The Global Challenge
to Industrial Districts

Small and Medium-sized Enterprises in Italy
and Taiwan

Edited by
Paolo Guerrieri
Simona Iammarino
Carlo Pietrobelli

Edward Elgar
Cheltenham, UK • Northampton, MA, USA
© Paolo Guerrieri, Simona Iammarino, Carlo Pietrobelli  2001

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical or photocopying, recording, or otherwise without the prior permission of the publisher.

Published by
Edward Elgar Publishing Limited
Glensanda House
Montpellier Parade
Cheltenham
Glos GL50 1UA
UK

Edward Elgar Publishing, Inc.
136 West Street
Suite 202
Northampton
Massachusetts 01060
USA

A catalogue record for this book
is available from the British Library

Library of Congress Cataloguing in Publication Data

The global challenge to industrial districts : small and medium sized enterprises in Italy and Taiwan / edited by Paolo Guerrieri, Simona Iammarino, Carlo Pietrobelli.  
  P. cm.
   Includes bibliographical references and index.
   1. Industrial districts—Italy. 2. Industrial districts—Taiwan.

HC310.D5 G56 2001
338.6'42’0945—dc21
2001033071

ISBN 1 84064 698 5 (cased)
Printed and bound in Great Britain by Biddles Ltd, www.biddles.co.uk

Contents

List of figures
List of tables
List of contributors
Foreword
Acknowledgements
List of abbreviations
Map of Italy
Map of Taiwan

1. Introduction
Paolo Guerrieri, Simona Iammarino and Carlo Pietrobelli  1

2. Models of Industrial Clusters' Evolution and Changes in Technological Regimes
Paolo Guerrieri and Carlo Pietrobelli  11

3. The Dynamics of Italian Industrial Districts: Towards a Renewal of Competitiveness?
Paolo Guerrieri and Simona Iammarino  35

4. The Dynamics of Taiwan's SMEs: The Case of Electronics
Wen-Jeng Kuo and Jiann-Chyuan Wang  63

5. Small Firms Competing in Globalized High-tech Industries: The Co-evolution of Domestic and International Knowledge Linkages in Taiwan’s Computer Industry
Dieter Ernst  95

6. New Challenges for Industrial Clusters and Districts: Global Production Networks and Knowledge Diffusion
Dieter Ernst, Paolo Guerrieri, Simona Iammarino and Carlo Pietrobelli  131
Figures

2.1 Enterprise constellations 15
2.2 Typology of industrial districts 22
2.3 Possible transitions through types of enterprise clusters 23
3.1 Export orientation, 1997 50
3.2 Output sold to top 3 customers by industrial district, 1997 50
3.3 Type of previous experience of the entrepreneur 51
3.4 Product innovations 51
4.1 Export orientation, 1998 75
4.2 Output sold to top 3 customers, 1998 76
4.3 Type of previous experience of the entrepreneur 76
4.4 Percentage of firms engaged in innovation (1996-98) 78
4.5 Differences between the BTO model and the original PC shipment model 89
5. Small Firms Competing in Globalized High-tech Industries: The Co-evolution of Domestic and International Knowledge Linkages in Taiwan’s Computer Industry

Dieter Ernst

1. INTRODUCTION

Over the last decade Taiwan has established itself as a world-class supply source for a variety of electronic hardware products. It is the world’s largest supplier of computer monitors, motherboards, switching power supplies, mouse devices, keyboards, scanners and a variety of add-on cards. In 1996, almost 60 per cent of the world’s desktop PCs were either made in Taiwan or contained a motherboard made by a Taiwanese company. Moreover, since 1994 Taiwan has also become the world’s largest manufacturer of notebook PCs.

Progress has been equally impressive in the field of electronic components. Taiwan today has hundreds of passive component makers that have established a strong position relative to leading Japanese and US competitors. Taiwanese firms have also improved their position in the capital-intensive mass production of precision components, such as large-scale CRT picture tubes for computer monitors and sophisticated display devices (like active-matrix TFT-LCDs) for laptop computers. The same is true for integrated circuits (ICs).

Two recent structural changes show how Taiwanese firms have upgraded their capabilities: a rapid diversification beyond hard core PC-related products; and a shift from stand-alone manufacturing services to integrated service packages that cover a wide range of value chain activities, including higher value-added support services. Taiwanese computer companies now have established themselves as competitive suppliers in a variety of complementary, high-growth market segments, some of which display
considerably higher profit margins. Such diversification is evident in three areas: the development of so-called PC network products, especially modems and network interface cards; multimedia accessories, such as CD-ROM drives and add-on cards; and a variety of information services industries, such as multimedia software, system integration, turnkey systems and network services. Most of these information services owe their existence to the convergence of previously separated technologies used for computing, communicating and digital consumer applications, and require the capacity to combine various strands of technology to generate new applications and markets.

Taiwanese firms have also developed a capacity to provide a package of services across a wide range of value chain activities, sustaining their position as preferred OEM (original equipment manufacturing) suppliers to the industry. With the exception of R&D and marketing, practically all other stages of the value chain can now be performed by Taiwan's OEM contractors. Moreover, Taiwanese firms are beginning to shoulder essential co-ordination functions for the global supply chain management of their OEM customers.

Taiwan's achievements would be impressive for any country; they are even more impressive for a small island, about one-third the size of New York State. With a population of about 21 million people, roughly half the size of South Korea, Taiwan lacked a large and sophisticated domestic market, specialized capabilities and support industries, and the science and technology infrastructure necessary for developing a broad set of electronics products. From the outset, Taiwan's PC industry depended heavily on international markets and access to foreign technology. Penetrating foreign markets and absorbing imported technology, however, requires conscious efforts to develop a variety of domestic resources and capabilities through deliberate knowledge creation management. How do small enterprises develop such capabilities?

This chapter is divided into six sections. Section 2 describes the dominance of SMEs and their role as a source of flexibility; it also briefly sketches the kind of policy approach that has enabled small Taiwanese firms to get on to the virtuous circle of co-evolving domestic and international knowledge creation linkages. The rest of the chapter (sections 3 to 5) inquires into how inter-organizational knowledge creation has benefited from a variety of linkages with large domestic and foreign firms; some industrial upgrading requirements that result from this peculiar type of knowledge creation are also addressed. Finally, section 6 offers some concluding remarks on the chapter's main findings.

2. THE DOMINANCE OF SMEs

Small and medium-sized enterprises (SMEs) have been the main carriers of Taiwan's rapid development and remain important today. The role of SMEs as engines of growth and industrial transformation sets Taiwan apart from South Korea, where huge and highly diversified conglomerates (chaebols), have been the main carriers of the development of the electronics industry (Ernst, 1994a and 1998). Almost without exception, the chaebols have targeted those segments of the electronics industry that require huge investment outlays and sophisticated mass production techniques for fairly homogeneous products like microwave ovens, TV sets, VCRs, computer monitors, picture tubes and computer memories, especially DRAMs. The result has been a heavy focus on assembly-type mass production activities related to lower-end consumer products and standard electronic components, and a weakness in more design-intensive sectors of the computer industry.

Why did Taiwanese firms succeed in the computer industry, while their much larger and resource-rich Korean counterparts have largely failed? The answer lies in the fundamental characteristics of an industry in which high volatility and uncertainty put a premium on flexibility and the capacity to adjust to abrupt and frequently unexpected changes in demand and technology; small firm size can foster such flexibility. By combining incremental product innovation with incredibly fast speed-to-market, Taiwanese firms have been able to establish a strong international market position relatively early in the product cycle.

The primary source of this flexibility appears to be the specific organization of the domestic supply base in Taiwan, especially for parts and components. Two main features of this domestic supply base have contributed to the flexibility of Taiwanese producers, the first being an extreme form of specialization. By engaging in single tasks and by producing, purchasing and selling in small lots, subcontractors avoid heavy fixed capital costs. This in turn makes it relatively easy to shift production at relatively short notice and with a minimum of costs. The second feature is a certain network structure of multiple, volatile and short-term links that involve only limited financial and technology transfers. Spot-market transactions play an important role, but so do 'temporary spider web' arrangements that are assembled for the duration of a particular job. The result of these characteristics is an extreme form of open and volatile production networks, arguably even more so than the highly flexible production networks that characterize California's Silicon Valley. Firms maximize the number of jobs in order to compensate for the razor-thin profit margins; as a result, they avoid being locked into a particular production network. Domestic supplier networks thus have been highly flexible and
capable of rapid change, but short-lived and footloose.

If flexibility constitutes one prerequisite for Taiwan’s competitive success in computers, economies of scale and scope and speed-to-market have been of equal importance. Entry barriers have increased for those stages of the value chain which are of critical importance for competitive success, including particularly component manufacturing where production-related scale economies remain important. But the epicentre of competition has shifted beyond manufacturing to R&D and other forms of intangible investment required to complement price competition with product differentiation and speed-to-market. Only those companies can survive that are able to get the right product to the highest volume segment of the market at the right time. Being late is a disaster and often forces companies out of business.

In sum, what really matters for competitive success are substantial investments in the formation of a firm’s technological and organizational capabilities. How were Taiwanese computer companies able to successfully compete in an industry where size-related advantages are of critical importance? And, more specifically, what kind of organizational innovations have enabled Taiwanese firms to overcome their size-related disadvantages?

In order to answer these questions, we need to examine the issues of specialization and co-ordination. Andersen (1996) has recently provided an interesting theoretical explanation why excessive specialization may involve substantial trade-offs. He shows that, as an economy becomes more specialized, this increases the pressure for standardization. In turn, this may constrain innovation. The solution to this dilemma is the establishment of tight linkages between firms along the supply chain that enhance the prospects for inter-organizational knowledge creation, for instance between end product manufacturers and component suppliers. To understand how Taiwan avoided the dangers of excessive specialization and established tight inter-firm linkages, it is important to correct some popular misconceptions of the Taiwanese model. This is not an economy characterized by atomistic competition. SMEs do play an important role, yet they survive due to a combination of four forces: government policies that facilitated market entry and upgrading; strong linkages with large Taiwanese firms and business groups; the presence of foreign sales and manufacturing affiliates; and early participation in international production networks.

As far as the first factor is concerned, though Korea and Taiwan share many similarities, the two countries have chosen very different policy approaches. In the early 1960s the Taiwanese government introduced aggressive programmes to encourage investment by domestic as well as foreign companies. In line with similar programmes in Korea, these statutes provided generous tax incentives and laid down rules to facilitate the acquisition of land for industrial use by investors and access to utilities. Five features, however, distinguished Taiwan’s approach.

First, no limits were set on the number of firms within each industry group, with the exception of a few mining and utility industries. Any domestic firm could invest and enjoy the same tax and other privileges. This open policy gave rise to intense domestic competition, and was conducive to a diversified industry structure. Second, the government actively promoted the development and modernization of Taiwan’s SME sector. The first of such policies, ‘The Rule for Promotion of Small and Medium Enterprises’, was promulgated in 1967 and was subsequently revised several times as Taiwan’s SMEs grew. Government assistance to SMEs included market promotion, management rationalization, co-operation and promoting strategic alliances, loans and upgrading technology and labour training (Ministry of Economic Affairs (MOEA), 1991). Third, there was no discrimination against smaller firms within the SME category. Any firm, irrespective of size, could participate and was treated equally. This neutral policy was an important foundation for the development of Taiwan’s large pool of vibrant and entrepreneurial SMEs. Fourth, virtually equal treatment was granted to domestic and foreign investment, with the exception of some majority shareholding regulations applicable to foreign firms and strict foreign exchange control regulations governing domestic firms. This balanced policy attracted foreign investment without producing the ‘crowding-out’ that occurred in Singapore, where domestic firms have played a minimal role in the manufacturing sector.

Finally, an important difference that sets apart Taiwan’s industrial policies from those pursued in Korea is that directed credit has played a much less important role, at least until the early 1980s. This can be seen from the high real interest rates for secured loans that Taiwanese firms had to pay during this period. This has changed only since the mid-1980s, when the focus of industrial policy shifted to industrial upgrading. Any firm, irrespective of size, could participate in industrial promotion programmes, including concessionary credit. In contrast to the Korean government, which used its control of the finance sector to direct credit to a handful of chaebols, the Taiwanese government did not try to promote large national champions. One should also mention that curb markets have arguably played a more important role in Taiwan than in Korea as an alternative source of debt finance relative to bank credit. The result is that Taiwan’s corporate debt-equity ratio is substantially lower than in Korea: Taiwan’s net debt-equity ratio for 1998 is forecast to be around 30 per cent, compared with more than 180 per cent for Korea.

Differences in industrial policy have led to very different firm behaviour in the Korean and in the Taiwanese electronics industries. Arguably, some of
these differences explain why Taiwan has been less vulnerable than Korea to the impact of the financial crisis (Ernst, 1998). Taiwan’s industrial policy is focused on competition: relatively low entry barriers and non-discriminatory policies enable small firms to enter targeted sectors and to grow. At the same time the legal system puts relatively few obstacles in the way of bankruptcy. This has forced incuments to stay trim; they have also accelerated the spread of information, skills and knowledge. The result is that Taiwan’s smaller companies had to rely more on equity markets and corporate retained earnings than the chaebol: Taiwanese firms find it more difficult to raise capital for large-scale volume production and they are under much greater pressure to submit investment decisions to short-term financial considerations.

In sum, Taiwan’s development strategy generated forward and backward linkage effects, while relying on ‘market-augmenting’ policies that reduced risk and uncertainty rather than market-repressing policies that increased fragmentation and rent-seeking (Johnson, 1987, p. 141). Taiwan’s policy approach was not a static one, however, as the requirements of industrial upgrading changed over time, so did the nature of state intervention. This continuous upgrading of industrial policies has been an important defining element of Taiwan’s approach to knowledge creation.15

Policy requirements keep changing over time for two simple reasons: increasing complexity and a greater exposure to the international economy. As Taiwan’s industry moves up from simple and labour-intensive to more complex products, much more sophisticated policies are required. The main reason is that entry barriers rise with increasing complexity; investment thresholds increase and knowledge requirements become more demanding. For small enterprises this implies that they need to have access to externalities that would enable them to overcome their size-related disadvantages.16 A greater exposure to the international economy is a second reason why industrial development policies need to develop over time. An increasing complexity of the domestic industry necessitates more international linkages. Such linkages are necessary to facilitate local capability formation; they do not only encompass critical imports of key components and capital equipment and inward FDI. Such linkages also involve participation in global production networks (GPNs) as well as in a variety of specialized and informal ‘international peer group’ networks that are essential carriers of knowledge creation, especially in the computer industry. Left on their own, small enterprises are ill-equipped to reap the benefits of such international linkages. Again, the market needs to be complemented by selective policy interventions that can provide some of the necessary externalities.

3. THE ROLE OF INTER-ORGANIZATIONAL LINKAGES

We have seen that small, family-owned firms have played an important role in the development of Taiwan’s electronics industry. This had considerable advantages, both in terms of cost and flexibility: transaction costs were low, as family-run enterprises co-operated on the basis of informal social contacts. Outsourcing could be performed at much lower cost, risks could be substantially reduced and information circulated much more quickly.

This type of arrangement is now coming under increasing pressure, and appears to be ill-equipped to deal with the new competitive requirements. Family bonds erode, especially when the firm has to move production overseas and loose networks between family-owned SMEs are unable to raise the capital required for increasing fixed investments and R&D outlays. As a result, Taiwanese SMEs had to develop a variety of linkages with more powerful third parties.

It is difficult to say which of these different linkage arrangements are most effective to cope with the dual challenge of knowledge creation and internationalization. We find that Taiwanese SMEs, as well as the government, have pursued a plurality of approaches in parallel, rather than concentrating exclusively on one particular linkage.

Informal ‘Peer Group’ Networks

Taiwanese SMEs have always relied heavily on informal social networks for access to resources, capabilities and knowledge that they are unable to mobilize on their own. Over time, the focus of these networks has shifted from labour, capital and basic market information to technological knowledge and brand name recognition. Originally these networks were restricted to family and kinship relations. They are now rapidly being substituted by professional ‘peer group’ networks. This is especially true for the electronics industry where resource and capability requirements are much more demanding than in traditional industries, and where participation in international knowledge networks is of the essence.

Informal peer group networks come in a variety of forms. Typically, classmates (especially in elite schools) and former colleagues (especially in foreign affiliates) form tight networks that can be instrumental in the creation of start-up companies. For example, Taiwanese SMEs rely heavily on informal information exchange with former classmates for the generation of tacit knowledge on specific engineering and marketing problems and when they need confidential information on potential partners or competitors. Interviews at Acer for instance showed that even today, when this company has long moved beyond its earlier SME status, senior managers still prefer to
A Hierarchical Centre-Satellite System and Institutional Innovations for Internationalization

Another attempt to overcome the disadvantages of small firm size has been the government’s Centre-Satellite Programme (CS), launched in 1984, in response to the private sector’s reluctance to vertically integrate production through either merger or inter-firm co-operation. The objective of this programme has been to eliminate cut-throat competition and destructive price cutting practices by encouraging closer, interdependent and long-term ties between larger ‘centre’ firms (upstream suppliers, final assemblers, large trading companies) and their ‘satellites’ (especially component suppliers). In order to strengthen these links, the government provides a variety of financial, manpower training and technical engineering assistance to both the central plants and the satellites.

Most assessments conclude that the CS programme so far has only been partially successful (San Gee, 1995a and Wade, 1990, p. 167). Yet these assessments need to be placed in a broader context. Over the last few years the CS programme has generated an increasing variety of linkages between SMEs and large firms, linkages that frequently extend beyond national boundaries. Government policies to promote CS networks were particularly successful in accelerating the outward investment of SMEs to Southeast Asia and China. Once a foreign lead company of an OEM network had invested in these regions, this exerted a powerful pressure on Taiwanese satellites to follow suit and to move their production offshore. In many cases this has had the unanticipated effect of ‘hollowing-out’ the domestic supplier system. In order to correct and avoid such negative impacts, both government policies and firm strategies are currently being adjusted. Government policies now pay more attention to assisting SMEs to upgrade their domestic activities. This applies especially to incentives for technology diffusion and product-related R&D; incentives for training; policies to improve infrastructure and access to telecommunications services; and policies to improve financial services. For their part, firms are striving to diversify and internationalize their ownership, and to reap broader benefits from international specialization and the building of proprietary assets.

Industrial parks and, later on, science parks played a major role in the development of Taiwan’s locational advantages. This organizational innovation is now being transferred abroad, especially to the southern coastal provinces of China and Southeast Asia. Over the last few years there has been a rapid proliferation of special business zones and industrial estates that are geared primarily to the needs of Taiwanese small and medium-sized computer companies. The original role models are the ‘shoe city’ and the ‘textile city’ established in the southern coastal Chinese province of Fujian. This has been followed by similar arrangements in the electronics industry, such as two ‘Cities of Electronics’ (in Fujian and Guangdong provinces of China), the Penang Scientific Park in Malaysia, the Kung-Hua Industrial Park on Batan Island (Indonesia) and the Subic Bay Industrial Park in the Philippines.

Since the Taiwanese government cannot openly act as a third party, for political reasons, a variety of intermediary institutional approaches provide similar services. The largest project so far has been the conversion of Subic Bay, the former US naval base in the Philippines, into a major industrial park, primarily for Taiwanese and American electronic firms. The idea is to enable Taiwanese subcontractors to move jointly with their large Taiwanese lead contractors and major American OEM clients. The provision of low-interest loans by the International Economic Co-operation and Development Fund (IECDF), Taiwan’s foreign aid programme, is designed to help Taiwanese SMEs to invest in Subic Bay and other neighbouring locations. The goal is to transfer parts of the domestic Taiwanese supply base for components and sub-assemblies to Southeast Asia, so that final assemblers of monitors, motherboards and PCs and other PC-related products can have access on the spot to low-cost and flexible support industries.

At the same time this creates new mechanisms for inter-organizational knowledge creation. Take the case of Advanced Semiconductor Engineering Inc. (ASE), the world’s second largest independent contract assembler of ICs, which already has a plant in Penang, Malaysia, to supplement its parent facility in Kaohsiung. ASE now wants to expand in Subic Bay as well. The company already uses Philippine workers in Kaohsiung and has given them intensive training. Since the Taiwanese government allows foreign workers
to work in Taiwan for two years only. ASE will send them to Subic Bay as trainers of its workforce there.

**Linkages with Large Domestic Firms: Cross-sectoral Business Groups**

Contrary to conventional wisdom, large firms have played a central role in the co-ordination and development of the Taiwanese production system. They have also facilitated knowledge creation in small firms. After the Second World War the Taiwanese government took over the Japanese enterprises that had been established during the 50 years of colonial rule (1895-1945). In contrast to Korea, the government did not privatize these firms: instead they were run as public enterprises. By developing a strong public enterprise sector, Taiwan developed companies large enough to enter the highly capital-intensive production of basic materials, while at the same time avoiding the dominance of private conglomerates (San Gee and Wen-jeng Kuo, 1998; Schive, 1990).

Linkages with large firms have played an important role in the development of Taiwan’s SME sector. To start with, SMEs depend on the supply of basic materials provided by large public enterprises at low cost and high quality (Wade, 1990). Large firms have also acted as an important intermediary source of capital for SMEs. Taiwan’s banks direct most of their funds to large domestic public and private firms who then on-lend money for equipment and working capital to smaller customers, subcontractors and suppliers at higher rates through trade credit and loans on the informal curb market (MOEA, 1991).

It is important to emphasize that many SMEs are for all practical purposes members of a particular business group. The growing capital requirements and technological complexity that accompanied the rapid industrial transformation of the island produced new forms of business organization. When electronics took over from textiles as the leading industrial sector, this led to an erosion of Taiwan’s traditional form of business organization: the loose networks of family-owned SMEs (Kuo and Wang, Chapter 4 in this volume). In order to retain profitability, family firms were forced to venture across product lines and to move from industries with declining margins, like textiles, to the much more profitable electronics sector. In most cases, however, they were unable to raise the capital required for increasing fixed investment and R&D: as late as 1992, only 20 per cent of a sample of Taiwanese manufacturing firms were engaged in R&D.

Attempts to cope with these two conflicting pressures produced a peculiar Taiwanese form of business organization: cross-sectoral business groups. These business groups are very different from the large, hierarchical chaebols that are typical of South Korea, but they also differ from the keiretsu system that has dominated much of Japan’s industry. In Taiwan, business groups typically consist of a loose network of mostly medium-sized companies that produce a variety of products for different markets, with one core company exercising financial control. This type of firm organization reflects the need to combine the scale advantages of large firms with the speed and flexibility of smaller firms.

The ADI business group provides a typical example. Founded in 1979, the company is run by the Liao Jian-cheng family. From trading and construction it first moved into shoe manufacturing for international mass merchandisers. Around the mid-1980s the family decided to move into electronics. The breakthrough came in 1993, thanks to big orders from Compaq. Despite success in computer monitors, the owners maintain their diversification strategy. ADI has continued to expand its position in shoe manufacturing while at the same time investing in a number of new small start-up companies in software, system design, and in a variety of unrelated commercial activities.

The shift to business groups has been most pronounced in the electronics industry. This is hardly surprising, given the critical importance of economies of scale and scope in this industry. But in the Taiwanese case there are two additional reasons why SMEs became integrated into larger business groups: linkages with foreign customers through international subcontracting and OEM arrangements; and linkages with international supply sources, especially for key components. As a result of these linkages, size became essential to secure economies of scale and scope and achieve sufficient bargaining clout with foreign customers and suppliers. In order to fulfill an OEM contract, large Taiwanese companies like Tatung, First International Computer (which is part of the Formosa Plastics group), Mitac and Acer rely on hundreds of loosely affiliated domestic suppliers to which they can pass on an endless variety of low-margin, yet quite demanding manufacturing and design tasks. The typical Taiwanese small computer company thus often gets involved with foreign firms only in an indirect way; large Taiwanese business groups dominate the direct interface with foreign customers. The same is true for the affiliates of foreign multinationals like Philips, Matsushita, DEC and others that have substantial production platforms in Taiwan (see also Kuo and Wang, Chapter 4 in this volume).

A similar mechanism also works on the procurement side, especially for high-end key components like DRAMs, microprocessors, CRT picture tubes for computer monitors and liquid crystal displays (LCDs) for laptop computers. The insecurity of supply plays an important role in the formation of inter-firm linkages. Roughly 85 per cent of all semiconductors used in Taiwan are currently imported. Under ‘normal’ circumstances, Taiwanese SMEs rely on the ‘spot market’: they purchase these components from the
branch offices or agents of foreign component vendors. But normal circumstances are rare in these component markets. When a serious component supply shortage occurs Taiwanese SMEs will be the worst hit. Foreign vendors will either require sharp price mark-ups or refuse to deliver.

For SMEs, the only hope is to survive in the shadow of the large Taiwanese PC manufacturers. During a typical supply shortage, the large Taiwanese manufacturers will expand their procurement orders well beyond their real needs. By buying large quantities of components before price wars actually materialize, firms seek to buffer their effects; one could call this the 'component future trading' effect. Firms also seek to hedge against opportunism on the part of foreign suppliers. Major Taiwanese PC companies simply must keep large safety inventories of key components as a risk minimization strategy. Third, during shortages, foreign component suppliers normally only supply their strategic customers. For Taiwanese PC makers it is of critical importance to get on such 'strategic customer' lists. The way to do this is to inflate their component orders above their real needs to convince foreign suppliers that the Taiwanese customers are big and important. As a result of these purchasing strategies, Taiwanese PC makers regularly get bogged down with large inventories of key components. The product composition of these inventories keeps rapidly changing, with newer component generations vying for precious inventory space with older ones. Taiwanese PC makers are thus under strong pressure to re-sell parts of their component inventories to local SMEs. Most of these re-sales are components that are 'one generation behind the leading edge'. Prices charged are higher than the prices paid by the large PC maker to the foreign supplier, but lower than those charged on the spot market.20

Over the last few years the importance of big business groups has further increased, blurring the division between small and large firms. Taiwan's electronics industry has recently witnessed a rapid increase of concentration. In the PC industry the top ten firms today control roughly 80 per cent of total production, and some of the most powerful Taiwanese business groups (Formosa Plastics, HwaHsin, China Steel, YFY Paper) have now also entered the production of key components, like DRAMs, CRTs and displays.

Business Groups Centred around a Holding Company

Many Taiwanese computer companies have experienced very rapid growth since the last industry shake-out in 1992; the challenge now is to develop an organization that enables them to improve organizational learning. For PC manufacturers, the main role model is the client-server model. A rapidly growing company like Acer or Mitac spins business units into independent profit centres, creating a federation of loosely connected companies united by

four factors: access to common core technologies; access to the holding company's financial resources; access to its knowledge base, market intelligence and technology scouting capabilities; and a common brand name. This type of organizational innovation makes it possible to keep high value-added operations and core capabilities in Taiwan, while dispersing sales, marketing, procurement, product integration and service operations around the world, in close proximity to the main growth markets.

Each of the different members of a 'client-server organization' are separated by product lines and by geographic region, and each operates independently from the other. This allows them to make decisions quickly in response to market changes and to define the market segments where they feel fit for leadership. At the same time, however, all of these businesses have ready access to the lead company's knowledge base.

One important element of this re-organization is a new approach to overseas PC assembly. Acer provides an example.21 In order to reduce cost and increase speed-to-market for new products, Acer has established 15 modular assembly sites around the world. Each of these assembly subsidiaries is located close to important markets and performs only very limited activities: it receives PC housings and floppy disk drives by sea, with motherboards flown in directly to ensure delivery of the newest technologies. Central processing units (CPUs), hard drives and memory are sourced locally to fill individual user requirements, and the modular components are assembled quickly according to a standardized procedure. This strategy allows Acer to maintain control over product quality and keep inventory to a minimum, while providing fast assembly of competitively priced PCs that always contain the latest microprocessor generation.

The Taiwanese 'client-server' model comes strikingly close to the basic philosophy of many proponents of corporate re-engineering, especially the model that IBM's previous chairman John Akers had tried to implement for the ailing giant before he was ousted.22 Yet the basic motivation of firms like Acer has been fundamentally different from that of IBM; the goal is not to reduce the cost of excessive centralization, but to overcome some size-related barriers to knowledge creation and internationalization, without repeating the mistakes of excessive integration characteristic of US, European and Japanese firms.

4. THE CATALYTIC ROLE OF INWARD FDI

Inward FDI played an important catalytic role for knowledge creation during the critical early phase of the development of Taiwan's electronics industry. It exposed Taiwanese workers and managers to new organizational
techniques, which, while not necessarily ‘best practice’, contributed to a gradual erosion of traditional, highly authoritarian and ultimately inefficient management practices. The need to comply with some minimum international quality standards gave rise to learning effects that spilled over to a wide spectrum of local enterprises due to the high turnover in Taiwan’s skilled labour market.

Inward FDI also contributed to the development of local suppliers, at least for domestic market-oriented production. A combination of protection and local content requirements, directed especially at Japanese consumer electronics manufacturers, forced these companies to pull along their main Japanese component suppliers. Together they systematically groomed local vendors and established a broad range of local supplier networks.

**FDI in Consumer Electronics**

FDI-related linkages first emerged in consumer electronics. The pioneer was Philips which in 1961 established a large local manufacturing affiliate that produced TV sets, audio equipment, picture tubes and a variety of other related components. Originally this production facility was geared to the heavily protected local market, but by the mid-1960s domestic market-oriented production had been supplemented by export platform production. Philips Taiwan is now the exclusive production source for picture tubes for computer monitors within the entire Philips group, and it is among the three largest producers worldwide. Similarly, Philips played a critical role in the successful launching of Taiwan Semiconductor Manufacturing Corporation (TSMC) which today is the world’s leading silicon foundry.

In 1962 Matsushita followed suit with a large majority-owned joint venture in Keelung that produced both household appliances and consumer electronics, primarily TV sets. Until the mid-1980s, when the group established a network of huge export platform affiliates in Malaysia and Thailand, this was one of Matsushita’s main outposts in East Asia. Matsushita’s affiliate has been a trend-setter for Taiwan in factory automation (especially for printed circuit board assembly) and for the introduction of fastidious quality control management. In addition to being an incubator for local suppliers, Matsushita established Matsushita Electric Institute of Technology in 1981. With a work force of around 40 researchers, the institute’s main functions are ASIC design and software engineering, especially the development of Chinese-language application programs.

Matsushita has also given rise to a broad range of knowledge spillovers to local companies, through both employment mobility and the formation of local start-up companies. One particularly interesting example is the case of Fuhu Electronics Industrial Co. Ltd., a producer of high-end consumer electronics (author’s interviews and Gold, 1986). The owner of this company is the son of C.C. Hong, Matsushita’s original local joint venture partner. For many years C.C. Hong served as the chairman of Matsushita Electric (Taiwan). Yet, despite his 40 per cent share in the venture’s capital, Japanese managers were clearly running the show. Hong was given a free hand to build up close technical and business ties with several hundred local suppliers. Building on his father’s unbeatable connections within the local Taiwanese supplier community, Hong Junior (Hong Ming-t’ai) pursued a niche market strategy. By sourcing out a large part of manufacturing, Fuhu can concentrate on design and product development. Two figures are revealing: Fuhu claims to spend roughly 15 per cent of sales on R&D; and it classifies 15 per cent of its 800 employees as R&D personnel. This example shows how a Taiwanese start-up company can exploit the domestic supplier networks that were originally established for Matsushita, in order to further its knowledge creation.

Matsushita’s smaller rival Sanyo established its own production line in 1963, with a roughly similar product mix as Matsushita’s, followed by Hitachi in 1965 and Sony in 1967. These Japanese firms also developed close links with local suppliers, but focused much longer on the domestic market; export platform production remained the exception. Because the domestic market strategy could tolerate a certain degree of inefficiency and lower quality standards, Japanese consumer electronic affiliates in Taiwan had considerable decision autonomy not only for employment, work practices and salary, but also on how to organize production and procurement. A considerable number of local linkages were generated by these investments: local content was substantial, and gave rise to some domestic support industries, especially for lower-end general purpose components. All of these were powerful mechanisms for inter-organizational knowledge creation.

Toshiba pursued a different strategy. During the 1950s it acquired a 5 per cent equity share in Tatung Co., Taiwan’s only integrated electronics company. Originally Tatung served as an agent of Toshiba, selling its home appliances, consumer electronics and telecommunications equipment. In the 1960s, however, Toshiba granted a number of technology licences to Tatung, which became a supplier of key components, such as high-end compressors, CRT picture tubes and LCDs. This, in turn, led to other forms of cooperation. In the mid-1970s, for instance, Toshiba helped Tatung to capture OEM orders from Sears (the large US mass merchandiser), with the result that Tatung became one of the largest Taiwanese television exporters to the US. Tatung and Toshiba are now also engaged in a variety of OEM and technology co-operation agreements, involving monitors and other PC-related products.

During the 1970s Fujitsu followed with a similar approach: in 1973 it
established a joint venture with Tatung to sell and service Fujitsu computer systems and peripherals. This subsequently led to a variety of manufacturing joint ventures and OEM contracts, including FDK Tatung (Thailand) Co. LTD/Bangpakong, an affiliate of Tatung's joint venture with Fujitsu, called Tatung Fujidenka Co. Taiwan. The mother company is in Yangmei, Taiwan and produces high-end soft ferrite cores for TV sets, video display terminals and a variety of electronic devices. FDK Tatung today is one of the market leaders for the capital and knowledge-intensive production of soft ferrite cores. The sales of this affiliate are mainly destined for affiliates of National (Matsushita), JVC, Murata and Tatung's Makolin affiliate in Thailand and Malaysia.

FDI in Components

The first round of investment in consumer electronics and telecommunication equipment gave rise to a rapid growth in demand for electronic components. While most of the high value-added key components were imported, stringent local content requirements and increased local capacities resulted in the growth of local production. Starting from the mid-1960s Taiwan received substantial Japanese FDI in the production of electronic components.

The pioneer was Mitsumi Electric Corp., a medium-sized component producer. In 1967 its first affiliate was established in Kaohsiung, producing condensers, transformers (including coils), connectors, electro-mechanical subassemblies and other components. Two years later, in March 1969, this was followed by a second affiliate in Taipei, producing magnetic heads, small motors, plus a variety of subassemblies and other components. Similar investments were undertaken by TDK in 1968 (condensers, transformers and other components); by Hosiden in 1969, an Osaka-based producer of electromechanical components; by Mitsubishi Materials in June 1970 (condensers); and by Alps in 1970 (resistors, magnetic heads and other devices). In the 1970s most of the leading Japanese component producers set up shops in Taiwan or were engaged in consignment assembly with a growing share of output destined for sale in Japan or Japanese affiliates in Asia. In response to the combined effect of the yen appreciation and the domestic recession, Japanese electronics firms developed a regional supply base in the early 1990s that now includes higher-end components (Ernst, 1999b). These investments played an important catalytic role for knowledge creation in Taiwan's domestic supplier industry, through intense on-the-job training and employment turnover as well as through close linkages with local subcontractors.

Taiwan, however, has also now become a critical market for components and production equipment, especially for the computer industry and for the production of semiconductors, CRT picture tubes and displays. One consequence is that Japanese component manufacturers have extended the mix of products that they produce in Taiwan to include an increasing variety of computer-related components. This has helped to upgrade knowledge creation. For instance, both Sharp and Casio are today producing substantial volumes of mid-level STN-LCDs in Taiwan. Similar developments have occurred in semiconductors: second-tier Japanese DRAM producers like Oki and Mitsubishi Electric Corp. (MELCO) have recently concluded important technology licensing, second-sourcing and joint development projects with some of the newly established Taiwanese DRAM producers. The same is now happening for large-size CRT picture tubes.

As Taiwanese component manufacturers have broadened their knowledge base, Japanese firms are willing to engage in joint ventures and co-development projects; this has led to substantial investments by Japanese production equipment vendors. For example, Japan's Shinetsu Handotai Co. has a 40% share of Taiwan's market for silicon-wafer chips. The company's customers in Taiwan no longer want to depend on imports from Japan or from Shinetsu's affiliate in Malaysia, and insisted that Shinetsu establish a wafer fabrication plant in Taiwan. Given the huge demand from Taiwanese customers, Shinetsu complied and established a majority-owned $110 million joint venture in silicon-wafer fabrication. A second stage involving an additional $70 million investment is already planned. Shinetsu claims that, in terms of the technology used, 'there will be no difference between the factories in Taiwan and in Japan'.

FDI in the Computer Industry

All investments reviewed so far have been in consumer electronics and component manufacturing. But what about FDI in the computer industry itself? In the early 1960s IBM established an affiliate in Taiwan where a few thousand people were employed wiring core frames by hand. IBM's move to Asia did not occur in isolation: its competitors also established core plane wiring operations in Taiwan and Hong Kong (Harman, 1971). IBM thus gave rise to a new model of international production for American electronic firms: the redeployment of labour-intensive stages of final assembly to Asia. These investments, however, consisted of primitive 'screw-driver' assembly and thus generated very limited localized knowledge (Ernst, 1983).

The next round of computer-related FDI did not take place until the early 1980s. In 1982 DEC established a large integrated affiliate in Taiwan to produce a broad range of products: PC motherboards and chassis, monitors, terminals and printers. Today DEC Taiwan is the company's largest assembly line for desktop PCs and is also Taiwan's largest foreign-owned PC
manufacturer. For Taiwan, DEC's investment had important positive effects on knowledge creation, through training as well as through the development of local suppliers. For instance, DEC Taiwan is a major OEM buyer of monitors from both Philips Taiwan and the Lite-on Group. DEC also sources a broad range of peripherals and components from local Taiwanese companies.

DEC's investment was followed two years later, in 1984, by Hewlett Packard (HP), which established a joint venture with Taiwan's Nanya Plastics (part of the Formosa plastics group) for producing multi-layered printed circuit boards. This venture involved a substantial transfer of technology and capabilities. On the basis of this successful project, HP has transferred more complex technology and thus has given a major boost to the development of Taiwan's capabilities in motherboard production. In cooperation with the Ministry of Economic Affairs and with large local conglomerates like the President Enterprises Group, HP Taiwan has aggressively promoted the spread of computer-based factory automation.

Despite these and a few other cases of inward FDI in the computer industry, it is fair to say that such investments have played only a marginal role in the development of Taiwan's computer industry. Foreign computer companies did make an important contribution, yet such linkages worked primarily through the rapid proliferation of international outsourcing arrangements. These arrangements include subcontracting, consignment assembly and various forms of OEM contracts, and are no longer confined to parts and components but involve high value-added support services such as product customization, product design and production technology.

5. KNOWLEDGE CREATION THROUGH GLOBAL PRODUCTION NETWORKS (GPNs)

American computer companies like Apple, IBM, DEC, Compaq and HP have been pioneers in the subcontracting of component manufacturing, contract assembly, the spread of OEM and more recently ODM (original design manufacturing) arrangements that enable them to concentrate on what they do best. Japanese computer companies only followed suit during the early 1990s, once their tight grip over their domestic market was challenged by the aggressive price war strategies of American computer companies.

Spatial Dispersion

Today it is normal that the supply chain of a computer company spans different time zones and continents. For instance, final assembly is most likely dispersed to major growth markets in the US, Europe and Asia; microprocessors are sourced from the US; memory devices from Japan and Korea; motherboards from Taiwan; HDDs from Singapore; monitors from Korea, Taiwan and Japan; keyboards and power switch supplies from Taiwan, and so forth.

The picture gets blurred, however, as many of these suppliers in turn ship their products from widely dispersed overseas affiliates. Taiwanese OEM suppliers have shifted a growing share of their production to low-cost production sites in Southeast Asia and China. Since 1992 Taiwan's PC industry has experienced an extremely rapid expansion of overseas production. In value terms, the ratio of overseas production out of Taiwan's total PC production has increased from 10.4 per cent in 1992, to 14.9 per cent in 1993, 20.6 per cent in 1994, and 27.2 per cent in 1995. In 1996 this ratio increased to almost 30 per cent. Throughout this short period annual growth in overseas production value was consistently over 70 per cent, which implies that overseas production today plays a critical role for the success and failure of Taiwan's PC industry.

Most of the overseas production of Taiwanese computer companies is concentrated in neighbouring regions in China (most of it in China's southern coastal provinces) and in Southeast Asia. For instance, out of the 95 overseas production sites of Taiwanese PC firms that have been registered by the Market Intelligence Centre (MIC) of Taiwan's Institute for Information Industry (III), 75 production sites (that is almost 80 per cent) have been located in East Asia (exclusive of Japan). China alone has attracted 41 investments, that is 43 per cent of the total.

The logistic complexity of the new GPNs is not simply a result of their geographic spread; it is also a function of an increasingly complex division of labour. Each GPN combines different hierarchically structured and closely interacting sub-networks. For example, an American computer company such as IBM or Compaq is linked to first-tier contractors, say an American disk drive producer like Seagate with its GPN, or large Taiwanese OEM contractors like Acer. At the next level, we find medium-sized, specialized Taiwanese contractors like Delta Electronics, a major producer of switching power supplies that has production facilities in Thailand, China and Mexico. At the lowest levels, we find a myriad of sub-production networks, each centred around a small Taiwanese subcontractor, many of which have redeployed production to China or Southeast Asia. The complexity of such arrangements becomes clear when we look at the major customers list of a firm like Delta Electronics. This list reads like a Who's Who in the computer industry and covers 24 leading computer companies from the US, Japan, Europe and Taiwan.

In sum, Taiwanese firms in the electronics industry are deeply embedded
in complex global production networks that involve transactions between a large number of different national production systems. The increasing complexity of GPNs, however, has also allowed small enterprises from a small nation to participate and upgrade their knowledge base.

Key Features of Global Production Networks

What factors have induced computer companies to increase their reliance on outsourcing and hence to establish GPNs? For a typical lead company in the PC business, the cost of components, software and services purchased from outside has increased from less than 60 per cent to more than 80 per cent of total (ex factory) production costs. As external sourcing relations become geographically dispersed and increasingly complex, they are fraught with very high co-ordination costs: some firms report that the cost of co-ordinating such outside relations can exceed in-house manufacturing costs. As a result, the focus of cost reduction strategies is shifting from scale economies in manufacturing to a reduction of the cost of external sourcing through rationalization and internationalization.

Outsourcing is also motivated by a strategic concern. In order to survive the extremely intense competition that is characteristic of the electronics industry, global competitors are forced to concentrate on product development (architectural design), while at the same time remaining a low-cost producer. In order to meet these goals firms tend to focus on R&D, the production of some key components, limited involvement in the final assembly of higher value-added products and marketing. By outsourcing most of the other activities, the lead company expects to reduce the high fixed capital costs and risks that result from large in-house production facilities. Finally, the lead company may exploit competition among potential suppliers to reduce production costs.

What are the interests of small suppliers from Taiwan? Participating in a GPN can provide various advantages, despite the continuing pressures for cost cutting (Ernst and Ravenhill, 1999; Ernst and O’Connor, 1989 and 1992; Ernst 1994b). Manufacturing on an OEM basis is a significant source of knowledge creation for affiliated firms. Not only do foreign purchasers supply specifications for OEM suppliers, they also frequently send their engineers to help local manufacturers to meet quality specifications. Knowledge is thus transmitted in OEM production, not only through the supply of blueprints, but also through the interaction of personnel and the transfer of more elusive, tacit dimensions of technology (Bell and Pavitt, 1993; Ernst and Lundvall, 1997/1998).

Once a supplier has acquired the relevant technology and technical expertise, it may be possible to use these in manufacturing components or final products on an OEM basis for other multinationals. Taiwanese firms often participate in more than one GPN. By manufacturing for a number of assemblers on an OEM basis, they can achieve economies of scale; longer production runs in turn justify the installation of capital equipment (and thus often better quality control) which otherwise would not be warranted. Furthermore, the provision of letters of credit by the foreign purchaser can enable the local manufacturer to borrow additional capital that can be invested in knowledge creation.

Another advantage for small suppliers is that participation in a production network avoids the expense of building distribution, sales and service networks. The costs of acquiring knowledge about foreign consumer preferences, and of setting up the distribution and service networks that are essential for penetrating foreign markets, pose a formidable challenge even to large multinationals. This is particularly true in Japan. Moreover, a move to own-brand production risks a disruption of the technological links with purchasers established under OEM relationships. Firms seeking to produce under their own brand name frequently find it more difficult to obtain technical advice from companies that increasingly perceive them as rivals. Manufacturers may gain a price premium from marketing under their own brand name, but this premium may be negative if consumers associate the brand with poor quality. Korean exporters of consumer electronic products appeared to suffer this fate in the Japanese market in the late 1980s, when inferior products coupled with inadequate service networks damaged the reputation of Korean manufacturers.

Marketing products under the firm’s own brand name may place a company at the apex of the pyramid of technological and marketing capabilities, but Taiwanese companies have found that the costs incurred in setting up distribution, sales and service networks can outweigh the higher unit profits from OBM (original brand-name manufacturing). As they upgrade their production skills and capabilities, small suppliers are often able to change the bargaining relationship with the multinationals. There is evidence of Taiwanese firms moving from OEM to ODM, although still producing components or final products for sale under another company's brand name. In such circumstances, the balance of bargaining power between supplier and purchaser shifts, with the buyer becoming increasingly dependent on the skills of the local company. The ideal scenario from the perspective of the OEM supplier would be that the transfer of skills from the purchaser eventually leads to the hollowing out of the core competencies of the distributing company in the particular product line. This has been alleged to have occurred in the case of Samsung's manufacture of microwave ovens for GE (Magaziner and Patinkin, 1989).
Taiwan's Participation in Global Production Networks

Participation in international production networks has been of critical importance for the development of a highly flexible domestic supply base and its continuous upgrading. Manufacturing on an OEM basis has been the most important of such linkages. Taiwan's involvement in the OEM business has gone through different incarnations, from very simple arrangements to highly complex ones. Each of these has displayed a peculiar pattern of knowledge creation.

Taiwan's entry as a supplier for the international computer industry dates back to the mid-1960s. The breakthrough came in 1966 when IBM set up its International Procurement Office (IPO) and started to purchase computer parts and components from Taiwan. IBM's demanding procedures for product development, production ramp-up and quality control, as well as its gruelling requirements for vendor qualification, forced Taiwanese firms to radically upgrade their product quality. It also forced them to develop a broad spectrum of capabilities required for manufacturing as well as product design. In the process of qualifying as an IBM supplier, countless Taiwanese firms learned how to improve their input procurement and production control methods in order to cut costs, improve quality and to speed-up product development cycles and delivery. IBM engineers regularly visited Taiwanese suppliers, screened their production facilities and logistics and assisted them to improve their overall efficiency. These visits included countless missions by IBM engineers sent from the US or other affiliates of IBM's global production network. Being an IBM supplier has been a great asset to many Taiwanese firms: buyers feel that they can trust a supplier who has been able to cope with the stringent IBM procurement requirements. Going through an IBM apprenticeship thus has helped Taiwanese firms to overcome their negative image of unreliability and shoddy quality and win more orders from other foreign computer companies. Nonetheless, Taiwan had to wait until the early 1980s before it was able to establish itself as a credible supplier. Two external developments served to change this situation.

The first occurred in 1982 when the Taiwanese government responded to American pressure and declared the cloning of Apple II computers and video games illegal. With the benefit of hindsight it is obvious that this actually accelerated the move of Taiwanese firms to clone IBM PCs, which remained legal. These developments coincided with dramatic changes in the computer industry that created a window of opportunity for low-cost producers. In contrast to mainframe and mini-computers, PC design is based on standard microprocessors and operating systems. As a result, computers became mass-produced, standardized products (commodities). Barriers to entry to final assembly are low and the key to success for any 'cloning' strategy lies beyond manufacturing. A critical factor is time-to-market: the PC vendor needs guaranteed access to reasonably priced key components and the most up-to-date operating system; and its supply base for motherboards and other components must be able to respond fast and flexibly. Coping with the first prerequisite required close links with Intel and Microsoft, while the second prerequisite was perfectly matched to Taiwan's domestic supplier structure.

A second external factor facilitated Taiwan's entry into the international OEM business. In 1987 the US government imposed punitive tariffs of 100 per cent on Japanese PCs, both in response to US-Japanese trade conflicts in semiconductors and as a reaction to a perceived violation of COCOM rules by Toshiba. The punitive tariff on Japanese suppliers allowed the Taiwanese to demonstrate to American computer companies that they could replace the Japanese suppliers with good products at good prices and that they could even deliver more quickly. Although the tariff was removed one year later, it was by then too late for Japanese computer companies to recover their lost share in the rapidly moving OEM market.

Taiwan's subsequent involvement in the OEM business has gone through different stages. Each of these stages displayed a peculiar pattern of knowledge creation. In order to understand these different knowledge effects, we need to open the black-box of OEM arrangements. An important finding that runs counter to established wisdom (for example, Hobday, 1995) is that successful upgrading does not necessarily require a shift from OEM to OBM. At the beginning OEM arrangements were very simple, both in terms of products and required capabilities. The focus was on low-end desktop PCs and labour-intensive peripherals, like computer mice and keyboards. The OEM customer provided detailed technical 'blueprints' and technical assistance to allow the Taiwanese contractor to produce according to specifications.

There is a broad consensus that Taiwanese firms were able to reap substantial benefits from this easy phase of OEM. Yet these simple forms of OEM also had substantial drawbacks. Suppliers became 'locked into' OEM relationships that hindered independent brand name recognition and marketing channels. Profit margins are thinner in OEM sales than in own brand sales, which in turn makes it difficult for suppliers to muster the capital needed to invest in R&D required for the development of new products. In response to these drawbacks, a number of Taiwanese computer companies tried to expand their share of own brand-name manufacturing (OBM) sales. In 1988, for example, the share of Taiwan brand-name to total PC sales stood at roughly 28 per cent; by 1989 it had risen to 40 per cent (Eurotrade, Taipei, Vol. 2, January 1990, p. 32). Yet the transition to OBM turned out to be difficult and only a handful of companies were able to succeed; most others failed and are now content to consolidate and upgrade their position as OEM suppliers.
suppliers. The result has been a drastic decline of OBM sales out of total Taiwanese computer sales. Most recent figures show that the share of OBM has declined from 34 per cent of all Taiwanese computer hardware sales in 1995 to less than 25 per cent in 1997. The story of this upgrading process can be seen through the lens of Taiwan’s best-known computer company, Acer.

Acer’s Peculiar Upgrading Experience

Acer’s involvement in the PC cloning business dates back to 1983, when it was among the first Taiwanese companies to introduce an IBM XT/PC compatible. In the same year Acer had organized Taiwan’s first International Distributors’ Meeting, attended by delegates from over 20 countries. Building strong links with foreign distributors and OEM customers subsequently became an important priority, complementing Acer’s strong domestic roots. The years following 1986 brought a number of early successes. At that time 32-bit microprocessors (MPU) were just beginning to appear on the market and Acer was able to beat IBM in announcing a 32-bit PC based on Intel’s 386 MPU. During the same year Acer’s subsidiary Continental Systems, Inc. (now Acer Peripherals) received two successive Excellence Rewards from ITT, acknowledging the high quality of its OEM products. After changing the company name to Acer in 1987,47 the company got approval to list on the Taiwan stock exchange in 1988.

Acer’s export success was not wholly dependent on OEM sales, however. These early triumphs led Acer’s management to believe it could reduce this dependence and jump to producing its own brands. In 1988 Acer hired a senior IBM executive to reorganize the company with the explicit goal of transforming it into a global competitor. Expectations were running high. IBM was still considered the industry’s role model; by copying key features of IBM, Acer expected to speed up its leapfrogging effort. In particular, the idea was to increase the company’s vertical integration and generate a critical mass of proprietary assets that would enable Acer to develop its own brand name image.

This effort failed miserably. The IBM manager assumed that change could be imposed from above by forcing consensus on the local management. Such an aggressive top-down approach ran into stubborn opposition by Acer’s managers and engineers who were used to a substantial amount of decision autonomy. Furthermore, Acer simply did not have the resources that are necessary to implement such a strategy. The peak of leapfrogging euphoria came in 1989, when Acer shipped its one millionth computer; it ranked for the first time by DATAMATION among the top 100 IT companies in the world; was chosen as one of the ‘corporate stars of the future’ by the Wall Street Journal; and was chosen by Texas Instruments (TI) as its joint venture partner for DRAM production in Taiwan. Insiders knew that TI’s decision was based on the lavish financial package that Acer, in cooperation with the Taiwanese government, was able to offer.48 For a broader public, however, the tie-up with TI conferred tremendous prestige.49

The shift in strategy was supposed to occur quickly. Acer projected that the share of OEM sales would decline from 40 per cent of total sales in 1988 to 25 per cent in 1992. Not only did Acer intend to compete through its own brand, but it also wanted to broaden its product portfolio. This led to a rapid succession of acquisitions which almost ended in disaster. Acer acquired Counterpoint Computers with the intention of using it to build a strong position in minicomputers, but the follow-up costs of technology development and marketing were way above Acer’s expectations. Counterpoint lost $15 million in 1989 alone, almost as much as the $17 million that Acer had paid for it, and the firm was closed down. Undeterred, Acer tried again the following year, by acquiring Altos, an American producer of UNIX-based multi-user systems. At the time the expectation was that Altos’s UNIX experience and distribution channels would help Acer to speed up its product diversification.50 Bought for $94 million, the firm recorded a mere $125 million in sales in 1990, and was incurring heavy losses. Such losses continued for a few more years, but this time Acer also benefited. By acquiring Altos, the company was able to develop its computer networking capabilities and to enter the PC server market.

The awakening came in 1991 when Acer posted a loss ($23 million) for the first time. Acer’s over-ambitious diversification strategy came at the worst possible moment. The PC industry worldwide was swept by a crippling price war, as a result of which almost all companies faced a serious profit squeeze. Taiwan’s computer industry was particularly hard hit and went through a major shake-out. During the second half of 1991, 50 to 60 Taiwanese computer companies went out of business each month.51 Most of these firms were small companies. One could argue that this was a healthy development, as it indicated a long overdue consolidation of this industry. Moreover, the disappearance of small firms from a sector under pressure seems to be a fairly normal occurrence in Taiwan; many of them reappear making something else or at a foreign location. Since 1991, however, a number of larger Taiwanese PC companies like Acer were in serious trouble; some, such as Autocomputer, actually went out of business.

The spread of intense price wars constituted a major challenge for the Taiwanese computer industry, and readjustment came at a heavy cost. In order to sustain their position as OEM suppliers, Taiwanese firms had to implement drastic additional cost reductions at a time when Taiwan’s traditional cost advantages were rapidly eroding. Fuelled by the appreciation of the NT$, the cost of land and labour in Taiwan exploded in the early
1990s, with the result that Taiwan lost its comparative advantage as a low-cost production site. At the same time Taiwan faced serious competitive threats both from below and from above. New low-cost competitors entered the fray in Southeast Asia and China, while South Korea strengthened its position as a supplier of scale-intensive components, like DRAMs, monitors, CRT picture tubes and display devices. Furthermore, Japanese firms, which lost market share both at home and in export markets, had now started to fight back and to develop much more aggressive global market penetration strategies.

Most Taiwanese firms made a conscious effort to consolidate their position in this field, but Acer pursued a rather different approach. While it consolidated its position as an OEM supplier, it simultaneously continued to pursue an aggressive OBM strategy. Rather than trying to reduce its reliance on OEM contracts, the objective now was to quickly increase the OEM share to 50 per cent. This part of the strategy has worked well. For desktop computers, Acer is one of the five Taiwan-based producers that have collectively come to dominate the OEM market: Tatung, Acer, DEC’s Taiwan affiliate, FIC and AST’s local affiliate. In addition to its strong position in desktop PCs, Acer has also become a major OEM supplier of notebook computers for Apple and Canon. The result was that, in 1994, the OEM share of Acer’s PC sales had risen again to 35 per cent.

In sum, Acer’s strategy is to leverage its OEM business to generate the necessary financial resources to pursue its OBM strategy and to further upgrade Acer’s capabilities, especially in design and computer networking. The logical consequence is a focus on mass production rather than on niche markets. Acer’s goal is to become one of the world’s highest-volume producers of peripheral equipment, key components, sub-assemblies and design services, both for Acer’s worldwide computer assembly plants and for leading international computer companies like Apple, Canon and Fujitsu. Acer describes its own competitive strength as the ‘ability to market affordably-priced products quickly due to innovative production and distribution strategies, a component supply approach, a flexible and independent organization and economies of scale in manufacturing’ (The Acer Group Profile 1994, p. 4).

Meanwhile, Acer’s OBM strategy tries to combine the following, not always consistent goals: to establish a credible global brand image for a broad mix of ‘affordably-priced products’; to improve its ability to market such products quickly and to adapt them in response to changing market requirements; to penetrate secondary markets in Asia, Latin America and elsewhere in order to gain economies of scale; and to use these countries as a test-ground for refining its globalization strategy. In these markets Acer aims to price its products 10 to 15 per cent below Compaq’s prices. Gradually, Acer would build its product and marketing capabilities in a few very limited market niches. Acer’s acquisition of some American computer companies, like Altos, was one element of this approach, but much more important is the shift to digital consumer electronics and, possibly, Acer’s pioneering role in the field of software design and distribution. These objectives serve the overriding concern of developing an independent global brand image.

Until 1995 this dual strategy worked reasonably well: between 1993 and 1995, Acer’s share price almost quintupled.32 And in 1995 the group’s consolidated sales revenues were $5.8 billion, up from $690 million in 1989. This quick and impressive turn-around owed a great deal to sheer luck and to industry-specific factors that were beyond Acer’s control. Probably of greatest importance was the strong demand for DRAM chips which pushed up profit margins for this product. Without the windfall profits of TI-Acer’s DRAM joint venture, Acer would probably still have been suffering from its over-ambitious diversification strategy. In 1993, 90 per cent of Acer’s net earnings were generated by TI-Acer, and its share in Acer’s 1995 net earnings was still as high as 45 per cent. This, however, has drastically changed since 1996. As a result of the free fall of DRAM prices, TI-Acer has ceased to act as a cash cow for Acer’s OBM strategy.53

As for Acer’s core PC business, profit margins have improved. The surprise success of Acer’s multimedia home personal computer in 1994 has helped to improve the company’s position.52 In 1995 Acer became one of the top ten PC suppliers to the US market. Since then, however, not much has moved. In 1995 the US market still accounted for roughly 26 per cent of Acer’s worldwide sales, and in 1996 Acer America went into the red again. While Acer retained its top position in a number of rapidly growing, yet still quite secondary markets like Indonesia, Malaysia, Mexico and South Africa, the overall growth of sales revenues for computers has slowed down and Acer has still not succeeded in expanding its OBM market share in Japan and China.

All of this does not imply that Acer’s strategy has failed altogether. Rarely has a company grown so fast, and rarely has a small firm from a small nation been able to build up such a broad range of capabilities and to introduce far-reaching organizational innovations during a relatively short period of time. Yet it also shows that there is no easy and quick short-cut to success and that leapfroging is an illusionary concept that should be discarded.55 Developing a firm’s knowledge base is a time-consuming and laborious process: at each stage of its growth, new barriers arise that require a period of consolidation. The more Acer progresses and grows, the more demanding will be the barriers with which it has to cope. This precludes a frontal attack on the market leaders. Attacking from the sidelines is the only realistic option. This is certainly true as long as Acer has not yet reached a
size that qualifies it for Fortune 500 membership. The key to Acer’s success is that it has pursued a gradual market penetration strategy: it avoids direct confrontation and pursues markets where the market leaders are not present. Acer’s OBM strategy thus remains primarily focused on non-OECD markets, while at the same time it continues to upgrade its capabilities as an OEM supplier. This shows that Chandler is right in emphasizing the difficulties to overcome the first mover advantages of large multinationals (Chandler, 1990). Yet Acer’s story also shows that a small firm from a small nation can enter and grow in the rapidly moving computer industry, provided that it pursues a realistic market penetration strategy.

The Dynamics of Knowledge Creation in OEM Arrangements

Developing a global brand image is costly and involves extreme risks. Acer’s approach to ‘attack from the sidelines’ and to focus its OBM strategy on non-OECD markets is one realistic response to this dilemma. As for market penetration in the US, Japan and Europe, Taiwanese computer firms will have to rely however for quite some time on OEM contracts. This is why upgrading Taiwan’s OEM position is currently the appropriate strategic priority. Let us look at some examples.

Since 1993 Taiwan became the main OEM supplier of PC-related products for leading American and European computer manufacturers and distributors. Compaq for instance now sources its monitors from ADI, Philips Taiwan and TECO; notebooks from Inventa, power supplies from Lite-on and Delta, and mouse devices from Logitech Taiwan and Primax. Probably the most interesting arrangement is that with Inventa, a company that has earned a reputation for innovative notebook design and that has already supplied notebooks on an ODM basis to Dell and Zenith, now an affiliate of the French computer firm Bull. Inventa is part of the family-owned Inventec business group that is involved in a wide range of products and services, but is most well-known for calculators and telephones.

Logitech Taiwan provides another illustration of how complex global production networks have become in the computer industry; it also highlights the high volatility of the OEM business and the need to continuously upgrade product mix and capabilities (Jolly and Bechler, 1992 and author’s interviews). Founded in 1981 in Switzerland and incorporated a few months later in the US, Logitech is the world’s largest producer of computer tracking devices (mice and trackballs). In 1987 Logitech shifted production to Taiwan and established a large volume production line in Hsinchu Science Park. Taiwan’s main attraction was that it offered a well-developed supply base for parts, qualified people and a rapidly expanding PC industry. In 1995, however, Logitech shifted all of its production from Taiwan to China. The result has been a drastic decline of Taiwan’s share of the global mouse market from almost 75 per cent in 1994 to 65 per cent in 1996. At the same time Logitech continues to use the same Taiwanese suppliers that have now set up shop close to Logitech’s new location in China.

Compaq provides another example of the increasing complexity of Taiwan’s OEM arrangements. In a recent turnkey production contract with Mitac, Compaq has outsourced all stages of the value chain for some of its desktop PCs, except marketing for which it retains sole responsibility. Other foreign computer companies have followed Compaq’s example. For instance, IBM signed an agreement with the Acer Group where Acer would use its global production network in developing countries to assemble lower-end IBM desktop and laptop PCs and to distribute and service them. Turnkey production arrangements constitute an important innovation and show how rapidly OEM relationships have moved beyond production to encompass an increasing variety of knowledge-intensive, high-end support services. The spread of such broad cross-value chain arrangements shows that leading foreign computer companies are confident that Taiwan’s computer industry is now sufficiently well integrated to serve as a one-stop shopping centre.

Japanese PC manufacturers have also drastically increased their OEM contracts with Taiwanese firms for desktop PCs, motherboards, terminals and monitors, and a variety of other PC-related products. NEC for instance gets monitors and motherboards from Tatung and Elite, Fujitsu has relied primarily on OEM supplies from Acer, and Epson, Canon, Hitachi, Sharp and Mitsubishi have all become major OEM customers.

Upgrading Is Possible Within the OEM Trajectory

It is important to emphasize that these developments benefit rather than harm Taiwan’s computer industry. This reflects important changes in the competitive dynamics of the computer industry. Paradoxically, an increasing concentration of the global computer industry has been accompanied by a growing reliance on global outsourcing: the top five industry leaders, which are all Taiwan’s OEM clients, have increased their global market share from roughly 20 per cent during the early 1990s to almost 50 per cent. Their main strength is the definition of architectural standards and their global brand image. These global market leaders are at the cutting-edge of product development, but they outsource almost everything else. Close interaction with these industry leaders provides Taiwanese firms with a constant flow of precious feedback information on product design, new architectural standards, leading-edge production technology and sophisticated quality control and logistics procedures. Close links with these industry leaders act as a powerful vehicle for a further strengthening of the learning and innovation
capabilities of Taiwanese computer firms. We have seen that OEM contracts have now become much more demanding: they require a broad range of sophisticated capabilities that cover most if not all stages of the value chain. Taiwanese firms now need to provide more sophisticated services, including design and global supply chain management. While in 1993 roughly one half of all PCs supplied by Taiwanese OEM suppliers were based on Taiwanese designs, this share today has increased to more than 70 per cent. Of even greater importance is a tendency to extend OEM contracts to comprise an integrated package of higher-end support services, as illustrated in the turnkey production contracts of Compaq with Mitac, and of IBM with Acer. This implies that, with the exception of hard-core R&D and strategic marketing, Taiwan’s OEM supplier community must be able to shoulder all steps in the production chain and the co-ordination functions necessary for global supply chain management.

A major prerequisite for Taiwanese firms is a capacity to assist foreign OEM customers in the management of their global supply chain. All the leading computer companies have drastically rationalized their global supply chain and are moving rapidly toward order-based production. In their choice of OEM suppliers, they demand a capacity for just-in-time delivery: for Taiwanese suppliers, this implies that speed and flexibility of response are critical; Taiwanese suppliers also must establish their own global network of plants and sales affiliates in close proximity to major computer markets. In other words, organizational innovation is of increasing importance and can go a long way in compensating for weaknesses in technological innovation.

These fundamental changes in OEM relationships are producing a new division of labour between large Taiwanese computer majors and SMEs. Large firms appear to rely more on OEM contracts, while SMEs are much more active in ODM. For instance, OEM orders for desktop computers are all concentrated on a select group of large companies, such as Tatung, Acer, DEC Taiwan, FIC and MITAC. The same is true for other scale-sensitive products such as monitors and modems. This sounds counter-intuitive, but OEM contracts come in large orders; they typically generate razor-thin profit margins. Economics of scale and scope are of critical importance, and large firms are better placed to reap such economies. Time and again, we thus find that Chandler’s insistence on the continuous importance of scale and scope economies makes perfect sense, even in a fast moving sector like the computer industry (Chandler, 1990). Moreover, only a large firm can avoid becoming overly dependent on one particular customer.

Smaller firms may find it too risky to depend on large OEM contracts, as each of these contracts normally surpasses their maximum production capacity. They prefer to shift to ODM contracts where they have greater chances to sustain a diversified customer base and charge higher prices. In other words, SMEs are under greater pressure relative to large Taiwanese firms to improve their design capabilities to become credible niche market players within the overall OEM market. Many of these SMEs will not succeed, but those that do have good chances to grow and to improve their competitive position.

6. CONCLUSIONS

This chapter has been based upon an alternative conceptual framework that centres on the co-evolution of domestic and international knowledge linkages. This framework allowed us to analyse what permits small firms to compete in globalized high-tech industries. The chapter demonstrates that inter-organizational knowledge creation is critical for small firms that compete in the computer industry. If well organized and managed, such external knowledge linkages can effectively compensate for some of the original size-related disadvantages of small firms, at least for a certain period of time. However it is also shown that external linkages are no substitute for intra-organizational knowledge creation. This confirms Edith Penrose’s observation that ‘a firm’s rate of growth is limited by the growth of knowledge within it’ (Penrose, 1959/1995, Foreword to the 3rd edn, pp. XVI and XVII).

It has also to be emphasized that inter-organizational knowledge creation is not confined to regional clusters or to the nation state. In industrialized countries, many of these external knowledge linkages are with domestic organizations. This is very different for a small developing country. When Taiwan began to enter the computer industry during the late 1970s, domestic linkages did not exist or were at best embryonic. International linkages thus were initially of primary importance. This is in line with the findings of research on technological learning in developing countries. Two types of international linkages have been distinguished: inward FDI and the participation of Taiwanese firms in global production networks established by foreign electronics companies.

Inward FDI has played an important catalytic role for knowledge creation during the early phase of the development of Taiwan’s electronics industry. Participation in global production networks has been of critical importance for the development of a highly flexible domestic supply base and its consequent rapid internationalization. Manufacturing on an OEM basis has been the most important of such linkages. Taiwan’s involvement in the OEM business has gone through different stages. Each of these stages displayed a peculiar pattern of knowledge creation. It started with very simple OEM
arrangements that covered low-end desktop PCs and labour-intensive peripherals. The OEM customer provided detailed technical ‘blueprints’, components and technical assistance to allow the Taiwanese contractor to produce according to specifications.

Most of the literature has focused on this easy phase of OEM: there is a broad consensus that, during this phase, Taiwanese firms were able to reap substantial benefits. In response to their drawbacks, a number of Taiwanese computer companies have tried, during the early 1990s, to expand their share of own brand-name manufacturing sales. Most of them failed and are now content to consolidate and upgrade their position as OEM suppliers. This is hardly surprising: developing a global brand image is costly and involves extreme risks; it is way beyond the reach of most Taiwanese companies, with the possible exception of some larger companies like Acer. It is shown that, paradoxically, this increasing reliance on OEM arrangements has had positive effects for knowledge creation in Taiwan’s computer industry. Contrary to established wisdom, successful upgrading does not necessarily require a shift from OEM to OBM.

All this implies that requirements for knowledge creation have become much more demanding: Taiwan’s OEM supplier community must now be able to master all steps in the production chain, with the exception of hard-core R&D and strategic marketing. In addition, Taiwanese OEM suppliers must be able to perform for their customers co-ordination functions that are necessary for global supply chain management.

Moreover, benefits from international linkages do not come automatically. Of critical importance are government policies that have created a set of innovative institutions and incentives conducive for inter-organizational knowledge creation (see also Chapter 4 in this volume). Of equal importance are a variety of domestic linkages that range from informal peer group networks to a variety of innovations in firm organization that attempt to combine the scale advantages of large firms with the speed and flexibility of smaller firms. Contrary to conventional wisdom, large firms have played a central role in the co-ordination and development of the Taiwanese computer industry; they have also acted as important sources for knowledge creation in SMEs.

NOTES

1. If not indicated otherwise, data on Taiwan’s computer industry are courtesy of the Market Intelligence Centre of the Institute for Information Industry (III), Taipei.

2. ‘PC network products’ are defined as ‘products that are used for LANs (Local Area Networks), PSTN (Public Switched Telephone Network), ISDN (Integrated Services Digital Network), ASDL (Asymmetric Digital Subscriber Loop) and cable modems’. Main products include ‘network interface cards, hubs, bridging switches, modems and routers’. Definitions are taken from: Electronic Computer Glossary. Add-on cards include sound, video and graphics cards. Of these, video cards display higher than average profit margins.

3. There is a rich body of research, based on the assumptions of evolutionary economics, that specifies what type of capabilities are required and how the development of such capabilities affects firm organization. In addition to the references in note 1, see Lundvall (1988 and 1992); Carlsson and Stankiewicz (1991); Teecce, Pisano and Shuen (1997); Christensen (1996); Foray and Lundvall (1996); Foss (1996); Llerena and Zucovitch (1996); and Malerba and Orsenigo (1996a). For an application of this theoretical approach to research on developing countries, see Ernst, Mytelka and Ganiatsos (1998), and Ernst and Lundvall (1998). Much of the literature on firm capabilities, however, focuses on large multidivisional corporations and fails to discuss how small enterprises can develop such capabilities. Exceptions are Acem and Audretsch (1992); and Maskell (1996a and 1996b).

4. For the underlying argument, see Acem and Audretsch (1992). For a critical assessment, see Harrison (1994).

5. For details, see Shieh (1990) and Lam and Lee (1992, p. 112). Individual firms often bid for contracts beyond their own capacities; once a supplier gets the contract, it calls on other firms, often competitors, to help fill the order.


7. Chandler (1990), remains the most authoritative source. Economies of scale and scope in the computer industry are analysed in Flamm (1988 and 1990); Ferguson (1990); Ernst and O’Connor (1992); and Ernst (1997b).

8. ‘While standardization appears to be a necessary consequence of the attempts of economic agents to exploit economies of scale and to avoid dealing with impossible amounts of information, this may also lead to difficulties for innovative activities’ (Andersen, 1996, p.98).


10. The Statute for Investment by Foreign Nationals was first promulgated in July 1954 to attract foreign companies. In November 1955, this was followed by the Statute for Investment by Overseas Chinese whose purpose was to tap into the experiences and capital of the Overseas Chinese communities in Hong Kong and Southeast Asia. Finally, the Statute for the Encouragement of Investment was enacted in September 1960 (San Gee and Kuo, 1998).

11. For an analysis of such crowding-out effects on potential domestic investment in Southeast Asia, see Lim and Fong (1991).

12. San Gee (1995a, table 4). The real interest rates for secured loans in Taiwan were 14.14 per cent, 9.0 per cent, 8.05 per cent and 9.7 per cent respectively in 1965, 1970, 1975 and 1985. There was only one exception: in 1980, the rate fell to -2.80, which was primarily due to the second oil crisis in that year. Note that these figures are adjusted for inflationary effects.

13. Sotkovsky (1990, Figure 4.1) shows that, in most years between 1971 and 1980, Korea’s corporate sector debt to equity was between 310 and 380, while Taiwan’s ratio was much lower between 160 and 180. This is consistent with more recent figures quoted in Fields (1995, table 4.5 which show that in 1985, the debt-equity ratio of Korean manufacturing firms was nearly 350, relative to a ratio of 120 for Taiwan. See also the figures quoted in Park (1994).


15. For the most recent relevant developments of Taiwan’s industrial policy, with particular reference to electronics, see Kuo and Wang, Chapter 4 in this volume; for its evolution over time see San Gee and Kuo (1998); San Gee (1995a); Kohayashi (1995); Meaney (1994); Kajiwara (1993); Liu (1993); Schive (1990 and 1993); and Wong Poh Kim (1995).

16. Externalities requirements vary, depending on the market segment and the stage of development of a particular industry. For consumer electronics, they are obviously less demanding than for semiconductors. And within the same product group, i.e. semiconductors, such requirements become much more complex, once the focus shifts...
from low-end discrete devices for consumer applications to higher-end design-intensive devices.

17. Similar stories abound for foreign companies as well: RCA, the incubator of Taiwan’s semiconductor industry, Philips, IBM Taiwan, AT&T Taiwan, Matsushita, Toshiba, Sanyo, and Fujitsu.

18. See Liu, Liu and Wu (1994). The spread of such business groups partly reflects the impact of government policies; starting in the late 1980s, the government shifted its emphasis away from public enterprises to the private sector, providing guidance and essential externalities. This has set the stage for the growth of private firms.


20. A similar system apparently works for leading-edge components: while price levels, of course, are substantially lower than for the more vintage-type components, they still tend to be below price levels on the spot market.

21. Based on author’s interviews at Acer. Similar approaches have been developed by other leading Taiwanese computer manufacturers like Mitac and FIC.

22. Acer hired an IBM executive to assist its reorganization in 1988, with little success; however, the crisis of 1991 spurred a new round of organizational innovation (Business Week, November 27, 1995, p. 73).

23. Philips Taiwan’s integrated monitor facilities were single out by Cor Boonstra, Philips’ president, as one of the core activities of the group, as it ‘supplies leading brands’ (quoted from: ‘Philips strategy on electrical goods a year away’, Financial Times, February 14, 1997).

24. NEC actually was the first Japanese electronics company to set up a production affiliate in Taiwan in March of 1958. It established a small plant assembling communication equipment for the local market.

25. Until March 1989, Matsushita had invested roughly $500 million in its Taiwan affiliate which then employed 5,300 local workers and recorded sales of Yen 73.7 billion (The Japan Economic Journal, July 1, 1989, p. 4).

26. While these figures may be somewhat exaggerated, industry insiders confirm that Fulel does concentrate on higher-end support services relative to manufacturing. The company adds value through sophisticated design features and thus is able to charge premium prices.

27. This is in line with a general tendency of Japanese electronics firms to postpone the shift from exports to offshore export platform production until the catalytic effect of the yen appreciation in 1985 finally forced them to establish export platform production lines in Southeast Asia. See Ernst (1997b).

28. This, however, came at the expense of cost efficiency and quality which, due to the heavy protection provided to the domestic market, were of secondary concern.

29. This arguably results from the fact that Toshiba resembles the Siemens and Hitachi model in its relatively broad-based product mix that covers heavy electrical equipment and industrial electronics as well as consumer electronics.

30. Tatung’s Makolin affiliate in Malaysia is an interesting case which indicates what unusual forms of international co-operation are possible today. It is a joint venture between Tatung’s affiliate Chungshwa Picture Tubes and the Korean Dugo Electronics Company. Its main products are deflection yokes for 14, 20 and 21-inch colour tubes. Again, this affiliate supplies Tatung’s affiliates in the region as well as affiliates of Japanese TV set makers.

31. The super-twist-nematic liquid crystal display (STN-LCD) has lower contrast, a worse viewing angle, and a slower response time than the more advanced thin-film-transistor (TFT) LCD, but is less expensive to produce.

32. Interview with Richard Kuo, president of Topco Scientific, the Taiwan agent for Shinetsu, in FEER, 10/1295, p. 66.

33. Pugh (1984, pp. 250-51): ‘It was slow, tedious, meticulous work, stringing wires in just the right manner through each of the thousands of tiny cores in each core plane. But the cost of labor there was so low that it was actually a few dollars [per unit] cheaper than with full automation in Kingston (New York state).’

34. President Enterprises is a huge conglomerate that started out in the retail sector and with food processing and that now has established a major presence in China and South East Asia. In 1995 the group acquired the Taiwan operations of the once powerful US Wang computer company. Through its Wang affiliate, President Enterprises has established a joint venture with HP with the purpose of developing Taiwan’s market for factory automation and information networks (Computergram, April 20, 1994).

35. Definitions of what constitutes an OEM (original equipment manufacturing) contract keep changing. Probably the most widely accepted definition refers to arrangements between a brand name company (the customer) and the contractor (the supplier) where the customer provides detailed technical blueprints and most of the components to allow the contractor to produce according to specifications. Using this definition of OEM arrangements, we can then distinguish ODM (original design manufacturing) as arrangements where the contractor is responsible for design and most of the component procurement, with the brand name company retaining exclusive control over marketing.

36. Until the mid-1980s, Japanese computer firms were actually major OEM suppliers to American computer companies. We will see in a moment what factors have enabled Taiwanese firms to bypass Japanese companies as leading OEM suppliers.

37. In 1995 keyboards had the highest overseas production ratio (OPR), with 85 per cent of Taiwan’s total production value being produced overseas. Other products with high OPRs are: power switching supply (77 per cent), monitors (almost 50 per cent), motherboards (37 per cent), and mouse devices (24 per cent).

38. Questionnaire survey by MIC/II, conducted in 1996.


41. These and the following figures are based on company interviews, as reported in Ernst and O’Connor (1992, pp. 34 and 37).

42. Such costs are typically defined as ‘all incremental costs associated with dealing with suppliers remote from the initial design site and/or the final assembly site’, with communication costs and administrative overheads absorbing the largest share (Ernst and O’Connor, 1992, ibid.).

43. According to one source at IBM Taiwan, the mother company dispatched over 400 such missions during the 1980s in order to assist Taiwanese suppliers (author’s interview at IBM Taiwan).

44. Calton (1994); Wong Poh Kam (1995) and author’s interviews in the Taiwanese computer industry since 1987.

45. Flann (1988); Ernst and O’Connor (1992, chapters II and IV); Lengleis (1992) and Ernst (1997c).

46. Toshiba’s clandestine sale of a complex numerically controlled machine tool to the Soviet Union, judged to be of high value for arms production, provoked the action.

47. Acer is Latin for ‘sharp, acute, able and facile’.

48. Texas Instruments’ strategy is to choose wafer fabrication locations where most of the investment costs are shouldered by local governments. See Ernst (1994b).

49. By 1989, Acer’s consolidated sales revenues were less than $600 million and it had around 5,500 employees.


52. ‘Acer’s Edge: PCs to Go’, Fortune, 10/30/95.

53. In response to the accelerating fall of DRAM prices, Texas Instruments, in 1998, withdrew from this joint venture, and from the DRAM business altogether.

54. Its US affiliate was among the first firms to anticipate the demand for home multimedia computers – high-end systems with CD-ROM drives that play compact disc-based software with sharp graphics and stereo sound. Much of this was good luck. Acer just happened to
have the right product at the right time ready for the right market (Zielinger, M. 'Ace in the Hole. Taiwan’s Acer makes surprising comeback in America', Far Eastern Economic Review, 1/26/95, p. 52).

55. For an early critique, see Ernst and O’Connor (1989, chapter II).

56. Kotler et al. (1985) remains the classic source.

57. For the concept of global supply chain management, see Lee and Billington (1995) and Levy (1995).

58. Design, in this context, includes the capacity to make quick changes in the configuration of motherboards in order to be able to integrate the latest microprocessor generation. While this is a very demanding requirement, it is quite different from the capacity to define architectural standards and create new markets.

59. This research has clearly established that successful late industrialization critically depends on the international sourcing of knowledge. Examples include Dahlman, Ross-Larson and Westphal (1987); Bell and Pavitt (1993); Nelson and Pack (1995); Kim (1997); Lall (1997); Ernst and Lundvall (1997/1998); and Ernst, Ganiatsos and Mytelka (1998).

6. New Challenges for Industrial Clusters and Districts: Global Production Networks and Knowledge Diffusion

Dieter Ernst, Paolo Guerrieri, Simona Iammarino and Carlo Pietrobelli

1. THE VARIETY OF INDUSTRIAL CLUSTERS AND DISTRICTS AND THEIR EVOLUTION OVER TIME

The main findings reported in this book suggest three inter-related propositions. First, there is no one best model for organizing an industrial district or an industrial cluster, since a diversity of institutional arrangements is possible and each has proved successful in different circumstances. Second, clusters are not cast in iron, but they evolve over time. The third proposition is that globalization reshapes the upgrading options for SME-based clusters, by providing a variety of international knowledge linkages. In a nutshell, we argue that globalization changes both the concept of proximity and the scope of competition: a necessary prerequisite for competitive survival is the capacity to foster the co-evolution of local and global linkages and networks, to develop new interactive modes of knowledge creation and to adjust strategy and organization at short notice.

The first two propositions are fully confirmed by the reorganization of both the Italian industrial districts and Taiwanese SME-based clusters, particularly over the past decade, as assessed in this volume. The typical uniformity in the growth process of SME systems, experienced during the 1970s and 1980s in Italy’s local systems, has come to an end. New diversified patterns of growth have been observed and the range of options chosen expands when attempting to draw international comparisons. The empirical analysis, based on a survey carried out in some Italian IDs specialized in textiles and clothing, shows that the reaction to the globalization challenge may differ greatly even among IDs specialized in the same industrial sector. No common and unidirectional development pattern has proved valid any more, and different avenues have been followed to face...