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Contents

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Abstract

This paper presents the main findings of a SEI-SPRU research project on Pacific Asia's technological and economic development, developing a new taxonomy of government-firm relations in the region and implications for the European Union (EU). The research fills a gap in the literature by analysing the strategies, behaviours and functions of firms (local and foreign) in the region and, from this, argues that the effectiveness of direct government-firm interventions are generally overstated in the policy literature on Pacific Asia. By focusing on electronics, the largest export sector, the paper is able to draw systematic inter-country comparisons between government policy approaches, the effectiveness of government-funded technology institutes and government-firm partnerships, corporate strategies, technological trends and product specialisations. Firm-level case findings provide a more detailed understanding of emerging Pacific Asian corporate strategies and technological strengths and weaknesses than hitherto available. The paper confirms the remarkable degree of technological progress over the past three decades but warns against any simple extrapolations into the future. While it is outside the scope of the paper to examine the present economic crises facing Pacific Asia, the research supports the view that the primary role of government is to secure macroeconomic stability, rather than to intervene in support of specific firms or sectors. The empirical evidence allows a critique and extension of current conceptualisations of the Pacific Asian developmental state, arguing that the conventional market to state continuum fails to capture important features of the region's development. The paper also comments on the relevance of the findings for modern resource-based theories of the firm and neo-Schumpeterian models of innovation. Finally, the paper uses the empirical and theoretical findings to draw implications for EU, by addressing specific policy concerns over the shift of employment from the EU to Pacific Asia, the 'hollowing' of EU corporations and possible lessons from the Pacific Asian experience.

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Introduction

Most observers today recognise the importance of technology to economic growth and development. Despite this recognition, there is remarkable little understanding of the nature and causes of technological change in Pacific Asia (with the partial exception of Japan). The ways in which firms (local and foreign) acquire, assimilate, adapt and generate technology are largely unexplored. Also, the mechanisms by which companies collaborate with governments in the region to bring about technological progress are poorly understood. As a result it is extremely difficult for the European Union (EU), the UK and other European Governments to make informed decisions about Pacific Asia and, in particular, to decide if and how to respond to competitive challenges and opportunities posed by the region's rapid economic development.

The difficulties in understanding the region's progress gave rise to a three year (1995 to 1997) research project, conducted jointly by SEI and SPRU on the technological dynamics of Pacific Asia.[1] The main objective of the research was to examine the technological progress of the region and, from this, to draw implications for policy making in the EU. To confine the research to manageable proportions, the field research concentrated on four countries - South Korea[2], Taiwan, Thailand and Malaysia - and was limited to the electronics industry. Electronics represents by far the largest export sector in each country, and the region as a whole, and the focus on one sector enabled systematic comparisons between firms and countries. The research identified the sources and directions of technological change within Pacific Asia and illustrated the ways in which technology transfer contributed to the region's industrial progress.

The purpose of this paper is to draw together some of the main findings of the research project and present a taxonomy of government-firm relations in the above four countries. The paper draws heavily on other papers produced during the project (see Annex 1) and attempts to show how technological progress relates to industrial competitiveness and future prospects in the region. By contrasting systems of governance in two East Asian (South Korea and Taiwan) newly industrialising economies (NIEs) with two South East Asian NIEs, the paper is able to reveal major differences between the East Asian countries, driven by local enterprise, and the South East Asian economies, led by foreign TNCs.

The paper is structured as follows. Part 1 presents the rationale for the research, touching on previous research, relevant theories and key questions raised by policy makers in the UK and the EU. Part 2 presents a cross-country policy taxonomy to illustrate major differences and similarities across the four countries examined. Part 3 looks in more depth at emerging corporate strategies for technology and new patterns of sectoral governance as firms attempt to progress from the production of electronics hardware to software-intensive, information and communication technologies. Part 4 provides an assessment of the region's performance in electronics by identifying internal strengths and weaknesses and external opportunities and

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[1] The project is part of the ESRC's Pacific Asia Programme. It addresses two sections of the Programme: Section (1) Economic Development and Growth; and Section (3) Implications for Europe.

[2] Note that the terms South Korea, Korea and Republic of Korea are used interchangeably in the text.

threats to progress. Part 5 presents implications for the theory while Part 6 draws implications for EU policies. The conclusion summarises the main findings and shows how the study challenges and extends current interpretations of Pacific Asian progress.

While it is outside the scope of the paper to examine the causes and implications of the present, severe monetary and economic crises facing Pacific Asia, the research lends support to the argument that the primary role of government is to secure macroeconomic stability and financial confidence, rather than to conduct second-order interventions in support of specific firms or sectors. Failure to adhere to this basic principle may have contributed to some of the problems facing Pacific Asia at the time of writing.

Part 1: Key Research Issues

1.1 Rationale and previous research

Much of the economic and industrial research into Pacific Asian development has been conducted within what can be called the 'market *vs* state' debate. Some studies stress the importance of government intervention and the guidance of industrialisation (e.g. Amsden 1989, Wade 1990, Xue 1997). Others stress the role of market forces, interest rate policies and macroeconomic stability, rejecting many of the claims of the policy enthusiasts (e.g. World Bank 1993, Riedel 1988, Krugman 1994). Underlying both perspectives is the acceptance of a continuum of government-industry relations, typically running through from state-led, to corporatist, to market-driven (Evans et al. 1985, Evans 1995, Hong 1997).

Partly because of the dominance of this debate and partly due to the difficulties of conducting company-level research in Pacific Asia, there has been very little study of the technology practices of firms in the region. Even Japan is poorly covered from this perspective.[3] In particular, there is very little understanding as to how local firms overcame barriers to entry and developed their skills and competencies. This is a serious oversight as firms are the locus of competition, innovation and productivity in Pacific Asia, as elsewhere. Also, there are major differences between firms' strategies and performances within the same economy, which cannot be explained by differences in the economic or policy environment and which, therefore, deserve serious attention (Nelson 1991).

The SEI-SPRU research project therefore analysed the mechanisms by which local companies learned technology, the role of TNCs in transferring technology to the region and the ways in which firms worked together with governments in technology projects and programmes.

The project builds on previous research on the technology strategies of 'latecomer firms' in the four dragons - South Korea, Taiwan, Singapore and Hong Kong (Hobday 1995). The latter study shows how Pacific Asian latecomer firms differ from leaders and followers in that, initially at least, they are dislocated from advanced markets and world sources of technology. Strategically, the latecomer firms had to overcome these difficulties.

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[3] For a rare and excellent exception see Abegglen (1985).

This project upon which this paper is based, extends this base of initial research in four new directions: first, by scrutinising the role of government-business partnerships for technology; second, by extending the work to South East Asia (Malaysia and Thailand) and thereby encompassing the advance of second-tier Pacific Asian economies led by foreign TNCs; third, by exploring, the implications for the EU; fourth, by assessing new Pacific Asian organisational innovations (notably the transition from so-called OEM to ODM and OBM[4]) which have revised the threats and opportunities facing Europe in the region.

1.2 Objectives of the research project

The overarching objective of the research was to provide an in-depth understanding of the technological dynamics of the Pacific Asian region from the perspective of firms and government-business relations. The specific research aims were to:

1. apply recent developments in innovation theory and political science to interpret the patterns and sources of technological capability in Pacific Asia; to show how technology relates to industrial competitiveness and to identify any best practice policy lessons for Europe;

2. provide case studies of (a) local firm and TNC technological learning and (b) government-business partnerships for technological development in Pacific Asia, showing if, and how, such collaborations contribute to the region's progress;

3. compare the technological activities and scope of European TNC operations in Pacific Asia with those of US and Japanese firms;

4. show similarities, differences and stages of development by comparing company strategies and government policies across four countries: South Korea and Taiwan (first-tier NIEs) and Malaysia and Thailand (second-tier NIEs);

5. draw lessons and implications for the EU from the above by: (a) comparing the performance of European TNCs with others in the region; and (b) identifying any 'best practice' corporate strategy lessons from Pacific Asia.

The current paper draws on the detailed studies produced during the project (see Annex 1) in order to develop a taxonomy of government-industry relations in the four NIEs, thereby providing a partial 'institutional map' of the electronics industry in the region.

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[4] OEM (original equipment manufacture) is a specific form of sub-contracting whereby a foreign TNC or buyer provides the detailed technical specification to the latecomer firm which then manufactures the product. ODM (own design and manufacture) occurs when the latecomer firm not only manufacturers but also designs the product, which is then purchased and distributed as in OEM. OBM (own brand manufacture) is where the latecomer has acquired the technology and marketing capabilities (and brand names) to compete head on with industry leaders (Hobday 1995).

1.3 Theoretical and conceptual issues

The two main branches of theory used to help guide the field research were (a) neo-Schumpeterian theories of innovation, and (b) political theories of the developmental state and government-industry relations. The research findings are also used to comment on and extend current theories.

Studies of government-industry relations in the NIEs (e.g. Wade 1990) have revealed substantial interventionism in what appeared to be free market success stories. However, despite this fruitful advance into previously neglected territory, existing taxonomies appear insufficiently precise to make sense of technological dynamics at the sectoral level. In particular, the tendency to typologise government intervention along a single continuum from state planned, to interventionist/corporatist, to market driven appears to do injustice to the subtlety and diversity of state intervention in Pacific Asia.

For example, in electronics in Singapore the Government intervenes strongly in infrastructural terms, but does not attempt to directly influence firms' strategic decisions (Hobday 1995). However, in South Korea the state intervenes both indirectly in infrastructural development and directly in the decision making of the local firms (the *chaebol*). Again, by contrast, in Hong Kong the administration has followed a *laissez faire* approach to technological development. Yet, in all three cases, each NIE has made remarkable progress in electronics.

Moreover, most accounts of Pacific Asian advance neglect the political role of firms, whether as lobbyists in their own right, members of sectoral associations, or as expert advisers to governments. Pluralist accounts still tend to treat firms as 'fictitious individuals' (i.e. simple actors) which are external to the policy-making process (but accepted to be influential upon it).

This paper interprets markets as systems of power and influence in which economic organisations (such as firms) and political institutions (such as ministries) are bound together in complex relationships, which vary across sectors and across countries. Even in the more hierarchical and 'Confucian' societies such as South Korea, rights and obligations in state-firm relationships are, to some extent, bargained and forced mergers between firms in collaborative R&D projects can lead to unpredictable outcomes and failures, as well as successes.

The second area of theory addressed is neo-Schumpeterian innovation theory. Conventional 'Western' models of innovation (e.g. Vernon 1966, Utterback and Abernathy 1975, and Abernathy et al 1983; Teece 1986 and 1996) focus on developed country firms which can be categorised as either 'leaders' or 'followers'. These categories do not appear to adequately explain the technology directions and strategies of firms in latecomer economies, or 'latecomer firms' - or indeed TNC subsidiaries operating within NIEs. In contrast to leaders and followers, previous research shows that latecomers are dislocated from key sources of innovation and the user-pull of demanding markets. Therefore, they are forced to adopt and adapt novel organisational forms (e.g. OEM and ODM) and new innovation strategies to overcome their difficulties. These differences in origin and strategy result in distinctive corporate structures, competencies, orientations, strengths and weaknesses (Hobday 1995).

Some of the classic locational work (Dunning 1975) and product life cycle theory (Vernon 1966) provides clues to the strategies and technology paths of latecomer firms. However, these accounts deal with production and technology location from the perspective of TNCs in the developed countries, rather than local, latecomer firms in East Asia or the TNC subsidiaries in South East Asia. It is the latter phenomenon which has prompted the surge of economic growth in the Pacific Asian NIEs. The comparison of East and South East Asia promises valuable analytical and conceptual insights into the paths and patterns of technological change and the strategies of firms in the region.

The paper also extends the general conceptual studies of technological learning processes and technology transfer to developing countries (e.g. Lall 1982, Dahlman et al 1985) to deal with company strategies for technology and the emergence of significant innovative capabilities among local firms and TNCs in Pacific Asia. The aim is to extend our knowledge of electronics exporters in Pacific Asia, to show how company strategies have evolved over time and to suggest likely trends for the future, both at the level of firm and government-firm relations.

1.4 Key policy questions

A major aim of the research project was to address some of the key issues commonly raised by policy makers in the EU. The following five policy questions were developed with policy makers in the DTI, the Foreign Office and the Commission of the EU, and subsequently addressed during our research:

(a) to what extent, if any, are European TNCs becoming 'revitalised' as a result of their operations in Pacific Asia? Are new practices being transferred back to corporate centres?

(b) how do European TNC technological activities compare with those of American and Japanese firms in the region? Are there any differences between the ways European firms are treated by governments in the region compared with other TNCs?

(c) what, if anything, can EU firms learn from the success of Pacific Asian latecomer firms? Are there best practice innovation lessons of relevance to European companies?

(d) can and should EU policy makers respond to the transfer of employment and investment by EU TNCs to Pacific Asia? What are the long-term implications of any 'corporate hollowing' for the EU?

(e) are there systematic country differences between firm strategies and government-industry practices which impact on competitiveness? Can any best practice Pacific Asian government policies be identified?

By addressing the above policy issues, the research attempted to feed data to UK and other EU policy makers, engaged in setting rules for interfacing with Pacific Asian countries in the area of science, technology and industry. In the event, most of the policy demand for the research was from UK organisations (Hobday 1997). However, attempts were made to address broader European issues (Heighes and Hobday 1997, Hobday 1997c, Hobday 1996).

In particular, the project attempted to inform the policy debate by illustrating the wide variety of government-industry relations in the region.

Part 2: Governance of Technology: A Cross-Country Taxonomy

In order to extend existing research into the politics of industrialisation and, in particular, the governance of technology (Haggard 1988, Wade and White 1984, Balassa 1981, Wade 1990) a detailed examination was conducted on the evolution of firm-state relations in the South Korean semiconductor industry (Ran Kim 1997a), as well as progress in electronics in Malaysia (Bell et. al 1996, Hobday 1996, 1998;), Taiwan (Ran Kim 1997b) and Thailand (Chairatana 1997). Broader sectoral comparisons were also made of TNC-led growth in South East Asia with that of local firm growth in South Korea and Taiwan (Hobday 1997b). Table 1 summarises some of the findings of these studies, touching on sectoral governance in electronics, government policy interventions and broad patterns of technology development.

2.1 Overall trends

Table 1 reveals huge differences in the changing roles of government and the extent and nature of their interventions which contrast sharply with conventional wisdom on the developmental state (see Part 5). Major differences can be seen in industrial structure, patterns of ownership and the role of government in stimulating technological progress. Differences are partly due to historical reasons, with the Republic of Korea closely linked to Japan and the Japanese model of development and Taiwan more closely associated with US industry, particularly in computers. Other differences are due to strategic and political choices, with Malaysia and Thailand allowing a degree of TNC freedom within their economies unacceptable to Governments in South Korea and Taiwan for most of the period analysed.

Also, there are major differences according to the particular period in question. In Taiwan and Korea for example, the role of TNC subsidiaries was important in the early period (e.g. 1960 to 1970) but declined with the rise of local firms. Recently, firms in both countries have attempted to re-introduce TNCs in order to gain assistance with the next phase of technology deepening and to integrate their local activities more closely with the global leaders' in electronics.

Despite the late start of the second tier South East Asian NIEs, their performance in electronics has proved to be very successful and, in some respects (e.g. export sales), comparable with the first-tier countries of South Korea and Taiwan (Hobday 1997b). In both East and South East Asia, government policies both shape and reflect industrial structure and corporate behaviour. Yet, as argued below, government intervention and firm-state partnerships have not been as effective as commonly presumed.

Table 1: Taxonomy of sectoral governance in electronics in four NIEs

	South Korea	Taiwan	Malaysia	Thailand
Historical extent of direct policy intervention in the electronics sector and in specific firms	Was strong in 1970s but declined during the 1980s and 1990s due to growing strength of the *chaebol*	Traditionally, a low degree of intervention; many small firms operating under market conditions	Strong but indirect support to TNCs through export-processing zones (EPZs); very little direct intervention	Similar to Malaysia, TNC-EPZ led growth and little direct support for indigenous firms or TNCs
Recent trends in degree of direct policy intervention	Policy intervention low by the 1990s, except in financial areas; conflicts between policies and firm behaviour	Increasing role for government in some areas (especially semiconductors) and in basic infrastructure (e.g. Hsinchu Ind. Park)	Continuing tax and EPZ support, but little direct intervention; attempts at 'grand plans', but little evidence of success	Similar to Malaysia; some selective support for local firms, but little evidence of success (some evidence of failure)*
Role of public technology institutes/firm-government partnerships	Despite many technology institutes, little evidence of much contribution in the 1980s and 1990s	One major institute (ITRI**) with a good record of success in semiconductors, but mixed record in other sectors	Few in number, focused mainly on training and standards; little direct impact on technology progress	Similar to Malaysia; technology activities occurred within TNC subsidiaries
Industrial structure and ownership patterns	Highly concentrated structure; a few very large local firms (*chaebol*) dominate electronics; few TNCs; weak SME*** sector	Dispersed and diverse structure with many locally-owned SMEs; some have grown larger; continuing role for joint ventures	Highly concentrated within the TNC sector; few backward linkages with local firms; an increasing role for second-tier TNC suppliers	Similar to Malaysia; less presence of European TNCs in Thailand; also competing with lower cost countries (e.g. China)
*Sectoral concentration and technological strengths in electronics***	Focus on mass produced hardware; scale and process intensive goods (e.g. DRAMs, consumer electronics, TV tubes)	Focus on personal computers (PCs) and related components; both scale intensive and niche market activities, reflecting diverse industrial structure	Focus on semiconductor assembly; more recently TVs and other components; major assembly and testing activities by TNC subsidiaries	Broadly similar to Malaysia; focus on labour-intensive stages of production within TNC global chain of commodity production
Extent of technological progress in electronics	World leadership status in a small number of product lines (e.g. DRAMs) but follower in most products; lacking key component, capital goods capability and design skills	Reached world leadership status in a few areas (e.g. process design for computer boards); mostly behind the design/R&D frontier, as in South Korea	Several years behind Korea and Taiwan, but technological progress occurring within the TNCs; main strengths in process technology	Similar to Malaysia - a 'stage of development' behind South Korea and Taiwan; perhaps a little behind Thailand in scale and depth of operations*

* Chairatana (1997)
** ITRI = Industrial Technology Research Institute (Taiwan)
*** SME = small and medium-sized enterprises
**** see Part 3 below for specific products

2.2 South Korea

Taking each country in turn, in the case of South Korea, the evidence shows a heavy direct involvement of the government in the general affairs of the large corporations (*chaebol*) during the 1960s and 1970s, giving way to firm-led 'corporate governance' during the 1980s and 1990s as the *chaebol* grew in stature and capability. There is little evidence that direct intervention (e.g. technology support programmes or initiatives) in the pre- or post-1980 period contributed to the export success of the *chaebol* or altered the strategies of the major firms in electronics.

However, the government did attempt to exert control over major decisions, such as the strategy to diversify into major new areas and to conduct investments abroad, and continues to do so. One key government motivation has been to restrain the domestic economic and political power of the *chaebol*, rather than to promote them technically. Government has made attempts to curb what it sees as the *chaebols'* excesses, particularly their thirst for unrelated and risky diversification, but with little success. Indeed, companies such as Samsung continue to diversify into major new areas (e.g. automobiles) defying the wishes of government. Overall, the *chaebol* have evolved in a bargaining relationship with the Korean Government over the past 15 years or so. However, these very large firms have developed sufficient industrial strength and market knowledge to make and execute strategic decisions, including technology ones, independently of government support.

This is not to say that the government has not been important to the growth of the *chaebol* during the past 15 years. At a general economic level, the South Korean Government provided macroeconomic stability for much of the period, as well as incentives for export-led development. Government policy also contributed to the pattern of extreme industrial concentration and firm-level vertical integration in electronics as well as other sectors. However, other factors also shaped industrial structure and vertical integration. The close geographical, colonial and industrial links with Japan, led to Japan being imitated as a role model by companies and policy makers in Korea. Indeed, the mass production, sub-contract route chosen in electronics owes as much to historical opportunity as to carefully chosen strategy. The small firm, entrepreneurial, market-led route followed in Taiwan was not an option open to South Korea. In other words, South Korea's particular historical circumstances shaped its industrial structure and strategy.

During the 1980s and 1990s, a dominant feature of corporate governance has been the internalisation of key functions within the *chaebol* and the very small role for external SMEs. Equally, the direction followed in Korea allowed little opportunity for FDI to expand as it did in South East Asia.

From a technological perspective, despite dramatic progress in some areas (notably DRAMs) by and large the *chaebol* continue to suffer from shallow R&D and design capabilities and their dependence on a narrow range of production process skills. As a result, in most product areas (e.g. consumer goods, computers, software and multimedia) the *chaebol* lag behind their competitors in Japan and the US, relying on the latter for new designs, capital goods and key components. In some cases, and with mixed results, the *chaebol* (e.g. Samsung and LG) have acquired firms in the US and Europe in order to upgrade their technological capabilities (Hobday 1997a)

Finally, in the Korean case, as in Taiwan, the role of public institutes and public support for technology appears to have been overstated in much of the literature (e.g. Wade 1990, Kim, Kim, and Yoon 1992, Xue 1997). With their growth and maturity during the 1980s and 1990s and their close connections with international suppliers of technology, the *chaebol* have been capable of developing necessary technology in house and/or by acquiring technology from overseas partners. As a result, there has been little need or demand by firms for contributions from public R&D institutes, except in a few exceptional areas such as semiconductors in Taiwan (Hobday 1996a; 1996b).

2.3 Taiwan

As Table 1 shows, compared with Korea, Taiwan exhibits a very different system of sectoral governance in electronics, characterised by less government intervention, a much more vibrant SME sector and greater entrepreneurialism. Taiwan benefited from overseas Chinese entrepreneurs, often suspicious of government intervention and policy programmes. In electronics, as in the economy overall, an important role was played by the informal sector and the underground economy.

Recently in Taiwan, a series of prominent firm-government partnerships for technology have been undertaken, particularly in semiconductors. However, these mostly appear after the start-up and take off periods in electronics (1960s to the mid-1980s) and are, perhaps, a consequence rather than a cause of Taiwan's export success in electronics. There is less convincing historical evidence of successful, direct intervention by government, particularly through the major technology institutes (e.g. ITRI) than is commonly assumed (e.g. Wade 1990, Mathews 1995, 1997, Xue 1997). Indeed, it is not yet possible to make a proper judgement on the performance of ITRI and other government institutes and programmes for technology. This would require a systematic evaluation of performance, costs, benefits, failures and effectiveness and separation of the impact of such programmes from other effects (Hobday 1996b). Such research has yet to be conducted.

In semiconductors, ITRI the main public institute for technology development, played an important part in absorbing foreign technology, training engineers and spinning off new companies. ITRI was useful because of the scale-intensive nature of semiconductor technology, compared with the small size of most Taiwanese firms and their limited R&D capacity. However, during the past decade several of the SMEs have grown large enough to produce semiconductors either alone or in partnership with foreign companies (e.g. Acer-Texas Instruments) and have not required or sought any assistance from government. In areas other than semiconductors (e.g. TV, computers, and consumer goods) as yet there is little convincing evidence of successful technology generation in consortia promoted by government institutes (Hobday 1996b).

Historically, in sharp contrast with Korea, sectoral governance was largely firm-led, driven by SMEs and the large family groups which diversified into new export areas (e.g. Tatung). However, as in Korea, the Taiwanese Government provided a sound educational system, macroeconomic stability and a policy to assist export-led growth. For reasons of culture and history Taiwan developed an industrial structure more flexible, pluralistic and responsive to change than did Korea. With little support from government, large and small firms successfully assimilated process and product design skills, often relying on their foreign purchasers for technology (Hobday 1995). Some (e.g. Inventec and Acer) have made major

investments abroad (e.g. in Malaysia and China). By contrast, Korea has been relatively slow to adjust to rising factor costs at home, due to a mixture of government overseas investment restrictions, regulations on domestic employment and inflexibility on the part of the large *chaebol*.

2.4 Malaysia and Thailand

As Table 1 indicates, the two second-tier NIEs (Malaysia and Thailand) stand in stark contrast to both Korea and Taiwan. While the former economies are at an earlier stage of development, both have sectoral governance structures dominated by FDI, with TNCs deciding on corporate strategy, technology transfer and local technology development in electronics. Contrary to popular wisdom, the evidence shows that TNC-led development has proved to be a remarkably successful strategy in South East Asia, producing an export performance comparable with South Korea and Taiwan, and delivering a steady but impressive performance in the assimilation of technology within the TNC subsidiaries (Hobday 1997b).

The Malaysian and Thai Governments provided infrastructure and incentives in both countries but rarely took a direct role in the activities of firms. The governments' primary function, as in South Korea and Taiwan, has been to provide macroeconomic stability for business investors. The dramatic, negative impact on electronics exports of recent exchange problems, coupled with concerns over the financial sectors of both countries, graphically illustrate the overriding importance of macroeconomic stability for industrial growth in electronics, as elsewhere in industry (see Part 4 below).

Part 3: Emerging Strategies and New Patterns of Sectoral Governance

The purpose of this section is to look into patterns of specialisation in electronics and to reflect on recent trends in the corporate strategies of local firms and the role of TNCs (European and other) in the four countries. Again, the existence of considerable heterogeneity across the countries is striking.

3.1 South Korea

In the case of Korea, as Table 2 indicates, the dominant technological trajectory has been scale-intensive production of hardware within a small number of large integrated firms, often conducted under OEM relations with foreign TNCs. In the past, this strategy produced very good results and it may continue to do so in the future. Electronics hardware is a sector unlikely to experience a fall in growth in the foreseeable future, especially with new demands generated by telecommunications, information processing, Internet and other major hardware user sectors. However, in order to expand into design-intensive systems, complex software, multimedia and network technologies, the successful strategies and structures of the past are unlikely to be adequate for the demands of the future (Cawson and Ran Kim 1997).

Table 2: Structure, strategies and emerging patterns of governance

	South Korea	Taiwan	Malaysia	Thailand
Dominant technological trajectories	Large firm, scale-intensive production; under sub-contract and original equipment manufacture (OEM)	A few large scale intensive firms; many flexible small local firms; dependence on OEM	Assembly services for global TNCs; production skills but little product design knowledge	As in Malaysia, skills confined to assembly process improvement and process-product interfacing
New corporate strategies	Aim is to break free of OEM and move to own brand manufacture (OBM); set up own distribution abroad	Like Korea wishes to reach OBM and higher value-added activities; lead firms also capable of export distribution	TNCs setting up disk drive and colour TV production; also some design skills for basic products	As in Malaysia, taking on activities previously carried out in NIEs such as Singapore and Taiwan
New product and process development strategies	Attempts at core components, multimedia and software; strengths in advanced hardware (e.g. LEDs widescreen TVs); DRAM and consumer electronics driven	Unlike Korea, driven by computer technology; examples include network PC (e.g. ethernet cards, scanners, monitors, motherboards); close links with US	Building on current strengths in chips and consumer goods (e.g. wafer fabrication, VCRs, disk drives); new investments from Taiwan and Singapore	Similar to Malaysia; less VCR production, increasing disk drive, monitor, TV and TV tubes; lags behind Taiwan and Korea by six years or so
Role of European and other TNCs	Very little presence of TNCs, especially European; increasing numbers of US firms (sales offices and joint ventures) to support capital goods' needs	Major presence of Philips (e.g. in monitors and chips); recent joint ventures with global firms in semiconductors (e.g. TI, Philips)	Dominant presence of TNCs; major role for European TNCs in consumer electronics; resulting from historical strategy of FTZs*, tax holidays and other TNC support	Similar to Malaysia; chip packaging operation by Philips; Thomson producing TVs; Europe significant but weak compared with US and Japan

* FTZ = Free Trade Zone

The research reveals four main motivations of the *chaebol* to break out of the cycle of mass production of hardware under the OEM system: (1) to capture more value added by moving into design and software activities; (2) a desire to help shape the global electronics and information technology industries, rather than responding to them with production services; (3) to reduce dependence on Japanese and US competitors for core components and new product designs; (4) to reduce the commercial risk of being confined to a narrow range of production activities. In other words, the *chaebol* would like to make the transition from latecomers to leaders in order to compete on an equal footing with the leading players in the global electronics industry.

However, the data show that the *chaebol* have not yet made much headway in software and multimedia (Cawson and Ran Kim 1997). Instead, they remain 'trapped' (albeit a successful

trap to date) in a repeated cycle of catching up in hardware production. The structures and strategies of the *chaebol*, unlike those of their Taiwanese counterparts, are not flexible enough to allow the development of creative software-intensive niches and to permit fast, flexible and innovative responses to new customer demands.

Regarding the participation of TNCs in South Korea, during the 1970s most TNCs withdrew as the *chaebol* took over the local electronics industry and, until very recently, Korea has remained virtually closed to FDI in electronics. The de facto exclusion of foreign firms has prevented the *chaebol* from forming alliances at home in sophisticated electronics and capital goods. Instead, the *chaebol* have purchased companies overseas (especially in the US) in the hope of integrating them into their internal organisations (Hobday 1997a).

Realising that the resulting strategy of vertical integration and mass production of hardware has met limits, Korean firms have recently begun to forge major strategic alliances with foreign TNCs within Korea (e.g. Anam with TI and Samsung with TI) and encouraged US and Japanese capital goods suppliers to enter Korea to meet the growing demands for sophisticated equipment. In some respects, the domestic market protection policy has isolated Korean firms on their home ground, leading to a rethinking of earlier policies and an awareness of the need for inward investment in Korea.

Regarding European TNCs, due to their product specialisation, firms such as Philips and Thomson have been viewed as direct competitors, rather than potential collaborators. This partly explains the extremely low presence of European TNCs historically within Korea (compared with the other three Asian NIEs). Korean firms have been much more closely linked to Japan in direct competition with European suppliers of consumer electronics.

3.2 Taiwan

Taiwanese firms, like their Korean counterparts, also wish to progress from OEM to design-intensive, own-brand sales in markets such as the US and Europe. Some firms (e.g. ACER) have had a degree of success, but most have not yet. In Taiwan, firms demonstrate a growing strength in product design in computers and related products, building on their close connections with Silicon Valley firms. Taiwan is now viewed by most major producers as 'the arms trade' for the computer industry. Many global brand leaders today depend on Taiwanese suppliers' low cost, highly productive innovative low end, low cost computer models and parts. Production networks in Taiwan are more closely aligned with American markets and TNCs, compared with the close links Korea enjoys with Japan (Ran Kim 1997b).

Regarding the role of TNCs, the historical presence of Philips (of the Netherlands) has been highly significant in the development of semiconductors and consumer goods in Taiwan. However, the growth of locally owned industry has dwarfed investments by foreign TNCs since the 1980s. During the 1990s more inward investment in joint ventures has occurred, as Taiwanese firms seek to make components for its burgeoning local computer industry (e.g. TI-ACER and TSMC-Philips).

3.3 Malaysia and Thailand

In Malaysia and Thailand, in stark contrast to Korea and Taiwan, the overwhelming dominance of TNC investment has left very little room for local firms. Policies to support FTZ enclaves have left most TNCs largely dislocated from the local industrial infrastructure (Hobday 1998). Some backward linkages to supply firms have been forged recently, but these have tended to be formed with second-tier foreign component suppliers, rather than with local firms. In Malaysia, many of the second-tier TNC investors are from Taiwan, which is now a leading foreign investor. A few local firms have made significant headway in Malaysia (e.g. Sapura and Likom) but these have been the exception to the rule, and some in Thailand (e.g. Alphatec) have faced serious financial difficulties due to their very fast, high risk growth strategies (Chairatana 1997).

Contrary to popular views of TNC subsidiaries as mere 'screwdriver plants', the research shows that in Malaysia a great deal of important technological progress has occurred within manufacturing plants, albeit focused mainly on process technology (Hobday 1996). Malaysian TNCs have now reached the stage of developing simple new products and tailoring existing designs for efficient mass production (so called 'design for manufacture'), which Korea and Taiwan reached a decade or so earlier. Such activities require knowledge of product designs, product-process interfacing skills, advanced automation, computer aided-design and software.

In Malaysia and Thailand, European TNCs are very active in consumer electronics, components and simple telecommunications products (e.g. Philips, Thomson, Grundig, Ericsson and Siemens). However, their presence, although important, is dwarfed by that of US and Japanese companies due to their much larger shares of world electronics markets and geographical and historical reasons (e.g. many Japanese firms invested very early on in Malaysia and Thailand).

The field research points to important learning within TNC subsidiaries competing in Pacific Asian markets. There was evidence of leading edge innovation practices in Siemens, MEMC, Philips and other European firms, as well as in American and Japanese companies. In general, these firms have not only benefited from the rapid growth of the regional market, but also from engaging in the fast changing, competitive dynamics of the region. There is some evidence that US TNCs have brought back 'lessons learned' to their headquarters. Motorola, for example, has appointed a Hong Kong national as regional director to its main board and given considerable weight to Pacific Asian investments. Similarly, Texas Instruments has developed a coherent strategy of revitalisation through its investments in the region. From Europe Philips was following a similar path, promoting a Taiwanese national to its board and creating new ventures in several NIEs. However, the extent to which parent divisions have been able to use such experiences to their advantages is not clear. This would require in-depth comparative analysis at the parent country location, an interesting topic for further research but beyond the scope of the present study.

Part 4: A Look to the Future: Strengths, Weaknesses, Opportunities and Threats

Before drawing implications for Europe it is first helpful to conduct a so-called 'SWOT' analysis for the electronics sector in Pacific Asia. SWOT is a standard method for examining: (a) strengths and weaknesses (internal to the four countries); and (b) opportunities and threats (external to the four) with a view to future prospects.

Table 3 outlines the challenges facing the four NIEs in electronics. Despite considerable industrial and technological catch up progress, major problems remain. In Korea, the large firms need to become more agile and entrepreneurial to compete. They also need to be more decentralised and less bureaucratic in structure and style, particularly if they wish to go beyond hardware production to compete in software-intensive areas such as Internet, business networks, multimedia and telecommunications services (Cawson and Ran Kim 1997). So far, efforts to promote a strong SME sector in South Korea have had little success, because of the concentration of human talent in the *chaebol* and their overwhelming dominance of the electronics sector. A transition to a more professional, less-family oriented business structure is widely viewed as a necessary step towards business efficiency and flexibility.

However, the strategy of mass production of hardware adopted in the past in Korea has often been called into question and may yet confound observers. Indeed, as a result of advances in information and communications technologies, more low cost hardware is constantly required and there is, as yet, no evidence of a slow down in the growth of the electronics hardware industry. With an ability to shape international hardware standards the *chaebol* may continue to grow in the future, without making the transition to software-intensive activities.

A more fundamental problem faces the banking, monetary and currency systems in Korea. Without reform of the latter, the resulting macroeconomic instability could well threaten the progress of individual firms in electronics as in other sectors. Assuming these problems can be resolved in the short- to medium-term, then the depreciation of the Won could, in fact, make Korean electronics exports less costly and more desirable on world markets, stimulating further rapid growth. However, it is by no means assured that the reforms required will be undertaken with sufficient zeal to reassure the international financial community.

Taiwan also faces a series of specific threats and opportunities. Unlike the other three NIEs, as yet, Taiwan has remained free from currency speculation and banking instability, although it is impossible to predict future events in this area. At the industrial level, several of Taiwan's smaller companies have grown to become global corporations (e.g. ACER and Inventec). As with the *chaebol*, most of these companies are still family-run and recognise the need to become less paternalistic and more professionally managed in the future. Due to the relatively small size of most firms, compared with South Korean companies, R&D capabilities are fairly weak and spending on R&D remains low as a proportion of GDP. Most Taiwanese firms, like their Korean counterparts, are dependent for new product designs, core components and capital goods upon major Japanese and US firms, often their targeted competitors. The challenge facing Taiwanese firms is to progress beyond simple OEM sub-contracting into the design and distribution of own brand products, to capture more value added and to expand market opportunities.

Table 3: Strengths, weaknesses, opportunities and threats facing four Pacific Asian NIEs

	South Korea	Taiwan	Malaysia	Thailand
Strengths	Huge *chaebol* capable of large capital mobilisation, cross subsidies and overseas investments; strong process capabilities for electronics hardware; major R&D facilities; world leader in DRAM chips	Small, flexible, fast moving firms; connected to overseas Chinese networks (in US, China and East Asia); risk taking entrepreneurial culture; computer design skills in larger firms; engineering skills in SMEs	Large export capacity; major base of FDI, integrating Malaysia into the global economy; strong in basic process technology; strong competition within Malaysia by TNCs; emergence of second-tier TNCs and new sectors	Similar to Malaysia; strong base of TNCs; major exporter of electronics and strong in labour-intensive stages of production processes (e.g. semiconductors)
Weaknesses	Questions over *chaebol* financial performance/close financial links with government; slow to adjust; weak brand image abroad; very narrow product focus due to weak product design; weak SME and capital goods sectors	Small size of many firms restricts R&D spending and major overseas investments; brand names weak abroad; very narrow product focus/heavy dependence on PC hardware markets; weak in PC software	Macroeconomic instability recently due to (a) currency strategy and (b) internal banking system; technical education poor; skill shortages; TNCs weak in product design	As in the Malalysian case, recent macroeconomic problems; skills shortages, weak backward linkages with local industry; weak in new product design
Opportunities	Long term, rapidly growing hardware markets (e.g. set top boxes); able to trade competencies with global leaders and contribute to world industry standards; high technology. acquisitions abroad	Rapid moves into new niche markets; re-shape strategies to meet new needs; expansion of PC market due to Internet; Chinese market links; re-location into lower cost regions	Global integration via TNCs; further FDI (if macro problems resolved); major TNC base to build upon in the future; new product markets (e.g. disk drives); catch up with Singapore	Similar to Malaysia; growing electronics markets; efficient services for investors; also close relationship with Japan; most preferred NIE investment location for Japanese firms
Threats	Banking and financial system under question; low cost competition (e.g. from China); disconnected from Hong Kong-China-Taiwan growth nexus; profit margins low in hardware; problems in new product design; market shift to systems, complex software	Political relations with China; low cost competition from other countries; weakness in R&D threatens own brand strategy; concentration on PCs/highly sensitive to international market recession; dependence on Japan for capital goods and key components	Exchange rate instability raised serious doubts over macro strategy and financial sector; instability of currency threatens investments and exports; low cost competition from China and Vietnam in electronics; wage increases and skill shortages	Many of the threats facing Malaysia apply; political will required to resolve financial and macroeconomic problems; shortages of skills; low cost competition from neighbouring countries; narrow product focus

While major opportunities remain in Taiwan's core areas of strength (particularly PCs) the narrow product focus means that production is highly sensitive to Western market recession. In the past, market downturns have caused industrial turbulence and heavy losses on the part of individual firms. In contrast with Korea, Taiwan boasts a diverse and robust industrial structure, involving high technology SMEs as well as large companies. Together they constitute a fast moving and responsive industrial base, closely connected to American firms and Western market needs. If political difficulties subside, Taiwan could well become a leading investor in China, which would open up dramatic new opportunities for these two 'natural' business partners.

Turning to South East Asia, despite the underlying strength of the electronics industry and its major role in the export development of Malaysia and Thailand, both countries confront severe problems in financial and macroeconomic management which need to be resolved if export growth in the medium-term (say two years) is to return to the high rates of the 1980s and early-1990s. The available evidence suggests that with sufficient political will these problems are resolvable (World Investment Report 1997 pp78-80, DTI Monthly Economic Assessment 1997 pp8-14, Mason 1997, Economist 1997 p18). Assuming the latter assessments are correct and the necessary macroeconomic and financial decisions are taken, then rapid growth in electronics could resume again by 1999 to 2000. Indeed, currency depreciations in both countries could benefit exporting TNCs (who trade in US dollars) by (a) a lowering of the cost of exports (b) fall in dollar costs of new investments (c) lower labour costs (in dollar terms) and (d) further export market expansion as a result of a, b and c. However, any benefits are only likely to be gained within a framework of resumed macroeconomic stability.

The South East Asian research points to surprising underlying technological capabilities, particularly within the TNC subsidiaries operating in Malaysia. The Thailand case appears to be similar but perhaps lags behind Malaysia in scale and depth of technological activities (Chairatana 1997). Apart from the current monetary problems, both countries confront competition from China, Vietnam and other low cost Pacific Asian countries. Skill shortages have also caused difficulties during rapid growth periods of the past. If fast growth resumes, skill shortages will need to be addressed. On the positive side, both countries are well integrated into the global strategies of the TNCs who have invested heavily in the region. Malaysia has become a low cost, alternative option to Singapore for FDI and, given the TNCs desire to continue growing within Pacific Asia as a whole, both Malaysia and Thailand provide a welcoming base from which US and European TNCs can compete. By contrast, Japan and Korea have, traditionally, been less open and less welcoming to FDI.

Part 5: Theoretical and Conceptual Implications

This section points to implications for theory arising from the empirical evidence of Pacific Asian developments in electronics. The main purpose here is to provide both a critique and an extension of state-market taxonomies (Part 5.1). The following theories are also touched on briefly: neo-Schumpeterian R&D innovation models (Part 5.2); TNC-based theories of the location of production (Part 5.3); modern resource-based theories of the firm (Part 5.4); and the distinction between technological and organisational innovation (Part 5.5)

5.1 The developmental state and state-market taxonomies

The research extends existing theories of market governance and calls into question simple state-corporatist-market taxonomies. Several factors are inadequately captured within existing taxonomies and policy studies of Pacific Asia (e.g. Wade 1990, Amsden 1989, World Bank 1993, Hong 1997). The evidence shows that the state-market continuum is a somewhat 'blunt instrument' for understanding Pacific Asian development. The data on electronics suggest at least four criticisms of, and extensions to, current development theory:

1. *Firm behaviour*: the activities and strategies of firms cannot be adequately accounted for in the state to market continuum; because of this, the role of firms as actors in their own right and the major differences between firms in behaviour, growth and performance cannot be accounted for. This is because firm behaviour tends to be viewed as a response to the environment, leaving little scope for the understanding of firm discretion (Nelson 1991).

2. *Sectoral specificities*: the state-market taxonomy is unable to deal with key features of (and major differences between) 'sectoral systems of governance'; even within electronics, the evidence shows major differences between sub-sectors.

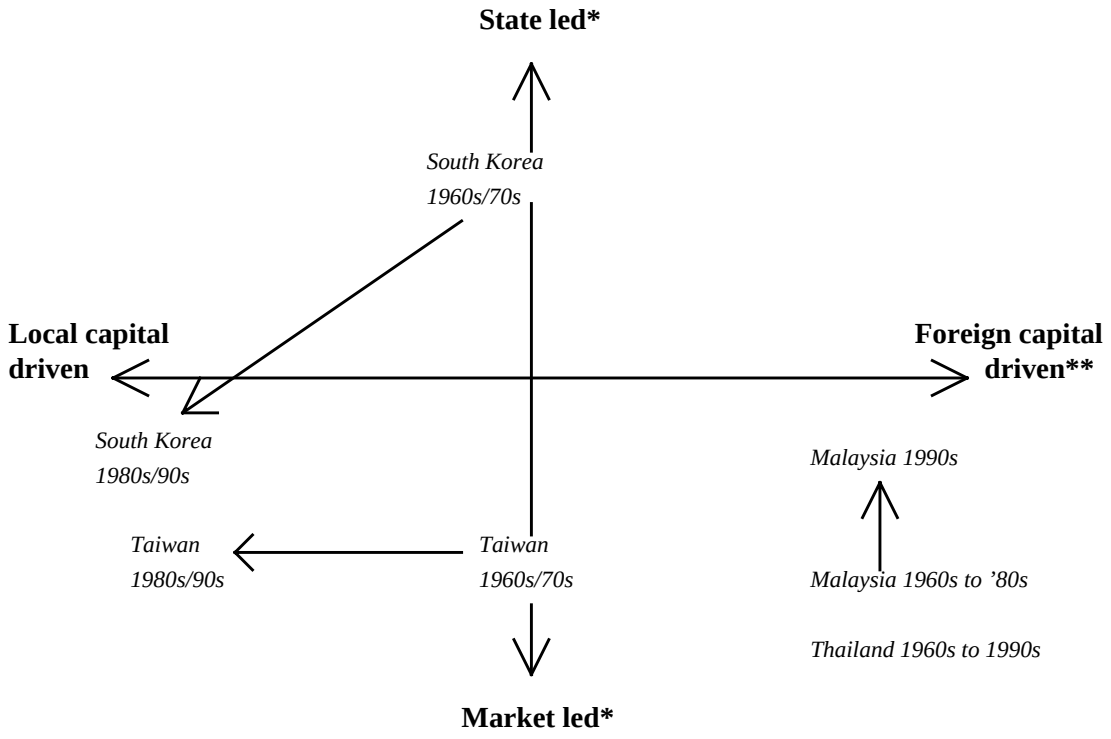
3. *The emergence of a post-development state in Pacific Asia*: the static nature of the developmental state concept fails to capture important changes which have occurred through time. Indeed, the evidence suggests that both South Korea and Taiwan are today, in most respects, in a 'post-developmental state' era. The findings in electronics therefore challenge not only the over simplicity of the concept, but also whereabouts on such a continuum the Pacific Asian NIEs should be placed.

4. *The role of foreign capital:* in each of the cases examined, foreign firms have engaged in the development process, transferring technology and modern business practices. The 'visible hand' of foreign firms is frequently underplayed or ignored in state *vs* market arguments.

Each of these points is elaborated upon below and a simple model is presented to capture the role of foreign capital and changes through time (Figure 1).

1. Role of firms
As emphasised, the state-market continuum is too blunt an instrument to account for the strategies of firms and the differences between them. Firms are assumed to behave in response to either government policy or market forces or both. However, as we see in the case of South Korea and Taiwan there are major differences between firms. In Korea, especially, individual large firms shape the environment in which they compete, in line with the theories of Nelson (1991) and Teece (1996). In Taiwan local SMEs led electronics development during the 1960s and 1970s in a market setting. By contrast, in the absence of a strong local entrepreneurial base, large TNC were invited in to lead the export-led growth of Malaysia and Thailand. Recently, local firms in both the latter economies have attempted to enter the thriving electronics industry, but with limited success.

Figure 1: The role of foreign capital and the dynamics of state intervention in four NIEs in electronics (1960s to 1990s)



* refers to the direct role of government in sectoral governance, firm activities and technology acquisition

** refers to the degree to which foreign TNCs contribute to exports, employment and technology acquisition, as reflected in the openness of each economy to FDI

Given the differences between Pacific Asian firms and, above all, given the distinction between latecomer Asian firms and leaders and followers in the West and Japan, firms need to be understood and therefore studied in-depth as actors in their own right. Understanding the role of firms, both local and foreign, their origins, strategies and directions provides a far deeper analysis than that possible through the state *vs* market debate.

As firms succeed in mastering technology and competing independently on the world stage, this process alters the role of government and can signify the beginning of the end to the 'developmental state' (see below). The Government of Korea for example, during the 1980s and 1990s, became much less of a promoter of development and much more a regulator and a follower in the economic and technological actions of the *chaebol*.

2. Sectoral specificities

The research reveals major differences between industrial sectors which simple state-market taxonomies cannot adequately capture. Within electronics, there exists a wide variety of sub-sectoral 'systems of governance' (e.g. semiconductors, computers and consumer electronics) and, by extension, even greater differences between electronics and other important sectors such as aerospace, chemicals and steel, as shown by Kim and Lee (1987) for the case of Korea.

In the case of Taiwan, there were long-term, strategic efforts by government to promote the semiconductor industry directly, compared with 'state neglect' in consumer electronics and computing. In the latter areas, which represent the bulk of electronics exports during the 1970s and 1980s, firms took the lead and acquired technology in a market setting.

3. Emergence of the post-development state

Figure 1 attempts to illustrate changes in the NIEs through time, along a state-market continuum but also adding a foreign capital dimension. In the case of Korea, the direction has been from state-led/foreign capital driven in the 1960s and 1970s, through state led/local capital driven in the 1980s, to local capital/market driven in the 1990s. During the 1970s in Korea (but not in Taiwan), there was an almost routine reciprocal subsidy in electronics, with government rewarding the *chaebol* for their export performance in various ways (Amsden 1989). However, during the 1980s and 1990s, the government became far less influential in shaping the sector and influencing firm behaviour, as the *chaebol* grew in size and dynamism (Ran Kim 1997a). Figure 1 shows this shift from state to market driven, as the infant industry period came to a close around the early-1980s. The evidence shows that Korean firms took direct control over most strategic decisions. In the case of R&D spending, the ratio of firm to government spending now stands at around 80:20, a reversal of the 20:80 position two decades earlier (Kim and Dahlman 1992).

Consequently, South Korea is approaching the position of a 'post-development state', led by firms and market forces. The research shows a marked degree of disentanglement of government agencies and technology institutes from the activities and strategies of firms (Ran Kim 1997a, Hobday 1996a). In contrast with earlier interpretations of firm-state relations (e.g. Amsden 1989, Wade 1990, Hong 1997) the empirical evidence in electronics reveals a de-coupling of government from corporate decision making and sectoral governance.

Alongside the growth of the *chaebol*, a variety of other forces have contributed to the reduction of direct intervention in industrial matters in South Korea. External forces for liberalisation, the government's desire to become full member of the OECD, 1980s neo-liberalist politics, and a growing cynicism over the ability of governments to guide industrialisation, have all played their part in the decline of the Korean state in electronics. Indeed, within Korea, the legitimacy and effectiveness of government in shaping industrial and technological affairs is often called into question. This transition can be seen as a fairly natural consequence of the dramatic economic progress which has taken place since the 1960s.

Several residual effects reflect and result from the emergence of *chaebol* governance. Government has now shifted its efforts into regulating the activities of the major firms and to control what it sees as excesses (e.g. property speculation and undisclosed political support to government parties). Government has also tried, with little success, to curb the diversification of firms such as Samsung. In the science and technology arena, the government has attempted to retain influence by increasing the share of government in total R&D spending and has established controversial targets and programmes in which it expects firms to participate. Many of these acts can be interpreted as bargaining for influence under the new post-development state conditions.

In contrast to Korea, in Figure 1, Taiwan is characterised by a move from local/foreign capital/market driven in the 1960s, to local capital/market driven in the 1990s. In this case, the importance of market forces in electronics since the 1960s stands in contrast to interpretations of Taiwan's progress (e.g. Wade 1990, Matthews 1995, 1997, Xue 1997). In electronics, the state played little direct role in acquiring technology or governing the sector until the 1980s and 1990s and then only within one sub-sector of electronics (semiconductors). In non-electronics areas, the role of government may well have been more prominent (Chaponniere and Fouquin 1989). Here again, the differences between sectors suggest weaknesses in general market-state taxonomies.

Historically, much of the entrepreneurial talent in electronics derived from the many SMEs and traders which led Taiwan first into consumer electronics and then computer peripherals. Many of these firms had scant regard for technology policies and were fearful of government. The fierce, market-driven system in electronics led to high rates of industrial entry and exit in response to new market opportunities provided by local traders, large foreign buyers and TNCs (Hobday 1994).

In recent accounts of Taiwan, perhaps too much emphasis has been given to the special case of semiconductors where government involvement has been prominent and successful. However, in other electronics sub-sectors (e.g. consumer goods and computers) there is less evidence of successful direct government involvement. Equally, there has been too much focus on government policies for technology (especially through ITRI) where in fact ITRI's overall record has yet to be properly assessed (Hobday 1996b). Indeed, many of the major exporters (e.g. Acer, Tatung and Inventec) appear to have very little connection with ITRI. Taiwan continues to be driven by fierce internal competition and market forces. However, as noted above, there is a slightly greater role for government (mostly in semiconductors) and for foreign capital, to which we now turn.

4. Role of foreign capital

Another area of neglect in simple state-market taxonomies is the role of foreign capital in promoting development by transferring technology and initiating new export industries. This dimension proved important in each of the four cases at various times and to various degrees. Figure 1 adds the foreign capital dimension to the usual firm-state taxonomy, providing an indication of the role of foreign capital, through time, in each of the four countries in electronics. In the 1960s in Korea, the government welcomed in TNCs who started up the electronics industries in wholly owned subsidiaries and in joint ventures (Hobday 1995). In the 1970s, the government encouraged the TNCs to leave and promoted the *chaebol* through subsidies, credits and protection. Very recently, the government has attempted to open up again to TNCs to enable the country to move to its next stage of technology-intensive industrialisation (as discussed above).

By contrast, in Malaysia, the evidence reveals a system of governance driven almost entirely by TNCs, encouraged by infrastructural support and subsidies from government (as in Singapore and Thailand). However, recently the Malaysian Government has attempted to implement a variety of major state-led projects within its five year plans (e.g. the Multi Media Super Corridor), reflected in Figure 1 as a slight shift towards more Government involvement. However, these recent attempts have yet to bear fruit and their outcome remains to be seen. Indeed, the MMSC may well be scaled back due to the financial crisis facing the government.

In the case of Taiwan, again, the standard approach does not reveal the role of TNC activities. These began as centrally important in the 1960s, declined during the 1980s and took on a greater role in the 1990s, as firms such as ACER forged joint ventures within Taiwan to produce semiconductors.

In conclusion, Figure 1 points to the importance of change in state-firm relations in different phases of industrialisation. It also points to different forms of state intervention, with Malaysia and Thailand engaging in indirect intervention through FTZs and relying on foreign TNCs for industrial development and technology transfer. Such differences cannot be captured by simple market-state taxonomies. One key finding is the critical role of foreign capital in the process of industrialisation. FDI assisted all four NIEs into the global electronics industry and opened up new export options for local firms in Taiwan and Korea. Figure 1 highlights major differences in the mode of NIE integration into world electronics industry, pointing to the changing roles of government, local firms and foreign capital.

5.2 Implications for modern resource-based theories of the firm

The research did not attempt to generate a new theory of latecomer innovation. This would require a great deal of evidence from other sectors and other countries and an evaluation of whether existing business theories (e.g. resource-based views) of the firm can or cannot deal adequately with latecomer innovation paths and processes. However, the work did show how the evidence contrasted with existing mainstream models of innovation and proposed a specific, simple model of latecomer innovation, for the case of locally-owned Pacific Asian firms in electronics (Hobday 1997a).

The evidence suggests that modern resource-based theories should deal more precisely with various categories of firms competing from 'behind' the technology and market frontier. Most modern theories (e.g. Teece et al 1994, Teece 1996) and earlier approaches (Penrose 1959, Ansoff and Stewart 1967) tend to assume leader or follower status, both in terms of intra-company resources and the external environment. Such technology resources and complementary assets (Teece 1986) cannot be taken for granted in developing countries. A latecomer theory should account not only for the disadvantages faced by firms dislocated from advanced markets and technologies but also advantages such as low cost manual, technical and engineering resources.

While at the national level, Gerschenkron (1962) dealt systematically with latecomer advantages and disadvantages, barring a few partial exceptions, this has yet to be done at the firm level. A full analysis of latecomer 'positions, paths and processes', to use the terminology of Teece et al (1994) is essential for understanding how and why some developing country firms overcome barriers to entry into advanced markets while others do not. This could be a fruitful area for further research.

5.3 Implications for traditional R&D-based innovation models

Regarding latecomer innovation, the evidence provides insights into how firms overcame barriers to entry in electronics. The strategies and stages witnessed contrast markedly with traditional 'Western' models of innovation, especially those which assume leadership or followership and place R&D, new technology, new product development, corporate visions

and market creation at the centre of innovation.[5] In comparison with such models, the path to Pacific Asian competitiveness was catch up learning, based on established markets and fairly predictable technological trajectories.

Hobday (1997a) proposes a simple model of the catch up process, the general thrust of which appears to be borne out by the Asian evidence. In contrast with Western models, the NIEs began with mature, standardised manufacturing processes and gradually moved on to more advanced stages of process engineering, product-process interfacing and product design. Only recently, and only very selectively, have local suppliers exploited R&D for new product development. Typically, firms graduated from mature to early stages of the product life cycle, from standard to experimental manufacturing processes and from incremental production changes to R&D. In this sense, NIE firms progressed 'backwards' along the normal stages of the product life cycle.

The evidence indicates that Pacific Asian firms developed competitive strategies in order to compete from a technologically weak position and to catch up. OEM production for established export markets enabled firms to engage in catch up learning, imitation and innovation, allowing companies to expand exports, to improve production capabilities and, in some cases, to begin new product innovation, as occurred previously in Japan.[6] This catch up process appears to have been a natural sequence among many successful OEM suppliers in electronics. In contrast with new product development strategies, firms tended to enter at the mature, well-established phase of the product life cycle. The route to more advanced design work and R&D was a long learning process, driven by the demands of manufacturing. Even at today's stage, most Pacific Asian suppliers are weak in new product design and R&D, compared with market leaders in the US and Japan.

5.4 Implications for TNC-based theories of the location of production

The South East Asian research (Hobday 1996, 1996c, 1997b, 1998) also has implications for traditional theories of production location and international product life cycles, based on strategies of TNCs (Dunning 1975, Vernon 1966). The evidence from Malaysia, shows that local TNC enterprise actively stimulated the relocation of production and deliberately brought about technology transfer from buyers and machinery suppliers. It is highly doubtful that relocation to Malaysia (also Singapore and Thailand) would have occurred to the same extent without substantial capability building on the part of the local subsidiaries. It is also unlikely that technology transfer occurred as an automatic consequence of an international product life cycle. On the contrary, local enterprise generated the skills and competencies to enable technology transfer to occur. Local skills were needed to install production capacity, generate productivity gains and to improve production processes. The Pacific Asian evidence adds to classical theories based on the decisions and interests of TNCs, by focusing on the role of domestic enterprise in bringing about the relocation of production.

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[5] See for example, Utterback and Abernathy (1975), Abernathy and Clark (1985), Clark and Fujimoto (1991), Utterback and Suares (1993), Hamel and Prahalad (1994), Chesbrough and Teece (1996), Tushman and O'Reilly (1997), Swann and Gill (1993) and in the marketing literature (Kotler 1976).

[6] See Abegglen and Stalk (1985) for Japanese corporate innovation patterns.

5.5 Technological *vs* organisational innovation

Although the research focused mainly on technology, organisational innovations were also evident, most notably the OEM (including ODM) system itself. By exploiting OEM in Taiwan and Korea many local firms were able to access foreign export channels, overcome barriers to entry and learn about new markets and technology. As an institutional mechanism, OEM provided a bridge between advanced users in the West and suppliers in the NIEs, forcing continuous improvements upon competing local suppliers. The OEM system is new to the marketplace and therefore constitutes innovation (albeit organisational) in the strict sense of the term. The regional development which occurred under OEM has no obvious historical counterpart and has already proved to be a large scale feature of economic development in Pacific Asia. With the expansion of OEM into China, Indonesia, Vietnam and the Philippines the system is likely to continue to bring about further rapid growth in Pacific Asia as a whole.

Part 6: Implications for the European Union

The purpose of this section is to (a) draw general conclusions from evidence and theory for EU policy and (b) to comment on the five specific policy questions raised in Part 1.4.

6.1 General implications for policy

As shown above, systems of governance are heterogeneous in the region. The NIEs differ a great deal in terms of company ownership, government policies, firm practices and industrial structures. Not only do major differences exist between the first- and second-tier Asian economies in their stage of development, but also in capital ownership with foreign firms leading the latter economies and locally-owned companies the former.

Because of these major differences, it follows that no one, single homogenous policy can be appropriate in areas such as technology collaboration, inward investment and competition policy. For example, EU policy towards South Korea and Taiwan might be geared to stimulate further inward investments to Europe by the *chaebol* (e.g. Samsung) and the larger corporations of Taiwan (e.g. Tatung and ACER). EU policies might seek to encourage technology collaboration in EU programmes, once these firms are sufficiently integrated into the EU manufacturing base. Within the EU, the UK has performed very well in attracting inward investment from South Korea and Taiwan, as well as Japan (Hobday 1997, 1997c, Heighes and Hobday 1997). EU policy groups may wish to consider why some countries, such as the UK, perform well in attracting FDI while others do not, and draw attempt to policy conclusions from this.

By contrast, a key policy issue for the South East Asian Economies, including not only Malaysia and Thailand but also Singapore and Indonesia, may be to improve European performance as an outward investor in the region. This brings with it the possible concern of the displacement of EU employment (discussed in Part 6.2). In South East Asia, EU firms compete strongly with Japanese and US TNCs. The EU may wish to consider ways in which European firms can be further supported in their efforts to compete in the region. Regardless

of any specific policies adopted, the main conclusion from the research is that in trade, technology, competition and investment policy issues, major distinctions need to be made between the NIEs.

6.2 Specific policy issues raised

1. The revitalisation of European TNCs
The research hoped to comment on the extent to which European TNCs were becoming 'revitalised' as a result of their operations in Pacific Asia. There is indeed some evidence that European TNCs operating in Malaysia (and Singapore) are benefiting from the general dynamism of the region. Hobday (1998) shows that EU companies such as MEMC, Grundig and Siemens (Germany), Thomson (France), Philips (Holland) and SGS (Italy) are competing with, and learning from, the world's leading companies in areas such as consumer electronics and semiconductors. The promotion of an indigenous Taiwanese director to the board of Philips (Holland) also reflects the importance that Philips attaches to the region.

Opportunities for learning new methods of production have certainly been created and some local TNC subsidiaries have introduced a variety of interesting innovations (Hobday 1996). However, the research was unable to assess whether this learning had been transferred back to corporate headquarters or had produced major effects on the performance of European firms as a whole. This would have required an in-depth study of TNC operations in their home base, a topic beyond the scope of the present study, but an interesting area for future research.

European revitalisation within Pacific Asia appears to have occurred, but because of the smaller scale of overall European FDI, the learning effects have been less than those afforded to US and Japanese firms who are far more numerous in the region.

2. European vs US and Japanese technological activities
The research shows that, compared with American and Japanese firms in the region, European firms have followed broadly similar patterns of technology upgrading as their competitors. Some are extremely dynamic and successful (e.g. Philips and Siemens). However, the major difference lies in the far smaller aggregate scale of European operations, which lags far behind that of Japan and the US.

Regarding the treatment of European TNCs, there was no indication that EU firms have been treated any differently from other TNCs in Malaysia and Thailand. In general, EU firms have benefited from the welcoming policies towards FDI in South East Asia and have confronted the same, somewhat less welcoming FDI policies of South Korea and Taiwan. In all four NIEs, there are new opportunities for European firms to expand as liberalisation proceeds, assuming the current macroeconomic and monetary difficulties can be overcome.

3. Learning from the success of Pacific Asian latecomer firms
Regarding lessons from success, there can be no model for EU firms to emulate, given the differences in origin, strategy and structure of EU firms. However, there may be scope to transfer back manufacturing lessons in some cases, as noted above. The research shows that, in contrast to EU firms, Pacific Asian companies are generally weak in R&D and lack the new product design capabilities of companies such as Philips and Thomson. EU firms should therefore compete by building on their distinctive strengths in R&D and design, a strategy

already followed by the leading European firms. This strategy raises the issue of opportunities for collaboration with latecomer firms in areas of mutual advantage. European firms may wish to trade their R&D competencies for say manufacturing technology in some areas. However, this will have to be carefully managed by partner companies to avoid any danger of one-way technology transfer.

Although latecomer Asian firms should not be copied, there are at least three general lessons from their experience. First, there is abundant evidence that important innovations occur in manufacturing, product design, and organisational change, and not just R&D as often stressed in the 'Western' literature. Much can be learned from Asia's latecomers regarding manufacturing and engineering innovation. Second, the experiences of latecomer firms point to the importance of market-focused technological innovation. Although there can be no single formula for success, linking technology to market needs has proved to be an extremely important for the progress of firms in Pacific Asia. Third, the evidence from Taiwan suggests that the need for large scale operations in electronics may sometimes be overstressed in policy discussion. Indeed, Taiwan shows that there is a good deal of scope for SMEs in electronics manufacturing.

4. Threats to EU employment and the 'hollowing' of EU companies

The possible displacement of employment and investment from the EU as European firms participate in Malaysia, Thailand and elsewhere is a genuine concern for some policy makers. This concern is often associated with the fear of the 'hollowing' of European firms, which refers to the loss of important capabilities such as manufacturing and product design. The research suggests that underlying these concerns is an oversimplistic, static view of competition and technology transfer. On the one hand, Pacific Asian firms are investing in Europe and natural processes of specialisation occur between countries at different stages of development. Europe may be weak in electronics production, but comparatively strong in pharmaceutical, banking, chemicals and so on (Hobday 1997). Also, as the markets of Pacific Asia grow, it is essential that EU firms participate directly in that growth in order to survive and prosper. In fact, EU firms have little choice but to compete directly within Pacific Asia if they wish to remain global players in electronics.

Underpinning the hollowing argument is a static, zero sum analytical framework which implies that an investment in Pacific Asia displaces an investment in Europe. In fact, by investing and succeeding in Pacific Asia, European firms stand a far greater chance of growing in Europe and keeping up (or ahead) of world leaders, although the composition of employment within Europe is likely to shift to higher value added activities, including design, R&D and high technology production.

A more suitable analytical framework would need to account for: (a) the imperatives facing EU TNCs wishing to survive and prosper in a global economy; (b) a dynamic shifting value chain, which involves various regions in a division of labour and technology; and (c) the importance of exploiting points of leverage in the value chain (e.g. by manufacturing in Pacific Asia). Such an interpretation would suggest that by investing in Pacific Asia EU firms are more likely to survive, grow and prepare for new market needs (e.g. in China). Indeed, manufacturing within Pacific Asia has proved very important for the overall productivity and competitiveness of EU firms in electronics. In other word, the hollowing is both static and misleading and rather than discouraging outward investment, firms should be encouraged to seek new opportunities in overseas markets.

Another concern sometimes expressed is that major parts of European industry may come under the control of foreign investors from Pacific Asia. As argued in Heighes and Hobday (1997) this has already occurred in the UK, first with US and then with Japanese investment. In fact, inward investment from Pacific Asia into the UK has greatly benefited the economy, generating employment, training and further repeated investments (Hobday 1997). There is evidence that, given sufficient time, the natural tendency of electronics investors is to go beyond simple assembly, to complex manufacturing, involving the participation of local supply chains, engineering and research. Japanese firms, for example, now boast around 120 R&D units in the UK and firms such as Samsung of Korea are now building R&D labs in the UK. If current macroeconomic difficulties in Pacific Asia can be overcome, there is no reason why, in principle, Korean and Taiwanese firms should not follow a similar path of upgrading in the EU.

5. Government policy lessons from Pacific Asia

As with firm strategy lessons, there can be no 'models' for EU policy makers, given the major, systematic differences between governments and industrial structures in the region as shown in the taxonomies in Parts 2 and 3. In South East Asia, within the TNC-led growth model, the role of government has been to facilitate, promote and retain foreign investment. The disadvantage of this model is the lack of linkage between the TNC enclaves and other parts of the economy. Also, there is the threat of 'footloose' investments going elsewhere, if conditions become preferable in other countries.

In the case of South Korea and Taiwan, the research indicates that the impact of government support for technology through R&D programmes and institutes has been less important than often assumed in the literature. For the past 15 years or so, the main role of government has been to provide a stable macroeconomy, good vocational education and to put in place outward-looking export-led policies.

As far as best practice is concerned, similar general lessons regarding macroeconomic stability, education and outward orientation apply as much to EU governments as to Pacific Asian ones . Regarding technology programmes, the EU may wish to question how effective EU R&D programmes have been in promoting competitiveness in Europe, as there is little compelling evidence of much effect in Pacific Asia beyond skills development and the general diffusion of technical knowledge (Heighes and Hobday 1997).

Regarding South East Asia, the problem in retaining TNC investments and encouraging firms to go beyond 'enclave' production is mirrored in the problems facing Scotland, Wales, Ireland and other countries which depend on electronics TNCs. Perhaps the main lessons come from Singapore (Hobday 1994a, 1996c) which treated EPZ/enclave production as only one step in a gradual progress up the technology ladder in electronics. The Singaporean Government, with some success, has encouraged new product design, research and the location of regional HQ's within Singapore. In the EU, perhaps more could be done to attract and integrate foreign firms into Europe's technological infrastructure, perhaps through more recognition of their importance and greater inclusion in the EU technology Framework programmes.

Conclusion

This paper presents the main findings of the SEI-SPRU research project on Pacific Asia's technological and economic development. Focusing on four countries (South Korea, Taiwan, Malaysia and Thailand), the paper develops a taxonomy of government-firm relations in order to illustrate the wide variety of development models pursued in the region. The research project fills a gap in the literature by examining the strategies and actual practices of firms, the main agents for economic and technological progress. The findings calls into question the often assumed effectiveness of direct government intervention in technology matters in Pacific Asia. Although it was outside the remit of the research to analyse the causes and consequences of the current economic crises facing the Pacific Asian region, the research lends support to the argument that one of the primary roles of government is to secure macroeconomic stability, rather than to intervene in support of specific firms or sectors. Failure to adhere to this basic principle has probably contributed to some of the problems facing Pacific Asia.

By focusing on electronics, the fastest growing and largest export sector in each of the four NIEs, the research was able to contrast the roles of government-funded technology institutes, government-firm partnerships for technology, company strategies and emerging technological trends and product specialisations. The institutional map of the electronics industry presented in Parts 2 and 3 reveal major differences in industrial structure, patterns of ownership and the effectiveness of governments in stimulating technological progress. Differences were partly due to historical reasons, with South Korea closely linked to Japan and the Japanese model of development. Taiwan followed an 'Overseas Chinese' approach, more closely linked to US industry, particularly in computers. Other differences were due to strategic and political choices, with the Malaysian and Thai Governments allowing a degree of TNC freedom within their economies unthinkable by Governments of South Korea and Taiwan for most of the period analysed.

The firm-level evidence provides a more sophisticated understanding of emerging Pacific Asian corporate strategies and strengths than hitherto available and points to major weaknesses and threats to progress. While accepting the remarkable extent of technological and economic progress over the past three decades or so, the difficulties identified warn against simple extrapolations into the future. Although the current financial and macroeconomic crises facing three of the four countries analysed overshadow remaining structural weaknesses at the firm level, the latter will also need to be confronted if Pacific Asian firms are to compete at the international frontier of electronics technologies.

The empirical evidence shows that simple state-market taxonomies fail to capture important causal factors in the region's progress. In South Korea and Taiwan, government-state collaborations played less of a role in technological progress than commonly assumed, with firms sourcing their technology from foreign buyers and capital goods suppliers in the West and Japan. Regarding Malaysia and Thailand, contrary to popular views of the TNC subsidiaries as mere 'screwdriver plants', the research shows that a great deal of important technological progress has occurred within local plants. Malaysia, for example, has now reached the stage of mastering production process technology and tailoring existing product

designs for efficient mass production, a stage which Korea and Taiwan reached a decade or so earlier.

The evidence was used to comment on several branches of theory concerning the developmental state, TNC location theory and modern resource-based theories of the firm. The findings extend existing theories of market-state governance suggesting that the state-market taxonomy is a very 'blunt instrument' for understanding Pacific Asian development. The paper argued for four extensions to current development theory, touching on firm discretion and strategy, sectoral specificities, the emergence of the post-development state and the role of foreign capital.

Regarding EU policy, the paper argues that because systems of governance are so diverse, even within electronics, it follows that no one single homogenous policy can be appropriate in areas such as competition, trade and technology policy. For example, EU policy towards South Korea and Taiwan might be geared to stimulate further inward investments to Europe. European governments may also wish to consider how to encourage technology collaboration within EU R&D programmes, once Pacific Asian firms are sufficiently integrated into the EU manufacturing base. By contrast, a key policy issue for Malaysia and Thailand, is to improve EU performance as an outward investor in the region.

As far as EU firms are concerned, there can be no single Pacific Asian corporate 'model' to emulate, given the differences in origin, strategy and structure of firms across the two regions. However, there may specific manufacturing lessons from Pacific Asia for some EU firms. In competing with Pacific Asian latecomers, the paper argues that European firms should exploit their distinctive advantages in, for example, R&D, product design, software and information and communication technologies.

The paper addresses concerns over the possible displacement of employment and investment in the EU as European TNCs participate in Pacific Asia. However, underlying these concerns is a static and misleading view of competition and technology transfer. The paper argues that, as the markets of Pacific Asia grow, it is essential that EU firms participate directly in the region in order to survive and prosper, suggesting the elements of a dynamic, positive sum framework for understanding European investments in Pacific Asia. Above all, the paper recommends that governments in Europe encourage a competitive, outward-looking approach to the Pacific Asian region.

To conclude, the main contribution of the research has been to develop an in-depth understanding of the technological dynamics of Pacific Asia by focusing on firms and government-business relations. In doing so, the study hopes to have demonstrated the value of in-depth research into the activities and strategies of firms as an important unit of analysis for understanding technological and economic progress.

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Annex 1: Papers and Publications Arising from the SEI-SPRU Project*

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