95 period, reaching a high in 1982, driven mainly by strong electronics and aerospace exports. The country's index declined in the early-mid 1980s as electronics exports fell following the closure of two semiconductor plants (see section 8.2.1), and more generally, as deregulation led to the development of low technology and labour intensive export manufacturing. However the ITC increased rapidly with the expansion of computer and electronics exports in the early 1990s.

Figure 7-2 combines a number of the indexes to better enable cross country comparisons. As expected Indonesia lagged well behind the first tiered NICs throughout the period as these countries not only displayed an initial structure that better favoured more knowledge intensive export manufacturing but were able to move more rapidly into these industries during the 1980s. Indonesia remained slightly ahead of Thailand and China throughout the 1970s and early 1980s but fell behind these two countries when they rapidly expanded their electronics exports in the mid-late 1980s. Malaysia was clearly the best performer in this second sample, with a sustained and rapid movement into computers and electronics which began in the late 1970s.

An important theme underlying much of the above analysis is the importance of computers and electronics in East Asian manufacturing exports. As discussed in Chapter 3, world trade in computers and electronics sectors has grown rapidly over the 1980-95 period, averaging 13.8 percent per annum while trade in other manufacturing products grew by only 6.5 percent per annum. An extraordinary feature of East Asia's export performance over the past few decades has been its penetration of world computer and electronics markets. Export growth in computer and electronics for the eight East Asian countries taken as a whole exceeded 22 percent over the 1980-95 period. In 1970 the same countries commanded only 3.4 percent of world Computer and electronics exports but by 1995 this had increased to 35.5 percent.

This rapid drive into computers and electronics in the region also plays a major role in the development of technology composition indices for most of the sample countries. Figures 7-1 and 7-2 show the indices of composition calculated with and without electronics and computers for the same countries. Except for Indonesia, the exclusion of computers and electronics significantly reduces the composition index for all sample countries. This is particularly the case for Malaysia, Thailand, Singapore, Taiwan and Korea. For Indonesia the exclusion of electronics and computers has no major visible effect upon the composition index until the early 1990s when electronics exports began to expand rapidly.

Another useful indicator of technology capacity using manufacturing export data is the index of specialisation (or *revealed comparative advantage*) as adapted by Sheehan et.al (1995) from the original standard measure as developed by Balassa

(1965). This index was defined in Chapter 6 to measure specialisation in primary products industries. In this section, the index is slightly modified to measure specialisation in the high technology industry group and also the combined computers and electronics industry as defined in Table 6-2. The index of high technology specialisation (HTS) can thus be formally defined as

$$\text{HTS} = \frac{X_j^i / X_t^i}{X_j^w / X_t^w} \qquad (1)$$

where the subscript j in this instance refers to the high technology industry group (or computers and electronics). As before the superscripts i and w refer to the particular country and the world respectively whilst the other subscripts t refers to the total manufactured exports respectively. A HTS value greater (lesser) than 1 indicates that the country has a greater (smaller) specialisation in the export of high technology products than the rest of the world as a whole. As indicated in Table 6-1, the high technology category consists of aerospace, computers, electronics and pharmaceuticals.

Figure 7-4a maps out Indonesian manufacturing export specialisation by technology category over the 1980-95 period. Indonesia's specialisation in the high and medium high technology export categories has remained low throughout the period. The index value for the low technology category increased rapidly throughout the 1980s and has remained well above average in the early 1990s, reflecting Indonesia's strong specialisation in labour and resource intensive manufacturing activities such as textiles, clothing and footwear and in processed wooden products.

Figure 7-4b compares Indonesia's export specialisation in computers and electronics with an average for the six other ANICs and China. Indonesia's specialisation in C&Es fell sharply in the early to mid 1980s reflecting, amongst others, the contraction in C&E exports over the 1984-89 period as well as the general move into the less technologically intensive industries discussed above. In the early 1990s there was a sharp increase in the index due mainly to a rapid expansion in electronics after the 1990 deregulation package (see Safarian and Harianto 1995, Thee and Pangestu 1994). However by 1995, the index value for Indonesia was still well behind the other sample countries as indicated in the fourth column of Table 7-6.

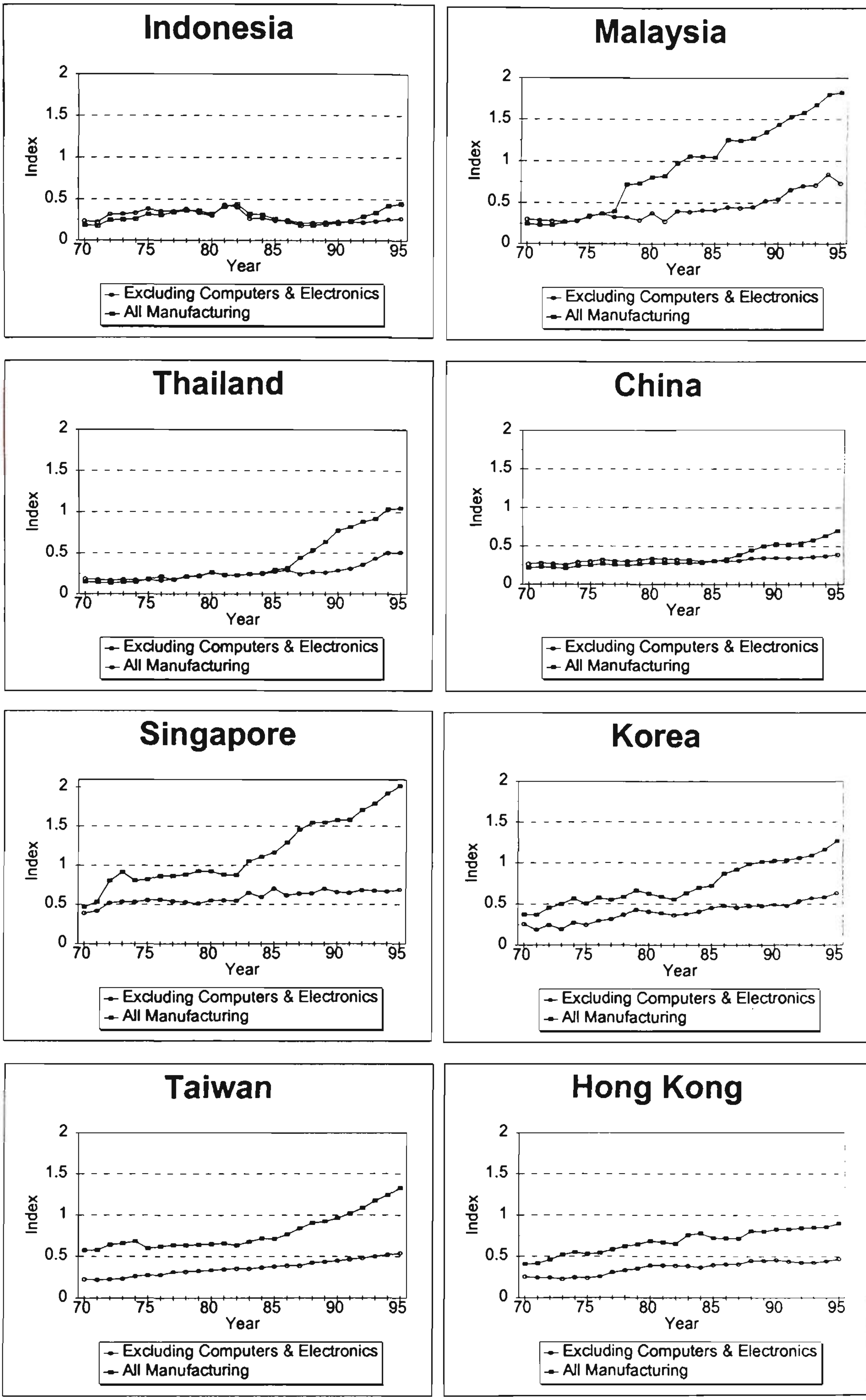
Figures 7-4c and 7-4d compare Indonesia's high technology specialisation with the six other ANICs and China. As expected Indonesia's index is well behind other first tier NICs, although converging to a certain extent with Hong Kong. Indonesia displayed a stronger high technology specialisation than Thailand and China in the first half of the 1980s, but was overtaken by these two countries as they became more specialised in computers and electronics in the second half of the 1980s and the early 1990s (Table 7-6). Malaysia, like Singapore, exhibited a strong specialisation in C&Es throughout the period, and finished with a RCA value in 1995 approximately six times that of Indonesia (Table 7-6).

As mentioned above, an important limitation of the ITC is that it assumes that the knowledge intensity for each of the 22 industry groups is constant across countries, ie fixed weights I_j are used. An alternative to weighting country exports by OECD R&D/production ratios is to use value added per employee (VA/L). Implicit in this approach is the assumption that labour productivity and technology intensity are directly related. Table 7-5 shows that for a number of Asian countries the ranking of technology categories by VA/L does not necessarily correspond with that of the OECD classification system which uses R&D/production ratios. In most cases the med-high technology category which includes chemicals, automotives and electrical machinery has a higher VA/L than the high technology category. Table 7-5 also indicates that by regional standards both the growth and level of Indonesia's VA/L is extremely low.

Figure 7-1

Index of Technology Composition

Selected East Asian Countries



Source: CSES estimates using IEDB (22 industry data).

Figure 7-2
Index of Technology Composition
Regional Comparison

Figure 7-2a

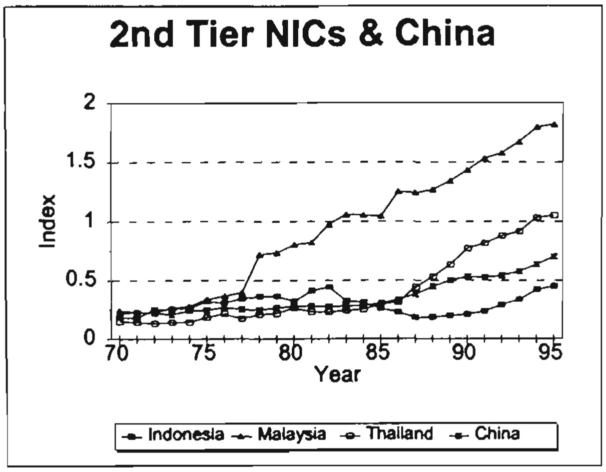


Figure 7-2b

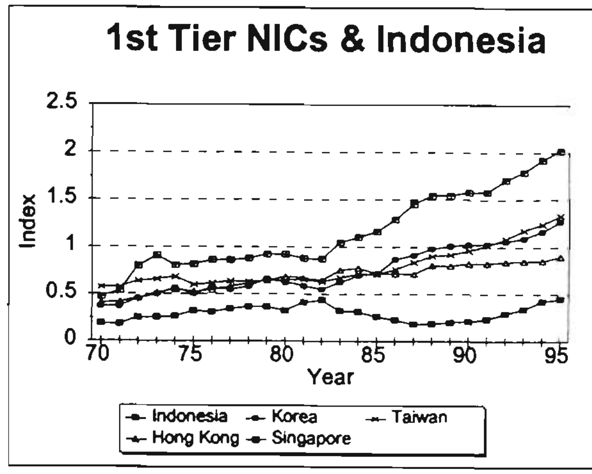


Figure 7-2c

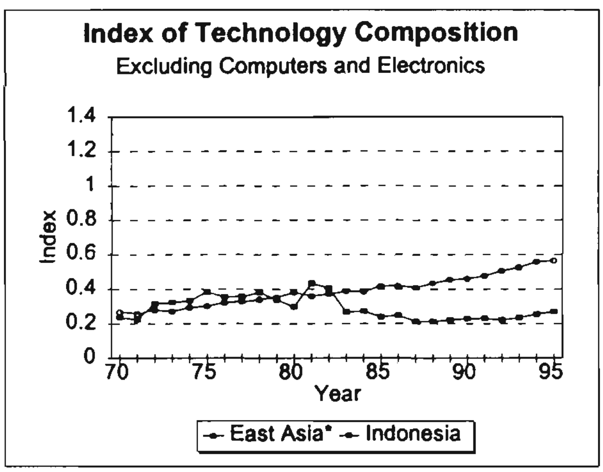


Figure 7-2d

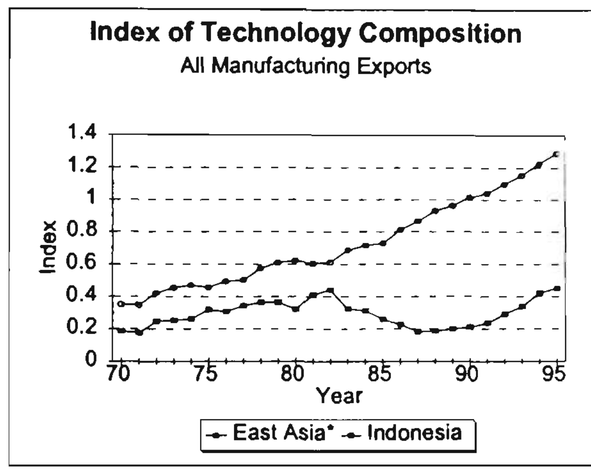
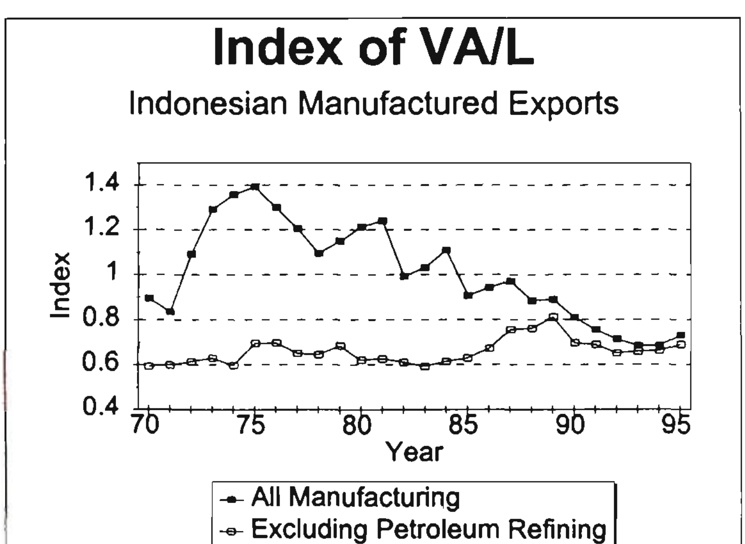


Figure 7-3
Index of Value Added per Worker Composition
Indonesia



Source: CSES estimates using data accessed via IEDB, ANU.

Figure 7-4
Specialisation in High Technology Activities

Figure 7-4a

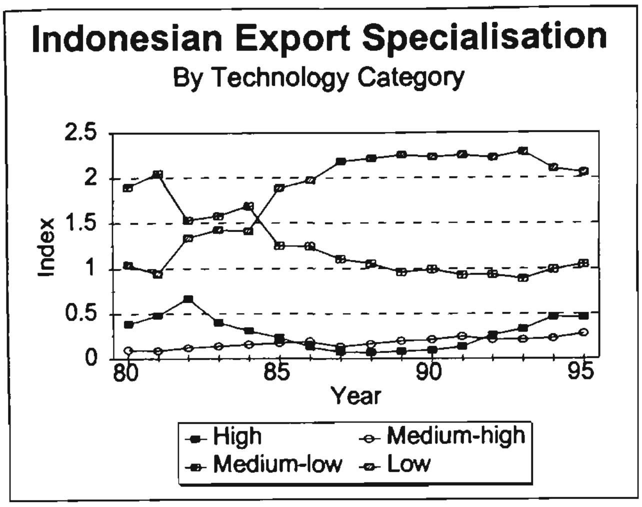


Figure 7-4b

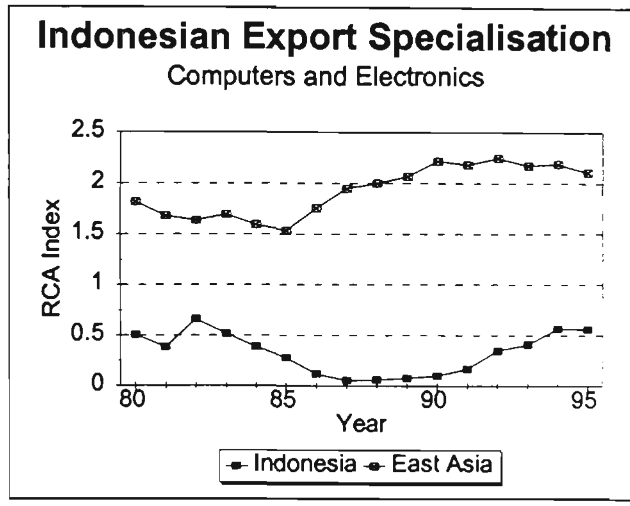


Figure 7-4c

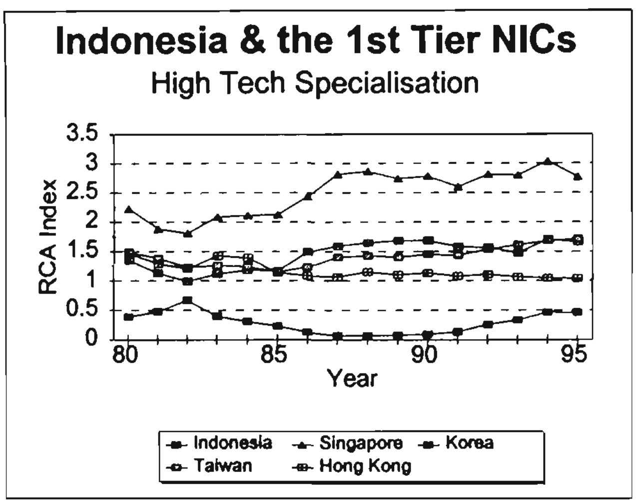


Figure 7-4d

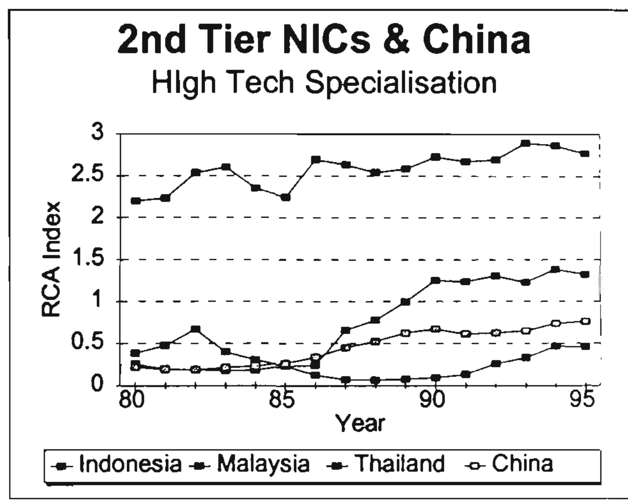


Table 7-6
Specialisation in Computers and Electronics

	1980	1985	1990	1995
Indonesia	0.51	0.28	0.10	0.56
Malaysia	3.02	2.95	3.57	3.27
Thailand	0.34	0.30	1.70	1.54
China	0.10	0.23	0.86	0.91
Taiwan	2.23	1.59	1.98	2.11
Korea	1.83	1.48	2.21	1.99
Singapore	3.03	2.61	3.66	3.67
Hong Kong	2.17	1.56	1.54	1.26
East Asia	1.82	1.53	2.22	2.11

Note:
The computers and electronics sector are defined as ISIC 3825 + 3832.
Source: Processed IEDB data from the ANU.

Table 7-6 Value Added per Employee by Technology Category ($ US ,000)

Country	Year	Technology Category: *High*	*Med-High*	*Med-Low*	*Low*	All Manufacturing
Indonesia	1981	5.4	8.8	5.7	3.4	5.1
	1991	5.0[1)]	7.1	3.8	5.2	5.3
Taiwan	1981	NA	11.3	10.9	10.4	10.7
	1991	NA	20.7	22.5	20.0	21.2
Singapore	1981	13.0	13.3	27.8	10.9	16.3
	1992	37.9[2)]	47.4	48.3	30.8	41.5
Korea	1981	10.2	13.5	10.9	9.8	10.5
	1987	18.2	22.2	15.4	15.5	16.7
Japan	1981	NA	59.8	58.0	45.6	53.1
	1991	98.6	105.8	87.9	70.8	85.2

Notes:
[1)] 1990 data
[2)] 1990 data

Source: CSES estimates using data accessed through the IEDB, ANU.

Using a similar approach as the ITC outlined above the Index of VA/L Composition can be constructed using Indonesian VA/L values for a given year (1989) for each of the 22 industry groups as the weight I_j in equation (7). An advantage of this approach is that it is not driven in large part by the high weightings given to computers and electronics as was clearly the case with the ITC. However, a major disadvantage is that it is not possible to make cross country comparisons using this index due to the fact that the index is weighted using purely Indonesian VA/L values. The index does however show the trend composition of value added in Indonesian exports. An index value greater than one indicates that the majority of the country's exports are in the higher value added industries whilst an index value less than one suggests a specialisation in export industries characterised by lower value added.

From the downward slope of the index in Figure 7-3 it can be seen that since mid 1970s the balance between higher and lower value added exports has been increasingly in favour of the latter. If however export group no. 12 (petroleum refining - see Table 6-2) is excluded the index of VA/L composition increases only marginally over the two decade period, from 0.6 in 1970 to 0.65 in 1993. This suggests that Indonesia's non-oil manufacturing export industries over the 1970-95 period failed to restructure in favour of more value added activities.

7.4.3 Patents and Other Indicators of Technological Development

The measures developed in the previous section do not provide unequivocal measures of knowledge intensity. The index of technology composition and the high technology specialisation index are driven in large part by computers and electronics. This result is not inconsistent with studies by Hobday (1994, 1995), O'Connor (1995) and Simon (1993) and others which typically emphasise the critical importance of computers and electronics to East Asia's industrial technological development. However the data used in the indexes is not sufficiently disaggregated to differentiate between truly knowledge intensive design and production activities and simple assembly operations. Thus the indexes may overstate the knowledge intensity of manufacturing of the less industrialised countries, such as Malaysia and China, where assembling and other low technology activities represent a significant proportion of manufactured exports. At the same time the indexes may understate the knowledge intensity of manufacturing in the more developed countries such as Korea and Taiwan, where R&D and other technologically advanced activities are carried out, but are not necessarily captured within export data.

It may therefore be appropriate to consider a number of alternative indicators which can be used to assess the Indonesia's comparative technological or innovatory capacity. Discussed in chapter 8 are some of those indicators at the 'input' level, such as numbers of scientists and engineers per million population, the number of science and engineering students or graduates, the various measures of R&D expenditures, royalty or license payments for the use of technologies and the knowledge intensity of FDI activities. A common result across all these indicators is Indonesia's technological backwardness in relation to other countries in the region.

At the 'output' level there are a number of other technological indicators which also deserve attention. Thee (1996, 1997) for example, uses the attainment of international standards as another indicator of firm level technological capability. As will be shown in Chapter 8, Indonesia has relatively few companies which have met international standards (ISO 9000), nor does it have the necessary infrastructure to promote their development. STAID (1993) uses international publications data as a technology indicator. Their analysis however finds that Indonesia clearly lags other East Asian countries and other large developing countries in the number of domestically authored articles found within the *Science Citations Index*[113].

Another important indicator is the number of domestic and/or international patent rights granted (eg Daniels 1993; Pavitt 1982, 1985, National Science Foundation 1995). As discussed earlier, patents secure the right to monopolise the use of a product/process innovation for a given period of time. The theoretical justification for the granting of patent rights is that in their absence there is less incentive to innovate as the economic returns to innovation cannot be fully internalised (STAID 1993).

According to the National Science Foundation[114] (1995) reported patent activity in East Asia highlights the region's rapid technological development. Citing data from the World Intellectual Property Organization (WIPO), the NSF notes that in recent years the number of patents granted within the East Asian region[115] increased at nearly

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[113]The *Science Citation Index* is maintained by the Institute for Scientific Information in the US. The index tracks approximately 3200 technical journals throughout the world (STAID 1993).
[114]Thereafter NSF (National Science Foundation).
[115]As determined by seven country sample which includes Japan, Taiwan, Korea, Singapore, India, Hong Kong and China. The NSF excludes both Malaysia and Indonesia from this sample as both of these countries tend to only supply applications data. Moreover they note that even this data is considered suspect given the inadequacy of IP protection in these countries.

twice the rate as in the United States. It is important to note however that any cross country analysis of technological or innovatory capacity using domestic patents data is complicated to a certain extent by differences in patent laws and implementation and the variation across countries in the ease with which patents can be obtained (see for example Pavitt 1982, Schiffel and Kitti 1978). To overcome this problem, the cross country analysis carried out below considers only Asian patenting in the US. Tables 7-7 compares Indonesia's technological performance with a sample of East Asian countries by US patents granted to foreign investors over the 1980-93 period.

Table 7-7 Foreign Owned Patents Granted in the US 1980-93

	Number Granted	Current Impact Index	Technological Strength
Indonesia	33	0.43	14.2
Malaysia	56	0.69	38.6
China	355	0.74	262.7
Hong Kong	540	0.98	529.2
Korea	2,451	0.77	1,887.3
Singapore	170	0.92	156.4
Taiwan	6,015	0.84	5,052.6
Japan	205,905	1.21	249,145.1
EEC	200,003	0.79	158,002.4
USA	598,611	1.04	622,555.4

Source: International Technology Indicators database, cited in National Science Board 1996.

As expected Indonesia was awarded far less US patent rights than the other East Asian sample countries. The number recorded for all East Asian countries is dwarfed by that of Japan and the US, but in many cases comparable to that for a number of smaller European countries. The disparities across regions and countries are further highlighted by weighting patent numbers by the current impact index - an index developed by the NSF (1996) which attempts to capture the impact of a country's patents on the technological community and the degree to which its patents contain important technological advances. It is calculated by how frequently a country's recent patents are cited by all of the current year's patents.

The above figures suggest than Indonesia is not yet able to carry out world class R&D and that which is carried out generates minimal technological benefit to the local science and technology community. Moreover, even when patenting activity is carried out in Indonesia, a significant component is performed by foreigners. Prior to the introduction of the patent law in August 1991, inventors in Indonesia applied for provisional applications with the Indonesian Office for Patents and Trademarks as a means to secure patent protection in the event that true patent legislation would be implemented (STAID 1993). However as can be seen from Table 7-8, such applications have been dominated by foreigners suggesting that indigenous innovative activities have been minimal.

Table 7-8 Provisional Patent Applications Filed at the Indonesian Office of Patents and Trademarks by Domestic and Foreign Applicants, 1953-1989

Year	Domestic	Foreign	Total
1953-1969	182	2870	3052
1970	4	276	280
1975	3	494	497
1980	5	475	480
1985	49	731	780
1989	113	661	774

Source: Indonesian Office of Patents and Trademarks, quoted in STAID (1993).

7.5 Conclusion

The objective of this chapter was to review Indonesia's response to the emergence of the global knowledge economy, by researching the growth and level of innovatory and technological capacity in Indonesian industry. A major theme which emerges from the analysis is the dominant role played by the Indonesian state in promoting national technological development. It was argued that this represents a continuation of a long tradition of state interventionism, and is manifested within modern technology policy through substantial public investment in Minister Habibie's strategic industries program.

However, despite the government's activist approach to national technological development, there is little evidence that this has generated much technological benefit for wider economy. Firm and industry level surveys indicate that innovatory capacity is low and there is continuing dependence on foreigners for technology inputs. More importantly, there is little indication that Indonesian firms have been able to extract much technological benefit from their linkages with foreign firms and have therefore been unable to progress into more value added activities such as ODM, OBM and R&D as is currently occurring in other countries in the region (Chapter 3).

Aggregate empirical measures developed in this chapter also suggest that the level of growth of technological capability remains low. Various cross country comparisons show that Indonesia is lagging most other countries in the region in the move toward more knowledge intensive activities. The empirical analysis suggests that the critical factor preventing Indonesia from developing a more knowledge intensive manufacturing sector is the relatively underdeveloped nature of local computer and electronics industries.

In this chapter and the previous chapter it has been established that there are new challenges confronting the Indonesian economy due to the emergence of the global knowledge economy, but that Indonesia's response to these challenges has so far been inadequate. Whilst acknowledging that there are a broad range of factors likely to influence Indonesia's modest response to the knowledge economy, the next chapter highlights a number of key areas where policy measures (or the lack of policy measures) has and continues to be critical.

8. Explaining Indonesia's Performance in Using and Producing Ideas: The Role of Policy

8.1 Introduction

The second section of this dissertation has explored both the challenge posed by the global knowledge economy and the response to it by Indonesian manufacturers and policy makers. An important conclusion that can be drawn from the analysis is that demand-side pressures associated with new global developments compel Indonesian industry to upgrade in favour of more knowledge intensive activities. However Indonesia's supply-side response to these pressures has so far been modest. Although improving in recent years, Indonesia's industrial technological effort was shown in Chapter 7 to be lagging other countries in the region.

The major objective of this chapter is to explain Indonesia's relatively modest performance in responding to the knowledge economy, with strong focus on the role of policy. Drawing heavily from the discussion in Chapter 3 on the practice of technological development in East Asia, this chapter considers six important factors which have constrained Indonesia in its effort to use science and technology as a basis for national development. These include the economy's traditional domestic market orientation, the nature of and restrictions on foreign investment, the general lack of skilled human resources, inadequate R&D institutions and incentives, and a lack of competitive behaviour in the manufacturing sector.

It should be emphasised that these are not the only important issues relevant to Indonesia's efforts to 'move up the technology ladder.' As noted by Lall (1992, 1993a 1993b), Pack and Westphal (1986) and others, measures to build national technological capability cover a broad policy agenda. The six themes considered below have been chosen on the basis of their importance to the discussion of the theory and practice of growth in chapters 2-4.

8.2 Domestic Market Orientation

Earlier, in Chapter 3, it was shown that manufacturing export activities associated with licensing and joint venture arrangements as well as original equipment manufacturing, original design manufacturing and other subcontracting arrangements represent an important mechanism for acquiring new technology and knowhow in East Asia. Latecomer firms in the region were able to use export channels to learn from foreign customers and/or partners, to monitor recent developments in their respective markets and to develop marketing and distribution channels abroad (Hobday 1995). From this analysis, it could be reasonably concluded that a policy regime that facilitates manufacturing export activity through linkages with foreign firms would also further efforts to upgrade manufacturing technologies. Conversely, an entirely inward looking trade regime that encouraged production for local rather than export markets may impede the development of linkages with foreign firms, and in so doing, restrict opportunities for learning.

However, it is important to emphasise that an orientation toward exports does not preclude the possibility of industry policy measures to nurture certain industries. As noted by the OECD (1992), Lall (1996), Wade (1990) and others, a number of high performing East Asian economies, such as Japan, Korea and Taiwan, pursued an export oriented industrialisation strategy throughout much of the past three to four decades, but within this strategy implemented a comprehensive set of industry policies, including import substitution measures. Various empirical studies, including Bradford (1986) and Dollar (1992), were able to show that the relative prices of traded goods in these countries were more distorted (ie less related to international prices) than that of a number of the large developing countries in South America (ie those economies more commonly associated with pursuing less successful import substitution strategies - OECD 1992). However, as noted in Chapter 3, a key difference between the interventionist approaches across these two regions was the ability of the East Asian governments to extract some kind of 'performance guarantee' (usually related to export performance) in exchange for policy assistance. According to Wade (1990), Lall (1996) and others, an important (yet often overlooked) lesson to emerge from East Asia's recent development experience is that an export oriented strategy and interventionist industry and trade policy measures are not always mutually exclusive.

However in Indonesia's case, it was shown in Chapter 5 that the interventionist policies measures pursued throughout much of the 1970s and early 1980s acted as a clear disincentive to produce for the export market. Moreover, it was found that non-oil exports (particularly manufactured exports) grew rapidly in the second half of the 1980s in direct response to the deregulation program initiated in 1985/86. These policy measures *inter alia* reduced the cost of imported raw materials and intermediate goods to export oriented firms, reformed the customs and port-handling systems, reduced the regulatory framework for exporters and encouraged inflows of export oriented FDI (Nasution 1991, Mihira 1990, Soesastro and Drysdale 1990). Periodic deregulation packages since the mid-late 1980s have continued to eliminate or reduce trade barriers, thus increasing competition in the economy.

Despite this on-going process of reform in the external sector, it has been shown by a number of sources, including Wymenga (1991), Kuyvenhoven et.al (1993), Fane and Philips (1991) and most recently Fane and Condon (1996), that the Indonesian trade regime during the post-deregulation period has continued to exhibit an 'anti-export' bias, although this bias has been diminishing overtime. An approach common to all these studies is to calculate effective rates of protection (ERP) for a large number of products and sectors. ERP captures the combined net effect of a complete system of trade policies (including tariff and non-tariff barriers, import licensing and export taxes) upon real value added per unit of production (Fane and Condon 1996, Kuyvenhoven et.al 1993). Real effective rates of protection (RERP) is similar to ERP but incorporates the impact of general increases in the wage and price level (Fane and Phillips 1991).

Table 8-1 provides a summary of estimates from the study by Fane and Condon (1996) of real effective rates of protection (RERP) for 1987 and 1995 across broad sectors of the Indonesian economy, including what they define as 'import-competing' and 'export-competing' sectors[116].

Table 8-1 Real Effective Protection across Broad Sectors 1987 & 1995

Sector	RERP 1987 (%)	RERP 1995 (%)
Agriculture (excl forestry, fishing & hunting)	9	4
Forestry, fishing & hunting	-14	-34
Mining & quarrying (incl. oil & gas)	-13	-6
Non-Oil Manufacturing	59	16
All Non-Oil Tradables (excl oil & gas)	16	2
Import-competing	29	11
Export-competing	-13	-13
Anti-trade bias	50	28

Note: see Fane and Philips (1991) for category definitions.
Source: Fane and Condon (1996).

The reduced rates of effective protection for the broad sectors suggest that there has been a significant degree of trade deregulation across all sectors of the economy over the 1987-95 period. While the greatest fall in RERP was in non-oil manufacturing, in 1995 it still was the most protected of the broad sectors. Within manufacturing the highest rates of protection were found in the more knowledge intensive areas such as machinery and electrical equipment, consumer electronics, batteries, motor vehicles and motor cycles.

It is significant to note the difference in signs on the RERP figures for the import-competing and export competing sectors. According to Fane and Condon (1996) a positive rate of effective protection to import competing sectors raises nominal wages and the average costs of inputs to all industries, thereby reducing the competitiveness of export industries. They note that this is the effect sometimes referred to in the complaint by consumers and exporters that protection in Indonesia has led to the emergence of the 'high cost economy.' This is reflected in a negative rate of

[116] See Fane and Phillips (1991) for a complete description of the delineation between export and import competing sectors.

protection for export competing sectors, as the protection of import competing inputs to these sectors (such as various machinery and transport equipment and key raw and intermediate products controlled by import monopolies) in effect raises export prices, thereby assisting Indonesia's foreign competitors in these markets.

The final row of Table 8-1 provides a summary measure known as the 'anti-trade bias' (ATB) which is used by Fane and Condon (1995) to gauge the overall extent to which the system of protection inhibits trade. The ATB is defined as the RERP for import competing sectors, relative to the RERP for export competing sectors. Hence the ATB will increase as the relative rate of protection for import competing sectors increases (which provides an incentive to produce domestically rather than importing) and/or the relative rate of protection for export competing sectors decreases (which provides a disincentive to export due to higher input prices). In 1995 Indonesia's complete system of protection continued to exhibit an anti-trade bias. However the percentage figure representing this bias against trade almost halved over the 1987-95 period.

According to the World Bank (1996) import protection, such as tariff and non-tariff barriers, accounts for approximately two-thirds of this continuing anti-trade bias, whilst export restrictions account for the remainder. This means that there is a continuing incentive to substitute for imports rather than to promote exports. Deregulation packages since 1995 have further lowered trade barriers, in accordance with the timetable for reduction in tariffs announced in 1995[117]. As a result the average unweighted tariff has declined from 19.4 percent prior to the 1995 reforms to 12.2 percent after the July 1996 deregulation package (DIFAT 1996). However as noted by USIS (1997) a number of impediments, particularly non-tariff barriers, continue to protect a large share of both agricultural and manufacturing production, whilst over half of Indonesia's non-oil exports continue to be subject to some sort of export controls.

[117] For a description of the timetable see *Gatra* (June 3 1995). See also DIFAT (1996) and USIS (1997) for a review of recent deregulation packages.

The key lesson to be drawn from this section is that the historical orientation of the Indonesian manufacturing sector toward the domestic market has restricted the opportunities for learning associated with the development of linkages with foreign firms through various types of subcontracting, original equipment manufacturing and licensing arrangements. This is no more apparent than in the electronics sector which, as emphasised in Chapter 3, has represented a crucial vehicle for technological advancement in a number of high performing East Asian countries over the past three to four decades.

8.2.1 The Case of Electronics

Various surveys of the Indonesian electronics industry, including Thee and Pangestu (1994), SRI (1992) and Harianto and Safarian (1995), emphasise the highly restrictive nature of the policy environment, particularly during the import substitution period 1974-85. Key elements of this restrictive regime included the imposition of high tariffs on electronics goods (ranging from 5-50% for industrial electronics, and 20-60% for consumer electronics), the banning of a wide range of electronics products (including TVs, radios, cassette decks and various telecommunication equipment), the introduction of new import licensing regulations, the banning of imported second hand equipment and tight restrictions upon entry and expansion for both foreign and domestic firms (Thee and Pangestu 1994, Harianto and Safarian 1995).

It should be emphasised that use of regulatory measures in the electronics industry was in no way unique to Indonesia. Dahlman (1993) for example, was able to show how various policy measures played a specific role in the development of the electronics sectors for a number of countries, both developing and developed. In East Asia such measures included high levels of trade protection (Japan, Korea and Taiwan), considerable restrictions upon FDI (Korea and Japan), public R&D (Korea), fiscal and financial incentives (Japan, Korea, Taiwan and to a lesser extent Singapore), government procurement (Japan, Korea and Taiwan), direct participation

(Singapore and Taiwan) and technical training and education (Singapore, Japan, Korea and Taiwan)[118].

In Indonesia's case, Harianto and Safarian (1995) note that there appears to have been no coherent policy with respect to the development of a local electronics industry, at least until the 1990 deregulation program. They argue that the import substitution phase prior to the mid-1980s was not intended specifically to target the electronics industry, 'but was more to reflect the general attitude of protectionism across the economy and not specific to a particular industry.' However, they and others including Thee and Pangestu (1994), SRI (1992) and the World Bank (1993b), note that a net result of the restrictive policy environment for electronics in the 1970s and 1980s was a distinct bias against export activity.

From Table 8-2 it can be seen that during the 1980-88 period Indonesia's average annual growth in exports of computers and electronics was negative, as opposed to strong positive growth in other East Asian countries. According to Harianto and Safarian (1995) and Thee and Pangestu (1994), key elements of this anti-export bias included the banning of certain imported components as well as various restrictions upon foreign investment, including the banning of imported second hand equipment which discouraged relocation type of investments since investment costs became higher. These studies also report that the structure of protection was biased in favour of consumer and home appliances with weak backward linkages (ie mainly assembling activities with imported components) and against more value added activities such as intermediate and capital goods manufacture.

[118] Other writers have also noted the widespread use of interventionist measures to develop electronics in East Asia. Hobday (1995) for example, describes how the Korean government in the 1970s and 1980s protected the local market in computers and peripherals and other low-end electronics using tariffs and foreign investment restrictions. In addition, Wade (1990) notes that in Taiwan the government used trade policy measures to ensure the development of key import substitutes for new export activities in computers and electronics.

Figure 8-1

The Indonesian Electronics Sector

Figure 8-1a

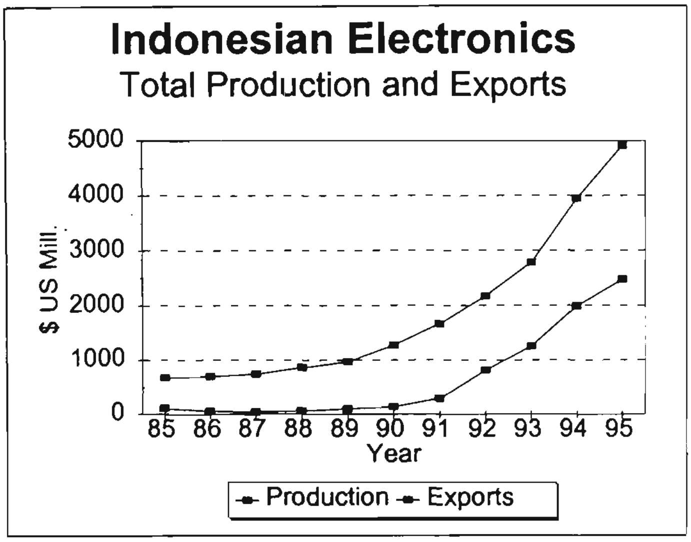
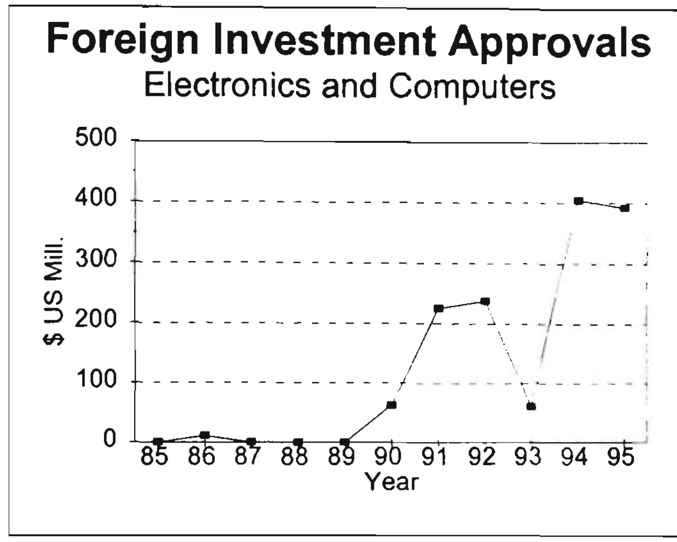


Figure 8-1b



Notes

Exports and Foreign Investment data is ISIC 3825+3832 (Computers and Electronics).
Foreign Investment data for 1995 is January-September.
Sources: 1) Yearbook of World Electronics (production).
2) IEDB, ANU (exports).
3) Unpublished 4 digit BKPM data (foreign investment).

Figure 8-2

Indonesian Foreign Investment (Inflows)

Figure 8-2a

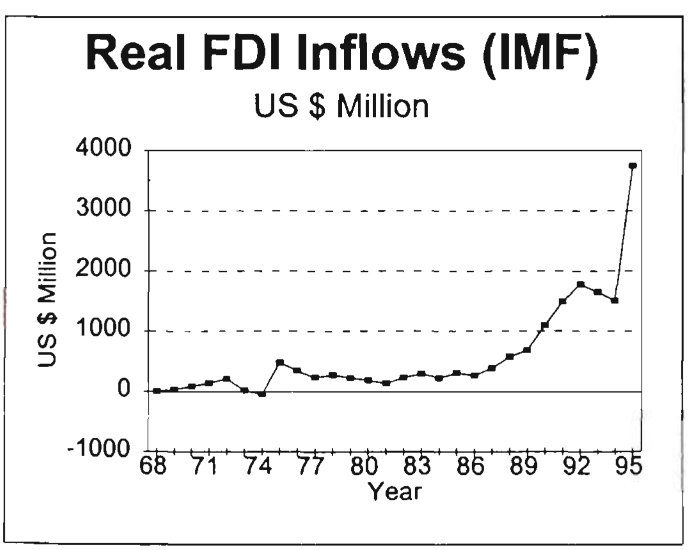
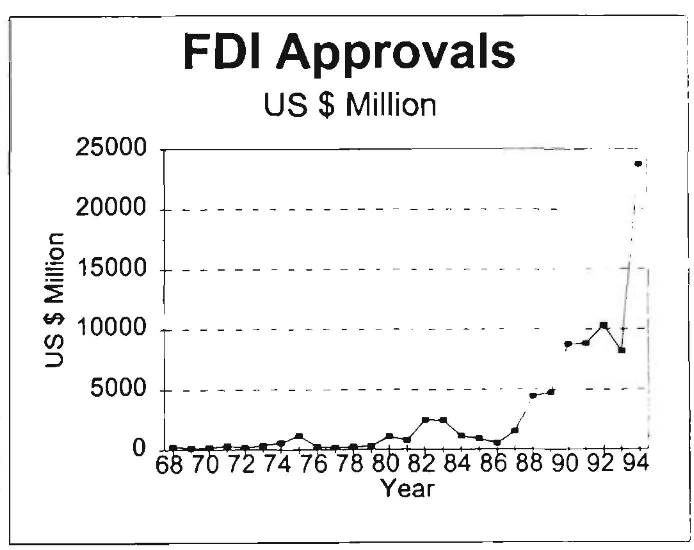


Figure 8-2a



Notes

See text for caveats on the use of FDI approvals data.
Sources: 1) IEDN, ANU (IMF Real Inflows).
2) BPS data (FDI Approvals).

Table 8-2 Average Annual Growth in Exports for Computers and Electronics (C&E) over the 1980-88 period, selected countries.

	Avg. Annual Export Growth
Indonesia	-1.7
Malaysia	19.2
Singapore	20.9
Taiwan	20.4
Korea	27.5
China	45.1
Thailand	24.9

Source: CSES Estimates using IEDB data.
Note: Electronics and computer exports is the aggregate of ISIC 3832 and 3825.

One segment of the Indonesian electronics industry which has seen its development both facilitated and impeded at different times by policy measures is semiconductors; an industry commonly emphasised in the literature as playing a crucial role in modern (particularly East Asian) technological development (eg Dahmen 1993, Hobday 1995). In Indonesia, the semiconductor industry in the late 1970s and early 1980s was dominated by two major US semiconductor companies, Fairchild and National Semiconductor. Both of these companies were able to set up 100 percent foreign owned subsidiaries within Indonesia, as part of the bonded warehouse facility available before the tightening of FDI regulations in 1974. According to Thee and Pangestu (1994) semiconductor exports from these two multinationals dominated Indonesian electronic exports up until the mid 1980s. From Table 8-3 it can be seen that in 1980 semiconductor exports commanded over 90.5 percent of all computer and electronics exports.

In 1986 however, both semiconductor plants were closed down due in part to the global slump[119] in the semiconductor business and to the policy environment within

[119]Thee and Pangestu (1994) note that in 1985 both companies were also scaling production and closing plants across a number of East Asian countries (such as Malaysia, Singapore, Korea and Hong Kong) in response to the fall in global demand conditions for semiconductors. The global slump in the semiconductor business is not reflected in export figures for the region (IEDB data). Apart from Indonesia, no other country experienced a contraction in semiconductor exports over the course of the

Indonesia which emphasised employment creation and discouraged automation[120] (Thee and Pangestu 1994). Figure 8-1 shows Indonesia's semiconductor exports falling sharply over the 1983-86 period and not recovering to previous levels until 1995. In contrast to Indonesia, most other East Asian countries continued to expand their semiconductor exports over the course of the 1980s. By 1995 Indonesia commanded only 0.21 percent of total semiconductor exports from all first and second tier ANICs (IEDB data).

Table 8-3 Indonesian Computer and Electronics (C&E) and Semiconductor Exports 1975-95 (US $ 1000)

Year	Computers	Electronics	Total Indonesian C&E Exports	Semiconductors	As a % of Total Indonesian C&E Exports
1975	270	5,442	5,712	71	1.2%
1980	79	100,034	100,113	90,638	90.5%
1985	89	114,357	114,446	71,664	62.6%
1990	966	137,200	138,166	18,315	13.3%
1995	508,227	1,963,620	2,471,847	145,343	5.8%

Note: electronics and computer exports are defined as ISIC 3832 and 3825 respectively and semiconductors are defined as SITC (rev1) 7293.
Source: CSES estimates and processed IEDB data.

According to Harianto and Safarian (1995) the deregulation of the Indonesian electronics sector was only started in 1990 when import tariffs on final goods and components were significantly reduced and the import licensing system was abolished. They note that these measures were designed to attract domestic and foreign investors into the downstream consumer electronics industry. The data summarised in figures 8-1 and 8-2 suggest that these measures were successful. After

1980s. This suggests that the policy environment played a more significant role in the closing down of the above-mentioned semiconductor plants.

[120] Repelita encouraging employment creation. Thee and Pangestu (1994) note that Fairchild had announced plans to upgrade to new labour saving technologies to improve competitiveness. Although eventually being granted permission to scale back its workforce, there was significant pressure upon the firm from the Ministry of Manpower and the local media to maintain employment levels.

1990 there was a dramatic rise in foreign investment approvals which was also accompanied by accelerated growth in total production and exports[121].

The export oriented firms that have developed rapidly since the 1990 deregulation program are reported to be significantly more competitive than the established firms oriented to the domestic market (Harianto and Safarian 1995). This is reflected in their rapid convergence in productivity levels with that of similar plants in Malaysia and Singapore and their ability to compete internationally in terms of cost-efficiency, quality standards and delivery time.

8.3 Foreign Investment

The most recent *World Investment Report* (UN 1996) identifies Indonesia as the second largest destination for FDI in the Asia region in the first half of the 1990s. However, it has been shown by a number of authors including Hill (1992b), Hobohm (1987) and others, that Indonesia has not always been a relatively open destination for foreign investment. Hill (1992b), for example, likens the policy regime for FDI in Indonesia as a 'sensitive barometer' of changing political sentiment as the policy pendulum in the post war years has swung from a stance of doctrinaire hostility (1958-65), to a more liberal and open posture (1967-73), to a more restrictive approach in the context of state-led industrialisation (1974-84), to a return to a more liberal approach in the late 1980s/early 1990s.

In Chapter 3 it was shown that FDI played a critical role in the start up of a number of key electronics export industries in the East Asia region in the late 1950s/early 1960s. Hobday (1995) described how foreign TNCs investing in a host country were able to transfer skills and knowhow to local companies via a number of mechanisms including the training of local engineers and managers, setting up sub-contracting or

[121] See also *Bisnis Indonesia* (11 October 1995) for discussion and analysis of the rapid rise in foreign and domestic investment approvals in the Indonesian electronic sector.

licensing arrangements or by simply acting as demonstrators and role models. However due to the deteriorating environment for foreign investment in the late 1950s and early 1960s, Indonesia was effectively precluded from using these mechanisms for learning. According to Thee (1994b) this restrictive policy environment culminated in the repealing of all foreign investment policies in 1959 and the nationalisation of Dutch enterprises in 1957/58 and other Western enterprises in 1963/64. With the country virtually cut off from FDI flows from the West, Hill (1992a) notes that the only real source of imported industrial technologies at that time was the Soviet Union and other East European countries.

8.3.1 Early FDI Flows

In the late 1960s/early 1970s Indonesia's foreign investment regime adopted a more liberal and open stance as a result of the 1967 foreign investment law. FDI flows increased sharply in the early years of the Suharto administration, as foreigners took an active part in the country's economic rehabilitation, with a particular interest in a number of key extractive industries such oil, mining and timber (Hill 1992b, Clapham 1970). This liberal regime continued until around 1973 when the government began to introduce a number of restrictions on foreign investment. The FDI regime was further tightened in early 1974 in response to the *Malari* riots. From then on, notes Hill (1996), a local partner was required in all foreign investment projects, employment of expatriate personnel was tightened and a number of sectors closed to new joint ventures.

Most authors describe the increasingly restrictive foreign investment regime pursued throughout the remainder of the 1970s and early 1980s within the wider context of the move toward a 'nationalist' or 'state-led' industrialisation strategy characterised by widespread import substitution and an ambitious public investment program emboldened by the revenue windfall associated with the OPEC induced oil boom (eg Hill 1992b, 1996; Robison 1986,87; Hobohm 1987). This inward and state-led industry strategy brought with it a number of important implications for the foreign investment regime.

The *first* relates to the bureaucratic constraints to project approval and operation confronting foreign investors at that time. A number of writers including Hobohm (1987), Kinoshita (1986) and Thee (1984) and others describe the disincentives to invest in Indonesia brought about by the regulatory activities of the Investment Coordinating Board (BKPM). These included restricting FDI to a progressively narrowing priorities list of industries as well as a number of other time consuming and cost increasing administrative procedures and requirements relating to the training of local staff to replace expatriate employees, the mandatory divestment to Indonesian nationals within a specified period and the use of frequently high cost domestic inputs. Another important FDI disincentive was the expected long delays[122] in getting clearance of goods (such as plant and machinery, spare parts and raw materials) though the notoriously corrupt customs service Hobohm (1987).

The *second* implication was the typically inward looking nature of FDI projects. Various studies and surveys including Thee (1984), Kinoshita (1986), and others note that the majority of manufacturing FDI throughout the 1970s and early 1980s was focused on meeting domestic demand in a market protected to a large extent from foreign imports. According to Kinoshita (1986) this protection from international competition reduced the demands upon efficiency in FDI manufacturers (ie the pressures to upgrade product and process technologies to produce cheaper and better products). He also notes that FDI manufacturers oriented to the domestic market were adversely affected when the decline in oil prices in the early-mid 1980s led to deteriorating market conditions for a number of key sectors where FDI dominated, such as the automotive industry, electrical home appliances and iron related industries. Moreover, the devaluation of the rupiah used by the government as a response to the

[122] According to Kinoshita (1986) prior to the 1985 reform, the time taken for customs clearance for goods after they arrived in Jakarta was 1-2 months compared to 2-3 days (maximum 1 week) in Malaysia, Singapore, Taiwan, Korea and Hong Kong.

ensuing balance of payments crisis increased the prices of imported goods and services further diminishing the profitability of FDI producers (Kinoshita 1986).

A *third* implication relates to the government's emphasis upon resource intensive activities within this state-led industrial strategy. As noted earlier, an important feature of Indonesia's industry strategy during much of the 1970s and early 1980s was the development of a number of basic industries to exploit Indonesia's abundant natural resources such as oil, gas, aluminium and other minerals (Soehoed 1988, Robison 1988). Upon invitation by the government a number of foreign firms participated in this heavy industry program, although a number of planned projects were never implemented (Hill 1996).

According to Kakazu (1990), FDI projects that were implemented in the 1970s carried little technological benefit for the Indonesian economy. He argues that most FDI projects were based upon resource and capital intensive technologies which could not be easily transferred to other sectors of the economy, such as labour intensive manufacturing. According to Thee (1984), as much as 60 percent of total accumulated FDI in Indonesia in the early 1980s was in the energy sector (oil, natural gas and coal). Even within the BKPM foreign investment approvals data for the manufacturing sector, resource intensive industries such as non-ferrous metals, chemicals and stone, clay and glass industries, dominated investment approvals over the 1967-80 period (Table 8-3).

It can also be seen from Table 8-3 that the more technology intensive industry categories, specialised supplier and science based, played a relatively minor role in BKPM approvals throughout the 1970s and 1980s. The export oriented electronics industry, as identified by Hobohm (1995), Simon (1993) and others as the key area where latecomer firms in East Asia were able to acquire new ideas from foreign investors, attracted very little FDI applications (by value) in Indonesia until the early 1990s. Harianto and Safarian (1995) note that export oriented electronics has only really been developing in Indonesia since 1991, stimulated by export oriented FDI which has arrived rather belatedly compared to the experience of Singapore, Malaysia and Thailand. As noted in the previous section, driving the rapid development of export oriented FDI in electronics in the early 1990s was the 1990 deregulation package. Prior to this reform, the policy environment discouraged exports and therefore export oriented FDI, and as a result excluded Indonesia from an important mechanism for learning already successfully exploited by other countries in the region such as Malaysia, Singapore and Thailand (Chapter 3).

Table 8-4 Industry Orientation of FDI Approvals 1967-95 for the Manufacturing Sector

Industry Orientation	1967- 80	1981- 89	1990- 95
Resource Intensive	54.5%	16.0%	13.7%
Scale Intensive	31.4%	68.6%	63.0%
Labour Intensive	12.4%	9.7%	12.3%
Specialised Supplier	0.0%	4.6%	10.7%
Electronics	*0.0%*	*0.1%*	*7.1%*
Science Based	1.7%	1.1%	0.3%

Note: Unpublished 4 digit industry data (ISIC codes) was obtained from the BKPM for the period 1967-95 and then classified as per the industry orientation aggregation scheme used by the OECD (1995) outlined below.
Resource Intensive: Food, beverages and tobacco (ISIC 31), wood products (ISIC 34), petroleum refining (ISIC 354+355), non-metallic mineral products (ISIC 36), non-ferrous metals (ISIC 372).
Labour Intensive: Textiles, apparel and leather (ISIC 32), fabr. metal products (ISIC 381), other manufacturing (ISIC 39).
Specialised Supplier: Non-electrical machinery (ISIC 382-3825), electrical machinery (ISIC 383-3832), electronics (ISIC 3832).
Scale Intensive: Paper and printing (ISIC 33), chemicals excl drugs (351+352-3522), rubber and plastics (ISIC 355+356), iron and steel (ISIC 371), shipbuilding (ISIC 3841), motor vehicles (ISIC 3843), other transport (ISIC 3842+3844+3849).
Science Based: Aerospace (ISIC 3845), computers (ISIC 3825), pharmaceuticals (ISIC 3522) and scientific instruments (ISIC 385).
Source: BKPM data, processed by the author.

8.3.2 FDI Flows in the 1980s and 1990s

From the mid 1970s to mid-late 1980s, both foreign investment approvals[123] and actual inflows remained fairly flat (Figure 8-2). FDI approvals increased sharply in 1982/83, but these figures were inflated owing to imminent changes to the taxation laws which acted as a disincentive to invest (Hobohm 1987, Hill 1992b). Over the 1983-86 period, the total number of approvals fell to pre-1975 levels reflecting both the deteriorating market conditions and the continuing restrictive policy environment for FDI.

The policy regime for FDI returned to a more liberal and open stance with the introduction of a number of key reform packages in the mid to late 1980s. As noted earlier, deregulation of the FDI regime was part of a more general process of deregulation to broaden the country's export base. Key elements of FDI reform within these deregulation packages included the opening up of new sectors to foreign investment (including the banking sector), the allowance for 95 percent foreign ownership of export oriented firms, the reduction of localisation and divestment requirements, the introduction of the duty drawback and exemption facility which enabled better and cheaper access to imported raw and intermediate goods and the complete overhaul of the customs service (Mihira 1990, Hill 1992b). Later reform packages (including those of June 1994 and June 1995) saw further relaxation of divestment regulations, the abolishment of minimum investment requirements, the opening up of previously restricted sectors (including a number of key areas of infrastructure, mass media and civil aviation) and the allowance of 100 percent

[123] Caution must be taken when interpreting FDI approvals data. This data represents planned rather than realised investment. According to Hill (1992b) the differential between approved and realised investment figures reflects *inter alia* the bureaucratic difficulty in carrying out investment projects in Indonesia. Others have suggested that this differential is due to investors filing multiple applications and later seek capital backing for selected projects (interview with Jakarta based consultant specialising on foreign investment approvals). Moreover approvals data exclude the oil and gas and financial services sector which historically represent a significant component of the Indonesian economy. As noted earlier Thee (1984) estimates that as much as 60 percent of total FDI in Indonesia in the early 1980s was in the energy sector (oil, gas and coal).

foreign owned companies for projects located anywhere in Indonesia, with certain exceptions including strategic sectors[124].

The FDI regime is now more competitive by regional standards (Hill 1996). Harianto and Safarian (1995) report that there has been a significant degree of policy convergence within ASEAN, where each country has developed broadly similar investment incentives (eg tax concessions, export incentives, import duty exemptions). However they also note that there remain considerable differences across these countries in terms of restrictive rules, performance requirements and bureaucratic efficiency. By many accounts, Indonesia continues to lag other countries in the region in providing the necessary economic and political conditions conducive for foreign investment (eg USIS 1997; Harianto and Safarian 1995, Hill 1996). Hill (1996), for example reports that issues relating to security of land tenure, the implementation process at the regional level, the localisation pressures of both equity and senior staff, and the general paucity of competent local partners and staff all represent significant impediments to foreign investors. Moreover he notes that smaller foreign firms are apprehensive of the increasingly 'predatory activities' of the newly emerging conglomerates owned by the various members of the President's family. Other continuing impediments to FDI as reported by the USIS (1997) include the business uncertainty resulting from vague or confusing laws and regulations and the corrupt practices commonly used by public servants of imposing illegal levies or extracting commissions from foreign as well as domestic companies.

The central point to be drawn from the above analysis is that the policy environment, by restricting FDI inflows, has impeded the transfer of new ideas into Indonesia . This was particularly the case during the state-led industrialisation period of 1974-85. The impediments to technology flows through the FDI mechanism at this time included the bureaucratic constraints which affected all FDI, the inward looking nature of FDI projects which reduced the demands upon efficiency in FDI manufacturers and the emphasis upon resource intensive activities, such as energy and oil, which carried

[124] for a review and summary of recent FDI deregulation measures see Minter Ellison (1996) and DIFAT (1996).

little technological benefit for local manufacturing. Most importantly, the policy environment, particularly prior to the 1990 reforms, impeded the development of export oriented FDI in electronics, which precluded Indonesia from an important mechanism for learning at this time.

8.4 Human Resource Development.

As emphasised throughout this thesis, human resource development is a crucial element of a developing country's technological advancement. Whereas in an industrial country technological development to large extent rests upon the ability to develop new products or technologies, technological advancement in a development context depends essentially upon the ability to scan, assess, import and adapt existing foreign technologies (Scherer 1993). For this reason education and skill levels are extremely important. As noted by Lall (1992, 1993a), Pack and Westphal (1986) and others, without an adequate supply of well trained technicians, engineers, computer operators and scientists a developing country will find it difficult to effectively integrate new ideas into local production systems.

The relatively low capabilities of local workers has been identified as an important disincentive to invest in Indonesia during the 1970s and early 1980s. Kinoshita (1986) for example notes that the advantage of low wages was more than offset by the low productivity of labour, thus making Indonesia a less favourable destination for export oriented manufacturing investment during the 1970s and early 1980s. He cites an earlier study by McCawley (1981) who identifies the key reasons for the low productivity of labour in the late 1970s/early 1980s as poor health and low levels of education and skills.

More recently it has been shown in firm level surveys by Thee (1990), Thee and Pangestu (1994), Hill (1991) and others, that the low technological capabilities of local manufacturers have impeded the learning of new technologies from foreign partners (other than that required for the efficient operation of plants) as well as constrained the development of substantial forward linkages (subcontracting networks) with FDI producers[125].

8.4.1 Regional Comparison

Statistics on Indonesia's comparative performance in improving human resource capabilities present a mixed picture. According to the UNESCO Statistical Yearbook (various issues) Indonesia has raised its national literacy rate from 67.3 percent in 1980 to an estimated 83.8 percent in 1995 and since the late 1970s has recorded a gross primary enrolment rate exceeding 100 percent (Figure 8-3b). However, care must be taken when interpreting these primary enrolment statistics. As noted by UNESCO (1996) it is possible for the gross enrolment ratio to exceed 100 percent if the actual age distribution of pupils extends beyond the official school ages. The UNESCO figures therefore do not accurately reflect the proportion of children in a particular age group that attend school. Empirical work by the World Bank (1996) shows that Indonesia's estimated net primary enrolment rate in 1992 was 92 percent. Moreover, statistics collected by the Ministry of Education and Culture show that throughout the 1980s and early 1990s there was well over 1 million primary school dropouts each year, or approximately 20-30% of the total number of yearly graduates (Ministry of Manpower 1993).

It can be seen from Figure 8-1 that for all other education statistics Indonesia's educational effort is lagging the other countries in the region, but is nevertheless improving. For example in the early 1990s, Indonesia had higher secondary enrolment rates than Thailand but was still lagging Malaysia and the first tier ANICs (Figure 8-3a). In the early-mid 1980s the percentage of population that had attained secondary

[125] A theme commonly emphasised in the journalistic literature is that because of the low level of technological capabilities in local firms, Indonesia has often been looked over as potential destination for technology or R&D intensive foreign investment eg *Warta Ekonomi* 8 May 1989 p. 8-15. See also *IBW* (July 31 1995) for an interview with the executive director of National Gobel (a large Japanese electronics joint venture) who explains that his firm set up R&D facilities in Malaysia rather than Indonesia because of the lack of human resources in the latter.

schooling was increasing rapidly in Malaysia and the first tier ANICs but remained fairly flat in Indonesia and Thailand (Figure 8-3e). For total years of schooling in the population over the age of 25 Indonesia has shown a strong and consistent increase since 1960, but in 1990 was still well behind the other sample countries (Figure 8-3d). This picture of a low level of schooling in Indonesia were confirmed in the SAKERNAS population survey carried out in 1992 which showed that 74.6 percent of the population had only primary level education or less, with 26.6 percent not completing primary school and 13.95 percent with no schooling at all (Wardiman 1994).

The one statistic on Indonesia's education effort that has not been improving over the past few decades is total expenditure on education. Figure 8-1f shows that as a percentage of GDP, education expenditure in Indonesia has been falling since the mid 1960s. Meanwhile in the other countries listed the relative commitment has increased or remained constant. Moreover, as noted in Chapter 4, the higher rates of economic growth in these countries has enabled them to increase the absolute level of per capita education expenditure at a faster rate than Indonesia.

8.4.2 Quality of Indonesia's Education System

The increasing demands upon Indonesia's education system (generated by an expanding population and rising enrolment rates) in the face of a declining share of public resources committed to education, suggest also that the quality of education provided by public institutions may not be improving. According to MacMahon and Boediono (1992) and Boediono (1994) the present low quality of primary and secondary education in Indonesia is reflected in the low wage differentials between workers with and without primary and secondary education. Further evidence of the relatively low quality of Indonesian schooling is provided by international comparisons, which show that in 1992 Indonesia's primary and secondary school students lagged behind their regional counterparts in reading competency tests.

Figure 8-3

Education Performance in the East Asia Region

Figure 8-4a

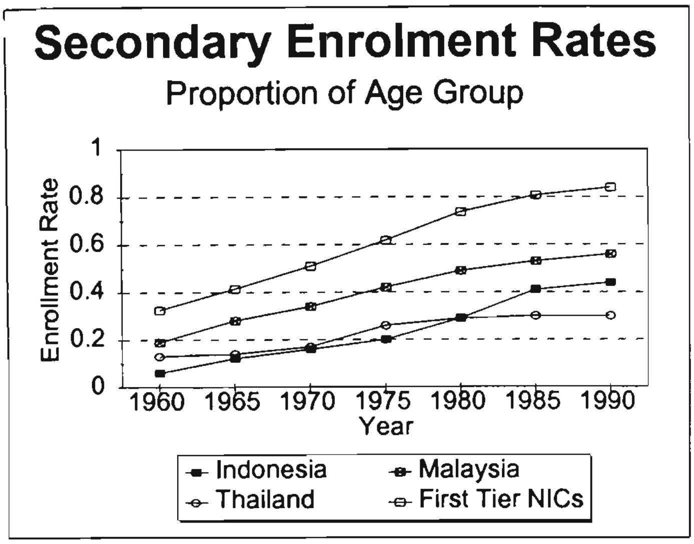


Figure 8-4b

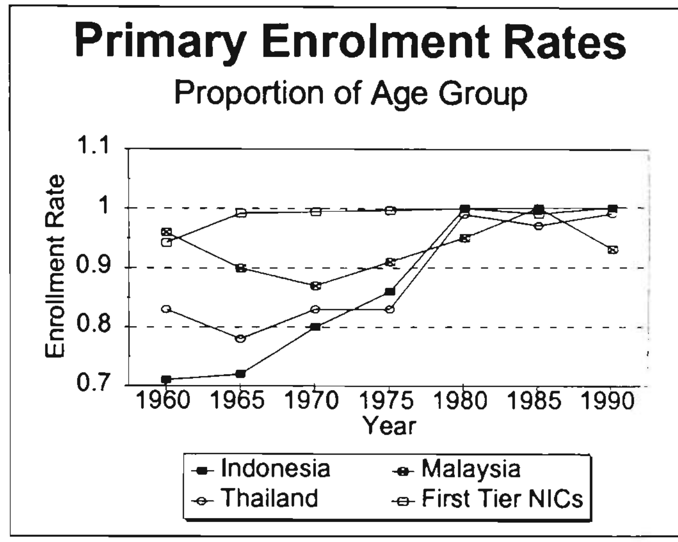


Figure 8-4c

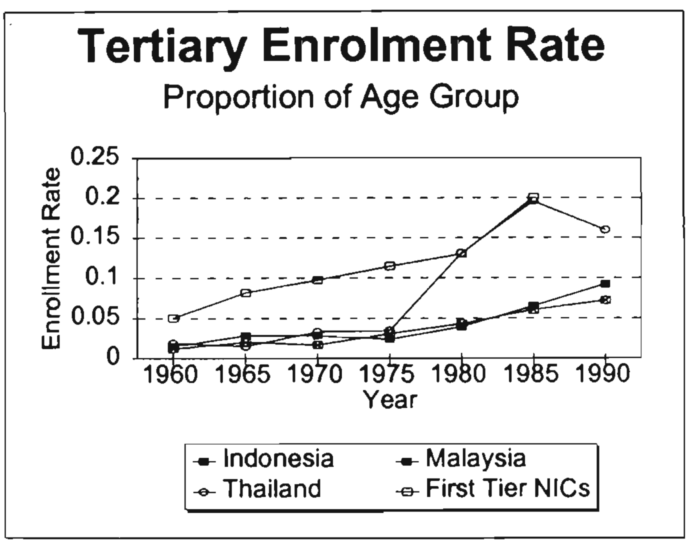


Figure 8-4d

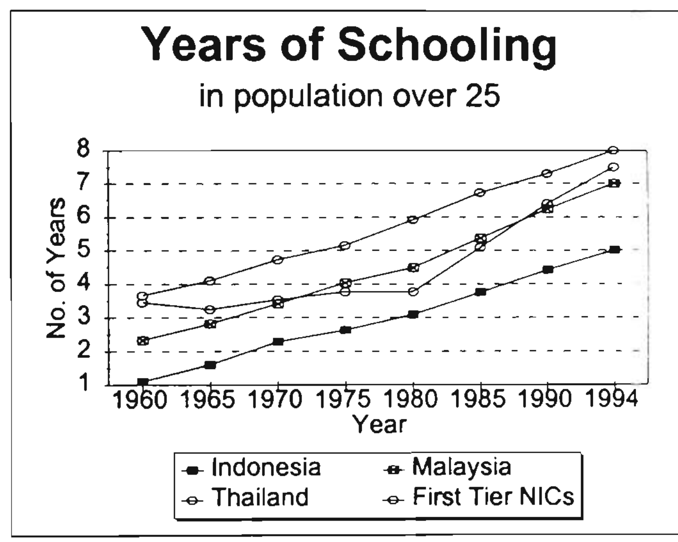


Figure 8-4e

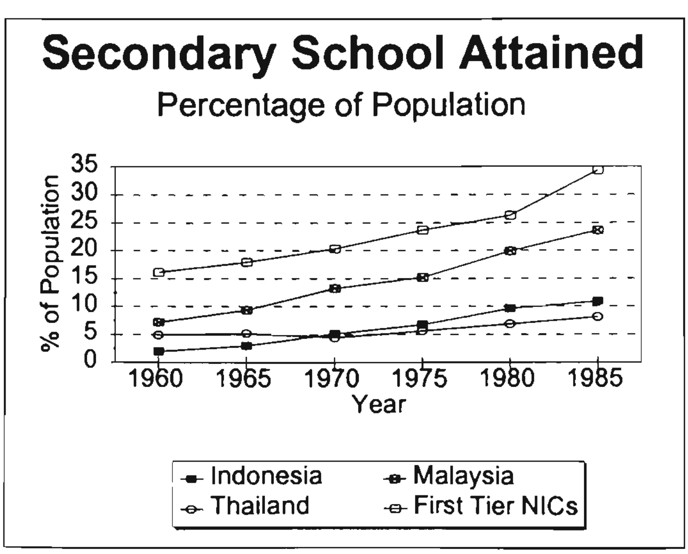
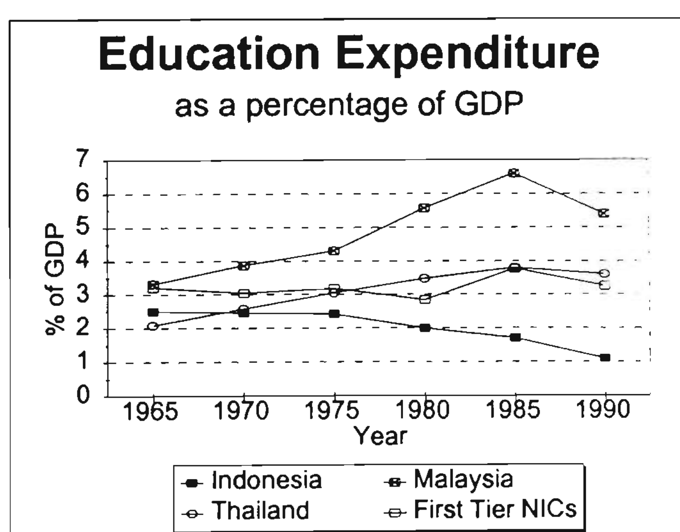


Figure 8-4f



Source: Barro and Lee (1994), UNESCO Yearbook - various years.

Note: Years of Schooling (1990 & 1994) were based upon Collins and Bosworth (1996), who extrapolated the data using Barro and Lee (1994).

Table 8-5 Reading Achievement Test Scores, 1992

Country	Mean Score
Indonesia	51.7
Thailand	65.1
Singapore	74.0
Hong Kong	75.5

Source: Greaney, V (1992) *Literacy Standards in Indonesia* (cited in World Bank 1994)

A central theme in much of the recent literature on Indonesia's education system is the need to improve the quality of education that can be delivered (eg World Bank 1996; Ministry of Manpower 1993, Boediono 1995, Clark and Oey-Gardiner 1988, Keyfitz et al 1989, Irawan 1994, Sadli 1995). Important issues discussed in this literature include the poor quality of teacher training, low teacher salaries necessitating additional jobs, the need to upgrade the curricula to make it more relevant to new market and technological realities, the high drop-out rates particularly within low-income groups and rural areas, the need to better involve the private sector (particularly in financing and vocational training) and the need improve the ability of students to think creatively and critically whilst de-emphasising rote learning.

Another important theme within the recent literature on Indonesia's education system has been the apparent 'mis-match' between the needs of industry and the skills of graduates (Keyfitz 1989, Irawan 1994, ILO-UNDP 1991, Tobing 1995). A study performed by the Central Bureau of Statistics (BPS)[126], based upon estimates of Indonesia's educational needs, found that in 1990/91 there was a significant over-supply of first degree graduates from arts, humanities and law accompanied by a chronic under-supply of graduates from science, engineering and mathematics. An earlier study by the ILO-UNDP (1991) based upon a 1988/89 survey of 213 employees in 51 firms in Jakarta and Surabaya likewise found evidence of general discrepancy between the skills required by industry and the actual mastery of those

[126] Cited in Irawan (1994).

skills by the employees. The report emphasised that there has been too much emphasis given to university education at the expense of vocational training due mainly to the higher cost of the latter vis a vis the former and the absence of comprehensive manpower planning[127].

8.4.3 Science and Technology Manpower

Table 8 also presents data on Indonesia's comparative technological capability with a particular focus on R&D and engineering indicators. As with the education statistics described above, Indonesia's technological indicators generally lag behind those of its neighbours. Due mainly to its size, Indonesia has a larger science and technology infrastructure than some of its smaller neighbours. This is reflected in the relatively large number of science and engineers involved in R&D. However, adjusted for population size, Indonesia's pool of researchers is smaller than the other sample countries, except for Thailand.

Indonesia's R&D expenditures as a percentage of GDP are much lower than that in the ANICs but are comparable to R&D shares in Malaysia and Thailand. On a per capita basis, Indonesians are the lowest spenders on R&D and over the 1981-91 period the growth in R&D expenditure was relatively low. Having a large population Indonesia graduates more natural scientists and engineers. However, adjusted for population the number of natural scientist and engineer graduates in Indonesia is far smaller than the other countries, including Malaysia and Thailand. Moreover, as a percentage share of natural scientist and engineer graduates in total graduates, Indonesia's figure is approximately half that recorded for the other sample countries. This is consistent with the view put forward by a number of commentators including Thee (1994a, 1995a) and Irawan (1994) that Indonesia's universities have tended to focus on academic areas such humanities, business and law at the expense of natural

[127] In response to the apparent mismatch of skills and needs, the government in recent years has initiated the so-called 'link and match' program which seeks to better involve the private sector in the training of secondary graduates. Under this program companies are offered tax cuts and other incentives to provide internships or apprenticeships for students. (*Jakarta Post* November 27 1995).

sciences, mathematics and engineering due to the greater demands upon scarce financial resources in the latter.

Other important indicators of Indonesia's human resource capabilities are the various firm level surveys of engineering manpower (eg STAID 1993, REDECON 1995). In carrying out a special survey of all medium-large manufacturing firms, STAID (1993) found that only one percent of the manufacturing work force in Indonesia had a diploma (technician) education or higher. Only 21.3% of all firms surveyed employed one or more natural scientists or engineers (Table 8-5). The industry group with the highest incidence of employment of at least one natural scientist and engineer was basic metals at 58%. However due to its relatively small size, the basic metals industry group accounts for only 2.1% of total natural scientists and engineers in the manufacturing sector. The lowest incidence of natural scientist and engineer employment was in the non-metallic minerals sector (12% of firms surveyed) whilst most natural scientists and engineers were employed in the Fabricated metals and Chemical and petroleum sectors (33% and 21.3% respectively)

Table 8-6 Manufacturing Firms Employing Natural Scientists and Engineers (BPS survey - December 1990)

Industry	No of Establishments	Number with natural scientist and engineers	Percent with natural scientist and engineers	Number of natural scientist and engineers	Percent of natural scientist and engineers
Food	4616	625	13.5%	4350	13.3%
Textiles	3958	575	14.5%	4000	12.3%
Wood	1946	450	23.1%	2500	7.7%
Paper	702	180	25.6%	1700	5.2%
Chemical and Petroleum	2059	750	36.4%	6950	21.3%
Non-metallic minerals	1323	160	12.1%	1500	4.6%
Basic metals	95	55	57.9%	700	2.1%
Fabricated metals	1595	685	42.9%	10750	33.0%
Other manufacturing	242	40	16.5%	150	0.5%
Total	16536	3520	21.3%	32600	100%

Source: Special survey for STAID (1993) by the BPS

Table 8-7

Science and Technology Capability Indicators

	Indonesia	Malaysia	Thailand	Korea	Taiwan	Singapore	Hong Kong	Source
Scientists & Engineers engaged in R&D	1988	1988	1991	1992	1990	1990		
- total	32038	5537	1728	88764	32100	4300	NA	1, 2
- per million population	181	326	173	1990	634	629	NA	
	1988	1989	1991	1994	1994	1994	NA	1,2
R&D expenditure as a % of GDP (i)	0.20%	0.10%	0.20%	2.61%	1.80%	1.10%	NA	
Approx. R&D expenditure per capita (constant 1985 US $ using PPP) (i)	3.9	5.1	7.1	140.1	145.1	128.8	NA	1,2,4
R&D expenditure 1991 Index 1981=100 (i)	113	NA	87	528	414	779	NA	
Tertiary Education	1992	1990	1992	1993			1992	
Total Graduates(ii)	177,725	20,886	209,162	342,721	NA	NA	21,806	
Graduates in NS&E 1990(ii),(iii)	23,925	5,244	42,983	95,379	NA	NA	7,479	1,2
% in NS&E	13.5%	25.1%	20.6%	27.8%	NA	NA	34.3%	
Graduates per million	966	1123	2134	7789	NA	NA	3752	
NS&E graduates per million (iii)	130	282	439	2168	NA	NA	1287	
Degrees in NS&E as a percent of 22 year old population (iii)	0.4 (v)	NA	NA	6	4.2	4.2		
No. of Scientific Publications 1995	287	603	629	5814	6516	1846	2302	3
Patent Applications (iv)	33	56	NA	2451	6015	170	540	5

Sources

1) UNESCO Statistical Yearbook (1996).
2) National Sources.
3) Science Citations Index.
4) Summers and Heston PWT 5.5.
5) National Science Board.

Notes

(i) Thailand and Indonesia - Government expenditure only.
(ii) Graduates for diploma, bachelor and postgraduate degrees.
(iii) NS&E includes natural sciences, mathematics and computer science, engineering.
(iv) Total patent applications in the US 1980-93 as reported by the National Science Board (1996)
(v) Based upon 23 year old polulation for Indonesia.

As well as revealing the low rate of incidence of employment of natural scientists and engineers, STAID (1993) also found that in 1991 only 14 percent of natural scientists and engineers were employed in the private sector, with over 78 percent employed in the public sector. Moreover, of the 32,600 natural scientists and engineers employed within the private manufacturing sector over half were found to be technicians with only diploma level education, while fewer than 2.1% had postgraduate qualifications (Table 8-6).

Table 8-8 Education level attained by natural scientists and engineers in the manufacturing sector

Education Attained	No. of natural scientist and engineers	Percent
Diploma (D3)	15825	48.6%
Bachelor (S1)	16100	49.4%
Masters (S2)	500	1.5%
PhD (S3)	175	0.5%
Total	32600	100%

Source: Special survey for STAID (1993) by the BPS

Using a smaller sample of firms (but covering all major sectors of the economy), a different research methodology and a definition of engineering manpower to include technicians and skilled workers[128], the firm level study by REDECON (1995) presents a similar picture to that presented above: ie a low incidence and education level of engineering manpower. Their study shows that engineering manpower makes up approximately 17 percent of total employees. However in each sector, skilled workers (of which only 36 percent have completed high school) account for about 90 percent of engineering manpower. Only about 27 percent of firms surveyed employed engineers or technicians. Most significantly, the REDECON study found that higher wages in the finance and trade sectors had lured a large number of engineers away from more traditional engineering sectors (eg manufacturing, construction and engineering). The percentage of engineering manpower relative to total employees in

[128] Engineering manpower in this study includes engineers, technicians and skilled workers.

the finance sector (0.3 percent) was double that for manufacturing (0.15 percent), which, according to the authors, suggests a substantial misallocation of resources.

The dominant theme to emerge from these firm level surveys is the low skill level of workers in the Indonesian manufacturing sector. The small percentage of engineers and natural scientists in total manufacturing employment suggests there is little opportunity for the sector to develop major change or design capabilities. This is consistent with the view that the Indonesian manufacturing sector is dominated by labour intensive assembling activities and still dependant upon foreigners for all , if not most, technology inputs.

8.5 R&D Institutions and Incentives

Earlier in Chapter 3, it was emphasised that local public R&D institutions have played a key role in East Asian technological development by undertaking basic research and by providing a number of important technological information, training and support services to industry. Critical in each case were the linkages those institutions could develop with the private sector.

In Indonesia there are 33 public R&D institutions with research activities extending across a broad range of areas, including agriculture, religion and social affairs, forestry, postal services, statistics, nuclear power and microelectronics. Twenty of these institutions (*Litbang Departemen* - departmental research institutes) are attached to government ministries or departments and carry out R&D specific to the needs of their respective ministries. The other thirteen institutions are categorised as non-departmental government R&D institutes (LPND - *Lembaga Penelitian Non-Department*) and carry out a broad spectrum of research activities to promote general national development.

The three R&D institutes most actively involved in undertaking research and providing technological support for the industry sector are the BPPI (*Badan Penelitian dan Pengembangan Industri* - The Agency for Industrial R&D), LIPI (*Lembaga Ilmu Pengetahuan Indonesia* - The Indonesian Institute of Sciences and BPPT (*Badan Pengkajian dan Penerapan Teknologi* - The Agency for the Assessment and Application of Technology) (Thee 1994a). The BPPI is attached to the Ministry of Industry and Trade, whilst the other two, LIPI and BPPT, fall within the non-departmental category (LPND) but represent important institutions within research and Technology Minister Habibie's large public science and technology infrastructure.

There are a number of recent studies which describe the activities of the above mentioned R&D institutes and in most cases provide a critical assessment of their capacity to promote technological advancement in the industry sector (eg Thee 1994a, 1995a, 1996, 1997; Scherer 1993; Murjani Atha Konsultan 1995; Bishry 1992; BPPI 1995; LIPI 1994; Lall 1993c; *SWA Sembada* July 1993). A complete review of this literature is an undertaking clearly beyond the scope of this thesis. Accordingly the approach taken here is to draw from this literature a number of important themes.

The first theme relates to the observation that the different categories of public R&D described above reflect fundamental differences in approach to technology policy (eg Thee 1994a; Scherer 1993). The first as reflected in the activities of the BPPI is what Thee (1994a) refers to as the 'broad based approach', that is to carry out functional assistance in the form of research, information and technology extension for industry in general. The second approach, which is commonly identified with Technology Minister Habibie and his programs, is to focus on the technological 'mission' of the Strategic Industries; that is to promote Indonesia's technological advancement though the production and design activities of a select number of state-owned high technology ventures (Scherer 1993). This second approach is reflected in the activities of the BPPT (and to a lesser extent, LIPI) in providing R&D and other technological support services to the Strategic Industries Program (BPIS).

The second theme that can be drawn from the literature relates to the general lack of linkages between the public R&D institutes and private firms, and relatedly, the general mismatch in the products services offered by these institutes and those needed by private industry. Firm level surveys (eg Thee and Pangestu 1994, Thee 1990) indicate that much of Indonesian industry is unaware of the public R&D institutes and the products/services they offer. Moreover those that are aware do not see them as relevant to their technological needs. According to Scherer (1993) this appears to be as true of small to medium scaled enterprises, which have particular needs of quality assurance, extension and information services, as it is for larger firms which have more specialised research, design and testing needs. An important result of this paucity of linkages is that the public R&D institutes are constrained from expanding their revenue base through sales of technological services and products and by undertaking cooperative research work with private companies. Moreover they are constrained in their efforts to keep up with rapid technological developments in their respective fields and to pass on new information and knowhow to those manufacturing firms in need of their technological support (Thee 1995a).

As emphasised in Chapter 3, an important mechanism for the promotion of the linkages between public R&D institutes and industry in a number of East Asian countries has been through the provision of metrology, standards and quality assurance testing services. In Indonesia's case, a recent report by the World Bank (1994a) found that the country's major measurement and testing laboratories have yet to be acknowledged internationally, whilst manufacturing firms have little knowledge of and/or access to information regarding international standards. Moreover, despite having standardisation activities in place for over a decade[129], Thee (1995a) reports that Indonesia has yet to develop the necessary policy and legal framework to ensure the promotion, implementation and enforcement of an effective national system of standards. Indonesia's relative slowness in meeting international standards is

[129] In 1987 the National Standards Council was formed to coordinate all standardisation activities and to promote the Indonesian National Standard system (SNI) (Thee 1997).

illustrated in Table 11. which shows that of the 5978 ISO[130] certificates issued to companies within East Asia by March 1995 only 55 (0.9%) were awarded to Indonesia based companies.

Table 8-9 ISO 9000 Certificates Issued in Asian Countries as of March 1995

Country/Region	ISO 9000 Certificates
Indonesia	55
Brunei	5
China	285
Hong Kong	551
Japan	1827
Malaysia	628
Philippines	79
Singapore	1003
South Korea	390
Taiwan	1060
Thailand	95
Total (East Asia)	5978

Source: Survey carried out by Mobil Europe Ltd in March 1995 quoted in Thee (1996)

Contributing to the general lack of linkages described above are the differences in capability and orientation across the various research institutes. The BPPI for example, with an extensive network of R&D, testing and training centres is considered to be better placed than BPPT and LIPI to cater for the operational needs of industry. However, notwithstanding some established relationships with SOEs (particularly those under aegis of the Ministry of Industry), the BPPI is reported to have developed few linkages with private industry (Thee 1994a,1997). This is due in large part to the general lack of human, physical and financial resources within the many research centres and laboratories of the BPPI which constrain them in their task of actively promoting technological upgrading in Indonesian industry (Thee 1994a, 1997; Lall 1993c; Scherer 1993). Data provided by PAPITEK-LIPI (1993) show that in the 1992/93 fiscal year BPPT and LIPI received four times the budget allocation than BPPI (Table 8-8). Moreover the data reveal that a much lower share of BPPI's

[130]The ISO 9000 is the most well known international standard system in Indonesia. By adhering to this international standard the Indonesian producer shows that it possesses an effective quality management system that guarantees consistent world standard production (Thee 1997).

budget is devoted to capital expenditure, which is consistent with the observation by Thee (1994a), Lall (1993c) and others that the equipment and facilities available to the BPPI are more obsolete and inferior to that available to LIPI and BPPT.

Table 8-10 1992/1993 Budget for Selected R&D Institutes (billion Rp.)

R&D Institute	Capital Exp.	Current Exp.	Total Budget
BPPI	4.3	6.9	11.2 (11.7%)
LIPI	3.0	9.8	39.8 (41.8%)
BPPT	2.8	16.3	44.2 (46.5%)

Note: Percentage figures in brackets indicate share of total budget for these three institutes.
Source: PAPITEK-LIPI (1993).

LIPI and BPPT are the single largest recipients in the budget for research institutions (PAPITEK-LIPI 1993). Furthermore it has been noted by Thee (1994) that LIPI and BPPT have more than twice the number of scientists and engineers than the number employed by all other R&D institutes combined (including the BPPI). Nevertheless, despite their superior physical and human resources, BPPT and LIPI are reported to have developed few linkages with private industry (Scherer 1993, Thee 1994a). According to Thee (1995a,1997) this can be attributed to overly bureaucratic internal management systems and administrative procedures which discourage managerial autonomy and accountability for results.

The lack of fiscal and financial incentives are another reason why private firms have not developed significant linkages with the public R&D institutes (Thee 1994a, 1995a; Kartowisastro 1993, Murjani Artha Konsultan 1995). In Chapter 3 it was emphasised that firms in other East Asian countries have been given the appropriate incentives to undertake technology development activities with public institutes. However, in Indonesia, Kartowisastro (1993) notes that there has been few explicit policy measures to promote such interaction. However, a recent development has been the establishment of the RUK 'partnerships' program in the 1995/96 fiscal year[131] (*Suara Karya* 23 August 1996). Under this program funds are set aside for approved

[131] See the '*Riset Unggulan Kemitraan*' (RUK) page on the *IPTEK* homepage (http://www.iptek.net)

research activities carried out as cooperative work between industry and public R&D and/or higher education institutes. Although acknowledging that it may be too early to assess the effectiveness of the program, Thee (1997) reports that in its first two years most of the research proposals have been 'supply-driven', that is initiated by public R&D institutes, instead of 'demand-driven', that is initiated by private industry. He therefore notes that it remains to be seen if the program will help foster any economically meaningful public-private sector linkages.

8.6 Local Competition Environment.

Earlier it was emphasised that competition is an integral element of a country's efforts toward technological advancement. The second theme of growth outlined in section 2.3 for example, states that *the production and use of ideas is driven in large part by market incentives,* meaning that competition for limited profits drives businesses to innovate as a means to make better quality and/or cheaper - and therefore more competitive - products.

In Indonesia there are many restrictions on domestic competition, impeding what Iqbal (1995) describes as the 'growth of progressive, efficiency-seeking entrepreneurship.' Such restrictions, according to the World Bank (1995) take various forms, "including cartels, price controls, entry and exit controls, exclusive licensing, public sector dominance, and *ad hoc* interventions by government in favour of specific firms and sectors." Some of the restrictions on domestic competition are outlined in Table 8-8.

According to Iqbal (1995), some of these restrictions are imposed separately or jointly by the central or local government, or in many other cases by trade and industry associations (often with official sanction or tolerance). It has been noted by the World Bank (1995) that, in many cases, the perpetuation of non-competitive behaviour in the manufacturing sector is justified on the grounds that a number of industries are deemed too "essential" to be left to the free market (eg. cement, fertiliser, as well as a number of commodities under the regulatory control of the National Logistics Agency, *BULOG*). In some industries, restrictions on competition accompanied by restrictions on foreign trade are used to promote infant industries and/or higher domestic value added in production (eg wheat flour, soymeal), whilst for other products, government restrictions are used to exploit Indonesia's power in global markets, eg. plywood (World Bank 1995). Moreover, as noted in the previous chapter, a number of 'infant' high technology state-owned enterprises (BPIS) are sheltered from international and domestic competition in the expectation that these firms will play a key role in future national technological advancement.

Table 8-11 Restrictions on Domestic Competition in Indonesia

Type of Restriction on Competition	*Sectors in Which Prevalent*
Cartels	Cement; Plywood; Paper and Pulp; Fertiliser; Textiles
Price Controls	Plywood; Retail, Rice, Paper, Cement
Entry and Exit Controls	Plywood, Autos, Wheat Flour Milling & Noodles, Cement
Distribution Controls	Plywood, Fertilisers, Cement
Exclusive Licensing	Clove Marketing; Wheat Flour Milling & Noodles; Soymeal
Public Sector Dominance	Steel; Fertiliser; Refined Oil Products, Steel , Aircraft, Ships and other Strategic Industries

Sources: World Bank (1995) Iqbal (1995); CIDES (1995); Various reports in the business media - eg *Gatra* (15 July 1995), *Eksekutif* (August 1995) and *EBRI* (22 July 1995)

The issue of non-competitive behaviour within Indonesian industry has become an increasingly controversial one over the course of the 1990s and has received much attention by the local print media[132] and is continually emphasised by the World Bank in its annual country reports (eg World Bank 1994, 1995, 1996) as a key area in need of reform. Fuelling the controversy recently has been the much publicised and blatant cartel-like activities of the paper, cement and plywood industries[133] as well as a

[132] See for example the series of reports in *Gatra* (15 July 1995 p. 21-30) and *Eksekutif* (August 1995 p. 29-46) , also EBRI (July 22 1995 p. 20-21), *Eksekutif* (February 1993 p. 28-31), and *Forum Keadilan* (3 Juli 1995 p. 90).

[133] See for example CIDES (1995), Warta Ekonomi (17 April 1995 p. 90), EBRI (July 22 1995:20-21), *Eksekutif* (February 1993: 28-31), *Forum Keadilan* (3 July 1995 p. 90) and *Media Indonesia Minggu* (2 July 1995).

continuing position of government privilege and protection for a few politically well connected individuals and business groups (conglomerates) in key industry areas[134].

A commonly used measure of competitive conditions within an economy or sector is the concentration ratio of the four largest firms (CR4). Using two digit Industry data, Kuncoro and Abimanyu (1995) found that seven out of nine industry sub-sectors listed in Table 8-10 had CR4 ratio's in 1993 well above the 40 percent threshold commonly used to indicate oligopolistic market structure. More importantly, over the 1985-93 period a weighted average of CR4 for all nine sub-sectors shows Indonesian industry becoming increasingly concentrated, contrary to the belief that deregulation should lead to increased market share for small-medium enterprises[135].

Table 8-12 Concentration Ratios in the Industry Sector 1985-93

ISIC Code	Subsector	1985	1990	1993
31	Food, drink & Tobacco	58	61	67
32	Textile, clothing and leather	26	22	26
33	Wood products	17	17	17
34	Paper products	47	63	56
35	Chemicals	47	44	47
36	Non-metallic minerals	62	54	55
37	Basic metals	66	57	55
38	Fabricated metal products and machinery	53	54	60
39	Other manufacturing	69	55	69
Weighted Average		**49**	**47**	**50**

Source: Kuncoro and Abimanyu (1995)

[134] There is a substantial literature describing an almost 'symbiotic' relationship between Suharto' New Order government and the large, usually Chinese, business groups (eg Robison 1986, 1987, 1991; Schwarz 1994, Macintyre 1991). See also Sato (1993) who describes how the Salim group was able to use its political connections as a means to successfully pursue a strategy of market domination in a number of key industries.

[135] Further evidence of the increasing oligopolisation of Indonesian industry was found in the 1995 mid-year report by Econit (1995). Using the standard concentration measure CR4, Indonesian manufacturing industries (4 digit) were divided into four categories by concentration levels, ie 0-25%, 25-50%, 50-75% and 75-100%. Over the 1988-92 period, Econit found that there was a dramatic increase in industries with a CR4 of 50% or higher. This was particularly the case for industries in the 75-100% CR4 category. Industries with a particularly high rate of increase in concentration over the period included ISIC 3117 (noodles and bakery products), ISIC 3419 (pulp and paper) and ISIC 3641 (household clay products).

As noted by Iqbal (1995) caution must be taken when interpreting the concentration ratios discussed above. The industry data is on an establishment basis and does not provide ownership information. Hence it is possible for an industry to be highly concentrated by ownership, but for this not to be reflected in concentration ratios. Moreover anti-competitive conditions may also not be captured by the concentration statistics if a sector is characterised by collusive and other cartel like behaviour. The plywood industry, for example is dominated by the cartel like activities of the industry trade association *Apkindo* (*Asosiasi Panel Kayu Indonesia* - the Association of Plywood Manufacturers) which maintains strict controls over all marketing and distribution channels and firm entry (World Bank 1996)[136]. However from Table 8-10 it can be seen that the wood products sub-sector (of which plywood products represent a significant component[137]) recorded a relatively low concentration ratio of 0.17. Thus the CR4 indicator is a limited indicator of non-competitive indicator. However the measured general increase in the concentration ratios is consistent with anecdotal and firm level evidence[138] suggests that the Indonesian economy is becoming increasingly oligopolistic

Earlier, in Chapter 3, it was emphasised that a common element in the approach to industry policy employed by a number of East Asian governments has been the determination to extract 'performance guarantees' from firms in exchange for assistance through subsidised credit, fiscal incentives, and other concessions. As noted by the OECD (1992) improved export performance was seen as a particularly important means for the firm to 'pay back' the government for its support.

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[136] See also the series of articles in *Sinar* (18 February 1995 p. 10-22) and Prospek (21 January 1995 p. 14-22) as well as other reports in *Indonesia Business Weekly* (31 July 1995 p.12), *Jakarta Post* (12 January 1995 p.4), *FEER* (23 July 1992), *Gatra* (8 July 1995) and other journalistic accounts of anti-competitive behaviour listed earlier.

[137] According to BPS data plywood products represented over 68 percent of total wood products production in 1992 and over 77 percent of total manufactured wood exports in 1993.

[138] A 1995 study by the Pusat Data Bisnis Indonesia (PDBI - Indonesian Business Data Centre) found that the contribution of the top 10 conglomerates to GDP increased from 15.2 percent in 1988 to 18.2 percent in 1992 suggesting that the Indonesian economy was becoming increasingly oligopolistic (reported in *Jakarta Post* 9 October 1995). More formally, Iqbal (1995) using five digit ISIC data for 118 industry subsectors found that there was a clear negative relationship between concentration and export orientation. Those industries with the highest concentration ratios such as food, paper and chemicals (areas where the conglomerates dominate) has the lowest orientation toward exports.

According to Robison (1988), Glassburner (1978), Hobohm (1987) and others, the large business groups or conglomerates have historically been the major beneficiaries of state intervention in the industry sector. However there is little evidence that this policy assistance has been used to better compete in export markets. There is clearly a lack of reliable data to accurately assess the export orientation of Indonesia's conglomerates[139]. Nevertheless an important theme to emerge from the available literature on Indonesian conglomerate behaviour is that these large business groups have eschewed competing in international markets in favour of expansion in protected domestic markets[140].

Recent studies have highlighted the high economic costs of this domestic market orientation on the part of conglomerates. Abimanyu and Xie (1995) for example found that Indonesian consumers are paying the conglomerates at least Rp. 20 trillion in subsidies for 33 important commodities ranging from food items to cement, zinc, fertilizers, textiles and paper. Their conclusion was based on the fact that the same commodities were on average 22% cheaper in international markets due to the concentration of domestic production and distribution in the hands of a few large business groups. Similarly, a report from INDEF (1995) found that, due to the monopolisation of the flour industry by vertically integrated Salim group subsidiaries, Indonesian consumers pay an extra Rp. 760 billion a year in implicit subsidies (quoted in CIDES 1995). Similar themes were explored by Econit (1995) arguing that the high domestic price of the conglomerate controlled strategic commodities were a key factor in explaining Indonesia's relatively high inflation rate.

Thus while industry assistance in a number of East Asian countries may have been rewarded by improved export performance, it could reasonably be concluded that in Indonesia, industry assistance measures have often resulted in rent seeking behaviour.

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[139] Data published by SWA Sembada (December 1992 p. 44) shows that three of biggest conglomerates, Salim, Astra and the Lippo Group, generated between 90-99 percent of their sales in the domestic market. However this data should be considered, at best, preliminary. It does however highlight the dependence of the conglomerates toward the domestic market.

[140] See for example Robison (1986, 1991), Sato (1993), Macintyre (1991) and the edited volume on Indonesian conglomerates by Kwik Kian Gie and Marbun (1991). See also various journalistic accounts in *SWA Sembada* (December 1992 p. 44-47;), *EBRI* (September 30 1995 p. 6-11), *Eksekutif* (February 1993 p. 39-50; August 1995 p. 29-45).

This in turn has diminished the incentive to learn through the use and production of ideas.

8.7 Conclusion

To conclude the second and final section of the thesis it is useful to highlight a number of key themes and findings which emerge from each of chapters 5-8. In chapter 5, it was found that Indonesia's growth performance over the 1960-90 period was impressive by international standards. High economic growth over the period trebled per capita income levels and transformed a backward and unstable economy in the early to mid 1960s into a rapidly industrialising and highly dynamic economy in the early 1990s. Economic policy played an important role in this rapid process of transformation. The international context was also favourable, providing strong demand conditions for its exports of oil and other natural resources. When oil prices fell in the early and mid 1980s, industry and trade deregulation enabled the country to better exploit its comparative advantage in labour intensive and other low technology manufacturing.

However, an important question which emerges from chapter 5 is whether this emphasis on resource and labour intensive activities which resulted in high rates of growth over much of the new order period will be able to generate similarly impressive growth rates in the future. This question was prefaced by considering two recent international developments which threaten a fundamental change in production and consumption activities the world over. The first was the revolution in information and communications technologies brought about by, amongst others, important new innovations in microelectronics, software and fibre optics. The second was the on-going process of international deregulation which has freed up international flows of trade, capital and technology. The combined result of these two developments has been the emergence of what is commonly termed the *global knowledge economy*

For all countries, including Indonesia, the emergence of the global knowledge economy brings with it many important implications for future economic growth. Most important is the increasingly sophisticated needs of consumers and producers the world over. This is reflected in the changing demand conditions in international trade where the most rapid growth in demand is for knowledge intensive products. Orientation to world demand growth is therefore a useful indicator of a particular country's ability to participate in the global knowledge economy. The various empirical measures developed in Chapter 6 indicate that Indonesia lags other countries in the region in its orientation to the more dynamic export industries. This is due to a number of factors including a continuing dependence upon resource and labour intensive exports for which income and price elasticities are low, and a relatively low historical specialisation in computers and electronics which represent two of the most knowledge intensive and dynamic industries in global production and trade.

The central conclusion that can be drawn from Chapter 6 is that changing global demand conditions associated with the emergence of the global knowledge economy compel Indonesian producers to upgrade in favour of more knowledge intensive activities. However, as was shown in Chapter 7, Indonesia's response to this demand side challenge has so far been inadequate. Considerable human and financial resources have been channelled into Minister Habibie'e Strategic Industries program to spearhead the drive toward national technological advancement. Whilst certain elements of the program may have achieved relatively high levels of technical sophistication there is as yet little indication that the overall program has generated much technological benefit to the rest of the economy. Various firm and industry level studies indicate that the innovatory or technological capacity of private industry remains relatively low. Moreover, a number of aggregate empirical measures show that Indonesia is lagging all other sample ANICs in the move toward more knowledge intensive production activities.

Key questions which emerge from Chapters 6 and 7 relate to Indonesia's comparatively modest performance in responding to the challenge posed by the emergence of the international knowledge economy. Specifically, what have been the constraints to a more effective response to this challenge and how might Indonesia better respond in the future? Chapter 8 gives explicit consideration to these questions. Whilst acknowledging that there is a broad range of potential factors influencing Indonesia's ability to participate and compete in the global knowledge economy, the approach taken in chapter 8 was to focus on five key areas where the influence of policy has and continues to be decisive.

The *first* relates the inward nature of Indonesian industry and trade policies. As was emphasised throughout this dissertation, linkages with foreign firms and customers represents a crucial mechanism for latecomer firms in East Asia to acquire and develop new technologies. Although most East Asian countries pursued various import substitution and other industry policy measures, a common element across these countries was their ability to foster linkages with foreign firms through a strong orientation toward exports. In Indonesia, however, the industry strategy pursued throughout much of the 1970s and early 1980s discouraged local manufacturers from exporting. Thus until the mid to late 1980s Indonesia, in contrast to other countries in the region, was relatively constrained in its ability to learn new productivity enhancing ideas through OEM, licensing and other subcontracting arrangements with foreign firms. The relative lateness in which Indonesia adopted a more export oriented trade and industry strategy therefore represents an important factor behind Indonesia's current technological backwardness.

The *second* area considered similar themes of openness, but focused on the regime for foreign investment. Noting the importance of foreign investment in the rapid and on-going development of the smaller or less developed ANICs such as Singapore, Malaysia and Hong Kong, as well as in the start-up of a number of key electronics and computer export industries in Korea and Taiwan (two countries which later de-emphasised FDI), it was proposed that in Indonesia the restrictive policy environment for FDI pursued throughout the early 1960s and then during the 1974-86 period, in effect precluded the country's manufacturing sector from an important channel for learning. Moreover, those technologies that were transferred (particularly in the 1970s and early 1980s) tended to be based upon resource and capital intensive technologies which could not be easily transferred to other sectors of the economy, such as labour intensive export manufacturing.

Poor human resource capabilities, the *third* area considered in Chapter 8, is another factor inhibiting the use and production of ideas in Indonesia. It was shown that the low incidence of technically trained personnel has not only prevented Indonesian manufacturers from integrating and developing latest product and process technologies from abroad, but has also provided a clear disincentive for inflows of technology intensive FDI. A *fourth* and related area considered in chapter 8 is the capability and relevance of local R&D institutions. It was shown that Indonesia's R&D institutions, due essentially to poor linkages, capabilities or incentive structures, do not provide adequate technology support and/or basic R&D services for private industry and are instead focussed in most part toward the technology needs of the public sector Strategic Industries program. Contributing to the general lack of relevant R&D and other technological support services for private industry in Indonesia is the unavailablility of a range of fiscal and financial incentives otherwise available in other East Asian countries.

The environment for both local and international competition represents the *fifth* area considered in Chapter 8. Throughout this thesis it has been emphasised that competition between firms for limited profits represents a crucial stimulus for innovative behaviour. However, in this chapter, it was shown that the oligopolistic nature of Indonesian industry, distorts these incentives to innovate. Moreover, it was suggested that policy assistance to industrialists has not been rewarded through increased exports (as has commonly been the case in other East Asian countries) but has often resulted in rent seeking behaviour, inimical to the efforts toward national technological development. Thus profit seeking behaviour, in many cases, is not driven by efficiency seeking entrepreneurship through the use and production of ideas, but is more a function of collusive and other anti-competitive practices.

Earlier, it was also shown that another important factor distorting the incentive structure for innovation was the dominance of the state in most high technology areas of the Indonesian economy. Particular attention, in this regard, was focussed on the Strategic Industries program, described in Chapter 7. This program 'crowds out' the private sector by commanding a substantial proportion of the country's scarce financial and human resources, but also, due to the lack of competitive pressures within these industries, distorts the overall incentive environment for innovative behaviour. A crucial lesson to emerge from the analysis is that Indonesia must follow the model set by a number of other successful economies in East Asia by allowing the private sector to become the principal driver of national technological development.

This is not to argue that the process of rapid growth through the production and use of ideas is simply a matter of deregulating the economy so that market forces determine all flows of ideas and human and physical capital. Clearly, an important element in ideas driven growth is the harnessing of the dynamic innovative potential of efficiency seeking firms and individuals. However, as has been seen throughout East Asia, policy has an important role to play in ensuring a systematic response to the challenge posed by the emergence of the global knowledge economy. This has included ensuring adequate access to international flows of ideas through various well defined channels, by improving domestic technological capabilities and by providing the necessary incentive structures to facilitate investment by private firms in the use and production of new ideas. For Indonesia to continue to enjoy rapid economic growth within these changing global circumstances an equally systematic approach will be required to ensure that these preconditions for the use and production of ideas are met.

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Bisnis Indonesia

Bursa

EBRI - Economic Business Review Indonesia

Eksekutif

FFER - Far Eastern Economic Review

Forum Keadlian

Gatra

IBW - Indonesian Business Weekly

Jakarta Post

Kompas

Media Indonesia Minggu

Prospek

Sinar

Suara Karya

SWA Sembada

The Economist

Warta Ekonomi

WSJ - Wall Street Journal