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AND THE IMPACT OF SOUTH KOREA'S
INROADS.

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THE EUROPEAN SEMICONDUCTOR INDUSTRY
AND THE IMPACT OF SOUTH KOREA'S INROADS

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1. INTRODUCTION

Components, and specially semiconductors (SCs), are, along with consumer and industrial electronics, informatics and telecommunications, an important integral part of the information technology industry.

This paper deals with the European SC industry, and particularly with its structural features and future prospects. It also tries to point out the challenges that new entrants, such as South Korea, poses to the European industry, a topic which, unlike those dealing with mature competitors (the US or Japan), has not been yet extensively researched.

It is very well known that the European electronics industry is extremely weak in world competition and has experienced a very poor performance in recent years [CCE, 1991].

The importance of SCs for the European information technology industry and even its entire industrial sector does not need to be stressed. Since consumer electronics and informatics feature a strong dominant position of Asian and North-american producers¹, the SC sector is one of the few ones in which European presence is yet noticeable. Moreover, the ability to design and manufacture SCs is probably one of the keys to maintain the competitiveness of the entire information technology industry [HUMBERT and PERRAULT, 1991].

Nevertheless, in spite of the strategic importance of SCs, the European industry is lagging behind US companies (Intel and

¹ For Europe, this situation has strong implications: high trade deficits, overseas dependence in major vital inputs, ... [CCE, 1991: 10].

Motorola) in microprocessors and Japanese (NEC, Toshiba, Hitachi, ...) and even South Korean (Samsung) firms in memories², devices which together represent about a third of world SC production [OECD, 1992].

Moreover, the European SC crisis aggravated in recent years because of demand contraction (caused by the decline in the computer business), import competition from low-cost countries and inward investment by big US and Japanese producers.

These trends threaten to dash once and for all European companies' hopes for a fully independent technological base. Furthermore, the decline has continued despite heavy government subsidies, tough protection against imports, and recent strategic alliances with US and Japanese companies.

The paper explores the main reasons of this continuous downward trend and also the reactions undertaken by European companies in an effort to recapture lost markets. Secondly, the inroads of South Korea in world and European markets are briefly highlighted. It is suggested that South Korean companies may pose a big challenge to the European SC industry in coming years.

² SCs may be divided in three main categories: discrete devices, integrated circuits and optoelectronic devices. The second type of SCs represent the bulk of world sales (around four fifths). Integrated circuits are mainly memories and microprocessors [OECD, 1992]. Memories, such as DRAMs (Dynamic Random Access Memories) or SRAMs (Static Random Access Memories), are general purpose integrated circuits used to store large quantities of information in binary code in the form of electrical charges. Microprocessors are more complex integrated circuits used to perform the central functions of microcomputers [HOBDAV, 1989: Appendix].

2. THE CRISIS IN THE EUROPEAN SC INDUSTRY: REASONS AND REACTIONS

The European SC industry is in bad shape. European manufacturers' share of world SC sales has been consistently declining in the 1980s and early 1990s: 16 percent in 1979, 12 percent in 1985 and 10 percent in 1992 (Table 1). The decline in the second half of the 1980s is specially worth-noting [DOURILLE-FEER, 1992: 87-8] because it took place despite

- recent pan-European support programs, such as JESSI (Joint European Submicron Silicon Initiative), launched in 1989 and directed towards catching up with the US and Japan by developing 64 Megabit (Mb)³ DRAM devices by 1995;

- protectionism towards imports, under the form of anti-dumping levies against Japanese and South Korean products, and tough local-content rules in SC users' production;

- strategic alliances with foreign companies, such as the partnerships between Siemens and IBM (1990), Siemens-IBM-Toshiba (1992) or SGS-Thomson and Mitsubishi (1993).

Moreover, among the main European makers (Philips of The Netherlands, French-Italian SGS-Thomson and Germany's Siemens)⁴, none reaches 5 percent of the world market, which is considered

³ This very large scale integration (VLSI) technology allows for 64 million (or megabit) circuit elements to be condensed onto one tiny chip.

⁴ Philips Semiconductors, based in Eindhoven (Netherlands) has plants in The Netherlands, Germany, France and Belgium. SGS-Thomson Microelectronics was formed from the 1987 merger between France's Thomson Semiconductors and Italy's SGS Microelettronica and is controlled by the French and Italian governments. It has three manufacturing plants in Italy and four in France. Germany's Siemens has fabs in Regensburg (Germany), Villach (Austria) and Corbeil-Essonnes (France, jointly with IBM). A fourth but smaller European producer is UK's GEC-Plessey Semiconductors, with all its plants in the United Kingdom [BOULT, 1993: 147].

to be the minimum critical share, and only Philips is listed the world top-ten ranking of suppliers (Table 2). In 1992, among the world's ten largest producers, six were Japanese and three were US-owned. World-wide sales of Intel, NEC or Toshiba are bigger than those of the three European companies combined. In 1990 the combined world market share for integrated circuits of Philips, SGS-Thomson and Siemens was 7.4 per cent while NEC's was 8.9 and Toshiba's 7.7 per cent [DE JONQUIERES, 1991].

Furthermore, the European market share of European-owned firms hardly reaches one-third, while the own-market share is 70 per cent in the US and 85 percent in Japan [NAKAMOTO, 1992a]. What is more, this share has declined from 44 percent in 1979 to 34 percent in 1992 (Table 3). Although Philips is yet the biggest European market supplier, Siemens and SGS-Thomson, which were no. 2 and no. 3, respectively, in 1990 and 1991, have been surpassed by Intel and Motorola in 1992 (Table 4).

The main reasons of this crisis may be summarized as follows:

- stiff competition from imports, specially from Japan and South Korea in memories and from the US in microprocessors. The prospects for the next few years are bleak, because European Community (EC) tariffs on imported SCs may be downgraded from 14 to 9 percent to comply with the GATT's Uruguay Round requirements and also to reward pressures from European chip users and US producers;
- massive inward investment from the US and more recently Japan [NAKAMOTO, 1992b]. The list of non European SC producers owning and operating plants in Europe is impressive: Intel in Ireland, NEC in Scotland (UK), Toshiba in Germany, Motorola in France and Scotland, Hitachi in Germany, Texas Instruments in

Germany and Italy, Fujitsu in the UK, Mitsubishi in Germany, IBM in Germany and France, ... Several other smaller companies, such as AT&T, Analog Devices, Betatherm, Burr-Brown, DEC, General Semiconductor, ITT and National Semiconductor, have also invested in Europe [BOULT, 1993: 146]. Tariff-jumping reasons, tough local-content rules against Japanese screwdriver plants, and other factors have prompted foreign direct investment directed towards producing locally 4Mb DRAMs (Texas Instruments in Italy, Intel, NEC and Fujitsu in the UK, Mitsubishi and Hitachi in Germany, ...). Those investments will surely lower the import-penetration ratio (which has already fallen from 44 percent in 1991 to 20 percent in 1993) but also raise the proportion of foreign production in total output. Recent investments by Texas Instruments, Mitsubishi and Hitachi may be explained for a number of reasons [SKAPINKER, 1991]: the prospects for completion of the EC single market; tariff-jumping decisions, along the lines suggested by, for instance, Kojima [1978] or Bhagwati [1987]⁵; the will to escape anti-dumping investigations; the need to be closer to customers and to support firms which have themselves set up factories in Europe (cars, consumer electronics, printers, ...) and are subjected to pressures to raise their local-content ratios; and, last but not least, financial support from European governments. For instance, Texas Instruments' investment in Avezzano (Italy) in 1992 was half-funded by the Italian government;

- failure of JESSI US\$ 4.7 billion chip research project [VICKERY, 1992: 78-9]. This pan-European support program, launched in 1989 for an initial period of seven years, was a high-profile EC project which has proven to be a glaring

⁵ Kojima [1978] explains pure tariff-jumping investments while Bhagwati [1987] also analyses preventive investments, such as those responding to protection threats or those directed to lower trade frictions.

disappointment, like, for instance, the high-definition TV program. JESSI was not effective because it spreaded too little money (one twentieth of the Japanese SC firms' effort on R&D) among too many companies and because Europe was already too far behind Japan and even South Korea in commodity memory chips. Philips pulled out from memories in 1990 and Siemens defected some JESSI's projects to join IBM the same year and Toshiba in 1992. Moreover, this "technological mercantilism" [BARBET and LANZONI, 1993] has been forced to retrench: in October 1991, JESSI was scaled back and refocused; its budget for 1992 was cut by 25 percent below the original expected level, mainly because of a contribution from the EC which fell short of the promised financial support; since 1992, JESSI has concentrated in flagship projects closer to market needs, like lithography, applications and competitive manufacturing [DANCE, 1992: 64]. In September 1991, JESSI and the US consortium SEMATECH agreed to collaborate after two years of talks. Budget cuts in both Europe and the US, the will to face Japanese competition, the increasing complexity of SC manufacturing technologies, and complementary between know-hows prompted cooperation. In practice, integration of development activities is yet limited to the so-called Autowec (Automated Wafer Environment Control) and has not been extended to other areas, mainly because of American industrialists' suspicions about JESSI's future. Its budget for 1993 (US\$ 433 million) is lower than the already reduced financial ability for 1992 (US\$ 500 million). JESSI's budget cutbacks are probably the result of political problems arising from the fact that this common project appears to benefit only a few countries, while being paid for by all EC members. On the contrary, the US SC industry enjoys advantages arising from its links with the Department of Defense procurement section. The Japanese receive government subsidies through the highly successful strategic policy of Japan's Ministry of International Trade and Industry (MITI), directed to finance SC development through profits on

other electronic goods sales or even non-electronic products of the keiretsu [BOULT, 1992: 171].

- growing technological and financial barriers to entry, which made difficult for European producers to recapture lost markets. For instance, DRAM storage capacity has been growing rapidly in the last years and is projected to raise even more quickly until the end of the decade. There are important hurdles in developing the next generation of DRAMs, with 64 and 256Mb capacity. The need to shrink circuit elements in order to comply with narrower line width (that is, the critical dimension of microminiature circuit patterns), which is projected to be only 0.25 microns⁶ in 256Mb DRAMs, is coupled with the necessity of refining optical lithography systems. Other technological risks are those associated with reliability and cleanness: making-rooms must be virtually 100 per cent clean, so costly automation is needed in order to isolate equipment from human contact. Moreover, the high R&D cost (around US\$ 1 billion for 256Mb DRAMs) has to be added to another billion or so for each manufacturing plant. These high technological and financial requirements (see Table 5) impose an extremely difficult challenge for the small and cash-trapped European firms.

- the fragmentation of the European SC market, along with its nationalistic policies [HOBDAV, 1989 and 1991], made impossible for EC producers to obtain large economies of scale and prevented the formation of a giant European maker, arising from the merging, as recommended by a report commissioned by the French government [CGP, 1991], of the three leading European firms, financially able to compete with huge foreign companies. The prospects to merge the three main European chip makers have

⁶ A micron is a millionth of a meter, that is, 1/300th the thickness of human hair.

faded, partly because of the agreement between Siemens and IBM-Toshiba and partly because of the different political attitudes towards trade and subsidies in the German and French/Italian governments.

- finally, Europeans are increasingly concentrating on Application Specific Integrated Circuits (ASICs). They have abandoned their ambitions to compete with the Japanese and the Koreans in commodity memories and with the US in microprocessors. In 1990, Siemens abandoned its plans to manufacture its own 16Mb device and decided to collaborate with IBM's factories in Europe. As already noted, Philips pulled all together from memories the same year. As European companies are marginal producers of DRAMs (Siemens is the only European producer making these devices) and microprocessors, and because ASICs are more suitable to areas requiring extended capability⁷, this strategy may be a rational choice. Nevertheless, it is subjected to a growing pressure from US and Japanese subsidiaries in Europe, which were initially directed towards the DRAM market. Foreign facilities in Europe, such as those of Motorola, Intel, Fujitsu and Toshiba, are now making inroads in this important segment of the Continent's SC industry.

The European SC crisis further aggravated since 1990. SC divisions of the three main European companies plunged into red or increased their already substantial losses. Stiffer competition from North-american and Asian suppliers was a result of the US dollar decline towards European currencies and of South Korean and Taiwanese firms and even Japanese steel makers entering the market. The subsequent oversupply sharply lowered prices: for instance, 4Mb DRAM unit price declined from US\$ 60

⁷ ASICs reduce power consumption, component size and fault potential, enhance product quality and lower costs.

in January 1990 to US\$ 25 in December 1990, to US\$ 15 in December 1991 and to US\$ 11-14 in March 1992 [ECE, 1993: 229]. Another reason for this decline was the acute demand contraction caused by the worldwide economic recession, the crisis in the computer market, and political-inspired cutbacks in military spending [BOULT, 1992: 170].

The early 1990s decline has raised concerns. Some fear that, if the ability to design and produce SCs in Europe fades or disappears, even Europe's still healthy telecommunications, machine tool and robotic industries may fall prey to big and integrated Japanese companies [BUSINESS WEEK, 1991].

Having faced these realities, European firms are now implementing cost-cutting measures, focusing on specialized chips, forming alliances with overseas companies and trying to obtain more government subsidies. Scaling back past ambitions, they are cutting on investment spending, slashing payroll and transferring assembly to low-wage countries. They have made a noticeable percentage of their workforce redundant. Siemens has recently relocated chip assembly from high-cost Bavaria to Singapore and Malaysia. This latter trend seems to re-edit past processes, such as the relocation of the US SC assembly to Southeast Asia in the 1960s and 1970s in order to reduce labor costs and take advantage of the US tariff structure, which imposed duties only on value added abroad in products made with US components [FLAMM, 1985; HENDERSON, 1989 and UNCTAD, 1990]. As a result, in 1980 90 percent of the total US imports of SCs were re-imports from US subsidiaries in Southeast Asia [SCOTT, 1987].

A second reaction is more far-reaching. European companies are focusing on specialization in Erasable Programmable Read-only Memories (EPROMs) and ASICs, that is, specialty circuits for

telecommunications (such as mobile phones), automobile equipment (full-injection systems) and consumer electronics. In 1992, SGS-Thomson was 3rd in the ranking of the main producers of EPROMs, only behind AMD and Texas Instruments, reaching 14.5 per cent of world market. It was second in other specialty chips, such as EEPROMs (14.9 percent) and special SRAMs (13 percent in 1991)*. Nevertheless, the strategy, as already noted, seems risky. Depressed markets in commodity DRAMs are pushing Japanese subsidiaries in Europe, such as those of Fujitsu, NEC, Hitachi and Toshiba, into ASICs [BUSINESS WEEK, 1992].

Thirdly, European companies are forming alliances, in the form of partnerships or joint ventures, with foreign firms. The growing costs of design and manufacturing and the will to circumvent national antimonopoly laws are pushing towards international agreements at the firm's level. Siemens joined IBM in 1990 to share R&D costs in 64Mb DRAMs and to start production of 16Mb DRAMs at the US firm's factory at Corbeil-Essones outside Paris. Japan's Toshiba was added in July 1992 to design and develop 256Mb DRAMs. In May 1993, SGS-Thomson reached an agreement with Mitsubishi in order to co-produce the so-called flash memory chips. The entry of the European companies into this strategic gamble seems to have begun later than in North-America or Japan. During 1980-90, 160 agreements of this kind were detected by Barbet and Lanzoni [1993], but the bulk were US-Japan alliances (AMD-Fujitsu, Texas Instruments-Hitachi, Motorola-Toshiba, AT&T-NEC, Intel-Sharp, and so on). As the need to find partners in order to spread the technological and financial risks has become imperative, a more pronounced implication of European producers in this process may appear to be urgently needed.

Finally, some European firms, faced to little financial

* Electronique Internationale Hebdo, 11 February 1993.

assistance from JESSI, have been able to get direct government support. For instance, SGS-Thomson got in November 1992 US\$ 1.8 billion from the French and Italian governments for the 1993-97 period.

3. THE SOUTH KOREAN SC INDUSTRY AND ITS IMPACT ON EUROPE

In 1992 South Korea was the 6th world producer in electronic goods, the 4th in components, the 3rd in consumer electronics and the 2nd in DRAMs [GLABI, 1993: 56]. The 4Mb DRAM world market is dominated by the Japanese, but South Korea ranks second, with a market share higher than those of the US and Germany combined (Table 6).

SCs are the single most important electronic product exported by South Korea. According to figures from the Electronics Industry Association of Korea (EIAK), SC exports will grow 30 percent in 1993 from a year earlier and will account for nearly 29 percent of Korea's total electronic exports⁹.

South Korea's share of the US DRAM market has grown spectacularly in recent years: 0.1 per cent in 1985, 5 per cent in 1987 [SAGHAFI and DAVIDSON, 1989: 62], 15 percent in 1990, 19 percent in 1991 and nearly 40 percent in 1992. This trend has prompted reactions among US SC producers: Micron Technologies presented in 1992 a lawsuit alleging that South Korean companies were dumping their DRAMs in the US (a similar move has been made by Siemens in Europe). What is paradoxical is that Korea's Samsung Electronics started its large-scale production facilities of DRAMs back in 1983 with the help precisely of Micron

⁹ "L'électronique coréenne prépare un nouvel assaut", Electronique Internationale Hebdo, n° 85, 28 January 1993, p. 6.

Technologies¹⁰.

Production and exports of DRAMs have consistently grown in South Korea. From a very narrow base of US\$ 100 million in 1984, output grew to US\$ 1.2 billion in 1988 and reached US\$ 2.5 billion in 1992, with exports accounting for US\$ 1 billion. Moreover, some South Korean SC producers are becoming increasingly involved in state-of-the-art technology. In December 1992, Samsung reached an agreement with Toshiba for the co-production of flash memory chips (which, unlike DRAMs, retain information after the power is turned off) in 1994¹¹. Scheduled for eight years, the partnership involves the transfer of so-called NAND technology and patents from Toshiba in exchange of the financial and manufacturing muscle of Samsung, which is already the second biggest world manufacturer of DRAMs, behind precisely Toshiba. In March 1993, in an unprecedented move, Samsung licensed technology for the production of 16Mb DRAMs to Japan's Oki Electric. So, South Korea's SC industry, like its entire electronics sector, has already reached a high profile in the world market [BLOOM, 1992].

This trend is specially worth-noting because electronics only emerged as the dominant export industry in the late 1970s. Large-volume production of SCs did not start until the mid-1980s [SUAREZ-VILLA and HAN, 1990: 273]. Before the late 1970s, South Korea was a low-cost assembly base for export-oriented SC multinationals [DAVIS and HATANO, 1985]. As in the whole region of East and Southeast Asia, the relocation of US SC activities was confined to assembly and final testing, while wafer

¹⁰ "New Kids on the Block. Dumping Suits Put Korean Semiconductor Makers on the Defensive", Far Eastern Economic Review, 5 May 1992, pp. 60-1.

¹¹ "Quick as a Flash. Japanese and Korean Chipmakers Form Alliance", Far Eastern Economic Review, 7 January 1993, p. 57.

manufacturing, circuit design and wafer processing continued to be located in the US [YOUNG, 1991: 201]. Nevertheless, the development of consumer electronics and computer production by local firms increased domestic demand for SCs. Korean firms started in the early 1980s to make large investments in design and manufacturing facilities, in part to serve that market [ERNST and O'CONNOR, 1992: 209] and also to catch up with Japan and to benefit from the externalities of SC production into the entire electronics sector [CHAPONNIERE, 1989].

The trend accelerated during the slump in the SC world market in the mid-1980s, when US and Japanese chipmakers were retrenching while Samsung and Hyundai, with then a very small proportion of international trade in SCs, made heavy investments in design and manufacturing [YOUNG, 1991: 204]. This was the second of the major export-driven take offs in Korean electronics production, since the first, in the mid-1970s, involved mainly consumer articles. Moreover, SC activity featured in the 1980s strong barriers to entry, such as high and increasing technological intensity, the need for efficient scale¹², large capital requirements, considerable uncertainty about prospects, unavailability of product and process technology and aggressiveness from competitors, specially from Japanese large companies [MODY, 1990: 298]. Such barriers normally deter late entrants [YOON, 1992: 254]. So, it is fair to conclude that "the development of advanced semiconductor manufacturing capacity marks a high point in the evolution of the Korean electronics industry, and, indeed, must be considered a landmark in Korean economic development" [MODY, 1990: 298].

The main reasons explaining this phenomenal success may be

¹² Unlike Japan, South Korea lacked in the 1970s a large domestic market able to produce the economies of scale necessary to underpin the export drives.

summarized as follows. Firstly, the US-Japan 1986 agreement on SCs (renewed in 1992) was an excellent opportunity for South Korean makers. The agreement established a floor price for Japanese DRAMs imported in the US and forced Japan to pledge to raise the foreign share of its domestic SC market from 8.5 percent in 1985 to 20 percent in 1991. Although the latter goal was only attained, after considerable pressure from the US government, in the fourth quarter of 1992, the agreement enabled Korean manufacturers (Samsung Electronics, Hyundai Electronics, Goldstar Electron,...) to slash DRAM prices in the US, quoting them to customers at up to 10 percent below the level agreed on by Japanese producers, and also to increase their exports to Japan.

Secondly, the existence of very large and vertically-integrated conglomerates (the chaebol) was an important factor behind South Korean success. The chaebol were able to finance the initial losses in the SC business with profits from other divisions in the same firm, to use up to 20 percent of their SC output in the company's own personal computers and video machines, and to spend heavily on R&D and even in high-tech laboratories in the US [ECONOMIST, 1989; CHAPONNIERE, 1992].

Thirdly, while the product cycle has lengthened (such as in 4Mb DRAMs), benefitting new entrants, Japan technologically upgraded its SC industry in the late 1980s, concentrating its resources in 16Mb and 64Mb DRAMs, so Korea could fill the 4Mb niche.

Fourthly, the price downturn in SCs, caused by massive excessive production capacity in Japan, prompted financial problems in the Japanese integrated electronics companies, which decided in the late 1980s to cut production targets and review capital investment in SCs, in an attempt to bolster prices. The

Koreans were able then to expand their SC capacity.

Finally, the skilled and cheap workforce, along with carefully targeted help from the government, including a very successful technological policy and 20 percent duties on imported SCs, afforded the South Korean companies with large advantages.

It has also to be taken into account that the export upsurge in South Korean SCs also related to the slowdown of the domestic consumer electronics industry and to expanding overseas investments by the chaebol in TVs, VCRs, microwave ovens and so on [ERNST and O'CONNOR, 1992: 122].

South Korean SC production is heavily biased towards commodity SCs, such as DRAMs and SRAMs, so the country has to import the bulk of its requirements of microprocessors and ASICs. The result is that Korea's SC industry exhibits both a high export ratio (84 percent in 1992) and a high import dependency ratio (84 percent in 1992). The bulk of foreign purchases is imported from Japan (40 percent), which exhibits a high trade surplus with Korea in SCs (US\$ 1.06 billion in 1992).

As South Korean companies are mainly low-end commodity producers and are weak in design and features, they will probably move into better designed products, such as 64Mb DRAMs and ASICs, a process which will surely intensify Korean pressure on the European SC industry. Moreover, the need of getting closer to customers (including Korean consumer electronics firms which have invested in the EC) and of defending themselves against dumping complaints will surely prompt a shift to overseas production of SCs by the chaebol [CHAPONNIERE, 1992]. It is likely then that South Korea may become another Japan in the SC business, adding strong pressures on the already depressed European sector. Samsung Electronics has already joined Texas Instruments to co-

produce DRAMs in Portugal¹³.

In addition, in order to lessen its dependence on Japanese SC equipment, South Korea is even considering to forge links with SEMATECH, the consortium of 12 SC companies established in 1987 by the US government, and with SEMI-SEMATECH, the US consortium of more than 400 US suppliers of equipment and material. South Korean would make cash contributions to SEMATECH and would be able to gain access to the entire technologies developed with significant US government's R&D funds. As Mr. Paek Man-ki, chief of the Semiconductor Industry Division at the Korean Ministry of Trade, Industry and Energy, explains: "our basic policy is to promote industrial cooperation between the US and South Korea, specially in semiconductors, to lessen our dependence on Japanese technology"¹⁴.

Gordon E. Moore, chairman of Intel, has recently declared that the Japanese reign over semiconductors may be over, because of the heavy Korean capital investments and Taiwanese competitors entering world markets. Dan Hutcheson, chairman of VLSI Research, suggests that Samsung's mass production technology is probably the world's best and that this company's capital investments are now bigger than those of the Japanese¹⁵.

5. CONCLUSIONS

The crisis of the European SC industry has been prompted by

¹³ "International Electronics Giants Join Hands in Semiconductor Technology", The Korea Herald, 31 December 1992.

¹⁴ "Koreans Ponder Sematech Links", Far Eastern Economic Review, 20 August 1992, pp. 58-9.

¹⁵ "Japan's Chip Market Reign May be Over", The Nikkei Weekly (Tokyo), 16 November 1992.

stiff competition from imports, massive inward investments by overseas firms, failure of pan-European JESSI project, growing technological and financial barriers to entry as the sector upgrades, and the fragmentation of the European market, together with the nationalistic policies pursued in the EC, which made impossible the creation of a single big European maker.

Although European firms are implementing strategies in order to recapture lost markets, the present trends suggest that the European SC industry may be adversely affected in coming years by an exacerbated international competition. To the pressures from US and Japanese big companies, it has to be nowadays added the growing impacts of new entrants, such as those from South Korean producers, whose achievements in recent years have been impressive.

South Korea is already the second world manufacturer of DRAMs, after Japan, as it surpassed the US in 1992. In 1992, the Korean share of the worldwide DRAM market was 24 percent (15 percent in 1990), while Japan's market-share shrank from 61 to 54 percent over the same period¹⁶. Korea's Samsung Electronics is already the first world producer of DRAMs, as it surpassed Japan's Toshiba in 1992. Samsung's inroads, besides those of the electronics divisions of the other chaebol (Hyundai and Goldstar), allowed South Korea to dominate in 1992 40 per cent of the US DRAM market. The strong investment capacity of these companies, along with their huge R&D budgets, suggest that Korea will be an even more impressive competitor in the next few years. A depressed SC sector like the European one should turn its attention much more to South Korea, as this new entrant may become another Japan in the SC business.

¹⁶ E. Lachica, "Korea's Growth Puts Japan on Guard. DRAM shortage a boon for Korean chip makers", Asian Wall Street Journal Weekly, 15 November 1993, Supplement, p. 2B.

STATISTICAL APPENDIX

TABLE 1. WORLD SC MARKET SHARES BY FIRMS' NATIONALITY

	<u>1979</u>	<u>1982</u>	<u>1985</u>	<u>1992</u>
European	16	13	12	10
US	46	51	42	41
Japanese	38	35	42	43
Other	-	1	4	6
Total	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>

Sources: Hobday, 1991: 81; CGP, 1991: 216 and Dataquest figures, January 1993.

TABLE 2. TEN LARGEST SC'S MANUFACTURERS, 1992 (sales and world market shares, US\$ billion and percentage).

	<u>Sales</u>	<u>Market Share</u>
1. Intel (US)	5.1	7.7
2. NEC (Japan)	4.9	7.6
3. Toshiba (Japan)	4.7	7.3
4. Motorola (US)	4.6	7.1
5. Hitachi (Japan)	3.9	5.9
6. Texas Instruments (US)	3.0	4.6
7. Fujitsu (Japan)	2.6	3.9
8. Mitsubishi (Japan)	2.3	3.5
9. Philips (Netherlands)	2.1	3.2
10. Matsushita (Japan)	1.9	2.9

Source: Dataquest figures, January 1993.

TABLE 3. EUROPEAN MARKET SHARES, BY FIRMS' NATIONALITY

	1979	1985	1992
European	43.4	38.3	34.0
US	53.7	50.4	45.1
Japanese	3.0	11.3	16.5
Other	-	-	4.4
Total	100.0	100.0	100.0

Source: Dataquest figures, 1990 and 1993

TABLE 4. TOP-TEN SUPPLIERS IN THE EUROPEAN MARKET, 1990 and 1992 (companies and market share)

1990		1992	
Companies	Market Share	Companies	Market Share
1. Philips	10.3	1. Philips	9.2
2. Siemens	9.0	2. Intel	9.1
3. SGS-Thomson	8.5	3. Motorola	7.9
4. Motorola	7.2	4. Siemens	7.4
5. Texas Instruments	6.0	5. SGS-Thomson	7.3
6. Intel	5.8	6. Texas Instr.	5.7
7. Toshiba	4.9	7. Toshiba	3.9
8. NEC	4.1	8. NEC	3.8
9. National Sem.	3.6	9. National Sem.	3.4
10. AMD	2.6	10. AMD	2.8

Source: Dataquest figures, 1991 and 1993

TABLE 5. SUCCESSION GENERATIONS OF DRAMS

Capacity	Line Width (microns)	Year	R&D Cost (\$m)
1Mbit	1.2	1985	100
4Mbit	0.8	1988	200
16Mbit	0.6	1991	350
64Mbit	0.35	1995	600
256Mbit	0.25	1999	1,000

Source: Business Week, 1992.

TABLE 6. 4Mb DRAM world market share, by country of manufacturer, 1991

Japan	80.2
South Korea	13.4
US	4.6
Germany	1.8
Total	100.0

Source: Dataquest figures, cit. in Butler and Thomson [1991]

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