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Technological and Trade Competition in High-Tech Products

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TECHNOLOGICAL AND TRADE COMPETITION IN HIGH-TECH PRODUCTS

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1. The Role of High-Tech Sectors in Advanced Industrial Systems

Technological change has been increasingly influencing the international competitiveness of all major industrialized countries over the past decade. A comparison of technological capabilities of these countries, that is their capacity to develop and diffuse innovations, represents an essential factor in evaluating their international competitive position. Such a comparison, however, presents several complex methodological and empirical problems, primarily because there is considerable difference in innovations across sectors in terms of different technological opportunities, sources and appropriability conditions (Levin, 1984; Pavitt, 1984,1988; Dosi, Pavitt, Soete, 1990).

In this respect, it is very important to consider the linkages between various sectors since they affect the competitiveness of the manufacturing system as a whole. The industrial system of a given country should not be taken as a group of independent sectors, but rather as a structure with its own internal hierarchy characterized by a complex technological interdependence among its various components (Rosenberg, 1982; Chesnais, 1986). Within this hierarchy, it is possible to identify a specific group of sectors that generate technological innovations which benefit the entire industrial system and have a profound impact on a wide range of sectorial activities related to the production of goods and services.

This group of sectors, known as science-based or high-tech

(hereafter HT) is related in that the sources and typologies of their innovative activities are closely tied to expenditures and investment in Research and Development (R&D), both basic and applied. Other common features are equally important in determining the competitiveness of firms in these sectors: on one hand, the high technological opportunities and the cumulative effect of innovative advantage, characterized by sharp 'learning curves' and 'dynamic economies of scale'; on the other hand, the high costs and risks associated with investments in R&D, together with markets that are typically oligopolies and a significant degree of internationalization of production.

As demonstrated in the large body of recent literature, the importance of the HT group for the growth of the production system as a whole does not depend entirely on the high technological content of its products. In fact, other sectors such as mechanical engineering, which exploit channels to develop innovations other than those resulting from R&D expenditures, may and do have an equally high technological content. Rather, the importance of the group of HT sectors lies primarily in the "horizontal" distribution of their innovations, that is, their influence on all the other sectors of production, and the accompanying high degree of inter-industry spill-overs (Scherer, 1982; 1986). The electronics industry is a case in point: its process and product innovations have been revolutionizing methods of production and organization in many other industries, including the mature and traditional ones.

Thus HT industries represent a kind of "technological base" for the entire production system, and their role clearly goes beyond their direct contribution to the production and trade balance of a given country, although the latter has been continuously growing over the last decade. In other words, they play a strategic role with respect to trends in international competitivenesss and more generally to growth patterns in all countries. In any assessment of the degree of technological capability of the most advanced countries, it is therefore extremely important to analyze their trade structure and performance in terms of the HT sectors.

In this respect, it is true that in the current phase of increasing market globalization and internationalization of production, technological competition between countries is certainly not determined solely by trade dynamics; rather, it is the result of the interaction of various levels of internationalization (trade, foreign direct investment, international agreements between firms). This is particularly true for HT sectors, which tend to be characterized by oligopolistic markets and in which increasing costs and risks related to research, development and marketing of new products have provided strong impetus for a move toward increased internationalization of production through both traditional channels (foreign direct investment) and relatively new ones (joint ventures and agreements). Nevertheless, trade continues to play an important role in the dynamics of interdependence among countries, and the analysis of trade patterns will reveal the most significant changes and trends in competitive positions of single countries.

The selection of sectors and groups of products included in the HT group in the present study was made by revising and updating an OECD sectorial classification (OECD, 1985) [for the methodology and list of the 'high technology' product groups see Appendix C]. Analysis is based on an original world trade data-base (Data base SIE-World Trade) which contains UN and as well as OECD statistics (see Appendix A). Unlike previous studies which were based on sources providing information only on trade within the OECD area, the database used here makes it possible to consider the entire matrix of world trade flows.

2. Long-run Changes in the Competitive Positions of the Major Areas

The first important feature to be pointed out is the high growth pattern that has characterized trade in HT products since the mid-1970s and that was particularly marked during 1980s. Growth in HT world exports (Figure 1), particularly in electronic

FIGURE 1. SHARE OF HIGH-TECH EXPORTS IN WORLD MANUFACTURERS EXPORTS

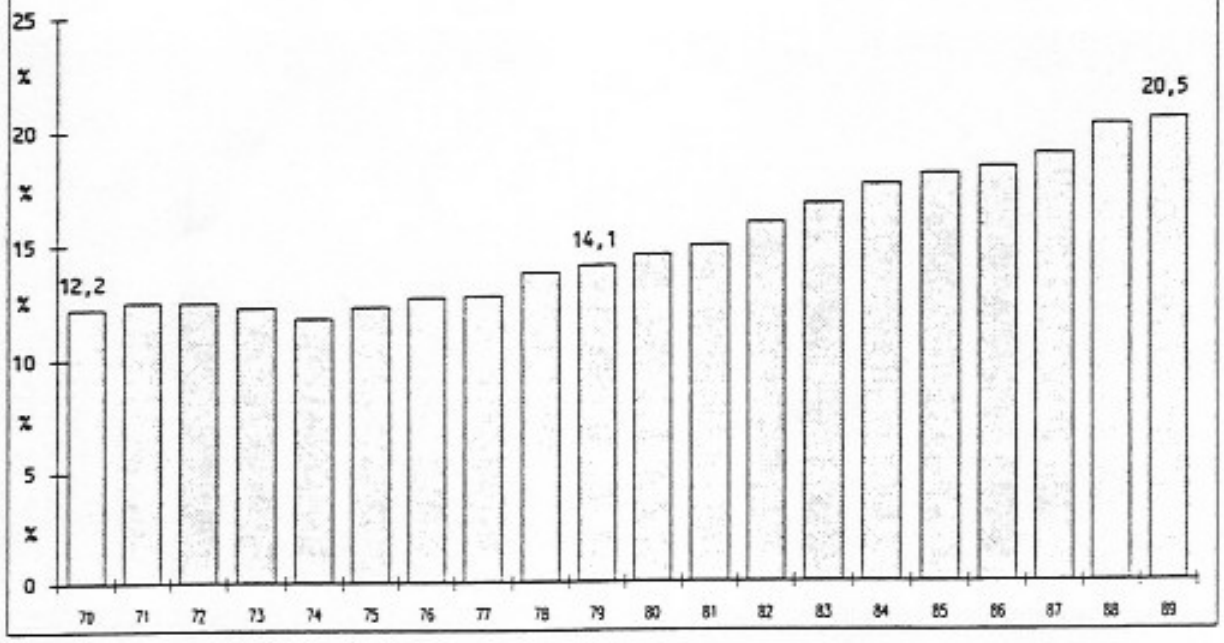
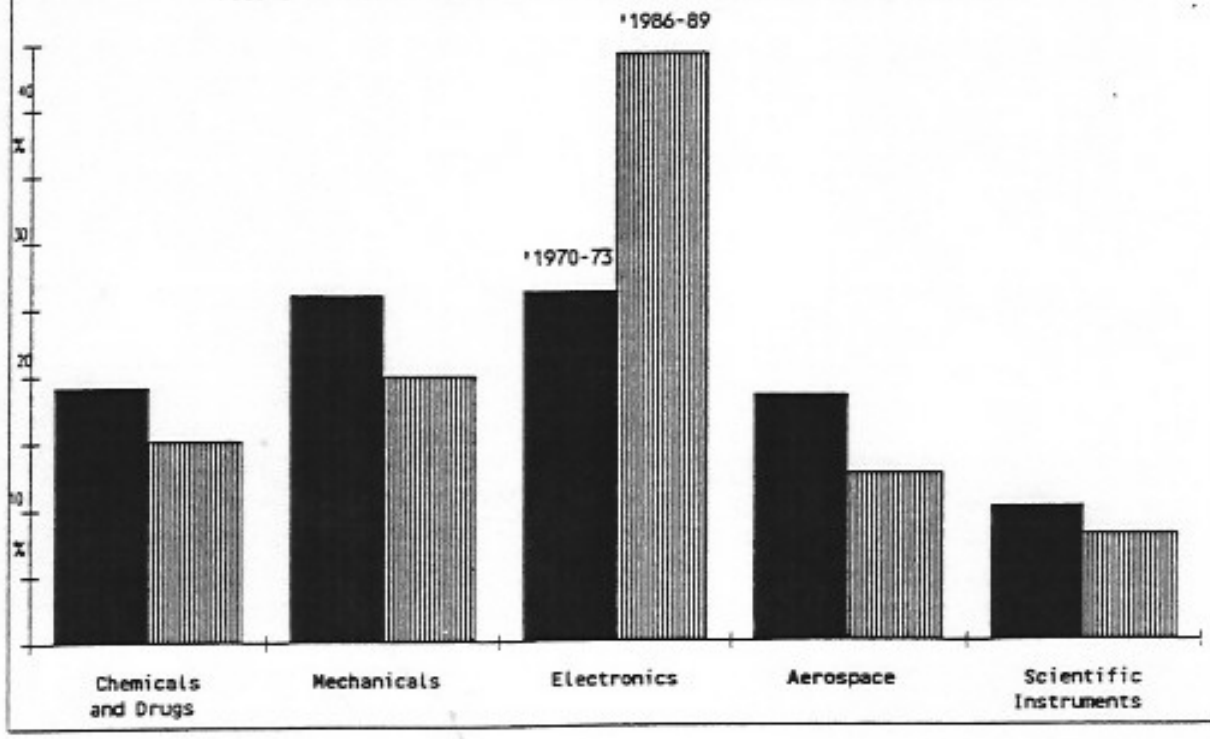


FIG. 2 SHARES OF SELECTED PRODUCT GROUPS IN WORLD HIGH-TECH EXPORTS



goods during the past decade (Figure 2), has been consistently higher than the average growth in world manufactures exports, so that the share of HT products with respect to total manufactures exports increased from 12,2 per cent in 1970 to 20,5 per cent in 1989 (Figures 1 to 2).

Competition among the major economic areas has strongly increased and has resulted in significant changes in their relative strength in this field. Briefly, it can be said that over the past two decades there has been a move from the technological hegemony of the US to an oligopoly of few countries on the technological frontier with the power of influencing the future direction of innovations. The relative competitive positions of the countries within this oligopolistic structure, however, changed considerably in the same period. In order to analyze these trends, therefore, several indicators of HT trade structure and performance in the major industrialized countries will be used. Only in this way can reliable information be generated on the evolution and future trends in the competitive positions of these countries.

The decline in the technological supremacy of the United States is demonstrated by the significant weakening of its competitive position in HT trade. Over the last two decades the US industry registered both decreasing market shares[1] (Table 1) and deteriorating trade balances (normalized by total world trade in HT products), the latter being an indicator of relative competitive position (Table 2, Figure 3)[2]. The first sharp decrease in US market shares was registered as early as the 1970s and, with the exception of a period of partial recovery at the beginning of the 1980s, they continued to decline significantly in the late 1980s despite the sharp depreciation of the dollar.

In terms of trade balance in HT products, the US continuously registered a surplus even in the 1980s. It must be pointed out, however, that standardized US trade balances underwent a first notable decrease in the 1970s; they later stabilized at relatively high levels (though with cyclical fluctuations) until the early 1980s, but they declined markedly in the latter part of the past decade (Figure 3). The sharp

Table 1. SHARES OF SELECTED COUNTRIES AND AREA IN WORLD EXPORTS OF HIGH-TECH PRODUCTS*

(percentage shares in value)

	1970-73	1973-76	1976-79	1979-82	1982-85	1985-87	1988-89
OECD Countries	95.57	93.93	91.52	88.79	86.60	85.40	83.64
United States	29.54	27.36	24.37	25.07	25.24	22.29	20.64
Canada	4.25	3.05	2.45	2.30	2.47	2.37	2.65
Japan	7.07	7.54	9.21	10.06	12.93	15.03	16.01
EEC (9)	46.38	47.50	47.48	44.14	38.26	38.60	37.38
Germany	16.59	17.07	16.52	14.66	12.98	13.07	12.52
France	7.27	8.06	8.78	8.10	7.26	7.07	6.80
United Kingdom	10.12	9.47	9.70	9.87	8.45	7.54	7.64
Italy	4.41	4.15	4.10	3.92	3.72	3.72	3.41
Other EEC (9)	8.04	8.74	8.38	7.59	6.84	7.20	7.02
Greece,Port.,Spain	0.50	0.65	0.71	0.85	0.91	0.58	1.12
EFTA	7.56	7.53	7.06	6.11	5.53	5.88	5.57
Non OECD Countries	3.99	5.64	7.61	9.29	12.03	13.70	15.03
Asian NICs	1.30	2.28	3.18	4.06	6.05	7.56	8.76
Singapore	0.40	0.79	1.11	1.37	1.88	2.17	3.03
South Korea	0.33	0.64	0.83	0.82	1.14	1.57	2.27
Taiwan	0.19	0.37	0.57	0.87	1.44	1.87	2.32
Hong Kong	0.39	0.49	0.68	1.01	1.59	1.84	1.14
Asian NECs (1)	0.09	0.41	0.68	0.99	1.33	1.39	1.70
American NICs (2)	0.58	0.68	0.72	0.80	1.37	1.85	1.46
CMEA	0.73	0.84	1.17	0.91	0.59	0.50	0.44

* Ratio of country's or area's exports to total world exports

(1) Indonesia, Malaysia, Thailand, Philippines

(2) Argentina, Brazil, Mexico

SOURCE: SIE - World Trade Data Base

reduction in US surplus appears to be the result of not only a major drop in exports, but also and primarily a large increase in its HT imports. The latter have increased at rates significantly higher than the world average, unlike HT imports of the other major countries (Table 12).

In the second half of the 1980s, the US registered trade surpluses (normalized) only with respect to the EC, while growing deficits characterized US trade not only with Japan, but also with Southeast Asian NICs (Figure 4). In the phase of dollar's devaluation of the late 1980s only the surplus towards the EC significantly improved, whereas the huge deficit with Japan remained stable and that with the Asian NICs only marginally decreased. It should be noted that trade balances with Asian countries have been deteriorating since the mid-1970s, suggesting that the loss in competitiveness of US industries may be attributed to structural competitive disadvantages rather than only to the appreciation of the dollar at the beginning of the 1980s (Lawrence, 1984).

Further evidence of this derives from an application of the 'Constant Market Shares Analysis' (hereafter CMSA) to the observed changes of US export share in HT products, as it makes it possible to distinguish the effects of factors which determine competitiveness from those connected to structural changes. The 'structural effect' refers to the geographic and commodity structure of a country's export relative to the structure and dynamics of world demand. It is positive (negative) if a country concentrates its exports on markets and/or commodities that grow faster (slower) than the world average (world demand). The competitiveness effect reflects the actual changes of a country's market share, assuming that its trade structure is constant; it represents that part of a country's trade performance deriving from its competitive factors, both 'price' and 'non price'. Here we have used a reformulation of CMSA in an effort to overcome most of the difficulties that have traditionally characterized the former versions of this method (see Appendix B).

The results of CMSA confirm that the decrease in US market shares in HT products is wholly attributable to a loss of US

Table 2 TRADE BALANCE OF SELECTED AREAS AND COUNTRIES IN HIGH TECH PRODUCTS*

	1970	1973	1976	1979	1982	1985	1987	1989
United States	22,43	16,63	16,05	12,24	12,07	4,19	1,74	2,48
Japan	1,88	3,24	4,64	5,77	6,92	10,07	11,88	11,69
EEC (9)	6,64	8,59	11,28	8,07	7,30	4,01	2,59	1,05
Germany	7,48	8,98	7,65	5,49	4,39	3,12	3,66	2,65
France	-0,56	-0,60	1,19	1,28	1,25	1,10	0,39	0,28
United Kingdom	3,01	2,37	2,73	2,14	1,95	0,61	-0,07	-0,25
Italy	-0,16	-0,83	-0,10	-0,38	-0,20	-0,55	-1,09	-1,18
Asian NICs	-1,74	-1,84	-1,67	-2,37	-1,91	-0,17	0,22	-0,99

*Standardized trade balances expressed as percentage of total world trade in high tech products
(For method and formula see note 2)

Souce: SIE - World Trade Data Base

FIG. 3 TRADE BALANCES IN HIGH-TECH PRODUCT *

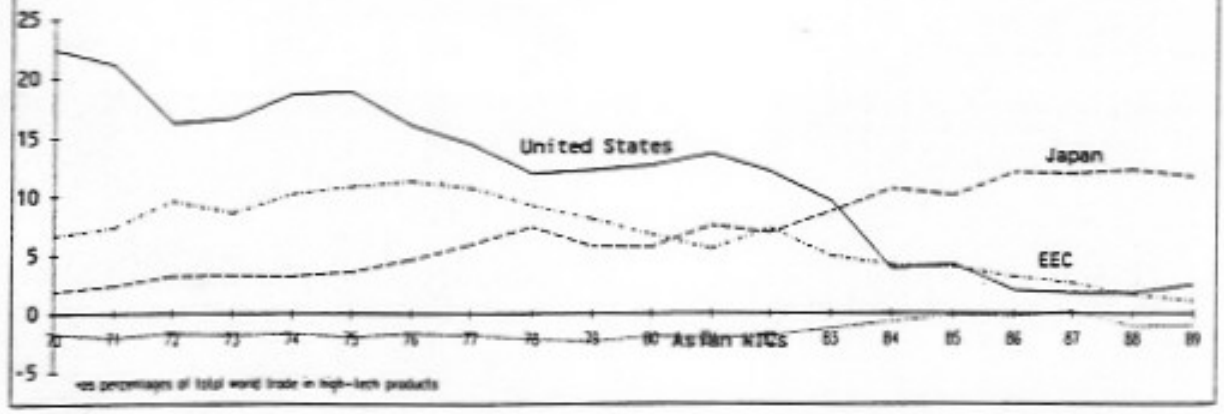


FIG. 4 BILATERAL TRADE BALANCES IN HIGH-TECH PRODUCTS OF THE UNITED STATES*

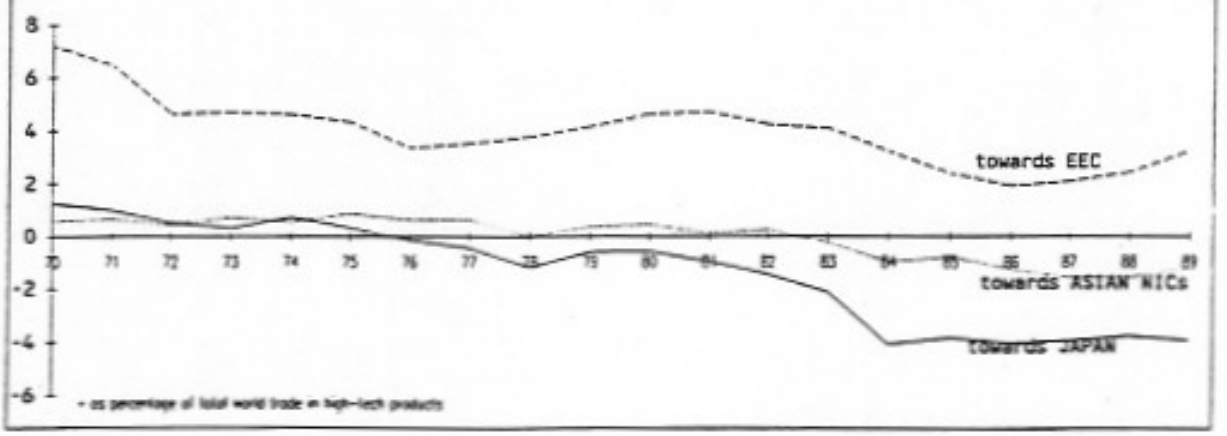
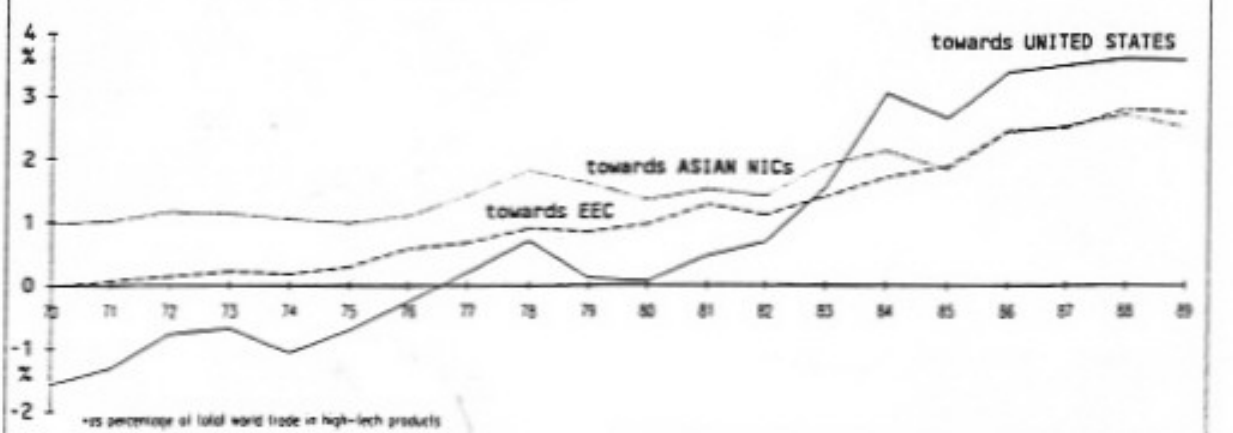


Fig. 5 BILATERAL TRADE BALANCES IN HIGH-TECH PRODUCTS OF JAPAN*



competitiveness over both the 1970s and the 1980s, whereas net structural effects played only a marginal role (Table 3). On the other hand, the United States had considerable gains from the commodity effect, particularly in the last decade, through the continuous introduction of new commercial products characterized by a fast growing demand.

In this regard, the US industry has been able to preserve a relatively high comparative advantage in the export of HT products. This is demonstrated by the high index of specialization that the US has maintained over the entire period considered in the present analysis (Table 6). Furthermore, as can be seen in Table 4, HT products account for a relatively high percentage of total manufactures exports (approximately 37 per cent in recent years) in the US, considerably more than in other industrialized countries (in OECD countries HT products represent, on average, approximately 20 per cent of total manufactures exports).

Japan has benefitted most from the weakening US position, as demonstrated by the truly remarkable improvement in all performance indicators analized here. Japanese market shares in HT sectors initially registered increases in the 1970s, and continued to grow at even higher rates in the past decade, more than doubling initial figures (Table 1). Another measure of Japan's upsurge in HT sectors can be determined by looking at the indicator for Japan's competitive position (the Japanese trade balance in high-tech products expressed in terms of world HT trade): in the early 1970s it was equal to one quarter of the US indicator and approximately one third of the indicator for the EC countries as a group; in 1989 it was respectively four times and six times higher (Table 2, Figure 3).

As shown in Figure 5, Japan is also the only major industrialized country which has a positive trade balance with respect to the other three major areas (US, EC and Asian NICs), and which continued to register gains in the second half of the 1980s. This position of strength is further demonstrated by substantial increases in its shares on all major markets, especially the US and the EC (Table 5). The results of CMSA

TAB. 3 THE RESULTS OF CONSTANT MARKET SHARES ANALYSIS OF THE EXPORTS IN HIGH-TECH PRODUCTS

(percentage values)

	CHANGES in MARKET SHARES (C)= (D)+(E)	COMPETI-TIVENESS EFFECT (D)	STRUCTURAL EFFECT TOTAL (E)= (F)+(G)+(H)	MARKET EFFECT (F)	COMMODITY EFFECT (G)	SPECIFIC EFFECT (H)
			1973 - 1987			
CANADA	-1,45	-1,85	0,41	0,91	2,07	-2,57
UNITED STATES	-5,15	-4,13	-1,02	-2,62	1,25	0,34
JAPAN	7,01	4,57	2,44	2,89	-0,54	0,09
ASIAN NICs	6,87	1,31	5,58	1,93	4,04	-0,39
GERMANY	-4,21	-1,26	-2,95	-2,05	-2,66	1,76
FRANCE	-0,29	0,83	-1,12	-0,73	-0,7	0,31
UNITED KINGDOM	-2,16	-1,07	-1,09	-0,39	-0,37	-0,33
ITALY	-0,51	0,44	-0,95	-0,58	-0,69	0,33

TAB. 4 SHARES OF HIGH-TECH TRADE IN TOTAL MANUFACTURING TRADE OF SELECTED COUNTRIES AND AREAS*

	HIGH-TECH EXPORTS/ MANUFACTURERS EXPORT			HIGH-TECH IMPORTS/ MANUFACTURERS IMPORT		
	1970-73	1978-81	1986-89	1970-73	1978-81	1986-89
WORLD	12,37	14,31	19,50	12,52	14,52	19,47
Canada	10,40	8,67	12,32	16,55	18,01	20,95
United States	27,03	28,26	37,72	8,90	12,84	19,93
Japan	9,72	13,93	25,85	15,57	14,13	16,60
EEC (9)	11,35	14,07	19,41	12,65	14,15	19,83
France	12,03	15,14	20,43	14,46	15,96	18,76
Germany	13,66	15,45	17,86	10,83	14,72	19,70
Italy	9,78	9,74	12,06	12,89	14,46	18,40
United Kingdom	16,18	20,80	25,85	12,18	16,07	20,92
Greece, Port.,	4,21	6,01	8,99	14,86	16,50	17,77
EFTA	13,35	13,39	16,93	11,52	12,97	17,06
COMECON	4,79	6,10	6,03	10,72	10,56	13,37
Asian NICs	6,57	11,39	22,36	13,51	19,99	26,66
Asian NECs	1,37	8,45	16,94	11,89	17,53	26,77
America NICs	5,66	6,05	13,79	18,23	18,35	25,96

*average value in each sub-period (percentage)

Source: SIE WORLD TRADE Data-base

(Table 3) show that both positive 'structural' and 'competitive' effects contributed to the remarkable gains in export shares achieved by the Japanese industry. Japan, after having suffered unfavorable structural changes in the 1970s particularly in terms of a negative 'product composition' effect, has shifted its export flows towards more dynamic products and markets in the 1980s.

These results are largely related to the profound transformations in the specialization pattern of Japanese industry over the past decades (Guerrieri and Milana, 1990). In particular, the pattern of Japan's exports has changed significantly, and within this pattern, HT products have played an increasingly important role, as demonstrated by increases in the specialization index (Table 6) and the sharp rise in HT exports with respect to total Japanese manufactures exports (Table 4).

The losses experienced by the US in the past two decades can be attributed not only to the gains of Japanese industry, but also to the very significant progress in HT exports by South-Eastern Asian NICs (South Korea, Hong Kong, Singapore, Taiwan) as seen in Table 1. While negligible in the early 1970s, the market shares of these countries have increased to account for approximately 8,9 per cent of the world market. The CMSA reveals that this increase in export-share was largely attributable to a positive structural effect, which has turned out to be by far more important than the 'competitive' effect during the entire period under consideration (Table 3). The ability to shift export composition towards highly dynamic markets and, especially, commodities has played a major role in improving the competitive position of the Asian NICs, although improvement in competitiveness has not been negligible.

Trade balances in HT sectors in the Asian NICs, unlike those in the other three industrialized areas, have registered persistent deficits over most of the period examined here. Trends in the competitive advantage indicator (normalized trade balance), however, show a significant reversal of this pattern beginning in the early eighties (Table 2, Figure 3). They have

continued to improve in recent years, benefitting primarily from the deterioration in the US position, achieving significantly positive trade balances in the late 1980s in the cases of Singapore and Taiwan.

Over the second half of the 1980s, the Asian NICs have registered trade surpluses with respect to both the US and the EC countries. This, however, has only partially compensated for their growing deficit in relation to Japan (Figure 6).

Change in the export patterns of Asian NICs has also been significant, with sharp rises in the share of HT exports with respect to total manufacturing exports from 6,5 per cent in 1970 to 22,4 per cent, as illustrated in Table 4. The latter value is greater than that of the average for the industrialized OECD countries. The specialization index reveals substantial progress as well, clearly indicating an improved comparative advantage for the Asian NICs in HT sectors, although entirely concentrated in the eletrocnic sector (Table 6). Of course, these trends are partly attributable to the extensive processes of production delocalization in this area through intense intra-firm trade by major US and Japanese firms and, to a lesser degree, by the European firms. They are also the result of the development of a production capacity in these countries which is destined to play an increasingly important role during the 1990s in world trade of HT products (Bradford and Branson, 1987).

With respect to the gains achieved by the Asian region, industries of EC countries lost considerable ground in the HT sector on domestic and international markets, though the decline in export market share was concentrated in the first half of the 1980s (Table 1). Trends in the EC trade balance (expressed in relation to world trade in HT products), though positive, reflect those of market shares, with different patterns in the 1970s and 1980s (Table 2, Figure 3). In the earlier period, the Community trade surplus registered continual growth, particularly in the years between the two oil crises, rivalling that of Japan by the end of that decade. But in the early 1980s, there was a reduction in the EC surplus, though it was attenuated by a modest increase in HT imports in that period. In the second half of the 1980s EC

FIG. 6 BILATERAL TRADE BALANCES IN HIGH-TECH PRODUCTS OF ASIAN NICs*

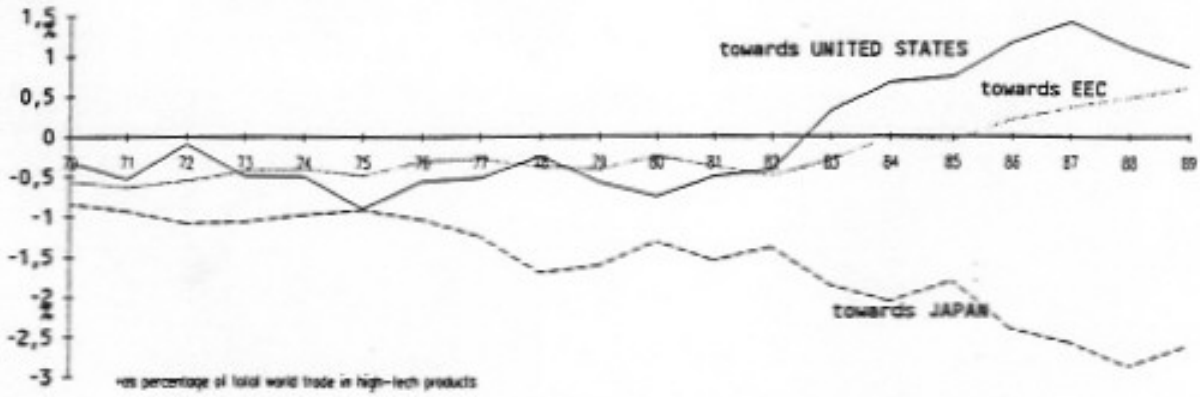


FIG. 7 TRADE BALANCES IN HIGH-TECH PRODUCTS*

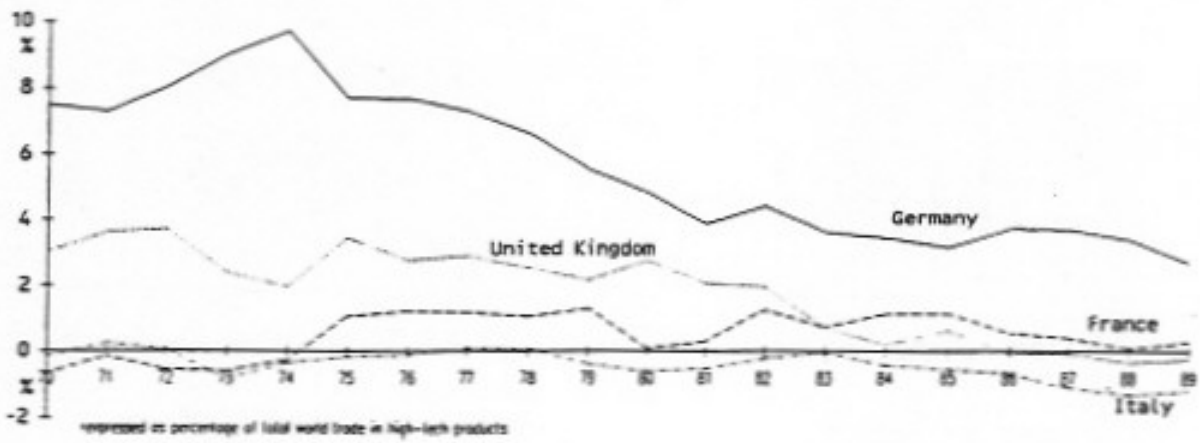
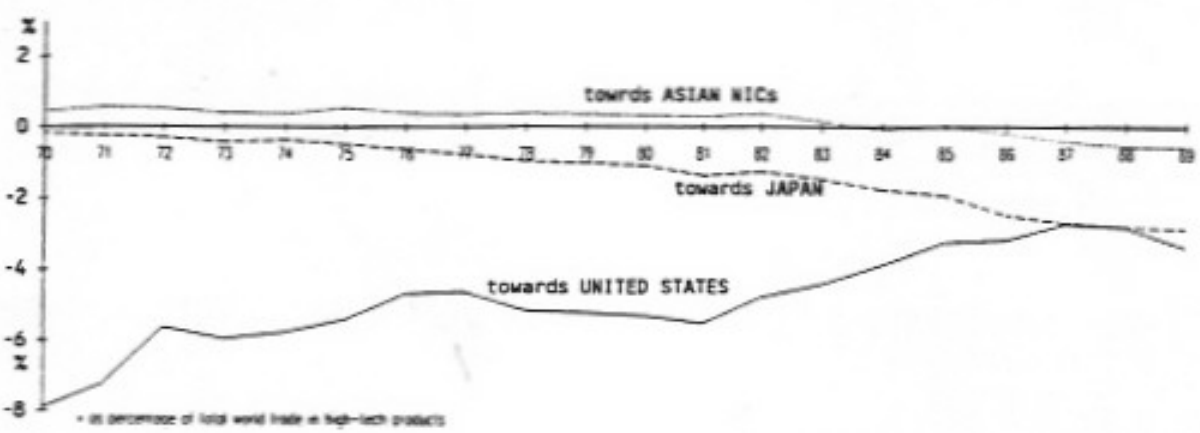


FIG. 8 BILATERAL TRADE BALANCES IN HIGH-TECH PRODUCTS OF THE EEC (9)*



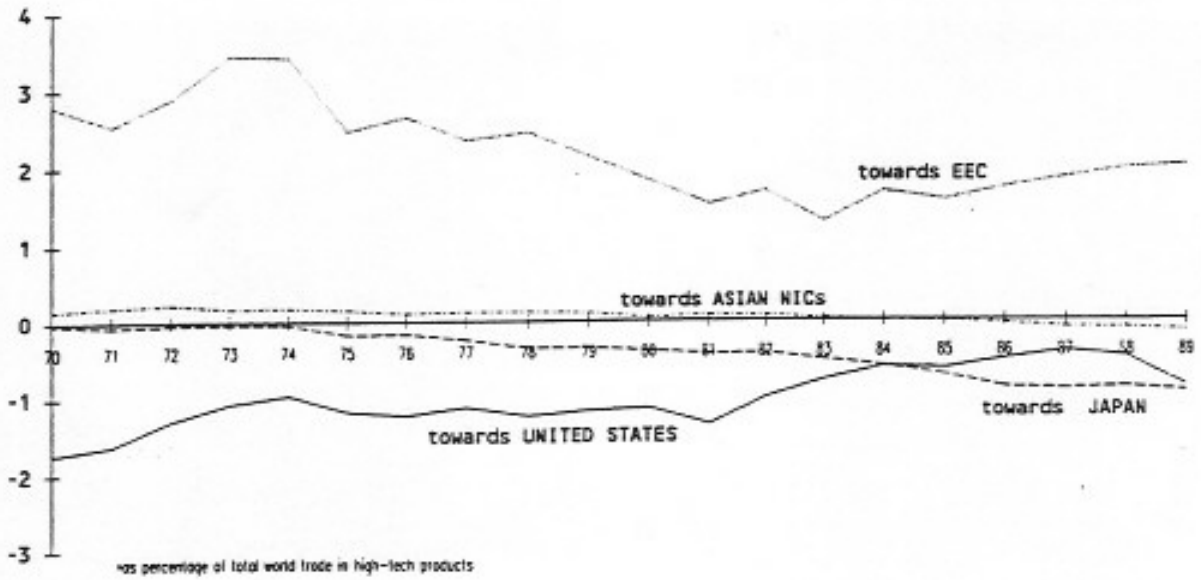
surplus again suffered a substantial loss, concurrent with renewed internal growth.

These generally negative trends in EC industry reflect unsatisfactory performance in all EC major countries, including Germany. In terms of market shares (Table 1), the United Kingdom experienced its greatest loss in the 1980s (-25%), as a result of both negative 'competitive' and 'structural' effects (Table 3). Germany also registered considerable losses (-23%), which were concentrated in the last decade and largely attributable to a negative structural effect. France's market shares were also considerably reduced (-22%) in the 1980s, particularly when compared to its substantial gains in the 1970s, achieved by improvements in its competitiveness (Table 3). Italy lost ground (24%) in the period 1970-89, thus decreasing its already small share in world exports because of a persistent negative structural effect (Table 3).

Trends in EC trade balances are even more significant when normalized by total trade in HT sectors. As seen in Figure 7 and Table 2, Germany, which had the highest trade surplus in HT products of the European countries in the early 1970s, experienced a sharp decrease in its trade balance, and the United Kingdom, which was the only other European country with a significantly positive HT trade balance, registered deficits instead of surpluses over the last decade.

The EC countries as a group are characterized by negative patterns in another area. In the second half of the 1980s, the European Community was the only one of the four major regions to show a deficit in HT trade with each of the others (Figure 8). Germany also followed a similar pattern (Figure 9). Since the early 1970s, EC trade balance with the US and Japan has always been negative, becoming progressively worse in the latter case since the mid-1980s. With respect to the Asian countries, the declining competitive advantage of EC industry is not limited to recent years. Significant changes over the last two decades have affected the relative positions of the EC, Southeast Asia and Japan on the US market, with substantial losses in the market shares of EC countries and corresponding increases in South-

FIG. 9 BILATERAL TRADE BALANCES IN HIGH-TECH PRODUCTS OF GERMANY*



*as percentage of total world trade in high-tech products

TAB. 5 CHANGES IN COUNTRY'S EXPORT SHARES OF HIGH-TECH PRODUCTS IN SELECTED MARKETS (percentage values)

Markets	JAPAN		UNITED STAT		EEC (9)		GERMANY		ASIAN NICs	
	1970-79	979-89	1970-79	79-89	1970-79	79-89	1970-79	79-89	1970-79	979-89
WORLD	2,7	6,7	-8,8	-2,3	2,2	-10,1	-0,1	-3,5	2,9	5,1
United States	5,3	10,7	/	/	-2,6	-11,2	0,6	-5,1	13,7	2,9
Canada	1,3	4,0	-0,6	-10,9	-1,7	-1,5	-0,9	-0,4	1,1	1,4
Japan	/	/	-12,5	-2,0	1,2	-5,6	0,0	-1,7	7,5	7,7
EEC (9)	1,3	5,1	-10,4	-0,4	2,4	-5,2	0,3	-2,5	1,2	2,9
Germany	2,4	7,9	-13,4	-0,9	1,1	-8,8	/	/	2,3	3,3
France	1,1	2,8	-9,6	-1,3	0,8	-1,8	2,5	-1,0	1,0	1,9
United Kingdom	-0,4	7,1	-23,6	2,4	9,6	-0,6	3,1	-2,1	0,9	4,1
Italy	0,5	3,4	-12,4	-1,1	6,7	-6,3	-2,4	-5,3	1,1	2,4
Other EEC (9)	1,8	3,5	-0,9	-1,5	1,7	-7,0	0,1	-5,5	0,7	2,6
Greece, Port.,	1,2	1,8	-9,2	-0,7	7,3	-5,2	2,1	-3,0	0,8	2,8
EFTA	1,2	1,9	-4,1	-1,1	-0,2	-1,8	0,2	-3,8	0,5	3,0
NON OECD Count	3,2	6,0	-2,5	2,3	-2,0	-15,2	-1,1	-4,4	2,5	5,1
Asian NICs	-1,1	-0,3	-4,9	-4,4	-2,5	-4,5	0,5	-2,1	2,9	1,1
Asian NECs	-2,2	3,3	7,7	3,0	-6,9	-10,7	-4,2	-1,3	11,9	7,3
America NICs	4,6	-1,4	4,2	13,4	-4,5	-8,6	-2,4	-4,4	0,1	1,1
CMEA	-0,3	-2,1	-2,7	1,0	1,9	-0,2	2,3	3,6	-0,1	1,0

Source: SIE WORLD TRADE Data-base

Eastern Asian countries and Japan (Table 5).

In terms of trade structure, the European Community and its major member countries have also experienced a general increase in HT exports with respect to total manufactures exports over the last two decades, though this increase has been more limited than that of other advanced countries (Table 4). At the same time, there has been a decrease in the specialization index; it has been less than 100 throughout the period considered here (Table 6), demonstrating that HT products have played and are continuing to play a relatively minor role in the export structure of the EC as a whole with respect to the US and Japan.

3. Sectorial Specializations and Competitiveness

Various HT sectors are now considered in order to identify: (i) the product groups in which Japan and (to a lesser extent) the Asian NICs have been most dynamic in industry and trade; (ii) the product groups in which the US and Europe have been best able to maintain their relative competitive positions. Such an analysis is also important because of the heterogeneous nature of the single HT sectors. While they have common basic characteristics in terms of typologies and sources of technological innovations, HT sectors differ significantly with respect to their nature, structure, and organization of their production activities.

Japanese specialization in the HT sector is concentrated around two poles of high competitiveness: electronics, and engines and electrical industrial equipment (mechanicals) (Table 6). While starting from a relatively modest competitive position in electronic industries in the early 1970s, Japan has achieved its most significant results in the past two decades, thus leading to extensive changes in the relative competitive positions of the other major countries. In all product groups in HT electronics (data processing machines, office electronics, electronic components, telecommunications equipment) our indicators clearly demonstrate a remarkable improvement in the

competitiveness of Japanese industry (Figures 10 to 14). In fact, Japan's market shares increased sharply in HT electronics beginning in the early 1970s (from 9,6 per cent to 23,9 per cent in 1989) and by the late 1980s it had become the largest exporter country of HT electronic goods (Table 7). Its performance in terms of trade balance has been even more impressive. In electronic industries as a whole the Japanese trade surplus has shown continued increases which in many cases have been very large and indicative of a distinct competitive advantage (Figure 10). The introduction of more advanced product and process innovations (largely imported from the US), the lower costs of large-scale production, and aggressive industrial and trade policies have enabled Japanese electronics industries to penetrate international markets rapidly, overtaking US as well as European products.

The relative competitive positions of the US and Europe must be considered separately, however, because different patterns emerge for each over the course of the period examined here. The US enjoyed a position of strength and relative supremacy in the early 1970s in most electronic industries (Figure 10, Tab. 7). During the last two decades, however, it experienced a marked decline and a significant weakening of its competitive position in a series of setbacks felt first in telecommunications equipment, then in electronic components and, more recently, in data processing machines (Figures 11 to 14). The combination of considerable losses in market shares and the sharply declining trends in trade balance over the past decade clearly points to a sharp loss in competitiveness of US electronics industries as a group. Only in scientific and professional electronic instruments does US performance appear somewhat satisfactory, with market shares and trade surpluses which remain high, albeit lower than in the past (Figure 15, Tab.8).

This backslide in US competitive advantage is almost entirely attributable to the rise of Japanese industry and, more recently, to competition from South-Eastern Asian countries in the US domestic markets as well as in the other major regions. A case in point is data processing machines, a category of

TAB. 6 REVEALED COMPARATIVE ADVANTAGE OF SELECTED COUNTRIES IN HIGH-TECH PRODUCT GROUPS*

	UNITED STATES		JAPAN		ASIAN NICs		EEC (9)	
	1970-73	86-89	70-73	86-89	70-73	86-89	70-73	86-89
Total High-Tech	219	192	80	133	54	110	99	91
Chemicals and Drugs	111	124	86	47	45	46	123	130
Mechanicals	156	145	93	144	21	68	108	97
Electronics	212	168	110	200	132	190	95	71
Aircraft & parts	440	416	6	7	16	20	63	91
Scientific Instruments	207	208	86	100	15	43	103	109

	GERMANY		FRANCE		UNITED KINGDOM		ITALY	
	70-73	86-89	70-73	86-89	70-73	86-89	70-73	86-89
Total High-Tech	111	91	97	105	132	133	79	62
Chemicals and Drugs	159	132	99	156	103	122	114	84
Mechanicals	140	129	105	114	141	110	79	65
Electronics	99	57	97	72	113	122	88	53
Aircraft & parts	20	79	87	148	175	178	41	63
Scientific Instruments	138	135	93	95	135	199	53	54

* ratio of world export share of a given country in high-tech product group to world manufacturers share of the same country

SOURCE: SIE-World Trade Data Base

TAB. 7 SHARES OF SELECTED COUNTRIES AND AREAS IN WORLD EXPORTS OF ELECTRONICS*

	1970-73	73-76	76-79	79-82	82-85	85-88	88-89
Canada	2,95	2,44	2,03	2,19	2,47	2,11	2,10
United States	28,85	26,17	23,25	23,79	24,64	19,22	18,28
Japan	9,60	11,13	14,50	16,97	20,55	23,37	23,96
EEC (9)	44,65	43,09	41,30	37,43	31,08	30,79	28,60
France	7,30	6,94	7,02	6,36	5,05	5,02	4,40
Germany	14,83	14,32	12,95	10,94	8,51	8,35	7,46
United Kingdom	8,63	8,32	8,09	8,16	7,10	6,92	6,97
Italy	5,10	3,94	3,91	3,80	3,19	3,19	3,00
Asian NICs	3,13	5,86	7,72	8,70	10,91	13,37	15,11
Singapore	0,85	1,83	2,69	2,80	3,09	3,88	5,17
Corea del Sud	0,97	1,89	2,05	1,62	2,07	3,05	4,04
Taiwan	0,53	1,04	1,46	2,03	2,82	3,75	4,12
Hong Kong	0,78	1,11	1,53	2,25	2,94	2,70	1,78

*Ratio of a country's or area's exports to total world exports

SOURCE: SIE-World Trade Data Base

FIG. 10 TRADE BALANCES IN HIGH-TECH ELECTRONICS*

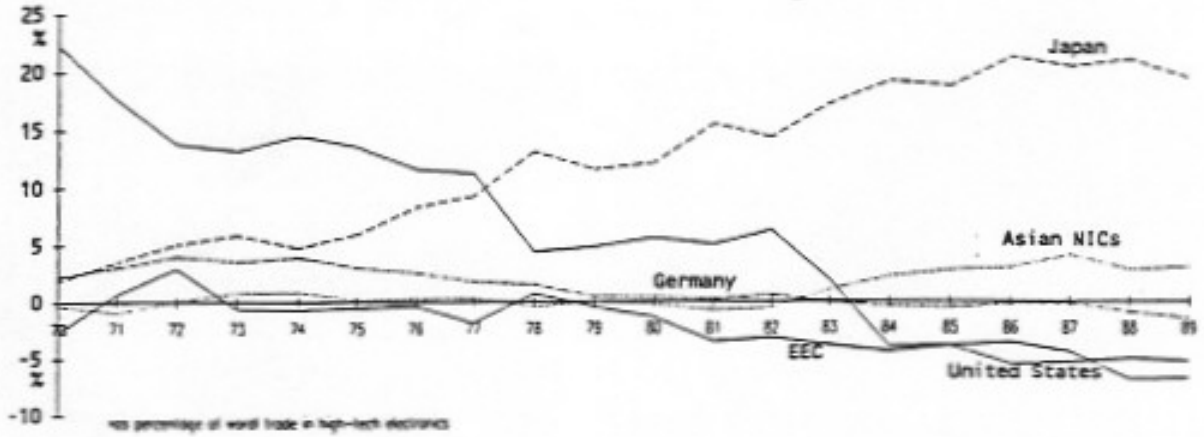


FIG. 11 TRADE BALANCE IN ELECTRONICS COMPONENTS*

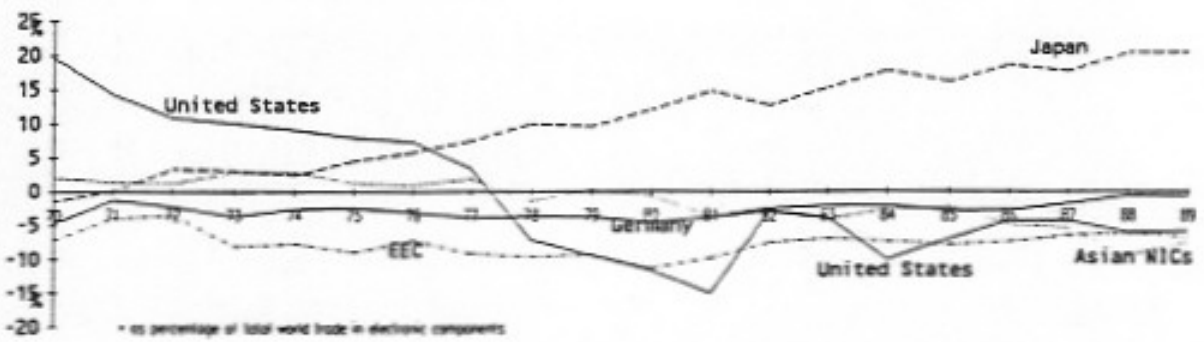


FIG. 12 TRADE BALANCE IN ELECTRONIC OFFICE MACHINES*

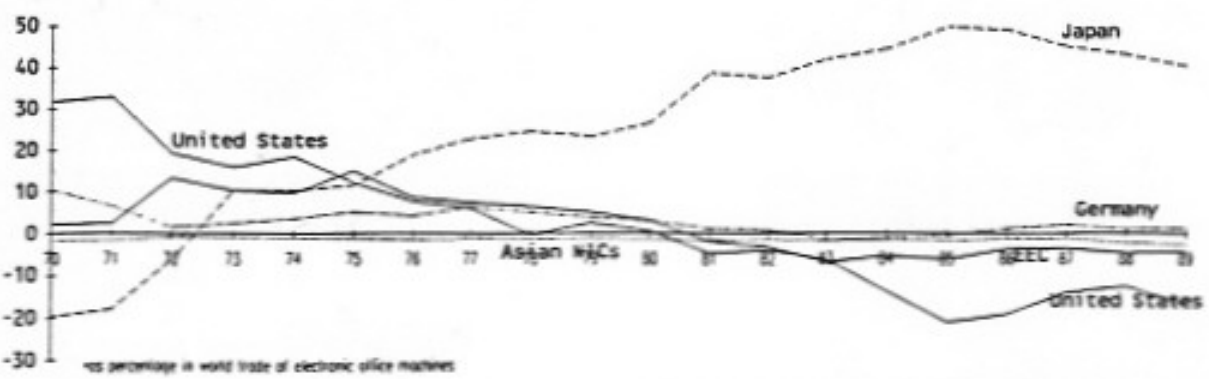
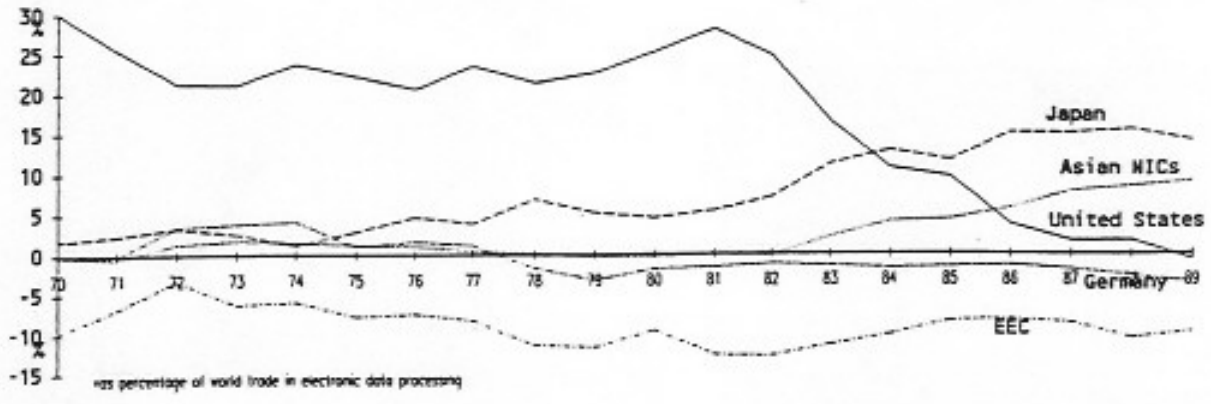
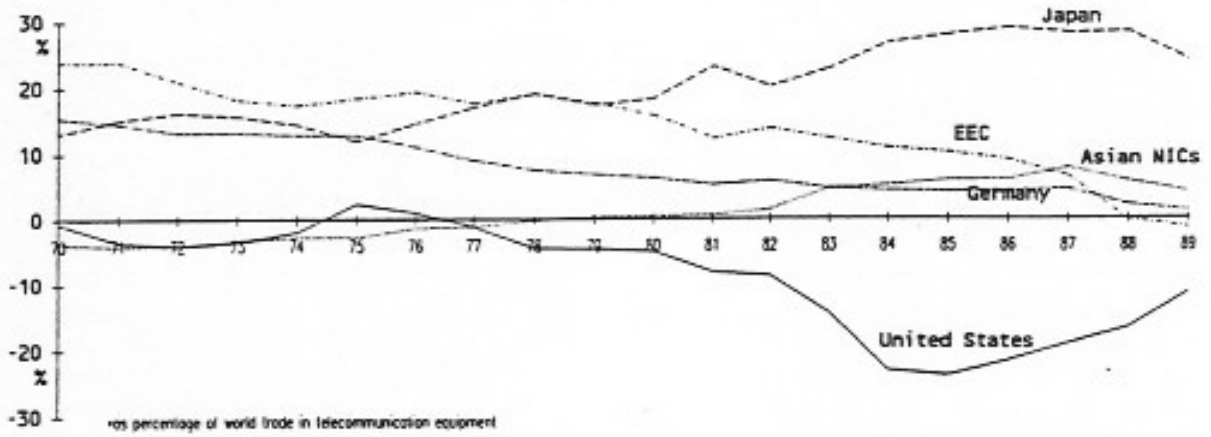


FIG. 13 TRADE BALANCE IN ELECTRONIC DATA PROCESSING*



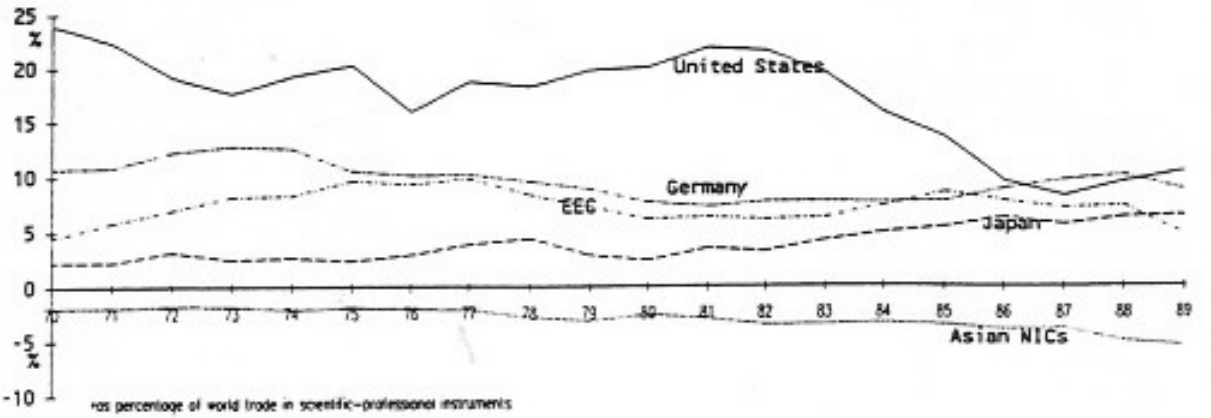
*as percentage of world trade in electronic data processing

FIG. 14 TRADE BALANCE IN TELECOMMUNICATION EQUIPMENT*



*as percentage of world trade in telecommunication equipment

FIG. 15 TRADE BALANCE IN SCIENTIFIC-PROFESSIONAL INSTRUMENTS*



*as percentage of world trade in scientific-professional instruments

strategic importance to information technologies and a dynamic industry which registered the greatest trade growth of all HT products in the 1980s. The competitive advantage indicator (standardized trade balance) for this product group in Japan rose from 1,7 per cent in total world trade in this HT group in 1970 to more than 14 per cent in 1988-89. This increase, together with the precipitous drop in the US standardized surplus over the same period from a high of approximately 30 per cent (in terms of total world trade in data processing machines) in 1970 to -0,7 per cent in 1989, clearly demonstrates a radical shift in the relative competitive position of the two countries in this category (Figure 13).

An equally important factor is the increased trade surplus in electronic data processing and in telecommunications equipment in South-Eastern Asian countries (Figures 13 to 14), in both those such as Taiwan and Hong Kong which developed electronics industries based on local US and Japanese multinationals, and those such as South Korea, which developed its own autonomous industry within few years. Thus, the Asian NICs were able to quintuplicate their share in world export of HT electronic products over the last two decades (from 3.1 per cent in 1970 to 15.1 per cent in 1989, see Table 7). Clearly, there is a complementary relationship between the Japanese upsurge and the rise of the Asian NICs in electronics, resulting in greater penetration of both actors on world markets.

In short, the major finding that emerges is that while the US continued to enjoy a relatively high specialization in electronics in the second half of the 1980s as shown in Table 7, it appears to have lost its past technological supremacy; its former leadership in many product groups has now been shifted to or is shared with Japan.

The EC has also experienced a persistent and progressive decline with respect to the striking gains made by the Asian region in most electronic products (Table 7, Figure 10). Since the mid 1970s, losses in EC market shares have been very substantial for data processing machines, electronic components and office electronics on both domestic and external markets.

Furthermore, in each of these three product groups, the EC as a whole and all its major member countries (Germany, France, the United Kingdom and Italy) registered significant deficits over the course of the 1980s, exhibiting highly negative trends which clearly indicate a deterioration in EC competitive position over time (Figures 11 to 13). These deficits arose primarily in the trade with Japan and the United States, despite the advantages enjoyed in the first half of the 1980s as a result of the sharp rise in the dollar. By the mid-1980s even the Asian NICs had accumulated surpluses with respect to the EC in all major segments of the electronics industry.

By contrast, the EC countries have shown relatively positive trends in scientific electronic instruments and in telecommunication equipments. In the latter, the normalized trade balance of the EC as a whole and, particularly, that of Germany have remained positive during most of the period under consideration, though they have been characterized by declining trends, particularly in the 1980s, leading the EC to a trade deficit and Germany to a sharp decrease of its surplus in this product group in most recent years (Figure 14). It must be pointed out that former high surpluses are largely attributable to preferential terms and the relative protectionism enjoyed by European firms on various national markets. But these conditions are changing as a consequence of the radical technological breaktroughs and the recent developments in telecommunication regulations, which have negatively affected the European firms in most recent times.

It should also be noted that the continued deterioration in EC competitive position in electronics is being cause for concern because it is a high growth industry with expanding markets and, above all, because of its strategic role in the processes of production restructuring under way in all the most advanced economies.

In HT mechanicals, such as engines and electrical industrial equipment, the various indicators also reveal substantial gains by the Japanese industry, with market shares that have more than doubled and a trade surplus that has tripled over the last two

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In HT mechanicals, such as engines and electrical industrial equipment, the various indicators also reveal substantial gains by the Japanese industry, with market shares that have more than doubled and a trade surplus that has tripled over the last two

decades (Figure 16, Tab.9). The European industries, and particularly those of Germany, have, however, managed to hold their ground in these areas, in which they have traditionally had high levels of specialization (Table 6), better than the US industry, which registered significant overall deficits in the second half of the 1980s (Figure 16). After showing high surpluses in the 1970s, the EC started to show declining trade balances, particularly in the second half of the 1980s, though surpluses continued to be relatively large. This decline is largely attributable to the weakening of the positions of Germany and the United Kingdom. Although Germany has maintained its relative surplus, it has been losing ground with respect to Japan, recently showing some signs of recovery only because of an increase in its balance of trade with other EC countries.

Unlike the HT sectors examined thus far, chemicals, pharmaceuticals and aerospace are characterized by patterns which indicate that the US and the EC have maintained and strengthened their positions of supremacy. The US has had relatively large and stable market shares in HT chemicals and pharmaceuticals (Table 10), in contrast with the losses registered in other HT products, and has consolidated its position of strength in terms of positive trade balances (Figure 17).

The EC also appears to have a relatively stable competitive advantage in chemicals and pharmaceuticals. Its market shares in these HT groups, unlike those in most other major HT sectors have continued to be relatively large (Table 10); trade balances following a decline in the second half of the 1970s have shown substantial surpluses in the last decade (Figure 17). Of the EC countries, Germany has held a position of supremacy with respect to the other partners, as indicated by its high surpluses throughout the period examined here (Figure 17). In the late 1980s, the EC showed a positive trade balance with respect to both the US and Japan, though the bulk of its surplus was generated by trade with areas outside the OECD. The high specialization and competitiveness of EC countries in chemicals must be pointed out as this sector plays a strategic role in advanced countries, not least because of the increasing

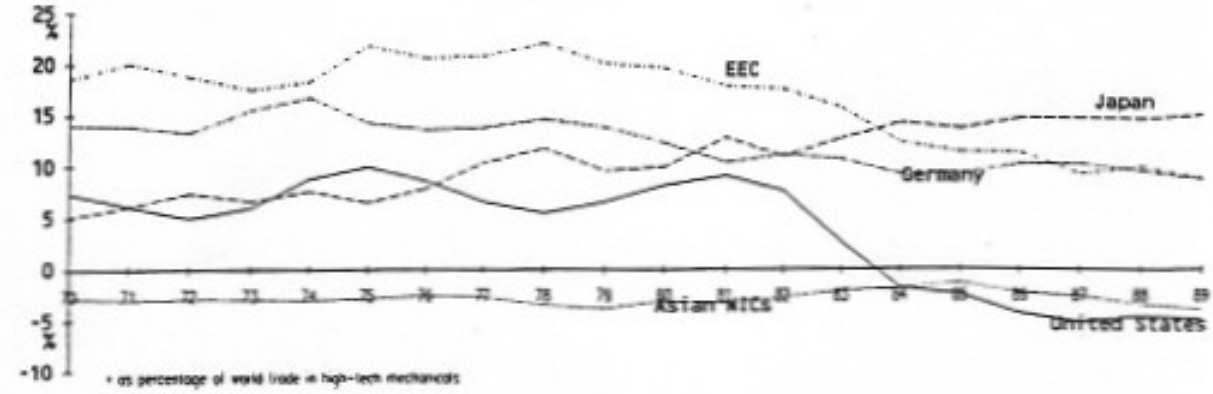
importance of new HT products within this group, as new materials.

Japan does not appear to be a threat to European and US supremacy. The Japanese market shares and trade balances in HT chemicals and pharmaceuticals have been decreasing since the early 1970s (Figure 17, Table 10). Despite this highly negative trend, particularly in pharmaceuticals, it must be recalled that Japanese firms have recently been increasing R&D expenditures, primarily in the field of biotechnology. It is also important to note that although its products have been characterized by low competitiveness, Japan continued to keep its imports down, with trade balances approaching zero as late as the late 1980s. This is in line with the anomalous pattern in Japanese trade discussed earlier in this paper, which is the source of bitter controversy among the other major countries.

Of the various HT categories, aerospace and its related industries (aircrafts & parts), traditionally characterized by considerable support from the public sector, is the area in which the US has the strongest specialization (Table 6) and competitive advantage, registering a large market share - more than 40% of world trade in the late 1980s (Table 11) - and a declining yet substantial surplus (Figure 18). In the mid-1980s, the US trade surplus in aerospace amounted to almost half of its total HT surplus.

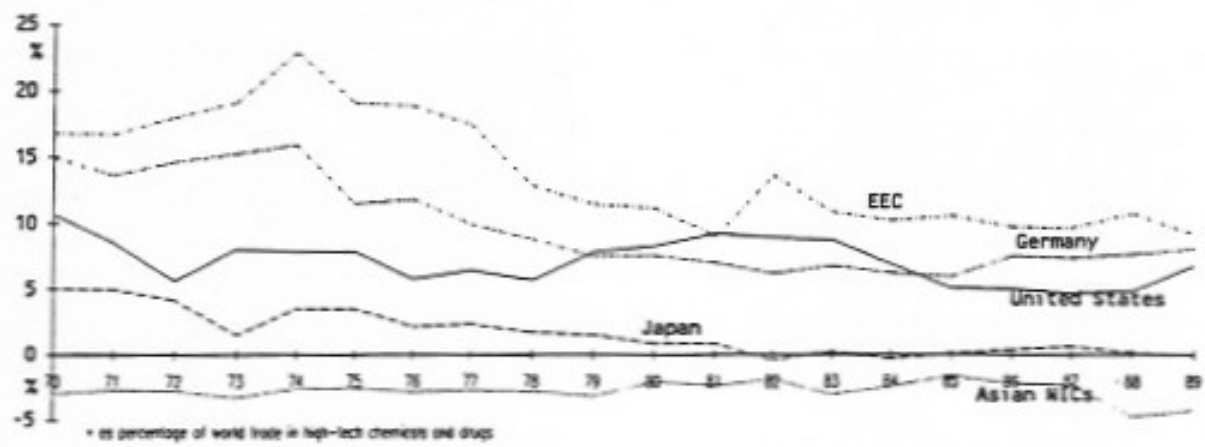
The EC has also registered highly positive trade balances in this product group since the mid 1970s, with increases in its market shares and surplus. This is particularly true of aircraft and parts, in which EC industries gradually succeeded in rivalling the formerly uncontested US supremacy during the last decade. Advances were first made in military products, particularly on markets outside the OECD. EC technological performance was later given impetus by the French-British Concorde programme, though it was not a commercial success. The subsequent Airbus venture, however, achieved significant results. Finally, it must be noted that Japan has never been able to achieve adequate economies of scale in aircfraft production, and continues to play a marginal role with respect to the US and

FIG. 16 TRADE BALANCE IN HIGH-TECH MECHANICALS*



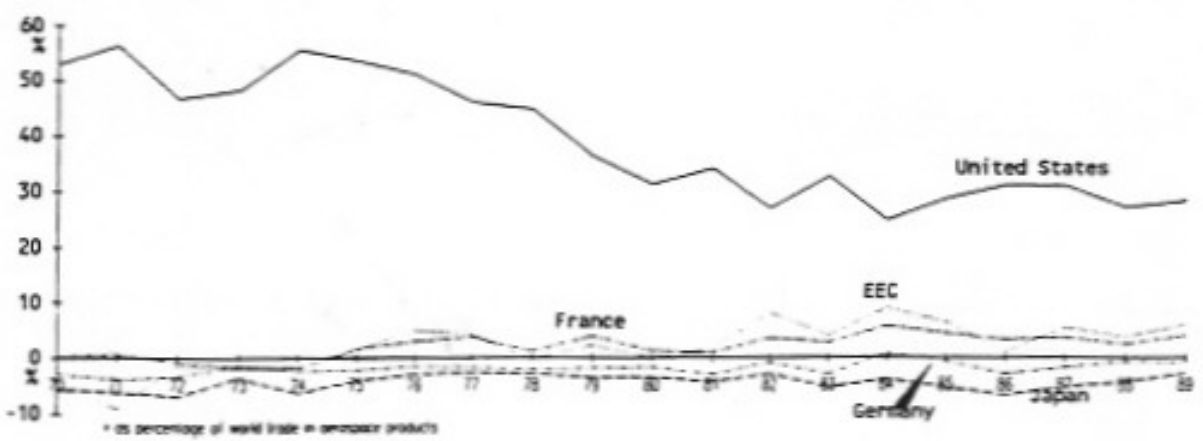
* as percentage of world trade in high-tech mechanicals

FIG. 17 TRADE BALANCE IN HIGH-TECH CHEMICALS AND DRUGS*



* as percentage of world trade in high-tech chemicals and drugs

FIG. 18 TRADE BALANCE IN AEROSPACE PRODUCTS*



* as percentage of world trade in aerospace products

TAB. 8 SHARES OF SELECTED COUNTRIES AND AREAS IN WORLD EXPORTS OF SCIENTIFIC AND PROFESSIONAL INSTRUMENTS*

	1970-73	1973-76	1976-79	1979-82	1982-85	1985-88	1988-89
Canada	3,31	2,53	1,99	2,13	2,50	2,02	2,05
United States	27,99	24,93	25,57	29,13	28,79	23,45	22,91
Japan	7,73	7,32	7,83	7,86	9,62	11,15	12,63
EEC (9)	48,25	49,52	48,86	44,94	42,84	46,00	45,08
France	6,91	7,87	8,38	7,43	6,67	6,66	6,16
Germany	20,67	21,07	19,59	17,38	16,26	18,60	18,89
United Kingdom	10,40	9,68	10,15	10,74	10,85	11,25	11,21
Italy	2,97	2,72	2,89	2,86	2,83	3,10	2,95
Asian NICs	0,39	0,77	1,27	1,50	2,18	2,94	3,45
Singapore	0,12	0,24	0,39	0,54	0,71	0,87	1,13
Corea del Sud	0,08	0,26	0,42	0,42	0,48	0,61	0,89
Taiwan	0,07	0,10	0,15	0,23	0,45	0,79	1,00
Hong Kong	0,13	0,19	0,32	0,32	0,55	0,67	0,43

*Ratio of a country's or area's exports to total world exports

SOURCE: SIE-World Trade Data Base

TAB.9 SHARES OF SELECTED COUNTRIES AND AREAS IN WORLD EXPORTS OF HT MECHANICALS*

	1970-73	1973-76	1976-79	1979-82	1982-85	1985-88	1988-89
Canada	5,92	4,38	3,11	2,16	2,17	2,37	3,40
United States	20,85	20,65	19,08	19,84	19,81	17,00	15,68
Japan	8,23	8,98	11,65	12,80	15,11	16,62	17,39
EEC (9)	51,07	50,73	50,55	47,74	41,16	40,29	39,83
France	7,75	8,96	9,56	9,11	7,62	7,38	7,63
Germany	21,08	21,59	21,07	19,12	17,16	18,11	17,70
United Kingdom	10,97	9,51	9,59	9,56	7,35	6,18	6,34
Italy	4,44	3,90	4,20	4,45	4,16	3,66	3,62
Asian NICs	0,52	0,91	1,38	2,55	4,53	5,17	5,33
Singapore	0,27	0,41	0,57	1,08	1,83	1,77	1,74
Corea del Sud	0,10	0,25	0,32	0,40	0,54	0,65	0,85
Taiwan	0,11	0,16	0,29	0,54	1,05	1,42	1,60
Hong Kong	0,05	0,10	0,20	0,52	1,12	1,33	1,15

*Ratio of a country's or area's exports to total world exports

SOURCE: SIE-World Trade Data Base

TAB. 10 SHARES OF SELECTED COUNTRIES AND AREAS IN WORLD EXPORTS OF HIGH-TECH CHEMICALS AND DRUGS*

	1970-73	1973-76	1976-79	1979-82	1982-85	1985-88	1988-89
Canada	1,05	1,02	1,73	2,23	2,05	2,38	2,46
United States	14,99	13,71	13,79	15,48	16,70	13,86	13,41
Japan	7,97	6,92	5,84	5,20	5,70	5,56	5,53
EEC (9)	57,66	60,37	58,46	54,78	52,35	54,11	54,88
France	7,24	9,17	10,16	10,68	10,72	10,42	10,45
Germany	23,93	22,90	20,39	17,98	16,89	18,19	18,62
United Kingdom	7,98	7,76	8,78	7,87	7,21	6,96	6,90
Italy	6,32	6,57	5,59	4,88	4,89	5,03	4,66
Asian NICs	1,13	1,40	1,50	2,10	2,73	3,39	3,36
Singapore	0,22	0,48	0,48	0,56	0,66	1,00	1,29
Corea del Sud	0,08	0,08	0,11	0,36	0,56	0,71	0,91
Taiwan	0,10	0,17	0,27	0,44	0,59	0,58	0,58
Hong Kong	0,75	0,67	0,65	0,74	0,92	1,10	0,58

*Ratio of a country's or area's exports to total world exports

SOURCE: SIE-World Trade Data Base

TAB. 11 SHARES OF SELECTED COUNTRIES AND AREAS IN WORLD EXPORTS OF HIGH-TECH AEROSPACE PRODUCTS*

	1970-73	1973-76	1976-79	1979-82	1982-85	1985-88	1988-89
Canada	7,59	4,79	3,26	2,85	3,30	3,85	3,93
United States	58,69	59,02	50,43	42,56	41,47	46,65	42,37
Japan	0,57	0,32	0,25	0,38	0,48	0,64	0,89
EEC (9)	29,58	31,63	37,48	39,48	40,99	36,68	39,59
France	6,55	7,11	9,02	7,64	8,89	9,34	10,04
Germany	2,95	4,43	8,01	10,31	12,37	10,38	11,58
United Kingdom	13,18	13,29	13,87	15,08	13,18	10,30	10,60
Italy	2,25	2,63	2,96	2,91	3,73	3,78	3,34
Asian NICs	0,41	0,70	1,29	1,28	1,69	1,76	1,41
Singapore	0,24	0,43	0,42	0,47	0,90	0,76	0,74
Corea del Sud	0,11	0,19	0,71	0,68	0,65	0,89	0,66
Taiwan	0,00	0,00	0,01	0,02	0,02	0,02	0,02
Hong Kong	0,07	0,07	0,15	0,12	0,12	0,10	0,00

*Ratio of a country's or area's exports to total world exports

SOURCE: SIE-World Trade Data Base

Table 12. SHARES OF SELECTED COUNTRIES AND AREA IN WORLD IMPORTS OF HIGH-TECH PRODUCTS*

(percentage shares in value)

	1970-73**	1973-76	1976-79	1979-82	1982-85	1985-87	1988-89	CHANGE 1970-89
OECD Countries	72,86	69,22	66,89	67,35	69,41	72,52	73,94	1,07
United States	10,14	9,46	10,35	12,04	17,22	19,00	18,17	8,03
Canada	6,89	5,96	4,87	4,71	5,05	4,57	4,64	-2,26
Japan	4,26	3,75	3,17	3,45	3,71	3,58	3,96	-0,30
EEC (9)	37,21	36,03	36,46	36,08	33,09	34,18	35,37	-1,84
Germany	8,40	8,29	9,46	9,71	9,06	9,26	9,35	0,95
France	7,49	7,47	7,37	7,15	6,02	6,18	6,50	-0,99
United Kingdom	6,75	6,62	6,90	7,42	7,34	7,14	7,79	1,04
Italy	4,45	4,37	4,05	4,22	3,90	4,35	4,58	0,13
Other EEC (9)	10,12	9,28	8,68	7,57	6,77	7,26	7,18	-2,95
Greece,Portugal,Spain	3,19	3,27	2,46	2,31	2,10	2,37	3,12	-0,07
EFTA	7,97	7,71	7,11	6,44	5,82	6,25	6,26	-1,71
Non OECD Countries	24,44	28,24	30,47	29,61	28,13	25,47	24,25	-0,18
Asian NICs	3,05	3,94	5,04	5,97	6,84	7,39	9,62	6,57
Singapore	0,66	1,05	1,46	1,84	2,11	2,11	2,77	2,11
South Korea	0,82	1,08	1,47	1,54	1,74	2,03	2,62	1,80
Taiwan	0,79	1,00	1,03	1,13	1,24	1,34	1,62	0,83
Hong Kong	0,79	0,82	1,07	1,46	1,75	1,92	2,63	1,85
Asian NECs	1,62	2,30	2,50	2,81	3,10	2,57	2,91	1,29
American NICs	4,00	4,04	3,12	3,17	2,27	2,35	1,85	-2,15
Former CMEA countries	2,62	2,98	2,86	1,99	1,53	1,40	1,24	-1,38

* Ratio of country's or area's imports to total world imports

** Average value in each sub-period (percentage)

(1) Indonesia, Malaysia, Thailand, Philippines

(2) Argentina, Brazil, Mexico

SOURCE: SIE-World Trade Data Base

European producers (Table 6, Figure 11).

5. Concluding Remarks

Very different patterns emerge in the relative competitive advantage of the major countries in HT products. There is evidence of a decline in US technological supremacy and a complex array of positive and negative trends in specialization patterns of other major countries across the HT sector.

The substantial increase in Japanese competitive advantage has been concentrated in the following HT product groups: electronics, engines and electrical industrial equipment. In each of these groups, and particularly in electronics, Japanese industry has gradually achieved a strong position in world trade, registering the most significant gains in recent years.

An analysis of the many different factors which account for this rise in Japanese competitiveness and increased specialization in the HT group would be beyond the scope of this paper. In general, however, the Japanese performance in this field during the past two decades may be attributed to a series structural competitive factors associated with the profound transformations in the specialization pattern of Japanese industry over the last fifteen years. While Japan made its gains by intensively resorting to 'external borrowing' of technology it needed, particularly from the US, it also created domestic conditions for the systematic utilization of this technology in terms of production and trade in new goods and services. Thus, Japan has demonstrated that skills in management, planning and organization are as decisive factors in determining a country's competitive advantage in HT products as is a high autonomous capacity for scientific research. In addition to Japan's performance in product quality and marketing, its success may also be attributed to the significant role of Japanese public policy in providing incentives, support and direction for the technological change undergone by firms.

It will, however, be difficult for Japan to continue to

apply its successful development strategy in the future because of the hostility of all the other countries generated by its reliance on high domestic production and demand, extensive exports and marginal imports. At present, the Japanese economy is in a transition period, characterized by an increased role of domestic factors affecting growth, the internationalization of production and, above all, by the need to become a 'producer' of technology from the position of a 'technology follower'.

In the case of the United States, the most salient characteristic is that its technological supremacy has gradually been eroded as a result of the 'catching-up' process followed by the other major countries. Sectorial indicators reveal a sharp contrast between those industries which continue to be strongholds in US specialization (chemicals and pharmaceuticals, electronic machines and instruments, aerospace), and those (particularly several major electronic product groups) in which unfavourable macroeconomic conditions combined with structural competitive disadvantages have led to a sharp decline in the competitiveness of US industries on both domestic and international markets. This trend is indicative of the increasing difficulty the US is experiencing in translating its high capability of scientific research into innovative commercial products. A case in point is the electronics industry, in which Japanese firms have become leaders in the development and marketing of most major new products largely by exploiting 'primary innovations' conceived in the US. This is a consequence of numerous microeconomic and institutional factors, as demonstrated by the nature of US R&D expenditure, which is heavily concentrated in the military sector.

Individual sectorial trends, however, suggest that US industries enjoy a stronger competitive advantage than indicators for the HT group as a whole would suggest. In these sectors US competitiveness appears connected to a strong R&D capability and to a domestic market whose size and development make it an important framework for supporting innovation activities. Given its powerful technological infrastructure, therefore, it would appear that the US will be able to continue to play a primary

role in many HT industries.

For the EC countries, trends in individual categories of HT products present a less well defined picture. Sectorial indicators show a consolidation of European competitiveness in chemicals and pharmaceuticals, electrical industrial equipment, scientific instruments, and, more recently, aerospace. In contrast to positive performances in these areas, however, there has been a sharp decline of EC competitiveness in all major electronic product groups. This negative trend has been exhibited by all major EC countries, including Germany, despite its uncontested supremacy in Europe in most HT sectors. The European position is cause for concern in light of difficulties associated with maintaining an autonomous high technological capability over the long term in the absence of a significant degree of independence in the production of those electronic technologies which are revolutionizing methods of production and organization of industry and service.

The causes of the disappointing performance of EC countries are well known: market fragmentation; relatively low and inefficent R&D; inadequate national industrial policies with respect to current world-scale competition; failure of organization and management to keep pace with changes. Of course some progress has recently been made with the moves toward the Internal European market. The first reassuring results have been achieved in terms of inter-firm agreements as well as in programmes for technological cooperation among European countries. But these are just first steps and they certainly do not justify the excessive optimism many feel about the future of the EC industry. There are profound gaps to be bridged in technological levels and competitiveness. This requires above all effective coordination at the European Community level of the national policies on technology. This goal is far from being reached, not least because of the profound differences in performance and innovative capability of individual EC countries.

NOTES

(1) Export market share of country (j) in total world exports with respect to a given group of products (i) is worked out as follows:

$$MS = \frac{{}_{j}X_{i}}{{}_{w}X_{i}}$$

${}_{j}X_{i}$ = total exports of country (j) in product group (i)
${}_{w}X_{i}$ = total world exports of product group (i)

(2) The standardized trade balance or the indicator of relative competitive position (IRCP) highlights the international distribution over time of trade surpluses and deficits among countries in each group of products. Trade surpluses and deficits are normalized by total world trade in the same group of products (CEPII 1983, CEPII 1989). The evolution of trade balance distribution permits to highlight competitiveness patterns of various countries in a certain group of products. For each country (j) the indicator is given by:

$$IRCP = \frac{X_{i} - M_{i}}{WT_{i}}$$

X_{i} = total exports of country (j) in the product group (i)
M_{i} = total imports of country (j) in the product group (i)
WT_{i} = total world trade in the product group (i).

APPENDIX A

SIE-World Trade Data Base

The world foreign trade statistics used for the analysis in this paper stem from the SIE-World Trade data base.
The network of trade data worked out by the SIE (Servizi Informativi per l'Estero) provides detailed information on export and import of 83 countries with respect to 400 product groups, 98 sectors, 25 broad commodity groups and 5 main product categories. The data base includes trade statistics with respect to the 24 OECD countries, the newly industrializing countries (NICs), the other developing countries and the former CMEA countries, and makes it possible to examine and analyze the entire world trade matrix.
The source for the basic trade statistics of the SIE-World Trade is the publications of the OECD and the United Nations provided on magnetic tapes.
The SIE data-base is organized in different product group classification at various levels of disaggregation (400 product groups, 98 sectors, 25 categories, 5 branchs) according to the three Standard International Trade Classifications (SITC), Revised, Revision 2 and Revision 3, defined by the Statistical Office of the UN (1961, 1975, 1986) as to the periods 1961-75, 1978-87. 1988 on.

The High-Tech product groups classification used in this paper is based on the 400 product groups of the SIE-World Trade.

APPENDIX B

The Constant-market-shares-analysis (CMSA) is an accounting method for decomposing a country's export share (or aggregate export) change in world trade into various effects: 'structural change' effects and 'competitiveness' effects. Its usefulness is effectively summarized by Magee (1975, p.221): 'The technique reveals that, even if a country maintains its share of every product in every market, it can still have a decrease in its aggregate market share if it exports to markets that grow more slowly than the world average and/or if it exports products for which demand is growing more slowly than average'.
The CMSA has been here reformulated in a more convenient way in order to overcome the well known methodological limits linked to the traditional applications of this technique. The version of the CMSA applied in this paper decomposes a country's export share change into the following four effects:
a) competitiveness effect: it measures the change of a country's export share due only to competitiveness factors assuming that its trade structure (market and commodity) is constant
b) market effect: it represents the influence of the geographic composition of trade flows upon the aggregate export share of a country. It is positive (negative) if a country concentrate its exports on market that grow faster (more slowly) than the world average
c) commodity effect: it represents the influence of the product composition of trade flows upon the aggregate export share of a country. It is positive (negative) if a country concentrates its exports on products for which demand is growing faster (more slowly) than the world average
d) specific market-commodity effect: it represents the influence on the aggregate export share of a country stemming from specific composition product-markets more (or less) favourable.
The sum of b), c) and d) effects represents the overall 'structural effect', which measures those changes in aggregate export share of a country due only to changes in commodity-market structure in world trade.
The CMSA has been here worked out for the period 1970-1987, since some disaggregated data for the years 1988-1989 were not yet available. Further, to simplify the computation of the CMSA the resource-intensive and scale intensive sectors have been grouped into only one class of sectors named 'all scale intensive sectors' (see table 14).
For further details on the methodologies of CMSA here used see Milana (1988) and Guerrieri-Milana (1990).

APPENDIX C

There are different and alternative methodologies to define and quantify 'high technology' trade. They can be grouped into two broad set of measures. The first measure uses an indicator of technological inputs, such as R&D to sales ratio or engineers and scientific personnel to regular employees ratio, as a proxy for embodied technology, and defines as 'High Technology' industries all those industries characterized by a ratio higher than a given threshold value. All traded products included in these industries are then classified as high technology products (ITA, 1985; OECD, 1985).

The second approach uses more disaggregate data and relies upon the evaluation of industry experts in order to determine the technological content of the various products. At this level of detail, analysts' judgments are used to determine whether a product is high-tech (Amendola e Perrucci, 1990; Abbott, 1991).

There is no doubt that the two methodologies used for the classification of high-technology products are very different in their approaches since the first method takes a more objective measure of embodied technology whereas the second uses more subjective criteria to define high-tech. Both methods of classifying products, however, suffer from several major flaws and the usefulness of either measures depends upon the particular application.

In this study we use an intermediate classification system of the two alternative methods mentioned above. We use the ratio of R&D to sales of domestic producers to define and individuate high-tech industries. From each single industry we then select a given number of high technology products on the basis of different parameters and the opinion of a group of industry analysts.

Our classification of high technology products comprises the following list of product groups (5 digit level):

1. CHEMICALS AND DRUGS:

Synthetic organic dyestuffs - Radio-active and associated materials - Polymerization and copolimeryzation products (Polyethylene-Polypropylene-Polystyrene-Polyvinyl) - Antibiotics

2. MECHANICALS

Turbines - Electric motors - Electric power machinery and apparatus - Internal combustion piston engines

3. ELECTRONICS

Automatic data processing machines & Units - Telecommunications equipment - Semiconductor devices - Electronic microcircuits -

4. SCIENTIFIC AND PROFESSIONAL INSTRUMENTS

Electronic measuring instruments - Medical instruments - Optical instruments and appliances - Photographic apparatus and equipment

5. AEROSPACE

- Aircraft & associated equipment - Spacecraft

A complete list of the products included in each group could be provided on request by the authors.

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