Institutions and Dynamic Comparative Advantage: Electronics Industry in South Korea and Taiwan

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INSTITUTIONS AND DYNAMIC
COMPARATIVE ADVANTAGE:

ELECTRONICS INDUSTRY
IN SOUTH KOREA AND TAIWAN

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I. INTRODUCTION

Two dynamic economies, South Korea and Taiwan, are undergoing significant transitions. Having been paragons of labor intensive manufacturing, they are now applying equal diligence to technology and skill development. Having excelled at producing mature and standardized products, they are learning to maneuver in fast-changing markets by responding rapidly to new opportunities, taking greater risks, and meeting higher quality standards. In keeping with their past reputation, both economies have shown resilience and flexibility in facing the new challenges. However, the processes by which they have responded have been quite different.

An examination of the transition mechanisms in the two countries suggests a paradox. By almost any conventional measure, Taiwan has been a more developed economy than Korea. If development proceeds by stages, then Taiwan should precede Korea into the so-called high technology (or capital- and knowledge-intensive) product areas. Yet Korea has overtaken Taiwan in a number of important respects.

Acquisition and development of electronics technologies are central elements for both countries in their strategies to design and manufacture innovative products. I shall argue that Korea's lead over Taiwan in electronics production must be explained on the basis of considerations that usually are not incorporated into theories of dynamic comparative advantage. These considerations include institutions for risk taking, efficiency of capital markets, mechanisms for information generation and dissemination, and demographic factors affecting shifts in labor supply. A full account of these factors is not possible in this paper. I shall briefly discuss the implications of the size of the domestic market and then focus on firm and industry structures.

Even though Korean growth has been export oriented, the existence in Korea of a larger domestic market than in Taiwan has played an important role in the growth of Korean electronics output; this was particularly so in the late 1970s and early 1980s when world trade growth was slow.

Perhaps more important, the Korean government has been active over the last three decades in promoting conglomerates. The conglomerate organizational mode, together with the large size of the individual firms which make up the conglomerates, is permitting major investment in high technology markets. In many such markets, late entrants face significant entry barriers because product cycles are short and learning requirements are significant. Both Korea and Taiwan are latecomers. Korea, however, is in a much stronger position. As will be discussed, Korean conglomerates are able to break the entry barriers by virtue of their ability to raise capital efficiently and in significant amounts. Even for products with low entry barriers, Korean firms have a greater long-term incentive to upgrade product quality. For such products, Taiwanese firms usually start a jump ahead of Korean firms; over time, Korean firms narrow the gap and eventually make superior products.

Typically, the internal mechanisms of a firm have not been a part of the theory of comparative advantage. Indeed, the firm has had no role in
theories that assume constant returns to scale. More recently, work that recognizes increasing returns to scale as relevant to international trade flows has also recognized that the number of firms will be determined by the possibilities of trade (see Helpman and Krugman, 1985). However, even this literature does not ask why a firm exists in the first place. In this paper, I shall present evidence showing that the architecture and the inner workings of a firm are relevant to its ability to respond to changes in the country's comparative advantage. A theory of growth of firms needs to be a significant element in the theory of dynamic comparative advantage.

The purpose of this paper is not to recommend Korea's development strategy--most countries would be happy to live with Taiwan's phenomenally successful record. The purpose is to trace the transitional process in the two economies and indicate how domestic institutional structures lead to very different response mechanisms in dealing with changing international realities in a particular historical context. The key message of this paper is that an assessment of comparative advantage cannot be made simply on "factor endowments". How these endowments are built and brought together in production and trade is critical to the "realization" of comparative advantage. Countries that attempt to move to successively higher stages of development are called upon to acquire new sets of generic skills and capabilities. The manner and speed at which these skills are acquired depends on the institutional structure of the economy. The private returns to acquiring these capabilities depend upon the nature of the firm, the product market in which it seeks to operate, and the markets for the inputs (particularly capital and information markets). These "micro" features influence whether and to what extent the activity will be undertaken. The main contribution of this paper is to link micro features to the evolution of the comparative advantage of a country.

Given the emphasis on the micro features of an economy, it was necessary to focus on a specific industry for the purpose of this analysis. Electronics was a natural candidate. Electronics production ranges from labor intensive to highly capital- and skill-intensive products. The process of transition is ongoing in both countries, with firms actively seeking to move from their early focus on labor intensity and standardized products to capital- and skill-intensive products. Firm size and structure, the key variables for this analysis, vary significantly in the electronics sectors of the two countries. However, general supportive evidence noted in the concluding section suggests that the findings of this paper hold in other manufacturing sectors of Korea and Taiwan.
II. LEVELS OF DEVELOPMENT AND ELECTRONICS CAPABILITY

A. Development Measures

In 1961, the per capita income in Taiwan was about twice that in Korea (US$150 against $80). Although the gap has narrowed, even in the early 1980s the Taiwanese per capita income was about 50 percent larger than in Korea (US$2677 vs $1884 in 1983). Both savings and investment rates have been significantly higher in Taiwan. The industrial structure of Taiwan has been more "advanced": the share of agriculture in gross domestic product has been significantly lower and the share of industry has been higher than in Korea.

Similarly, estimates of capital and human resource development (per head of population) show Taiwan to have been significantly ahead of Korea in the early 1970s (Balassa 1981). Superior human resources in Taiwan reflect both higher average educational attainment and significantly higher life expectancy.

A study of the growth and structural transformation of the Korean economy points out that the industrial structures of Korea and Taiwan have followed identical patterns; Korea has traced Taiwan's path "with an eight-year lag explained entirely by the different income levels" (Kim and Roemer 1979). In the same spirit, a study of Korean and Taiwanese patterns of trade between 1960 and 1977 has concluded that though Korea and Taiwan had very similar trade patterns during this period, "some skill intensive or heavy manufacturing industry products which could not be found in the Korean case are shown in the Taiwanese list", with "list" referring to the ten products in which the countries had the highest revealed comparative advantage (Lee 1986).

Thus, by all these indicators, Taiwan was at a more advanced stage of development until the late 1970s. However, in the 1980s Korea began to catch up and, in some instances, has moved ahead of Taiwan.

B. Korean Lead in Electronics

Electronics production was higher in Taiwan than in Korea through the 1970s. During that period there was also little difference in the growth rates in the two countries and thus Taiwan maintained its lead. Starting around 1980, the Korean electronics industry grew more rapidly and had closed the gap by 1985; in the past few years Korean production has overtaken Taiwanese production. Figure 1 shows the production trajectory in the two countries. The vertical axis measures the logarithm of production, and hence the slope of the production curves measures the growth rate of production. The higher Korean growth rate is evident. Since 1982, Korean electronics production has grown at the rate of 33.3 percent every year whereas Taiwanese production has grown at 27.8 percent. Though the purpose of this paper is to explain the relative performance of Korea and Taiwan, it should be

1/ The appendix discusses the data sources for production and trade statistics.
noted here that both these countries have performed outstandingly compared to other countries. Over the same period, Japanese electronics grew at 16.5 percent and U.S. electronics grew at the rate of 9.1 percent per year. The electronics industry in Korea and Taiwan has also grown much faster than Brazilian and Indian electronics industries. (Mody 1989).

Taiwan exports a larger share of its electronics products, which means Taiwanese exports have continued to be greater. However, by 1986-87, the difference in absolute export levels was largely eliminated (Figure 2). Although Korea has performed better than Taiwan, the Taiwanese share of world electronics exports has also grown in the last decade. In 1987, the combined exports of Korea and Taiwan were 10 percent of world exports.

Korea’s impressive performance becomes further evident when we examine the structure of electronics production and trade. Both Korea and Taiwan had followed the Japanese trail through the 1970s. In the 1980s they made a strong attempt to close the technological gap with Japan. Korean industry began to move into higher-growth products in the early 1980s (advanced semiconductors, microwave ovens, video cassette recorders). These products were generally more capital- and skill-intensive than the products either country had produced earlier (televisions, resistors, capacitors). Taiwan has also attempted moving into new high-growth areas and has been successful in some (particularly electronics data processing) but has been unable to overcome entry barriers in others. These changes are discussed in considerable detail in the rest of the paper. I shall present only a few examples here.

2/ According to another source discussed in the appendix, Korean exports were higher in 1987.
Figure 1: Production of Electronics

Source: Yearbook of World-Electronics Data, Benn Electronics Publications, London (formerly known as Macintosh Yearbook of Electronics Data).

Vertical axis represents log of production values measured in $US million.
Figure 2: Share in World Trade of Electronics Exports

Source: International Trade, General Agreement on Tariffs and Trade, Geneva.

1. World trade is assumed to be the sum of exports from developed countries and exports from Korea, Taiwan and Singapore. Data on exports from other countries was not available; however, since exports from all other countries are very small the pattern of Korean and Taiwanese shares described here are likely to be reasonably accurate.
Until the early 1980s, the components segment was the most labor intensive part of the electronics industry, while the industrial products segment was the most capital- and knowledge intensive. Taiwan concentrated on components production to a significantly greater extent than Korea. The share of industrial electronics production was higher in Korea even by the late 1970s (Table 1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Korea</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consumer</td>
<td>Industrial</td>
</tr>
<tr>
<td>1976</td>
<td>39</td>
<td>9</td>
</tr>
<tr>
<td>1980</td>
<td>40</td>
<td>13</td>
</tr>
<tr>
<td>1983</td>
<td>39</td>
<td>17</td>
</tr>
</tbody>
</table>

Source: 1. Electronics Industries Association of Korea
2. Taiwan Electric Appliance Manufacturers' Association.

The same difference is observed at the individual product level (Table 2). Among consumer products, the video cassette recorder was, and is, the most advanced item produced in either country. In 1984 both countries were just beginning to produce VCRs (Korean production was about twice that of Taiwan in that year). At present Korea is the second largest producer of VCRs in the world (after Japan) while Taiwan continues to produce very small quantities. However, Taiwan has been ahead of Korea in the production of low-technology products, such as radios and sound recorders. A similar picture emerges for components, where Korean production has been larger in picture tubes (a relatively high-technology product) and in large scale integrated circuits. Taiwanese production has been greater in low-technology capacitors and resistors. Indeed, a closer look suggests that the Koreans have made greater progress in the higher-end capacitors and resistors.

3/ The major exception in the components category is the fabrication of semiconductors, which is a very capital intensive process. Until recently, however, firms in both countries mainly assembled semiconductors, using labor intensive methods.
Table 2: PRODUCTION VOLUMES OF SELECTED PRODUCTS IN 1984
(1000 units)

<table>
<thead>
<tr>
<th>Product</th>
<th>Korea</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color TV</td>
<td>4,614</td>
<td>2,271</td>
</tr>
<tr>
<td>Black and White TV</td>
<td>5,362</td>
<td>2,873</td>
</tr>
<tr>
<td>Video cassette recorder</td>
<td>361</td>
<td>172</td>
</tr>
<tr>
<td>Radio</td>
<td>2,514</td>
<td>9,068</td>
</tr>
<tr>
<td>Sound recorder</td>
<td>15,317</td>
<td>19,632</td>
</tr>
<tr>
<td>Computer system</td>
<td>1,060</td>
<td>871</td>
</tr>
<tr>
<td>Magnetic disc drive</td>
<td>49</td>
<td>934</td>
</tr>
<tr>
<td>Printer</td>
<td>14</td>
<td>95</td>
</tr>
<tr>
<td>Terminal</td>
<td>2,132</td>
<td>876</td>
</tr>
<tr>
<td>Monitor</td>
<td>1,205</td>
<td>3,212</td>
</tr>
<tr>
<td>Telephone set</td>
<td>4,577</td>
<td>11,784</td>
</tr>
<tr>
<td>Switchboard</td>
<td>585</td>
<td>563</td>
</tr>
<tr>
<td>Electronic tube</td>
<td>34,553</td>
<td>11,840</td>
</tr>
<tr>
<td>Capacitor</td>
<td>8,213,363</td>
<td>10,653,981</td>
</tr>
<tr>
<td>Resistor</td>
<td>8,108,607</td>
<td>10,850,271</td>
</tr>
</tbody>
</table>

Source: 1. Electronics Industries Association of Korea.
III. DOMESTIC FIRMS AND THE DOMESTIC MARKET

In the early 1960s, electronics products were produced by relatively small firms in both Korea and Taiwan. At that time, with the change in political leadership in Korea, an effort was made to accelerate the pace of growth in that country. One dimension of this effort was the fostering of favored business groups (see Scitovsky, 1985 and Myers 1984). The effect of this policy was that production became concentrated in relatively few Korean groups or conglomerates. These conglomerates span a wide range of products including shipbuilding, chemicals, heavy engineering and electronics. In 1984, Samsung of Korea had worldwide sales of US$10 billion. By 1987, Samsung had doubled sales to US$20 billion (Table 3). Though the disaggregation of Samsung's sales is not publicly available, Fortune magazine classifies Samsung as a predominantly electronics firm. It is likely that about 20 percent of Samsung's sales come from electronics. Samsung, Goldstar and Daewoo almost totally dominate consumer electronics production in Korea; they also produce major inputs such as picture tubes. Hyundai started producing electronics products only in the mid-1980s and is already considered a major electronics company with interests in personal computers and semiconductors.

Table 3: SALES OF KOREAN CONGLOMFRATES
(US$ billion)

<table>
<thead>
<tr>
<th></th>
<th>1980</th>
<th>1984</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sales</td>
<td>Rank</td>
<td>Sales</td>
</tr>
<tr>
<td>Hyundai</td>
<td>5.5</td>
<td>72</td>
<td>10.3</td>
</tr>
<tr>
<td>Lucky Goldstar</td>
<td>4.5</td>
<td>101</td>
<td>8.9</td>
</tr>
<tr>
<td>Samsung</td>
<td>3.8</td>
<td>125</td>
<td>10.3</td>
</tr>
<tr>
<td>Daewoo</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

a/ Rank in terms of aggregate sales among non-U.S. corporations.

b/ n.a. - not available.


Meanwhile, the Taiwan electronics industry has maintained a smaller-scale approach. Taiwan has well over 2,000 firms producing electronics, and the number has grown steadily. In contrast, in the early 1980s, 600 firms produced the Korean electronics output; the number of firms actually fell for some years, then increased in the wake of rapid acceleration of
output. Tatung, Taiwan's largest electronics company, had sales of US$500 million in 1984 (compared to Samsung's $10 billion in total sales and about $2 billion in electronics sales).

Why did the Taiwanese and Korean industries develop two quite different organizational forms? As noted above in Section II, Korea trailed Taiwan by about a decade in terms of per capita income and industry structure during the 1960s. Unlike Taiwan, Korea also experienced political conflicts and tensions (Cumings 1984). The Korean government was, therefore, under much greater pressure to strive for a "big push". In the industrial sector, one response to this "relative backwardness" (in the Gerschenkron sense) was the creation of conglomerates.

In the early years, conglomerates economized on scarce entrepreneurship. Conglomerates in Korea are the "first-generation products of a single driving entrepreneur," and until recently control has generally been concentrated in that individual (Jones 1987). Over time, the conglomerate has proved to be a versatile organization, and particularly appropriate for managing transitions. In transitional phases, firms need the ability to respond rapidly to changing conditions by investing in high-yielding projects. Williamson (1975, 1986) has argued that in such situations the impersonal capital market fails. Detailed knowledge of the project and the persons who will implement it, along with methods of monitoring, are required. The impersonal capital market does not have the knowledge required or the monitoring capability. In contrast, with well-managed conglomerates the "surgical precision" needed to identify and monitor projects does exist, making it a superior alternative to the capital market.

Conglomerates can also gain from economies of scope in manufacturing and in research and development (Teece 1980 and Hughes 1988). Moreover, when a conglomerate produces technologically related products, production can be shifted from one product line to another to ride out temporary fluctuations in demand (Levy and Haber 1986).

One method of promoting conglomerates in Korea was through channeling credit to favored firms. Particular sectors and firms had preferential access to working capital and were charged lower interest rates, for instance. Until the early 1980s, the cost of borrowing was lower for heavy industry and for large firms (World Bank 1987).

At the same time, adequate protection was provided against imports and from foreign firms' manufacturing in Korea. Television imports were

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4/ Scitovsky (1985, pp. 223-224) tells a similar story for the manufacturing sector as a whole.

5/ Conglomerates have been criticized for being over-bureaucratic and slow. Recent evidence from the United States is that conglomerates have narrowed their product ranges in the past decade (Williams, Paez and Sanders 1988). Restrictions on conglomerate growth in Korea are discussed in Section VI.
virtually banned until the early 1980s since televisions were a key product of the conglomerates. More recently, as Korean producers entered the personal computer (PC) market, severe quantitative restrictions were placed on PC imports. Direct foreign investment by foreign firms in these products was also almost completely restricted. Taiwanese firms were exposed to greater international competition. Unlike Korea, Taiwan relied on high tariffs to protect domestic production of key electronics items. Taiwan also permitted considerable foreign investment in its industrial sector (see Schive and Yeh, 1980).

Television production provides a good example of the different organizational conditions in Korea and Taiwan. Initially, four firms shared the growing television production in Korea. As parts of conglomerates, they were able to invest rapidly in large plants. Moreover, the experience and profits from their television production provided the technical and financial wherewithal to move into new products.

In contrast, Taiwanese firms (including Tatung and Sampo, which had Japanese joint venture partners) faced significant competition from foreign firms in the initial phase when production in Taiwan was still domestic market oriented. About a dozen firms produced television sets, and the domestic firms certainly did not account for the largest share of that output. As export possibilities became apparent, the domestic Taiwanese firms did not have the financial capability for rapid build up of capacity to achieve significant scale economies.²

Though both countries have been export oriented, the domestic market has played a more significant role in Korea. Korean electronics production started in 1959 with the assembling of radios, followed in the mid-1960s by production of black and white televisions and radio communication equipment. The impetus to electronics production was provided by the government’s import substitution policy: final goods that had been imported into Korea now began to be produced in Korea. Production was initiated by domestic firms, initially for the domestic market, on the basis of imported, "packaged" technology that "included assembly processes, together with product specifications, production knowhow, technical personnel and component parts" (Lim 1980).

Although a pure import substitution phase lasted only briefly (longer for radios than for other products), it had significant implications for the subsequent development of domestic technological capability. Product design and production experience were acquired through the process of implementing the packaged technology. Foreign technology suppliers played an important role in training local personnel. The need to import packaged technology was soon eliminated; the "mobility of experienced technical personnel was evidently the major mechanism for the diffusion of production technology within the country" (Lim 1980).

²/ Scale economies in television production are both technological and organizational (on organizational economies, see Jones, 1987).
In the more recent phase of electronics production, the domestic market in Korea has played a larger role: it has been not merely a training ground for launching into exports but a substantial source of demand in itself (Table 4). Between 1979 and 1984, the Korean domestic market doubled in size from US$3 billion to US$6 billion; over the same period, the Taiwanese domestic market grew from US$2.7 billion to US$4.3 billion. Thus, in 1984, the Korean domestic market was about 40 percent larger than the Taiwanese market. More significantly, the domestic sales possible for domestic producers (locally-owned firms and foreign subsidiaries) grew in Korea from US$1.4 billion to US$3 billion, while they remained relatively unchanged at about US$1.5 billion in Taiwan. These differences reflect:

- a Korean Gross Domestic Product that was about 30 percent higher than in Taiwan (Korea had a per capita income 50 percent less than in Taiwan but a population that was about twice the Taiwanese population);
- the Korean government actively developed the domestic market in key areas such as televisions by increasing the infrastructure for television broadcasting; and
- Korea's lower propensity to import, partly reflecting greater import restrictions.

Given export constraints in the early 1980s (because of increased competition, slowdown in world trade and protectionism), the Korean domestic market helped sustain growth and allowed Korea to push ahead of Taiwan.

Table 4
DOMESTIC MARKET FOR ELECTRONIC PRODUCTS
(US$ million)

<table>
<thead>
<tr>
<th>Year</th>
<th>Domestic Market (1) = (2) + (3)</th>
<th>Imports (2)</th>
<th>Sales by Domestic Producers g/ (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Korea</td>
<td>Taiwan</td>
<td>Korea</td>
</tr>
<tr>
<td>1976</td>
<td>1,081</td>
<td>1,194</td>
<td>699</td>
</tr>
<tr>
<td>1977</td>
<td>1,498</td>
<td>1,513</td>
<td>847</td>
</tr>
<tr>
<td>1978</td>
<td>2,088</td>
<td>2,450</td>
<td>1,156</td>
</tr>
<tr>
<td>1979</td>
<td>2,621</td>
<td>2,710</td>
<td>1,386</td>
</tr>
<tr>
<td>1980</td>
<td>2,308</td>
<td>2,250</td>
<td>1,440</td>
</tr>
<tr>
<td>1981</td>
<td>3,847</td>
<td>3,563</td>
<td>1,774</td>
</tr>
<tr>
<td>1982</td>
<td>3,785</td>
<td>3,731</td>
<td>1,979</td>
</tr>
<tr>
<td>1983</td>
<td>5,194</td>
<td>2,994</td>
<td>2,683</td>
</tr>
<tr>
<td>1984</td>
<td>6,102</td>
<td>4,289</td>
<td>3,136</td>
</tr>
</tbody>
</table>

g/ Production-Exports.
Source: Same as Table 1.
IV. THE EFFECTS OF MARKET FAILURES

Market failures occur, for example, when lumpy capital investment is required, when considerable uncertainty about the prospects of the new ventures exists, and when product and process technology is not easily available. When new opportunities arise, market failures can constrain their fruitful exploitation. At the firm level, these failures are seen as entry barriers. Such is the case in segments of the semiconductor and consumer electronics industries.

Korea is the third largest producer of dynamic random access memories (DRAMs), an advanced semiconductor product. It is expected that in the 1990s the Korean conglomerate, Samsung, will be among the top ten producers of DRAMs in the world. Korea is the world's second largest producer, after Japan, of video cassette recorders (VCRs) and microwave ovens. One in four VCRs and one in three microwaves sold in the United States come from Korea; one in five microwaves sold in the United States is made by Samsung. Five years ago Korea produced negligible quantities of these products. Taiwan is still an insignificant player in these markets.

Barriers to entry for consumer electronics products such as microwave ovens and VCRs are not as large as for semiconductors. However, even in consumer electronics large scales of production are important. Moreover, since some of the operations (such as assembling printed circuit boards) are common to the different products, economies of scope also exist. A key barrier is access to component technology: magnetrons in the case of microwave ovens, and recording heads in the case of VCRs. Samsung invested several years of reverse engineering effort toward the microwave oven but could not produce an acceptable magnetron. Japanese firms refused to sell magnetron technology. Samsung got lucky when a US producer of magnetrons was in financial distress; Samsung bought the firm (see Magaziner and Patinkin, 1989). In VCRs, Korean firms have been more successful in developing the required components although with substantial effort. Finally, for firms selling under their brand names, creating a reputation and developing market channels is a major task.

A. Semiconductors

The development of advanced semiconductor manufacturing capability marks a high point in the evolution of the Korean electronics industry and, indeed, must be considered a landmark in Korean economic development. Unlike the heavy industry development of 1970s, which was taken up largely at the behest and with the financial support of the government, semiconductor production has been the result of private initiatives.

Both Korea and Taiwan are aiming to become proficient in manufacturing semiconductor products that require a high degree of design and production skills. By no criteria can these products be considered mature or standardized. They are characterized by a high rate of technical change.
Moreover, because of large investment requirements, the markets for such products tend to be oligopolistic and to have high barriers to entry.

In entering such markets at the present time rather than at a later stage when the technology matures, the Koreans and Taiwanese are trying to anticipate their future needs. They are viewing semiconductor production and design capabilities as a necessary ingredient of industrial literacy and capability in the electronics era. As such, the value of semiconductor capability is seen as extending beyond the narrower concern of profits in semiconductor production. The pecuniary externalities deriving from efficient design and production of semiconductors, which will then feed into electronics systems, are the larger concern of this effort.

In such a situation, there is an obvious possibility of market failure, made all the more likely because of the entry barriers in international markets, as already noted.

It is my hypothesis that although the goals are similar, the Koreans will continue to be more successful than the Taiwanese because the evolution of their organizational structure—specifically, the growth of large firms—has placed the Koreans in a position to undertake major and risky investments. In contrast, the Taiwanese firms, because of their small size, are considerably more dependent on government support.

B. The Players

The principal firms in the Korean semiconductor industry all belong to the three major conglomerates: Samsung Semiconductor and Telecommunication, Goldstar Semiconductor, Hyundai Electronics. The fourth large conglomerate, Daewoo, has invested in a U.S. firm, Zymos. Developing country firms typically perform the labor-intensive tasks of assembly and packaging; some also process wafers for simple integrated circuits. The four Korean firms are all engaged in processing wafers for very large scale integrated (VLSI) circuits, the most complex and capital intensive activity in semiconductor manufacturing. Unlike Samsung and Goldstar, Hyundai did not progress through a consumer electronics stage but began directly by making computers and semiconductors.

The largest Taiwanese electronics firms (Tatung and Sampo) opted not to enter the semiconductor market. At the center of the Taiwanese semiconductor industry has been the Electronics Research and Service Organization (ERSO), established in 1975. It was set up with a grant from the Taiwanese government, and for a number of years government grants continued to be its main source of finance (see Lin, Shyi Ming, 1987 and Lin, Yeo, 1987). However, in the past few years, about 40 percent of its revenue has been generated by services it renders to electronics firms.

ERSO has its own integrated circuit (IC) production facility. A number of its services are related to production of ICs, but ERSO also is active in their design. The significance of ERSO to the Taiwanese semiconductor industry is that it has been the source of a number of "spin-offs".
The presence of ERSO has been critical to operation of new entrants. These entrants have cooperated with ERSO in design activities and used ERSO's production facilities.

The major Taiwanese manufacturer of semiconductors is United Microelectronics Corporation (UMC). UMC was spun off from ERSO in 1979. Till 1987, UMC was the only Taiwanese firm with wafer fabrication facilities. In 1987, the Taiwan Semiconductor Manufacturing Corporation (TSMC) set up a modern wafer fabrication plant. In the past few years, three Silicon Valley start-ups have shown an interest in setting up manufacturing facilities in Taiwan: Vitelic, Quasel and Mosel. These start-ups are using the production facilities of UMC or ERSO to train their employees, but they expect to have their own wafer processing capability in the near future. These firms have raised the bulk of their capital in the U.S., where they will also do their design work and marketing; Taiwan is to be used mainly as a low cost manufacturing base. All these firms are located in the Hsinchu Science Park, which in turn, is located within a few miles of ERSO.

The most ambitious Taiwanese venture is TSMC, which has drawn capital resources from the Taiwanese government, local banks and Phillips of Holland. Both the current and past TSMC presidents have come from U.S. industry; however, for its production and design staff TSMC is dependent on ERSO. TSMC is expected to become a world class semiconductor manufacturing facility (Electronic Engineering Times, October 26, 1987, pp. 26-28).

C. Samsung Semiconductor and Telecommunications (SST) and United Microelectronics Corporation (UMC)

To consider in more detail the differences between Korean and Taiwanese industry, I examine the scale of operations and performance of the leading semiconductor firms in the two countries--SST and UMC. The large gap between the two firms in terms of sales, production scale, and processing technology may be seen from Table 5.

2/ I shall discuss below the significance and prospects of TSMC.
The superior ability of SST to invest in semiconductor production arises from a set of interrelated causes. Not only is SST much larger than UMC, but it is also, unlike UMC, part of a large family of companies. Not many are privy to whether and how internal transfers of funds take place; it is known, however, that the companies act as loan guarantors for each other. This is crucial since SST is a very highly leveraged company. During the period 1981 to 1984, SST's debt-equity ratio fluctuated between 260 percent and 450 percent. Some indicators of intercorporate financial support are the following:

- During 1985, SST's share of the total sales of the Samsung group was about 2.5 percent while its share in the total investment of the group was about 33 percent (The Daishin Review, June 1985, p. 7).\(^8\);

- Even within SST, revenues have been generated principally by its telecommunications products while recent investment has gone mainly for augmenting semiconductor production capacity;

- In 1987, SST sold semiconductors worth US$350 million and made investments worth US$580 million (B.E. Electronics, August 1988). In view of these heavy investments, in late 1988 SST was formally merged into the parent company, Samsung Electronics.

In contrast, Taiwan's UMC has no big brother. Initial investors in UMC included the Bank of Communications, China Development Corporation,

\(^8\) The total investment of the Samsung Group in 1985 was about US$1.5 billion, of which SST accounted for US$500 million and semiconductors for US$250 million.
Kuang Hua Investment Co. and electronics manufacturers such as Teco, Sampo and Walain-Lhwa Electric Wire and Cable Corporation. The UMC debt-equity ratio in 1984 was 91 percent. Early in 1985, UMC went public to finance part of its projected capital expenditure of US$100 million over the next three years.

SST's rapid movement toward the technology frontier has meant considerable dependence on external sources of technology. The principal links have been with Micron Technology of Idaho, USA and with the Belgium-based Bell Telephone Manufacturing (a subsidiary of International Telephone and Telegraph of USA). There has also been a less publicized technical link with Sharp of Japan, and recently a major and highly publicized tie-up with Intel of USA. Intel is widely regarded as a world leader in a range of micro-electronic products, particularly microprocessors.

The links with Intel are noteworthy and point to an important feature of the technology market. Intel is generally reluctant to part with its highly valued microprocessor technology unless it expects a major quid pro quo. In allowing Samsung to produce its microprocessors, Intel is betting that Samsung will be able to popularize the microprocessor architecture. Dr. Robert N. Noyce, Intel's vice chairman, visited Korea to sign the contract with Samsung. At a press conference he said: "We believe Samsung's experience in manufacturing and their commitment to this sector will help spread the presence of the Intel architecture in the Pacific basin to our mutual benefit." Thus, Samsung's reputation has played an important role in its ability to acquire technology.

Acquisition of foreign technology has not been a straightforward exercise. In 1985, Texas Instruments accused Samsung of patent infringement. Under the threat of having its DRAMs banned from the US market, Samsung ended up paying almost US$100 million as royalty to license these patents. Samsung is also embroiled in another patent infringement with Standard Microsystems. Possibly in anticipation of these roadblocks, Samsung has made significant internal attempts to absorb and develop technology. Like other Korean firms, SST has set up a subsidiary in California's Silicon Valley to develop new products and technologies. SST also has a large design facility (employing over 600 engineers) in Korea; this facility is expected to design several hundred new products a year. Finally, and possibly most important, the parent company, Samsung Electronics, has an R&D budget of about US$100 million as of 1989. This research is focused on optical fibers, switching systems, local area networks, and office and factory automation (Korea Economic Report, March 1989, p. 35).

Developments in all these areas have a central impact on the developments in semiconductor technology. The close synergies thereby made possible are a major factor in the efficiency of research at Samsung. A major

2/ See Business Korea, March 1985, p. 62.

10/ Hyundai was unable to sustain its Silicon Valley operations and shut them down in 1985 (San Jose Mercury News, October 1, 1985).
feather in Samsung's cap was its recent 13-year cross licensing agreement with IBM. Under this agreement Samsung and IBM will have full access to each other's current and future patents on semiconductors. Samsung will pay a large fee to IBM because Samsung's patent portfolio is much smaller. However, even for a fee, IBM does not allow access to its patent portfolio unless it believes that the collaborating company's research is of considerable significance.

UMC has, in contrast to SST, a much more home-grown technology. Since its formation, UMC has relied to a large extent on its own engineers. About 25 percent of UMC's employees are engineers (not all, of course, being design engineers) and another 20 percent are technicians; these are significantly larger proportions than prevailing in US semiconductor firms.

As noted, UMC's management came from ERSO, which also sold the newly formed company a number of its product and process technologies. There is, of course, an indirect foreign link, since ERSO had an early collaboration with RCA of USA. Recently, UMC has cooperated with MoseI and Quassel in the development of some products. This points to a recurring theme in the Taiwanese context, but which is almost completely absent in the Korean context: the cooperation among competing firms.

Finally, UMC has established a presence in Silicon Valley. The UMC outpost, known as Unicorn, is much smaller in capital and labor strength than its Korean counterparts; it is expected to design custom chips for UMC and eventually for outside buyers.

D. Consequences of Market Failure

In the face of market failures, realization of the potential comparative advantage can be done either with or without government intervention. Government intervention is not required when existing firms are capable of handling the market failures through their internal mechanisms. When existing firms are not able to internalize market failures, government intervention can serve a facilitating function. Typically, this takes the form of subsidizing the emerging activities. The subsidies can take place through cheap capital, creation of science parks to provide agglomeration economies, and promotion of research institutes to facilitate technology transfer to domestic firms.

Korea and Taiwan have taken different paths. In Korea, the conglomerate's ability to cross-subsidize has been central to the development of the semiconductor industry. This accords with Williamson's more general conclusion on conglomerates (Williamson, 1975 and 1985). Williamson treats the conglomerate as a special form of the M-form corporation and, as noted above, describes the main virtue of these organizations as their ability to substitute an internal capital market for imperfect existing markets.

In contrast, in Taiwan the market failure has been tackled largely through the government. Thus, although the Taiwanese savings rate and the flow of capital from overseas Chinese have provided low cost capital in
Taiwan, the semiconductor industry's experience shows that when there are significant risks and when the process technology is not freely available, the role of the government becomes important in encouraging the industry. Overseas Chinese have begun to establish semiconductor activities in Taiwan (for example, the firms Vitelic, Mosel and Quasel), but this has come after ERSO's efforts over a decade and with its design and production support. Set up with considerable fanfare, Mosel and Quasel have not performed well, and Vitelic's commitment to Taiwan is unclear. It continues to act as a design house based in Silicon Valley, though there has been some discussion of setting up manufacturing in Taiwan.

The most significant development in the Taiwanese semiconductor industry is the setting up of the Taiwan Semiconductor Manufacturing Corporation (TSMC). As noted above, TSMC is expected to become a world class facility in its wafer handling capacity and ability to draw fine linewidths. However, it will be considerably smaller than Korean firms in its scale of operations. In backing this facility, the Taiwanese government has placed its bet on the so-called application specific integrated circuits (ASICs). Unlike mass produced semiconductors, ASICs are tailored to specific needs and are produced in smaller volumes. Under the presumption that economies of scale are not important in the production of ASICs, Taiwan has chosen the "niche" market strategy. Its vision is that the several small design houses that have sprung up in the Taipei and Science Park area will provide designs customized to end-user requirements, and TSMC will manufacture them.

TSMC's prospects will depend very crucially on whether their assumptions about ASICs production and design are indeed borne out. As ASICs production is maturing, economies of scope are emerging. This is manifested in the increasing share of large established firms in ASICs production. At the manufacturing level, large firms are coordinating production lines so that the move from standardized products to ASICs is made easy. In the design area, sophistication of design depends upon access to "libraries", which consist of circuit elements of various kinds. Small firms cannot develop and support large libraries. If such economies of scope eventually predominate, it is likely that Taiwan will have to rely very much on low value-added ASICs.
V. ABSENCE OF MARKET FAILURE

What does Taiwan do best? Taiwan responds swiftly to new market opportunities, provided entry barriers are not high. The strong presence of small and medium-sized firms makes the Taiwanese electronics sector very flexible. These firms use relatively labor-intensive techniques (the smaller ones rely on female production labor and the medium-sized firms compete on the basis of their engineering talent). Flexibility is made possible by well-developed marketing and information networks. In this section, I will describe Taiwanese and Korean performance and strategy in a few products that are not handicapped by high entry barriers.

A. Telephones

In the spectrum of electronics products, telephone sets are a relatively unsophisticated product. The components for assembling low-value telephone sets are readily available, and assembly technology is widely known. In 1983, a surge in U.S. demand for telephone sets followed the deregulation of the telecommunications market. The Taiwanese were able to respond very rapidly to the increased demand. A large number of firms, both old and new, entered the market, increasing Taiwanese production of telephone sets from 3.5 million in 1982 to 26 million in 1983. The flip side of this flexibility is, of course, the much greater variability in production. In 1984, demand for Taiwanese telephones slackened off because of problems with the sets sold in the previous year and because of frequency changes in cordless phone transmission and reception. Taiwanese production fell to 12 million sets but climbed again to 21 million sets by 1987. The Korean response was slower: in 1983 total production of telephone sets was 7 million; since then Korean production has developed steadily: 10 million phones were produced in 1987.

Telephones, however, are not a standardized commodity. As the market has developed, phones have sold for their "features" as well as for their price. Have Taiwanese firms done well in terms of features? In the early years, an average phone from Korea and Taiwan was a low-end product. In 1984 the unit value of a Korean or Taiwanese phone sold in the US was US$21 while a Japanese phone typically sold for US$61 (Table 6). By 1987, an average telephone from Korea cost US$27 and one from Taiwan cost US$12 (a Japanese phone in that year cost US$55). The difference between the price for a Korean and a Taiwanese phone arose because almost 60 percent of Korean phones were higher-valued multiline phones, whereas only 7 percent of the phones from Taiwan were multiline. As a consequence, although Taiwan continued to sell more phones, the gap in total value narrowed considerably.
Table 6: U.S. IMPORTS OF TELEPHONES

<table>
<thead>
<tr>
<th></th>
<th>1984</th>
<th></th>
<th>1987</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity</td>
<td>Value ($ million)</td>
<td>Unit Value ($)</td>
<td>Quantity</td>
</tr>
<tr>
<td>All Phones</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td>2</td>
<td>42</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>Taiwan</td>
<td>6</td>
<td>130</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>Japan</td>
<td>3</td>
<td>182</td>
<td>61</td>
<td>4</td>
</tr>
<tr>
<td>Single-Line Phones</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Taiwan</td>
<td></td>
<td>14.3</td>
<td>169</td>
<td>12</td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td>2.5</td>
<td>119</td>
<td>47</td>
</tr>
<tr>
<td>Multi-Line Phones</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td>1.9</td>
<td>75</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td>0.35</td>
<td>12</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>1.5</td>
<td>103</td>
<td>70</td>
<td></td>
</tr>
</tbody>
</table>

Note: Number have been rounded off; unit values were calculated before rounding off.


B. Computers and Peripherals

Not only did the Taiwanese get off to a quick start in "cloning" early Apple computers but they also responded rapidly to the introduction of the IBM personal computer (PC). If and when the Apple's Macintosh computers are cloned, they are expected to come from Taiwan. Taiwanese firms have recognized the high growth potential of this sector and have focused on various products within the sector. In 1987 almost 30 percent of Taiwanese electronics output was electronic data processing, the umbrella under which computer and related products are classified.

However, the advantage of size has not been unimportant even in this sector. Daewoo and Hyundai in Korea have begun marketing large volumes of personal computers. Korean firms have invested several hundred million dollars in new computer plants to improve efficiency and have been pricing their products aggressively to gain market share. The Korean firms also have the advantage in quickly switching their factories from television and VCR
production to computers if necessary. Daewoo and Hyundai have emerged among the top ten producers of low-end personal computers sold in the United States; Acer Corporation is the Taiwanese representative on that list.

In 1984 Taiwan had a 13 percent share of the U.S. market for low-end computers whereas Korea had less than a 4 percent share. By 1988, Taiwanese firms had gained 5 percentage points to reach an 18 percent market share, whereas Korean firms had gained 10 percentage points and had 14 percent of the market (see Figure 3 (a)). Once again the gap was narrowed through better Korean performance in unit value of goods sold.

Over the four years a very striking change occurred: in 1984, Taiwanese unit value was three times that of the Koreans, but by 1988 the Korean unit value was 15 percent higher than that of Taiwan (Figure 3 (b)). (In two of the last three years, the Korean unit value has been higher than the unit value of Taiwanese exports.) Moreover, in this case, unit values probably underestimate the extent of quality and value-added differences between products originating in the two countries since the larger Korean firms have been more aggressive in their pricing strategies. The unit values in Figure 3 (b) are plotted relative to Japanese unit values. The Korean and Taiwanese unit values rose relative to Japanese unit values in the initial years after these countries entered the market; however, since 1986 they have not been able to gain on the Japanese. This suggests that Koreans and Taiwanese are able to make the early easy quality improvements but then find it more difficult to catch up.

Some Taiwanese computer firms, such as Acer (the largest) and Mitac, have acquired a reputation for high-quality products. However, the bulk of Taiwanese exports comes from small producers who generally assemble part of the PC from standard components. These are sold in the United States through retailers who add value by doing further assembly, writing manuals, providing a brand name, and handling after-sales service. Korean producers, especially Daewoo and Hyundai, add more value than the average Taiwanese producer. Their computers are also identified by brand names (Daewoo and the producer of Leading Edge, and Hyundai by its own name).

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Daewoo's Model D received a 'Best Buy' rating from Consumer Reports. The competitive strength of Korean PCs has been widely described in the commercial press; see, for example, Business Digest of Southern New Jersey, May 1986, pp. 18 and 21 and The Wall Street Journal, November 6, 1986, p. 12. Korean producers have also been successful in more sophisticated markets. An example is a highly priced competitive color graphics and publishing workstation designed and manufactured by SST and distributed by MicroDirect (News Release, July 29, 1986, p. 1).
Figure 3(a): Import Shares in U.S. Market for Low-End Computers


a. Import shares are based on value of imports.
b. Low-end computers are defined here as import categories 6761520 and 6764530.
Figure 3(b): Relative Unit Value of U.S. Imports of Low-End Computers


a. Unit value of computers from Korea and Taiwan are measured as a percentage of unit value of exports from Japan.

b. Low-end computers are defined here as import categories 6761520 and 6761530.
Finally, when we consider computer monitors, the basis for an interesting theme emerges. Of the three product groups considered in this section, monitors are the only product in which Taiwan has maintained a significant lead over Korea in unit value. The production of monitors in Taiwan is dominated by Tatung, which has had a long relationship with IBM and in fact has been the main supplier of monitors for the IBM PC. Tatung has had the time, resources and stability to invest in high-reliability monitors. The resources required have not been as large as for the more advanced products discussed above. Tatung has also been able to use its television production expertise to good use. Since monitors are not sold on a brand-name basis, Tatung has not suffered from any disadvantage vis-à-vis Korean competitors. At the same time, the stable relationship with IBM has been an advantage.

There is a pattern in these three case studies. Telephone production in Taiwan is dominated by small firms. Korean firms, having started late, have grown steadily in production volume; the unit value of telephones from Korea is about twice the unit value of telephones from Taiwan after having been the same in the early 1980s. Personal computers in Taiwan are produced by a mix of companies, some of which are medium-sized and dynamic, but a large number of which are small. Once again the Korean firms started later than the Taiwanese firms but have caught up and slightly exceeded Taiwanese firms in the unit value of the products sold. Of the three products considered, computer monitors is the only one in which Taiwan has maintained a lead in unit value of products exported. The largest Taiwanese electronics firm is the major producer of monitors in Taiwan and, moreover, it has close links with IBM.

C. Discussion

Is a "niche market" strategy a viable one for Taiwan in the long run? Can Taiwan continue to move from one product to the other with continuing agility?

The term "niche market" is used in different ways. Sometimes it denotes a high-quality product, such as a sports car or a telephone with special features. However, high quality is not a necessary characteristic of a niche product. Often a small, emerging market is called a niche market. For example, not long ago personal computers were a "niche product"; more recently, workstations were regarded as being a "niche".

The similarity between the two types of niche products is that their aggregate market is expected to be small. However, in an economic sense, they are quite different. The ability to produce high-quality products depends upon a sustained level of investment in product design and engineering. The ability to enter a new, emerging market depends upon access to information on market trends, product specifications and standards, and

12/ Monitors are the only significant computer peripheral exported from either Korea or Taiwan.
sources of input supplies. A high-quality product can persist as a low-volume product for a considerable period of time, as barriers to entry are maintained through high product performance and brand identification. No similar prediction can be made about emerging products. As long as they represent small markets they do not attract many competitors.

Although both countries have been making an effort to upgrade their product quality, neither Korea nor Taiwan has yet acquired a reputation for high quality products. The niches that Taiwanese producers seek are new emerging markets. Thus, at the early stages Taiwanese firms have a competitive advantage; however, as the market grows to include larger firms, smaller Taiwanese firms are not able to remain competitive. They need to move on to a new product. Taiwanese firms thus follow a niche strategy that is different from that of many European firms. European firms typically produce very high quality products customized to end-user needs; their success depends upon access to advanced design and production skills and requires continuing investment in product development.

The key difference between Korea and Taiwan is the time at which they enter a market. If entry barriers are not high at the start, Taiwanese information systems allow them very quickly to enter emerging markets. In comparison to Taiwan, Korea is much slower, even though its information gathering process is as efficient as that of the Taiwanese—the difference is that the Korean search process takes longer. Since the Koreans make a significant commitment to a product, they look for greater assurance regarding its eventual success. Since the costs of exit from the market are much higher for the Koreans than for the Taiwanese, the Korean decision process needs to be more deliberate.

Once the Koreans commit themselves to a product, they have greater resources and a greater incentive to add value or upgrade quality. Taiwanese firms have a lower incentive because they have the relatively easy option of moving on to a newer product. In recent papers, analysts (Chiang and Masson, 1988, and Rodrik, 1988) also have concluded that the unit value of exports from Taiwan will be lower than from Korea. They look at the problem from the demand side and argue that since foreign buyers cannot examine the quality of each of Taiwan's many small producers, they will offer a price that reflects a perceived "average quality". This results in a low incentive to upgrade quality at an individual firm since the average quality, and hence price received, will change very little when there are large numbers of competing firms.

The argument is not fully convincing. Even small Taiwanese producers have mechanisms for making known the quality of their products.

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13/ This is so not only in electronics but also in many other areas. One example is recreational bicycles. Almost immediately after they emerged as a market in the United States, Taiwanese producers quickly geared up to produce them.
Taiwanese firms have over the years acquired a reputation for delivering the quality that they commit themselves to. Often they work directly with large buyers who can evaluate product quality at the firm level. A more important factor determining Taiwanese quality levels is that small firms have the easy option of moving into new markets at equivalent technology levels but have limited technical and financial resources for sustained quality improvement.

However, the current practice of shifting from one product to the other without investment in higher quality could come under pressure as lower-wage countries start encroaching upon Taiwan's areas of competence. In this sense the Taiwanese structure has "excess flexibility".

One implication of the above line of reasoning is that at any given time Taiwan is likely to be producing more products than Korea. To empirically test this proposition, I examined whether the Taiwanese production structure is more diversified than that of Korea. I was able to obtain comparable data for the period 1982 to 1988 for 31 product categories. The measure of dispersion used was the inverse of the coefficient of variation. Until 1985 Taiwanese production was in fact much more dispersed than Korean production (Table 7). After 1985, Taiwan moved heavily into electronics data processing (in 1988, 29 percent of Taiwanese production was expected to come from this category). Unfortunately, no breakdown for this category is available, and hence the measure of dispersion shows that Taiwanese production is becoming more concentrated. In fact, the Taiwanese firms are probably producing many different data processing products. I recalculated the dispersion for sectors other than electronics data processing, and these numbers indicate that Taiwanese production was considerably more dispersed over the entire seven years.

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14/ A larger value of this measure indicates greater dispersion. The intuitive interpretation of the measure is as follows: a high coefficient of variation indicates that production is concentrated in a few sectors; the inverse, therefore, is a measure of dispersion. I also calculated the share of each product in the total (for the 31 products) and calculated the 'entropy' of these shares to measure diversification. A larger value of entropy signifies greater diversification. Although the entropy measure is less sensitive than the measure used, the results were the same.
Table 7: DISPERSION OF PRODUCTION IN KOREA AND TAIWAN g/  

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<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>0.72</td>
<td>0.62</td>
<td>0.59</td>
<td>0.74</td>
<td>0.78</td>
<td>0.74</td>
<td>0.70</td>
</tr>
<tr>
<td>Taiwan</td>
<td>0.89</td>
<td>0.89</td>
<td>0.89</td>
<td>0.75</td>
<td>0.62</td>
<td>0.57</td>
<td>0.52</td>
</tr>
</tbody>
</table>

Including EDP b/  
Korea  
Taiwan  

Excluding EDP  
Korea  
Taiwan  

g/ Dispersion is measured as the inverse of the coefficient of variation of production in 30 comparable product categories. Details of these categories can be obtained from the author.

b/ EDP = Electronics Data Processing  
Source: Yearbook of World Electronics Data, Bena Electronics Publications, London (formerly known as Macintosh Yearbook of World Electronics Data), various issues.
VI. WHAT DOES THE FUTURE HOLD?

Taiwan has a potential choice. It can go the way of European niche producers targeting high quality, low volume products; or it can follow the Korean (and Japanese) strategy of producing standardized products in larger firms. I shall argue in this section that current trends indicate that Taiwan is veering towards the latter route.

A. Medium-sized firms

The growth of the computer industry in Taiwan has been driven largely by medium-sized new entrants. Such firms have also emerged in Korea, but they have been dominated in terms of total output by the larger Korean firms. The medium-sized firms become viable when their aggregate sales are in the region of US$20-$25 million and employ a few hundred people. Some of them in both countries have grown considerably beyond that level. These firms are started by the entrepreneurs among the large engineering talent produced in both countries. In Korea, firms are often established by engineers who have worked with large firms. Typically, they are set up to supply a specific domestic need that the larger firms do not meet.

In both countries a technical and financial infrastructure to support these firms is a serious government priority. The technical support is provided in Taiwan by ERSO and in Korea by the Electronics and Telecommunications Research Institute. Moreover, Korea has recently sought to redress its bias against small and medium firms by creating specialized venture capital firms to finance the growth of innovative ideas (for details, see Monthly Review, 19 (7), July 1985, Korea Exchange Bank, Seoul). The Taiwan government has approved the establishment of two private venture capital firms. In addition, the Bank of Communications, the China Development Council and the National Science Council have been sources of finance for new start-ups.

These medium-sized firms are mainly engaged in the design and assembly of computer systems. Their chief contribution has, in the past, been in meeting the requirements of small market segments (or niche markets) both within the country and in Southeast Asia. The medium-sized firms, therefore, require, and possess, a design capability, not merely in software production, but also in introducing hardware modifications. The fact that the comparative advantage of these firms is based on design capabilities, rather than on manufacturing capabilities, is worth noting. This represents a change from an earlier period when the comparative advantage of newly industrializing economies (NIEs), such as Taiwan and Korea, depended on the low cost of production workers; the new advantage stems from the low cost of engineers.

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15/ These are the Asiatic Venture Capital (registered capital of $20 million) and Sino Scan Venture (with a capitalization of $5 million). This information is based on a private communication from Mr. Barnaby Powell, dated January 21, 1986.
The medium-sized innovative firm exploits best the current comparative advantage of NIEs that have a significant base of engineers. Rather than producing components and subassemblies for computer systems, these firms exploit the possibilities presented by new components (or hardware) that US and Japanese firms continuously turn out.

The production of hardware is increasingly capital intensive because of the trend towards automation. This applies not merely to semiconductor devices such as microprocessors and memories (as was described above) but also to computer peripherals, such as floppy disc drives and printers, which require a high degree of precision engineering. As such, few firms based in NIEs have the capability to undertake cost efficient production of the major parts and subsystems that go into micro and mini computers. Nevertheless, it is easier to conceive of, and implement, new combinations of hardware that permit improved system performance. The new combinations may be based on existing hardware and exploit the fact that the mass produced systems do not meet every requirement, or they may be based on new hardware. In this respect, being a latecomer is an advantage, since an older producer may be locked into an existing design and constrained by hardware that was available when the design was made.

The difficulty with low-end niche markets is that they do not exist forever. As was noted above, they shrink, disappear, or grow into mass markets. In the latter case, niche producers face all the difficulties of gearing up to mass production. In imperfect capital markets, their ability to raise capital is limited. But perhaps the main problem lies in their inability to compete with the major players in the computer market. For example, even in the Chinese-language computing systems, where Acer (then known as Multitech) and Mitac had an early lead, and are possibly still the world's largest players, the competition is severe:

"While companies in Taiwan were working the bugs out of their Chinese-language systems, some of the world's largest computer firms, eager to protect their market position in non-English speaking countries were also hard at work on multi-lingual systems. Reducing the vast diversity of the world's writing systems to a unified system of binary codes has been the object of considerable investment by Wang, IBM and Hewlett-Packard to name a few...." (Asia On-Line, January 1985, pp. 9, 11).

This example illustrates how a niche market can evolve into a mass market and attract major producers. In such a situation, it is difficult for the original medium-sized firms to remain competitive. They have to seek new niche markets or get absorbed into larger firms.

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16/ The problem is somewhat mitigated in the case of Acer and Mitac since both these firms derived revenues of the order of $40 million from their trading activities in 1985; these revenues have possibly grown since then.
It is possible that a few such firms may succeed and grow into large firms with greater competitive power. Acer has been a striking example of this possibility. Sales in 1988 were US$550 million compared to US$50 million in 1983. Size is an avowed goal at Acer, and the magic figure of US$1 billion is the corporate target. Acer is one of the few firms able to move into successive new niche markets as competition has increased in its domain. Recently it moved into the area of designing chip sets for cloning various IBM personal computers. This has been a relatively small, niche market dominated by a few U.S. firms, such as Chips and Technologies and Western Digital Corporation. In 1988, the total market of IBM-compatible logic chip sets was expected to be US$145 million. However, it also is expected to be a market with significant growth potential. Hence major international firms, including Intel, National Semiconductor, Fujitsu and Toshiba, are planning to enter this market (Electronic Business, April 15, 1988, p. 30-31). Acer will then be faced with greater competition.

However, Acer's success has come largely from production of standardized products (mainly a line of IBM-compatible personal computers). Acer has effectively used its design skills in rapidly cloning, and in some instances improving upon, standardized products. It has leveraged its design skills by installing a modern, highly efficient manufacturing facility. Thus, although Acer will continue to produce niche products, its main cash flow is likely to be generated by standardized products. In this respect, Acer is moving closer to the structure of Korean firms.

B. The Viability of Small Firms

In contrast to medium-sized firms, small firms (firms with sales in the range of US$1-$2 million and about 20 employees) are not likely to be viable for long in either country. These firms have played a major role in the export thrust of both economies in the past. They have produced labor intensive products with low design content. Typically, they have operated in markets where products are standardized, production technology is well known, and there are no economies of scale. As such, low input prices have been the critical factor for competitiveness.17/

The most important input for small firms has been cheap female labor. Factory workers (as distinct from technicians and engineers) in the electronics industry have largely been young women; about 75 percent of female factory workers fall in the 15 to 24 age group (Diamond, 1979, p. 320). Curiously enough, the female labor market has almost entirely been viewed from the demand side. It is recognized that female labor is paid significantly lower wages than male labor for comparable work. It is also recognized that

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17/ In contrast, larger firms, even when operating in commodity markets, have to deal with scale economies, learning by doing within the firm and other such factors which call upon the organizational and human resources of the firm. Input prices while always important are often not the critical determinants of competitiveness.
when technical change causes the demand for cheap labor to fall, the demand for unskilled female labor declines. Technical change is usually taken to be exogenous, with female labor participation merely a reflection of these changes. In comparing Korea and Taiwan, however, it turns out that this view of female labor participation is limited. Female labor supply has a dynamic of its own that can influence the pace of technical change and organizational evolution (for a similar view, see Koo, 1984, and Liu, 1984).

Accompanying the changes in product structure described above was the change that occurred in the structure of the labor force. The number of Korean electronics factory workers (mainly unskilled females) fell from 126,000 in 1978 to 83,000 in 1982; over the same period the number of technicians and engineers (mainly males) increased from 34,000 to 42,000. A similar change took place in some sectors of the Taiwanese electronics industry, but the pace was much slower than in Korea. The share of women in the Taiwanese workforce was around 70 percent between 1978 and 1984. In Korea, the share fell to less than 60 percent.

Taiwan has a younger population than Korea. In 1987, 28 percent of the Taiwanese female population was in the age group 15-24 compared to only 20 percent of the Korean female population. Participation rates (proportion of female population in the workforce) have been much higher in Taiwan than in Korea (Table 3). More significantly, participation rates have been falling more steeply in Korea. The decline in Korea is related mainly to rising expectations; female school enrollments, for example, have risen sharply (Park 1985). Even within the available labor supply, an increasing number of workers are going into services and clerical work rather than to shop-floor production.

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18/ The data for Korea is from the Electronics Industries Association of Korea and that for Taiwan was provided in a private communication by the Council for Economic Planning and Development, Taiwan.

19/ Michell (1983) has also argued that the Korean services sector has exercised a pull on relevant female labor force by offering wages higher than in the factories. No similar effect has been noted for Taiwan.
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<tr>
<td>15-19</td>
<td>947</td>
<td>976</td>
<td>936</td>
<td>910</td>
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<td>20-24</td>
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<td>937</td>
<td>977</td>
<td>965</td>
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<tr>
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<td>340</td>
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<td>586</td>
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<td>15-19</td>
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<tr>
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<tr>
<td>Female Employment ('000 workers)</td>
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<tr>
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<tr>
<td>Participation rate g/</td>
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<td>20-24</td>
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<td>45</td>
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</tbody>
</table>

\[g/\text{Participation Rate} = (\text{employment/population}) \times 100.\]

Source: 1. International Labor Office *Yearbook of Labor Statistics*, various issues
2. Taiwan (Republic of Korea) *Statistical Yearbook*, various issues

Taiwanese reliance on cheap female labor may similarly have to decrease in the near future. The Taiwanese female population between the ages 15 and 19 is not being replenished, and labor participation rates are falling, even if slowly. Certainly such labor is going to be cheaper in Thailand and China. Taiwanese themselves are beginning to seek low-wage labor in China for products such as footwear, garments, and electrical and electronics products. "Small" firms have traditionally produced these products but it is unlikely they will continue to produce them for long.
C. Convergence of Production Structures?

Coming closest perhaps to the strategy of the Korean firms has been the series of recent moves by Nan Ya Plastics of Taiwan. Nan Ya is not only the largest firm in Taiwan but is twice the size of Tatung, which is currently the largest electronics firm. In addition, unlike Tatung and more like the Korean firms, Nan Ya is part of a web of relationships involving many major Taiwanese firms. In collaboration with Hewlett Packard (HP), Nan Ya set up a fully automated multi-layered printed circuit board facility. Setting up the facility provided the experience that led to the formation of a joint venture with HP for the production and sale of factory automation software. In addition, HP and Nan Ya have signed an agreement to produce the HP-3000 series minicomputers.

In the meantime, Tatung has grown impressively: between 1984 and 1987, sales more than doubled from US$500 million to US$1.2 billion.\textsuperscript{20} Tatung's impressive performance, the entry of the largest Taiwanese conglomerate, Nan Ya into electronics, the emergence of Acer as another heavyweight, and the declining viability of small firms suggest that Taiwan may be moving to a structure not dissimilar from Korea's.

At the same time, there has been a growth of small and medium-sized technology intensive firms in Korea working both independently and in subcontracting relationships with the larger firms. As the Korean economy matures, this base of smaller firms will be necessary for providing flexibility to the economy. Large firms have taken on the world on their own but increasingly need to contract out specialized production and design tasks to smaller firms. This process is occurring slowly but inevitably.

D. What of the Korean conglomerates?

In November 1986, the Economic Planning Board in Korea introduced the Monopoly Regulation and Fair Trade Act, partly to limit the economic power of conglomerates (\textit{Financial Times}, August 18, 1987, p. 3). There has also been concern that as the new generation of entrepreneurs replaces the first generation who created the conglomerates, the dynamism of the firms may diminish (\textit{Far Eastern Economic Review}, June 18, 1987).

However, the current momentum ensures that large Korean firms will continue to make headway. They have established much greater brand name presence (hence, credibility and higher profit margins) than Taiwanese firms. Increasingly, the integrated nature of the Korean firms is allowing them to take on tasks ranging from design through manufacturing to marketing. In

\textsuperscript{20} A word of caution is needed here. According to my interviews in Taiwan, the links between firms in Taiwan are more subtle than in Korea. Thus the total size of a Taiwanese conglomerate is likely to be larger than is publicized. However, given the large differences indicated above, there is little reason to doubt that the Korean conglomerates are much bigger than their Taiwanese counterparts even when the subtleties are accounted for.
other words, Korean firms are breaking out of subcontracting relationships. And they are doing this in relatively new and sophisticated products. For example, if one believes the tea leaves as reported in the trade journals, Korea is going to be a major player in increasingly sophisticated computer networks. Since the world is moving towards greater systems integration, such capability will allow not only greater profit margins on products but also increased efficiency of internal operations.

In speculating on the future, I visualize Korea as a substantial player in world markets with stakes in a number of products, with alliances with major international firms, and with the ability better to withstand fluctuations in international markets. That does not mean Korean firms will not make serious mistakes—as they almost did in semiconductors. Their "big pockets" will be a help, and windfall gains, such as those arising from the U.S./Japan semiconductor trade pact, will not be unwelcome.

Taiwanese firms will continue to act principally as subcontractors, supplying parts or subsystems as their main revenue source. However, they will become increasingly sophisticated subcontractors. The ability to move from one niche to another will sustain a number of firms. A few firms will graduate to a more stable existence in which they will organize efficient manufacturing as an important ingredient for success. These firms could come to dominate Taiwanese production in the next decade.

It is tempting to infer that Korean firms’ large investments make their strategy more risky. As I have suggested above, the Korean search process is also more intensive—precisely because they make large investments. A good search does not imply perfect judgement; thus it is likely that when a mistake occurs the consequences will be more dramatic than in Taiwan. However, there is no evidence that the extent of errors or their overall impact is greater in Korea than in Taiwan.
VII. CONCLUSIONS

A number of observations made in the context of the electronics industry apply more generally. Small firms are a pervasive feature of Taiwanese industry, while conglomerates dominate many major sectors in Korea. The domestic market in Korea has generally been more protected than in Taiwan. Since 1975, the share of exports that can be characterized as labor intensive has fallen in Korea and has slightly increased in Taiwan (Yeats 1989). The diversity of products exported by Taiwan has been higher than in Korea, though the difference has narrowed over time (GATT 1988).

The ability of a country to respond to changing opportunities depends on institutional capabilities for flexible response. Both Korea and Taiwan have demonstrated that the effective development of institutions to mobilize resources and execute strategies is essential to economic development. I have focused on the Korean advantage over Taiwan only because the paradoxical situation of Korea's being a less developed economy than Taiwan, and yet leapfrogging over Taiwan in important respects offered the possibility of demonstrating clearly the role of institutions.

Both Korea and Taiwan have treated endowments such as physical capital and skills as endogenous to the process of changing comparative advantage. Korea has become strongly creative only in the past decade. Taiwan probably has a longer history of creative activities, though, as described in this paper, some of the options open to Korea have not been open to Taiwan in recent years. Taiwan has used a variety of productivity, research, standardization and marketing institutions to gather and disseminate information to its firms. These institutions often have been financed in their initial phases by the government, but their success has depended upon industry participation. For the types of products that Taiwan produced until recently, such institutions functioned perfectly well. Indeed, Taiwan has continued to perform very impressively, and institutions such as ERSO and its parent organization, the Industrial Technology Research Institute, have played a critical role. For many developing countries seeking to manufacture similar products, such support institutions would perhaps be more relevant than the Korean-type conglomerates.

Moreover, countries producing labor intensive manufactured goods need to invest in creating a reputation. Despite its many small firms, Taiwan is able to sell large volumes of manufactured goods because it has acquired a reputation for meeting certain basic minimum standards. Reputation is acquired through actually producing and selling in the market; it cannot be treated as an endowment. How important such considerations are in other contexts is an empirical question, and I hope this exercise will prompt further examination.

It should be clear, therefore, that I am not suggesting that the Korean strategy is the right one for all times and places. Gerschenkron, who identified a similar role for institutions in overcoming "backwardness," suggested that different institutions will be needed at different points in
history. If economies of scale and scope become less important, if improved telecommunications lead to a large decline in marketing costs, and if capital markets become less imperfect, then the need for Korean type reliance on conglomerates or similar institutions will be greatly reduced. It is my judgement, however, that scale and scope economies and advantages of an internal capital market will persist. In this spirit, I have suggested that Korea and Taiwan may at the present time be moving toward each other's structures as they take on the challenges of the coming decades.
APPENDIX: PRODUCTION AND TRADE DATA

Though establishing propositions on individual products is relatively straightforward, compiling a picture of macro performance of the electronics sector is more difficult. The main reason is that electronics is not a precisely defined sector. It has also been difficult obtaining long time series from any single data source.

National industry associations publish data on production and trade. Taiwanese data for recent years was, however, unavailable. Comparing national statistics carries the risk that electronics in the two countries may include somewhat different products. The Yearbook of World Electronics Data published London by Benn Electronics Publications compiles comparable data for several countries. The Yearbook is compiled from a variety of national and international statistics. Production data for 1982-87 with a forecast for 1988 from this source is used in Figure 1. During 1982-84 when production data from both national sources and the Yearbook are available, the numbers are quite close (Table A.1). More importantly for this exercise, the direction of change implied by the two series is the same. The national statistics show that the gap between Korean and Taiwanese production began to narrow in the 1980s, and the Yearbook statistics reaffirm that, showing moreover that in the second half of the 1980s Korean production exceeded Taiwanese production.

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Export</th>
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<tr>
<td></td>
<td>National</td>
<td>Export</td>
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<tr>
<td></td>
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<tr>
<td>1976</td>
<td>1.4</td>
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<tr>
<td>1978</td>
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<td>3.2</td>
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<tr>
<td>1979</td>
<td>3.3</td>
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<tr>
<td>1980</td>
<td>2.9</td>
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<td>5.6</td>
<td>5.3</td>
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<tr>
<td>1984</td>
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<tr>
<td>1985</td>
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<td>1986</td>
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<td>1987</td>
<td>16.7</td>
<td>13.3</td>
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<tr>
<td>1988</td>
<td>23.5</td>
<td>15.9 y/ 11.1 y/</td>
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y/ Forecast
y/ Estimate

Source: (1) Electronics Industries Association of Korea
(2) Taiwan Electric Appliance Manufacturers Association
(3) Yearbook of World Electronics Data, Benn Electronics Publication, London
(formerly known as Backintosh Yearbook of Electronics Data), various issues.
(4) International Trade, General Agreement on Tariffs and Trade, Geneva, various issues.
Export statistics are available from the General Agreement on Tariffs and Trade (GATT) in addition to the other two sources noted above. The GATT statistics have been used in Figure 2 to compare the export performance of the two countries. The GATT numbers are compiled from its international trade statistics database. The fact that these numbers are close to the national numbers, though slightly lower, gives one confidence in both sets of statistics. The GATT numbers are also very close to the estimates made by the Yearbook for 1986 and 1987.

Finally, national statistics were used in Table 4 for estimating the size of the domestic market. They were the only source which provided consistent data on production, export and import. However, they were available only till 1984. For the purpose of this paper that was sufficient since the main point that needed to be demonstrated was that in the early 1980s the domestic market played an important role in Korea.
BIBLIOGRAPHY


General Agreement on Tariffs and Trade (GATT), International Trade, various issues Geneva: GATT.


Lee, Young Sun, "Changing Export Patterns in Korea, Taiwan and Japan," Welirtschaftliches Archiv, 122 (1), 150-163, 1986.


Lin, Shyi Ming, 1987, History of the Development of IC Industry in Developing Countries: A Case Study of IC Industry in Taiwan, MBA thesis, National Taiwan University.
Lin, Yeo, 1987, *Industrial Technology Policy in Newly Developed Industrialized Countries: The Case of Taiwan*, manuscript.


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