Foders, Federico

Working Paper

The technological specialization of Europe in the 1990s

Kiel Working Papers, No. 675

Provided in cooperation with:
Institut für Weltwirtschaft (IfW)

Kieler Arbeitspapiere
Kiel Working Papers

Kiel Working Paper No. 675
The Technological Specialization
of Europe in the 1990s*
by
Federico Foders
February 1995

Institut für Weltwirtschaft an der Universität Kiel
The Kiel Institute of World Economics

ISSN 0342 - 0787

Kiel Institute of World Economics
Düsternbrooker Weg 120
24105 Kiel
Federal Republic of Germany

Kiel Working Paper No. 675

The Technological Specialization of Europe in the 1990s*

by

Federico Foders

February 1995

* This paper is part of a multi-year research project on "Transfer of Energy Technologies to Eastern Europe: An Economic Analysis of the Bulgarian, Czech and Slovak Cases"; financial support has been provided by the European Commission in the framework of the Copernicus Programme. I am indebted to Kai Carstensen for research assistance, to Christel Hartz and Evelyn Jann for computational assistance, and to Irene Baur for mastering the paper's word-processing requirements.

Abstract

This paper contributes to the ongoing debate on the international position of Europe by (i) presenting new evidence on technological specialization and competitiveness and (ii) exploring methodological issues underlying the empirical analysis. The results show that the technological profile of the member countries of the European Union offers a wide scope for technology transfer and inter-industry trade both within the European Union and between the member countries of the European Union on the one hand and Japan, the United States and Eastern Europe on the other. However, risks loom large in the possible eastward enlargement of the European Union and in the formation of a monetary union, because of the former's and the latter's potential impact on the European Union's technological profile and the international competitiveness of European firms.

Contents

List of Tables and Figures

I. Introduction

In its White Book on "Growth, Competitiveness and Employment" the European Commission spotted deficits in three key areas of economic policy. In particular, European unemployment is attributed in part to changes in the relative position of the member countries of the European Union (EU) vis-à-vis the United States and Japan with respect to world market shares, R&D, innovation, and the ability to commercially exploit new products (European Commission 1993, p. 10). This rather pessimistic diagnosis concerning the health status of European economies and firms has been vigorously challenged in a survey on "The European Union" recently published by The Economist: "For all the liabilities of its social costs and lack of entrepreneurs, the EU has plenty of assets: for example, a well-educated workforce ..., good engineering skills, and a tradition of expertise in advanced technologies" (Vol. 333, No. 7886, 22 October 1994, p. 18). It is not the first time that the issue of European technological (in)competence or lack of international competitiveness in high-technology products is raised. What makes the current discussion in Europe different is that the marked diversity of opinion found at the policy level is now not only matched by a renaissance of the academic debate on competitiveness but also by similar developments in the United States (Nelson, Wright 1992). Michael Porter (1990) and Paul Krugman (1994) have refuelled the academic debate in the United States, to a certain extent as a reaction to a public discussion largely influenced by Lester Thurow (1992) and Laura d' Andrea Tyson (1992), who borrowed from Jean-Jaques Servan-Schreiber's (1967) spirit as reflected in his book "Le défi américain" to detect something like "Le défi européen et japonais".

It is the main purpose of this paper to contribute to the current discussion on the international position of Europe by presenting empirical evidence on the actual technological specialization of EU member countries and confronting it with the pessimistic and the optimistic hypotheses sketched above. Empirical studies of the international technological position of countries may also find some justification in recent developments in economic theory, especially in the field of economic growth. In the new theory of economic growth technology occupies centre stage. Taking an international perspective, the theory attributes growth to (endogenous) technical progress and its diffusion, and predicts the emergence of two groups of countries in the international division of labour: technological leaders (innovators and exporters of technology) and technological followers (imitators and importers of technology) (Grossman, Helpman 1994, p. 41). Finally, research on the current role of EU member countries in the world economy could help to anticipate the potential impact of the recent northward enlargement of the Union to include Austria, Finland, and Sweden - for the time being, Norway remains a permanent candidate -, and of the eastward enlargement projected for the early years of the 21st Century. Official plans foresee the membership of only a few Central and Eastern European countries (Poland, Hungary, the Czech Republic, the Slovak Republic). But in view of the fact that the list of potential candidates for membership is extended almost daily in public announcements (to include Bulgaria, Romania, the Baltic States, etc.), eastward enlargement is very likely to remain high on the agenda of European integration in the next decades.[1] In accepting an increasing number of largely heterogeneous countries as full members, the international position of the old EU members is likely to be affected as it also might be in the wake of the further deepening of the EU along the lines of the Maastricht Treaty, for example, by forming a monetary union. Any enlargement- or Maastricht-induced changes in the international position of Europe - be they avoidable or inevitable - would be much easier to handle at the policy level if the point of departure were better known. The next section deals with methodological problems related to the empirical estimation of the technology content of trade. In Section III the empirical evidence on technological specialization is presented and discussed. Section IV addresses the relationship between technological specialization and competitiveness, and presents evidence on the latter. The last section comprises a summary of the main results and some policy conclusions.

II. Technology Content of Tradables: Methodological Aspects

1. Identifying High-Technology Products

The first step in the estimation of the technological sophistication of traded goods is to classify the traded goods into different groups according to their technology content. This is generally done in the literature by hypothesizing that a product's "technology content" is positively correlated with the level of the ratio of R&D expenditures to sales or value of output of the same product. If one were to accept

[1] The European Commission signed so-called "Europe Agreements" with Bulgaria, the Czech Republic, Hungary, Poland, Romania and the Slovak Republic. Hungary and Poland have already formally applied for membership in 1994, the Slovak and the Czech Republics could follow in 1995 and 1996, respectively. A Free Trade Agreement has been signed with the Baltic States.

this hypothesis as leading to a useful proxy, the immediate problem to be solved relates to the fact that statistics on R&D expenditures are usually available only at the firm level and sometimes at the plant level, but almost never at the product level. A formula has to be found to convert firm or plant data to product data. In case one succeeds, the next task is to divide the goods into the different categories needed for the subsequent analyses employing appropriate criteria. A glance at the empirical literature reveals that economists tend to vary greatly in their choice of the product composition of the high-technology category of goods. Without pretending to be exhaustive, Table 1 presents a selection of the most widely used definitions.[2] Balassa and Noland (1988), for example, define high-technology products as "products where the ratio of research and development expenditures to the value of output exceeded 3.5 percent in the mid-1970s in the United States" (Balassa, Noland 1988, p. 209). These authors are able to identify a total number of 19 US SIC categories using R&D data collected by the US Federal Trade Commission at the four-digit SIC plant level. Kravis and Lipsey (1992) draw heavily on a study on the behaviour of US multinationals in 1982 carried out by the US Department of Commerce and published in 1985, which also applies a R&D/sales ratio to determine the technological sophistication of goods, but for other reference years than Balassa and Noland.

A somewhat different approach has been proposed by Scherer and Huh (1992) who define high-technology goods as US SIC sectors "in which product and/or process innovation has been prominent" (Scherer, Huh 1992, p. 203). In doing so, Scherer and Huh seem to suggest that it might be helpful to improve our knowledge about the innovative industries, which is tantamount to say that expert opinion matters, possibly more than the R&D/sales ratio. Furthermore, to take recourse to expert opinion does not imply that thousands of interviews will have to be carried out and that it is necessary to know in detail which firm has recently invested in which kind of new machinery or new products. As far as process innovations are concerned, it is sufficient to consult expert opinion on organizational innovations, which are hypothesized by some authors (Porter 1990; Milgrom, Roberts 1992) to constitute the leading component of process innovations in the 1990s, following the example of the automobile industry (Womack, Jones, Roos 1990). The most important recent organizational innovation with an impact on manufacturing is computer-integrated manufacturing (CIM). Put in simple terms, CIM denotes the intensive use of computers to link key technical with key management functions within the

2 Alternative definitions have been proposed, among others, by Klodt, Stehn et al. (1994, p. 38).

Table 1. Alternative Definitions of High-Technology Products by SITC (Rev. 3) Code Numbers[a]

Foders	Balassa/Noland	Kravis/Lipsey	Scherer/Huh
54	54	54	54
72	-	-	72
74	-	-	74
75	75	75	75
764	764	764	764
772	772	772	772
774	774	774	774
776	776	776	776
778	-	778	778
792	792	-	792
793	-	-	793
87	87	87	87
88	88	88	88
-	56	-	56
-	583	-	583
-	6514 to 8	-	6514 to 8
-	71	-	71
-	8121	-	8121
-	-	786	786
-	-	-	64
-	-	-	5 (less 54, 583)
-	-	-	62
-	-	-	66
-	-	-	67
-	-	-	68
-	-	-	69
-	-	-	71
-	-	-	73
-	-	-	77 (less 772, 774, 776, 778)
-	-	-	78
-	-	-	79 (less 792, 793)
-	-	-	89

[a] The headings corresponding to the SITC (Rev. 3) code numbers are presented in Table A1 in the Appendix.

Source: Own compilation and conversion from US SIC to UN SITC (Rev. 3); Foders, Wolfrum et al. (1993); Balassa, Noland (1988); Kravis, Lipsey (1992), Scherer, Huh (1992).

manufacturing firm, thereby integrating such divisional units as design and engineering with manufacturing, quality control and marketing; CIM also allows for an incorporation of other firms (suppliers and/or customers) into the computer network. The main physical precondition for CIM (in addition to specific hardware and software) is the substitution of traditional capital goods for computerized and networked capital goods with a high degree of automation and flexibility. For example, in those industries in which machine tools are employed, the introduction of CIM calls for computerized numerical control (CNC) machine tools instead of mechanical machines. It suffices then to find out which industries have switched to CIM and reorganized to fully integrate state-of-the-art information technologies into the firm, a kind of data easily found in the business press and other related media where process and product innovations are usually made public.

In their study, Scherer and Huh also carefully scrutinize the changes over time of the R&D/sales ratios for a 17-year panel covering 308 US manufacturing firms and conclude that the ratios are subject to frequent and, more importantly, unsystematic changes, "related neither to import competition changes nor to other plausible explanatory variables" (Scherer, Huh 1992, p. 212). This finding seems to rather disqualify the R&D/sales ratio as an authoritative criterion to divide high- from low-technology goods. This explains why two independent researchers employing the same criterion, namely the R&D/sales ratio, but for different years or levels of aggregation, necessarily arrive at diverging sets of high-technology products for the same country. Moreover, in defining the group of high-technology goods, Scherer and Huh differ from other authors in that they emphasize the role of process innovations on the ground that competitive imports originating in Japan might have benefited from them, taking into account that "Japanese firms spend a higher fraction of their R&D budgets than American industry" on process innovations (Scherer, Huh 1992, p. 211). This procedure points at the risk of overlooking parts of the game by focusing only on product innovations in studies of international specialization, even if the latter were to constitute the distinct characteristic of domestic technical progress.

Finally, in searching for an optimal definition of different categories of technology-embodying goods a statistical issue has to be addressed. To statistically identify, say, high-technology goods at the lowest level of aggregation possible might be a very accurate way of discriminating between goods according to their technology content. However, since every classification is necessarily subject to the point in time at which it is made, extreme disaggregation will tend to make such a classification very sensitive to changes over time in the distribution of inventive activity over industries, processes, and products. In an era of ever shorter product (and process) life cycles, a higher level of aggregation would be the obvious recommendation. On the other hand, higher levels of aggregation suffer from being less accurate than lower ones due to the inclusion of goods that have not been affected at all by innovation. Higher levels of aggregation are bound to increase the risk of turning a fact into an artifact. Thus, the optimal level of aggregation should be preferably tailored to the purpose and time horizon of each study.

In this study a division of traded goods according to their technology content is used which has been derived in a two-step procedure. Following the approach suggested by Scherer and Huh and drawing on expert information about product and process innovations gathered in 1992/93, a first breakdown at the three-digit level of SITC (Rev. 3) was obtained. This classification was then complemented by the one used by Balassa and Noland (1988) in those cases in which expert opinion was ambiguous or not available. The final definitions were classified at a mixed level of aggregation, including one-, two- and three-digit SITC product groups. The definitions used in this paper (Table 1 and Table A1 in the Appendix) were originally applied in a multi-year study on entry barriers in North America faced by European firms carried out by Foders, Wolfrum et al. (1993).

2. Measuring a Country's Technological Specialization

The index of Revealed Comparative Advantage (RCA) is one of the most popular indicators found in the vast empirical literature on the patterns of inter-industry trade. Although the pure theory of international trade offers explanations for patterns of inter-industry trade based on pre-trade considerations, empirical tests have to operate with post-trade data. In this spirit, actual trade data is often taken to directly reflect a country's comparative advantage in terms of, say, relative factor proportions, the role of the RCA index in tests of trade theory being to present actual trade data in such a way that the relative position of a country vis-à-vis selected countries or the rest of the world can be inferred. The extent to which the different versions of the RCA index found in the literature (export in dex, net-export index, etc.) are correlated with proxies reflecting country characteristics (for example, factor inputs) has been the subject of a large number of econometric studies which yielded mixed results and led to a lively debate of the kind "my RCA index is better than yours" (Vollrath 1991; Memedovic 1994). One of the most relevant results of this still ongoing debate is that each version of the index may show a different trade pattern for the same country and point in time, and that the indices cannot be expected to be highly correlated with each other (Ballance, Förstner, Murray 1987, p. 159; UNIDO 1983, p. 337). The lesson from this is that the choice of the index matters.

This study differs from those mentioned above in that it focuses on trade specialization per se and not on the measurement of comparative advantage. This notwithstanding, it faces the same problem of index choice as the studies dealing with other aspects of international trade. With no generally accepted criterion around to identify the first- or second-best RCA index, in this study use is made of an index capable of showing a country's net-export position in a certain good (= specialization), weighted by its trade balance, which has been applied in empirical analysis by Wolter (1977), among others. The goods are classified according to their technology content as shown in Table A1 in the Appendix, enabling the index to reveal a country's specialization in certain categories of technology-embodying goods. The index, which for the purpose of this study shall be called the index of technological specialization (TS), in order to avoid a semantical confusion with "comparative advantage", is defined as:

$$(1) \qquad TS_{ij} = \ln\left[\frac{\dfrac{x_{ij}}{\sum_i x_{ij}}}{\dfrac{m_{ij}}{\sum_i m_{ij}}}\right] = \ln\left(\frac{x_{ij}}{m_{ij}}\right) - \ln\left(\frac{\sum_i x_{ij}}{\sum_i m_{ij}}\right)$$

where: x_{ij} = nominal value of country j's exports of good i to the OECD countries,

m_{ij} = nominal value of country j's imports of good i from the OECD countries,

$\sum_i x_{ij}$ = total nominal value of country j's exports to the OECD countries,

$\sum_i m_{ij}$ = total nominal value of country j's imports from the OECD countries.

Due to the natural logarithm, TS is normalized at zero. For deviations from zero the values of TS are subject to an elasticity of TS with respect to changes in x_{ij}/m_{ij} that decreases as $| x_{ij} - m_{ij} |$ increases. Moreover, taking limits TS is unbounded in both directions: if x_{ij}/m_{ij} tends to infinity, then TS also tends to infinity; if x_{ij}/m_{ij} tends to zero, then TS tends to minus infinity, with $x_{ij} = 0$ and $m_{ij} = 0$ generally undefined. As has been shown by Yeats (1985, p. 71), RCA indices neither fulfil the properties of ordinal nor those of cardinal measures, a fact that restricts the use of such indices to indicating, as in the case of TS, either specialization (TS > 0) or the absence of specialization (TS ≤ 0) in a particular good or group of goods. A shortcoming of this dichotomous measure is that values in the neighbourhood of zero, for example, 0.001 and minus 0.001, are both equally valid, albeit difficult to interpret. Similarly, TS = 0 detects the absence of specialization in the sense of inter-industry trade yet could also be taken to reflect a different kind of specialization, namely in the sense of intra-industry trade. In this study, however, we subscribe to the inter-industry interpretation of specialization.

Furthermore, in (1), the ratio x_{ij}/m_{ij} is weighted by the ratio of total imports to total exports which is tantamount to say that the trade balance has a role in making TS positive or negative. In other words, a country's specialization in a certain good changes over time (i. e. might turn negative) as shifts in the trade balance occur, even if x_{ij} and m_{ij} were to remain constant. For example, for $x_{ij}/m_{ij} = 2$ and $\sum_{ij} x_{ij} / \sum_{ij} m_{ij} = 1$, TS is equal to 0.69. A trade surplus leading to the second term in (1) becoming equal to 2.5 while the first term remains constant, results in TS = -0.23. Thus the weighting system tends to correct the ratio x_{ij} / m_{ij} for fluctuations in the exchange rate and/or protection measures affecting exports (subsidies) and/or imports (tariffs and non-tariff barriers) with an impact on a country's overall trade balance and technological profile.[3]

[3] It should be noted that the inclusion of the trade balance in TS does not contribute to highlight the "importance" of a particular good in a country's foreign trade. A simple example explains the issue: let total exports and total imports be constant and each equal to 100, and let a particular good's exports and imports fall from 80 to only 8 and from 10 to only 1, respectively. In the first case, TS = 2.08, and in the second case, TS = 2.08, i. e. TS is unchanged, in spite of the fact that the "importance" of this good (exports or imports as a share of total exports or imports) was drastically reduced. As was mentioned in the text, only the ratio between exports and imports really matters.

III. International Specialization of Europe

1. Overall Specialization

A glance at Table 2 reveals the international technological specialization of the twelve "old" member countries of the EU, the four countries which either joined the EU on 1 January 1995 or are expected to do so later (Norway), and five countries of Central and Eastern Europe, some of which could be eligible as candidates for the first eastward enlargement of the EU in the early years of the next century. Taking the year 1992 as a benchmark (the latest year for which trade data were available), three clubs of European countries can be identified according to their revealed specialization in standard-, intermediate- and high-technology products. The group of technological leaders specialized either only in high-technology goods or in both intermediate- and high-technology goods includes Germany, France, the United Kingdom and Sweden (Club 1), as well as third countries like Japan and the United States. Of the Club 1 members only France is not specialized in intermediate technology goods, a pattern that can also be observed in 1989. A second club is composed of countries focusing mainly on intermediate-technology products (with some scope for high and standard technology), the members of which are Ireland, Italy, Belgium/Luxembourg, Spain, Finland and Norway. The third club extends to countries exclusively specialized in standard-technology goods, comprising Denmark, Greece, the Netherlands, Portugal, Austria, Bulgaria, Czechoslovakia, Hungary, Poland and Romania.

A proposition of the new theory of economic growth maintains that technology and growth (and thus the level of income) are related, the only possible and transitory exception being the growth pattern of natural resource-rich countries (Grossman, Helpman 1994). It should be of interest to find out whether the clubs formed by grouping countries with a similar pattern of technological specialization also reflect similarities in the level of per capita income. Table 3 shows that at least on average a relationship between specialization and income exists, in spite of the fact that the deviation of the individual member's income from the simple club average is inversely associated with the degree of sophistication of its international technological specialization. Thus while Club 1 is quite homogeneous, Club 3 is characterized by members with rather diverging per capita incomes. These divergences seem to indicate that per capita income might not always be a reliable proxy for the technological specialization of countries.

Table 2. Europe: International Technological Specialization[a], 1989 and 1992

Country	Technology Content of Traded Goods					
	Standard		Intermediate		High	
	1989	1992	1989	1992	1989	1992
EU Member Countries						
Belgium/Luxembourg	0.02	0.01	0.04	0.06	-0.21	-0.19
Denmark	0.26	0.30	-0.64	-0.45	0.08	-0.08
France	0.04	-0.0004	-0.09	-0.05	0.06	0.08
Germany	-0.42	-0.37	0.22	0.14	0.28	0.28
Greece	0.63	0.76	-0.95	-1.13	-2.11	-1.87
Ireland	0.24	0.19	-0.61	-0.40	0.13	0.04
Italy	0.13	0.21	-0.37	-0.45	0.25	0.19
Netherlands	0.07	0.08	-0.01	-0.05	-0.11	-0.09
Portugal	0.61	0.57	-0.64	-0.58	-0.85	-0.84
Spain	0.07	0.15	-0.28	0.02	-0.77	-0.33
United Kingdom	-0.20	-0.23	-0.01	0.09	0.26	0.18
New or Potential EU Member Countries						
Austria	0.10	0.07	-0.04	-0.03	-0.13	-0.07
Finland	0.05	-0.12	0.07	0.20	-0.19	-0.19
Norway	-0.20	-0.51	0.91	0.85	-1.21	-0.83
Sweden	-0.09	-0.23	0.08	0.14	0.01	0.09
Potential Future EU Member Countries						
Bulgaria	0.58	0.75	-0.03	-0.78	-1.40	-1.55
Czechoslovakia[b]	0.69	0.77	0.03	-0.12	-1.77	-1.45
Hungary	0.75	0.58	-0.37	-0.32	-1.37	-0.94
Poland	0.40	0.54	0.05	-0.20	-1.57	-1.51
Romania	0.05	0.47	0.05	-0.41	-1.09	-1.82
Third Countries						
Japan	-1.19	-1.18	0.23	0.16	1.20	1.06
United States	0.05	-0.10	-0.39	0.02	0.40	0.07

[a] As measured by the TS index;
[b] OECD trade statistics for 1989 and 1992 are not yet available separately for the Czech and the Slovak Republics.

Source: Own calculations with OECD trade data.

Table 3. Europe: Technology and Income, 1992

Country/Club	Index of GNP per capita (US = 100)[a]
Club 1[c]	80.2
France	83.0
Germany	89.1
Sweden	76.2
United Kingdom	72.4
Club 2[c]	68.8
Belgium/Luxembourg	78.5[b]
Finland	69.1
Ireland	52.2
Italy	76.7
Norway	78.0
Spain	57.0
Club 3[c]	42.3
Austria	79.4
Bulgaria	22.2
Czechoslovakia	28.0[b]
Denmark	80.7
Greece	34.6
Hungary	24.8
Netherlands	76.0
Poland	21.1
Portugal	43.8
Romania	11.9
Third Countries[c]	93.6
Japan	87.2
United States	100.0

a World Bank estimates based on purchasing power parities and expressed in terms of gross national product (GNP);
b own estimates;
c simple group average.

Source: World Bank (1994, pp. 220 - 221) and own estimates.

What are the implications of the international technological position of Europe? The first conclusion to be drawn is that there are at least three "old" members of the EU (notably Germany and the United Kingdom, and possibly France) which match quite well the overall technological position of Japan and the United States, and that the northward enlargement of the EU brings in at least one more country, Sweden, with similar credentials. Moreover, overlapping specialization profiles indicate that five "old" EU members and two Scandinavian countries dominate the range of products representing intermediate technology. Finally, the rest of the "old" members meet Austria and the candidates from Eastern and Central Europe in that they are all specialized in goods embodying standard technology. Therefore, while the northward enlargement of the EU is likely to moderately strengthen the EU's technological position in the high and intermediate ranges, the eastward enlargement is bound to substantially increase the EU's output capacity for standard-technology goods.

Another implication of Europe's pattern of technological specialization is that there is scope for technology transfer within the EU, especially from Club 1 to Clubs 2 and 3, and from Club 2 to Club 3. To the extent that technology transfer takes place through trade, a potential for technology-driven inter-industry trade within the EU can be observed. In addition, existing technological disparities point towards a potential for commercial channels of technology transfer, such as licensing and direct investment, within the EU. With respect to Club 3 members from Eastern and Central Europe, the countries with the lowest relative level of income per capita, both commercial and non-commercial channels of technology transfer could have a role during the transformation process.

2. Specialization Within Product Groups

High-Technology Products

Of the four European countries in Club 1, only two, Germany and the United Kingdom, are specialized in 8 or more SITC product groups representing high technology, thereby coming quite close to the presence of Japan and the United States in the high-technology segment of international trade (Table A2). This notwithstanding, Japan is specialized in three product groups which are not listed in the Club 1's pattern of specialization: computers, semiconductors and optical equipment. All four Club 1 countries are specialized in pharmaceutical products and general machinery. Other important product groups are special machinery, medical apparatus, and ships. Overlapping of Club 1's specialization occurs with Club 2 (pharmaceutical products, aircraft, and ships), Club 3 (electrical machinery and ships), and Japan and the United States (all kinds of machinery, medical apparatus, ships, and scientific instruments).

Intermediate-Technology Products

This category of products is the most difficult to define accurately. It is composed of products as diverse as chemicals, sound recording equipment, manufactures made out of rubber and leather, and mineral fuels, some of which could be probably considered to embody high and others low technology. This is the reason why in some cases the leading suppliers of intermediate technology products are at the same time leading suppliers of either high- (Germany, United Kingdom) or low- (Austria, Poland) technology products (Table A3). Nevertheless, it is useful to have a category in-between in order to accomodate products and countries which would be certainly misclassified in either of the extreme categories, even if overlappings (of Club 2 with Clubs 1 and 3 as well as with Japan and the United States) were to be much more common in the intermediate- than in other technology segments.

Standard-Technology Products

Regarding standard-technology goods, the most important European suppliers (as measured by the number of product groups with TS > 0) are clearly located in Central and Eastern Europe, and closely followed by Southern European countries (Table A4). Overlapping with Club 1 is rare, as also are overlappings with the profiles of Japan and the United States. The opposite is true with respect to Club 2, however. Club 3 probably overlaps with the specialization of developing countries and some OECD countries not included in the sample.

IV. Does Competitiveness Matter?

Though the primary interest in this paper is to derive a cross-country picture of technological specialization at a certain point in time (1992), it is interesting to note that 9 countries (out of a total of 22 in the sample) were more or less affected by shifts in their respective specialization profiles (as measured by the TS index) occuring between 1989 and 1992 (Table 2). What are the reasons for those shifts? The detailed discussion of the index of technological specialization in the last section revealed that TS is sensitive to changes in the ratio of exports to imports of a good, and in the overall balance of trade. The latter implies, for example, that a formerly positive TS value for a particular product could become negative as a consequence of trade balance changes, even if the exports and imports of this product were unchanged. This means that the factors determining the overall trade balance and the ratio of exports to imports of individual products have an influence on the technological specialization profile of countries. According to macroeconomic theory, in an open economy the balance of trade is determined by the relative price level (the ratio of domestic to foreign prices) and the nominal exchange rate between the local and the foreign currency (Dornbush, Fisher 1990, pp. 750 and 751).

To the extent that certain conditions (elasticities) are met, each time the ratio of relative prices changes in such a way that domestic goods become cheaper and foreign goods dearer, theory predicts that exports will expand and imports contract, assuming the nominal exchange rate remains constant. The same effect can be achieved if either relative prices stay unchanged and the exchange rate depreciates or foreign goods become relatively dearer and the exchange rate depreciates. Increases in exports in response to favourable macroeconomic conditions are understood by some as an indication that the home country's competitiveness has improved vis-à-vis its trade partners (Dornbush, Fisher 1990, pp. 185 and 751). By contrast, Krugman (1994, p. 34) and Porter (1990, p. 6) have pointed out that there is no such thing as a competitive country, and that the word "competitive" should be used exclusively as an adjective for firms and/or products. Moreover, if a country were chosen as a location of economic activity by "competitive" firms successfully selling "competitive" products abroad, this does not mean that every firm located in that country or every single product produced in that country must be "competitive".

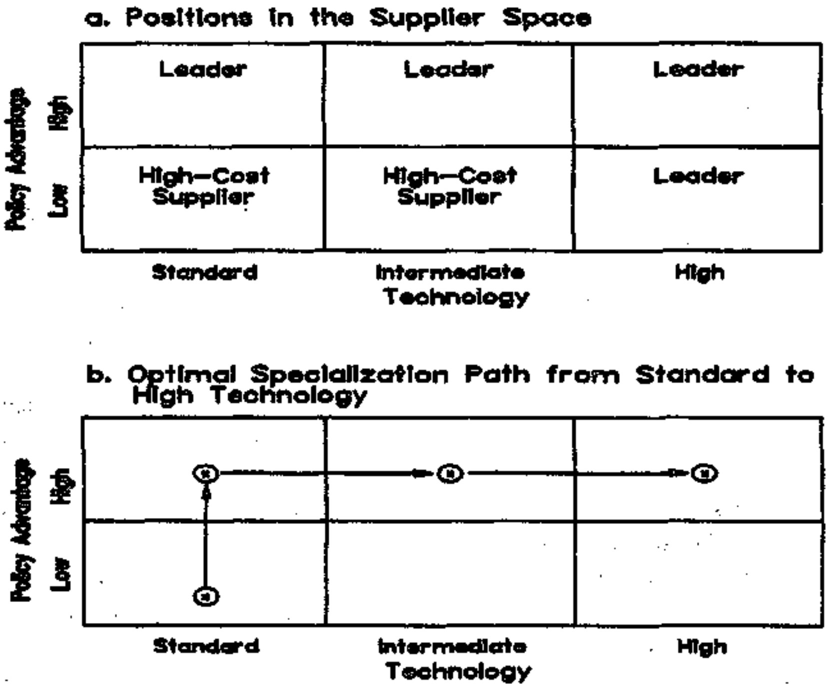
However, the ability of a firm to increase its sales abroad does not only depend on the firm itself (and on its products) but also on macroeconomic conditions. For a firm operating in the field of standard technologies, where prices are generally given and cost constitutes the only parameter under the firm's command, the ability of a firm to lower its cost does not extend to the ability to influence a country's macroeconomic conditions. Under these circumstances, relative prices and the nominal exchange rate certainly have a role in ultimately co-determining a firm's international competitiveness and, consequently, a country's specialization. Similarly, the competitiveness of firms offering intermediate-technology products for which many suppliers exist in the world and for which the scope for product differentiation is limited, is also influenced by macroeconomic conditions. The only case in which macroeconomic conditions could seem to matter less is when imperfect competition or monopoly prevails, a market structure often found in the high-technology field. The justification for imperfect competition in the high-technology segment stems from the nature of new technology as a nonrival but (partially) excludable good (Romer 1994, p. 13). Firms owning new technology are able to exclude competitors from using it for at least some period of time. As long as monopoly rents can be earned from innovations, the firm is free to adjust both parameters, price and cost, to market developments and to expand its market share by maintaining technological leadership, and thus potentially in a position to largely offset unfavourable macroeconomic conditions by choosing appropriate adjustment paths at the firm level.

Thus, by bringing in technological specialization, the location of economic activity seems to become relevant for firms longing to be competitive in standard and intermediate technologies. What actually matters are economic policies of countries to the extent that they affect trade (exports and imports), in particular, monetary, incomes and exchange rate policies; commercial policies are omitted in order to keep the approach simple. Even if one were to argue that optimal macroeconomic conditions are not sufficient for a firm to be "competitive", because it is still up to the individual firm to perform, the indication is that locational characteristics might constitute a necessary condition for a well-performing firm to keep on doing so, particularly if the firm supplies standard- and/or intermediate-technology goods. It is then straightforward to refer to locational characteristics in terms of favourable macroeconomic conditions as constituting a "policy advantage" of countries or regions. Figure 1 summarizes the discussion and presents a new framework within which countries can be positioned with respect to their technological specialization and policy advantage (Figure 1a); an optimal specialization path for countries is shown in Figure 1b.

The problem now is to find a suitable indicator for policy advantage. Considering that the nominal exchange rate and the ratio of domestic to foreign prices[4] have been identified above as the key variables influencing the quality of a location of economic activity for firms supplying the world market with standard- and/or intermediate-technology products, there are good reasons for choosing the real

4 Reflecting, among others, the impact of incomes policies.

Figure 1 – *Relationship between Technological Specialization and Policy Advantage*



effective or multilateral exchange rate (REER) as an empirical indicator of policy advantage. Put in simple terms, the REER is defined as

$$(2) \quad REER_j = e_j \cdot p^* \cdot trw_j$$

where: e_j = nominal exchange rate expressed in US \$ per unit of the country j's currency,

p^* = ratio of domestic prices to foreign prices,

trw_j = weights representing the share of country j's major trade partners in its foreign trade

Assuming that trw_j is constant, the REER is influenced by movements in the nominal exchange rate and relative prices as can be seen from Table 4. Exports are normally encouraged whenever the REER depreciates and discouraged whenever it appreciates; the opposite is true for imports. A constant REER equally benefits exporters and importers, because it reflects movements in the nominal exchange rate and relative prices which offset each other. In case both effects do not perfectly offset each other, the net impact on the REER can not be determined ex ante. Out of the several definitions of the REER applied in the literature (Durand, Simon, Webb 1992), in this paper use is made of the one found in the International Financial Statistics published by the International Monetary Fund (IMF 1985). The details of the algebraic derivation of the REER are contained in Appendix B.

For the countries in the sample, the values of the REER (Table A5) and the index of technological specialization in 1989 and 1992 (Table 2) lead to the picture shown in Figure 2. Compared to 1990, the base year of the IMF's REER index, there were shifts in the policy advantage enjoyed by some of the Club 1 countries, notably Germany and Sweden, as well as in the policy advantage of the United States. While the position of the United States improved, the one of Germany and Sweden deteriorated. However, this change in the REER did not affect the technological specialization of these countries, as far as high-technology products are concerned, possibly because, as was hypothesized above, these products tend to be independent of policy advantage or disadvantage. Shifts in the specialization profile were experienced by Club 1 countries only to the extent that they also supplied standard- and/or intermediate-technology products (for example, the United Kingdom and France). The most dramatic changes happened in Central and Eastern Europe (members of Club 3). Poland, Romania and Czechoslovakia lost their role as suppliers of intermediate-technology products, and Bulgaria, Hungary, Poland and Romania lost policy advantage in the wake of the transformation process. Hungary, in 1989 a leading supplier of standard-technology products, joined the other Eastern European countries in 1992 to become a high-cost supplier of those products.

Figure 2 – *International Position of European Countries 1989 and 1992*

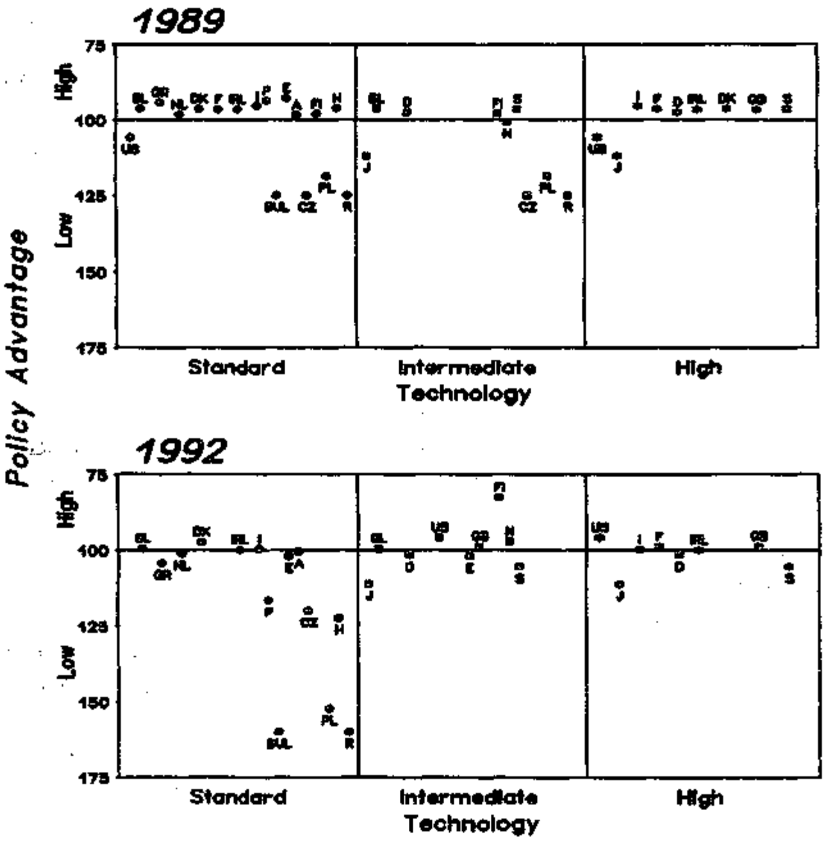


Table 4. Determinants of the Real Effective Exchange Rate

Nominal Exchange Rate		Relative Prices		
		Constant	+ Δ	- Δ
Fixed		no change	appreciation	depreciation
Flexible	+ Δ	appreciation	appreciation	indeterminate
	- Δ	depreciation	indeterminate	depreciation

Source: Own compilation.

V. Summary and Conclusions

It might be too soon to empirically test Lester Thurow's exclamation "Future historians will record the twenty-first century belonged to the House of Europe!" (Thurow 1992, p. 258). With respect to the optimism expressed in the survey on the EU recently published by The Economist (1994), the evidence presented in this paper with the intention to shed some light on the actual role of Europe in the world economy in the early 1990s does not go even half the way in the opposite direction, which implies that there is no ground for unconditionally sharing the rather pessimistic diagnosis concerning the technological position of Europe put forward in the European Commission's White Book (1993).

What is the good news? The findings indicate that the EU's international technological specialization covers goods of different technological sophistication. The profiles of the leading European countries match quite well the profiles of the United States and Japan in the high-technology field; any remaining differences between EU and these countries leave scope for mutually beneficial trade. The EU's broad technological portfolio reflects substantial differences between the profiles of the EU member countries, which can be taken as an indication of a vast potential for technology transfer and trade within the EU. Differences in the specialization patterns between the EU and Central and Eastern Europe also point at the existence of important opportunities for the EU member countries in helping to close the East-West technology gap.

The empirical results also identify a certain relationship between technological specialization and policy advantage, the latter denoting a country's monetary, incomes and exchange rate policies with an impact on international trade. This relationship is very close in the standard- and intermediate- technology segment and largely unimportant in the high-technology segment. In the former segments, movements in policy advantage draw the line between specializing in standard and/or intermediate technologies and between a high-cost location and a leading location for manufacturing activities. By contrast, high-technology products are generally supplied under imperfect competition and individual firms have price, cost and technological parameters under their command and are thus enabled to adjust to unfavourable local macroeconomic conditions (policy disadvantage of locations) without necessarily loosing world market shares. The estimates give support to the hypothesis that policy advantage is largely irrelevant in the high-technology field and to the hypothesis that policy advantage does matter for specialization and locational decisions associated with the production of low-technology goods.

The EU's technological portfolio can be interpreted as constituting a hedge against the risk of overspecialization in any one segment of the technological spectrum in a rapidly changing world and thus as offering a solid background for the tasks ahead, particularly for the northward and eastward enlargements, and for the implementation of the Maastricht Treaty. However, some risks remain. While the northward enlargement of the EU moderately strengthens the EU's specialization profile in the intermediate- and high-technology fields, the eastward enlargement is bound to substantially expand the EU's output capacity for standard-technology goods. To accommodate the Central and Eastern European countries' profile in the EU means to accelerate structural change in Southern Europe and in other member countries with overlapping profiles. This will only be possible to the extent that the single market is fully implemented in all industries and countries, and to the extent that highly protected industries (agriculture, steel, textiles) are liberalized. If a monetary union should come into being in the 1990s, as scheduled in the Maastricht Treaty, it remains to be seen whether the EU's monetary and exchange rate policy will benefit the EU as a location of economic activity for firms engaged in the standard- and intermediate-technology segment. Policies not meeting this requirement could make initiatives aiming at an eastward enlargement very difficult to succeed and, at the same time, create incentives for firms based in the EU member countries to relocate in third countries.

References

BALASSA, Bela, Marcus NOLAND, Japan in the World Economy. Institute for International Economics, Washington D. C. 1988.

BALLANCE, Robert H., Helmut FÖRSTNER, Tracy MURRAY, "Consistency Test of Alternative Measures of Comparative Advantage", Review of Economics and Statistics, Vol. 69, 1987, pp. 157 - 161.

DURAND, Martine, Jacques SIMON, Colin WEBB, OECD's Indicators of International Trade and Competitiveness. Economics Department Working Papers No. 120, OECD, Paris 1992.

FODERS, Federico, Rüdiger WOLFRUM et al., Marktzutrittsbarrieren in den USA und Kanada, Kieler Studien, 257, J. C. B. Mohr, Tübingen 1993.

GROSSMAN, Gene M., Elhanan HELPMAN, "Endogenous Innovation in the Theory of Growth", Journal of Economic Perspectives, Vol. 8, No. 1, Winter 1994, pp. 23 - 44.

INTERNATIONAL MONETARY FUND (IMF), International Financial Statistics, Supplement on Exchange Rates, Washington 1985.

--, International Financial Statistics, CD ROM, Washington 1994

KLODT, Henning, Jürgen STEHN et al., Standort Deutschland: Strukturelle Herausforderungen im neuen Europa, Kieler Studien, 265, J. C. B. Mohr, Tübingen 1994.

KOMMISSION DER EUROPÄISCHEN GEMEINSCHAFTEN, Wachstum, Wettbewerbsfähigkeit, Beschäftigung. Herausforderungen der Gegenwart und Wege ins 21. Jahrhundert. Weißbuch. Bulletin der Europäischen Gemeinschaften, Beilage 6/93, Brüssel-Luxemburg 1993.

KRAVIS, Irving B., Robert E. LIPSEY, "Sources of Competitiveness of the United States and of its Multinational Firms", The Review of Economics and Statistics, Vol. 74, No. 2, May 1992, pp. 193 - 201.

KRUGMAN, Paul, "Competitiveness: A Dangerous Obsession", Foreign Affairs, Vol. 73, No. 2, March/April 1994, pp. 28 - 40.

MEMEDOVIC, Olga, On the Theory and Measurement of Comparative Advantage. An Empirical Analysis of Yugoslav Trade in Manufactures with the OECD Countries 1970 - 1986, Tinbergen Institute Research Series No. 65, Thesis Publishers, Rotterdam 1994.

MILGROM, Paul, John ROBERTS, Economics, Organization & Management, Prentice Hall, Englewood Cliffs 1992.

NELSON, Richard R., Gevin WRIGHT, "The Rise and Fall of American Technological Leadership: The Postwar Era in Historical Perspective", Journal of Economic Literature, Vol. 30, December 1992, pp. 1931 - 1964.

ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD), Annual Foreign Trade Statistics. Trade Statistics by Commodities 1992, Series C, CD ROM, Paris 1994.

PORTER, Michael E., The Competitive Advantage of Nations. The Macmillan Press, London, Basingstoke 1990.

ROMER, Paul M., "The Origins of Endogenous Growth", Journal of Economic Perspectives, Vol. 8, Winter 1994, pp. 3 - 22.

SERVAN-SCHREIBER, Jean-Jaques, Le défi américain, Éditions Denoël, Paris 1967.

SCHERER, F. M., Keun HUH, "R & D Reactions to High-Technology Import Competition", The Review of Economics and Statistics, Vol. 74, No. 2, May 1992, pp. 202 - 212.

THE ECONOMIST, "The European Union". Survey, Vol. 333, No. 7886, 22 October 1994.

THUROW, Lester C., Head to Head. The Coming Economic Battle Among Japan, Europe, and America, Nikolas Brealey Publishing, London 1992.

TURNER, Philip, Jozef VAN'T DACK, Measuring International Price and Cost Competitiveness, BIS Economic Papers No. 39, Monetary and Economic Department, Bank for International Settlements, Basle 1993.

TYSON, Laura d'Andrea, Who's Bashing Whom? Trade Conflict in High-Technology Industries, Institute for International Economics, Washington D. C. 1992.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO), Changing Patterns of Trade in World Industry, UN, New York 1982.

--, Industry in a Changing World, UN, New York 1983.

UNITED NATIONS, Standard International Trade Classification Revision 3, Statistical Papers, Series M, No. 34/Rev. 3, New York 1986.

VOLLRATH, Thomas L., "A Theoretical Evaluation of Alternative Trade Intensity Measures of Revealed Comparative Advantage", Weltwirtschaftliches Archiv, Vol. 127, 1991, pp. 265 - 280.

WOLTER, Frank, "Factor Proportions, Technology and West German Industry's International Trade Patterns", Weltwirtschaftliches Archiv, Vol. 113, 1977, pp. 251 - 267.

WOMAK, James P., Daniel T. JONES, Daniel ROOS, The Machine that Changed the World. Based on the Massachusetts Institute of Technology 5-Million-Dollar 5-Year Study on the Future of the Automobile Industry, Ranson Associates, New York 1990.

WORLD BANK, World Development Report 1994. Infrastructure and Development, Oxford University Press, Washington 1994.

YEATS, Alexander J., "On the Appropriate Interpretation of the Revealed Comparative Advantage Index. Implications of a Methodology Based on Industry Sector Analysis", Weltwirtschaftliches Archiv, Vol. 121, 1985, pp. 61 - 73.

Appendix A: Tables

Table A1. Technology Content of Traded Goods by SITC (Rev. 3) Headings and Code Numbers

	Code Number	Heading[a]
1.	High Technology	
	54	Pharmaceutical products
	72	Machinery specialized for part. industries
	74	General industrial machinery and equipment
	75	Computer and other office machines
	764	Telecommunications equipment
	772	Electronic components (excl. semiconductors)
	774	Medical apparatus
	776	Semiconductors, etc.
	778	Electrical machinery and apparatus
	792	Aircraft and associated equipment, spacecraft, etc.
	793	Ships, boats and floating structures
	87	Professional, scientific and controlling instruments
	88	Photographic and optical apparatus and equipment
2.	Intermediate Technology	
	3	*Mineral fuels, lubricants and related materials*
	5 (less 54)	Chemicals and related products
	61	Leather, leather manufactures
	62	Rubber manufactures
	64	Paper, paperboard and articles of paper pulp
	71	Power generating machinery and equipment
	73	Metal working machinery
	76 (less 764)	Sound recording equipment
	77 (less 772, 774, 776, 778)	Household appliances, transformers, etc.
	78	Road vehicles
3.	Standard Technology	
	0	Food and live animals
	1	Beverages and tobacco
	2	Crude materials, inedible, except fuels
	4	Animal and vegetable oils, fats and waxes
	63	Cork and wood manufactures
	65	Textile yarn, fabrics
	66	Non-metallic mineral manufactures
	67	Iron and steel
	68	Non-ferrous metals
	69	Manufactures of metals
	79 (less 792, 793)	Other transport equipment
	81	Prefabricated buildings etc.
	82	Furniture etc.
	83	Travel goods, handbags etc.
	84	Articles of apparel and clothing etc.
	85	Footwear
	89	Miscellaneous manuf. articles
	9	Commodities and transactions not classified elsewhere

[a] Abbreviated; wording occasionally deviates from the official source.

Source: Own grouping; United Nations (1986).

Table A2. Europe: International Specialization[a] in High-Technology Goods, 1992

Countries	High-Technology Goods[b]	No. of Subgroups[c]
Old EU Member Countries		
Belgium/Luxembourg	54, 764, 778, 88	4
Denmark	54, 72, 74, 774, 793, 87	6
France	54, 74, 764, 772, 792, 793	6
Germany	54, 72, 74, 772, 774, 778, 793, 87	8
Greece	-	0
Ireland	54, 75, 87, 88	4
Italy	72, 74, 792, 793	4
Netherlands	774, 776, 792, 793, 88	5
Portugal	776, 793	2
Spain	792, 793	2
United Kingdom	54, 72, 74, 764, 774, 778, 792, 793, 87	9
Northward EU Enlargement		
Austria	72, 74, 772, 793	4
Finland	72, 764, 774, 793	4
Norway	793	1
Sweden	54, 72, 74, 764, 774	5
Eastward EU Enlargement		
Bulgaria	778, 793	2
Czechoslovakia	793	1
Hungary	778	1
Poland	793	1
Romania	793	1
Third Countries		
Japan	72, 74, 75, 764, 772, 774, 776, 778, 793, 87, 88	11
United States	54, 72, 74, 774, 778, 792, 793, 87	8

[a] As measured by the index of technological specialization (TS);
[b] only the SITC code number of those subgroups is reported here, in which the corresponding country shows a positive TS index;
[c] total number of subgroups is 13.

Source: Own calculations with OECD trade data.

Table A3. Europe: International Specialization[a] in Intermediate-Technology Goods, 1992

Countries	Intermediate-Technology Goods[b]	No. of Subgroups[c]
Old EU Member Countries		
Belgium/Luxembourg	5, 62, 76, 78	4
Denmark	71	1
France	5, 62, 71, 77, 78	5
Germany	5, 71, 73, 77, 78	5
Greece	-	0
Ireland	5, 61, 62	3
Italy	61, 62, 71, 73, 77	5
Netherlands	3, 5	2
Portugal	64, 77	2
Spain	61, 62, 78	3
United Kingdom	3, 5, 61, 62, 71, 73	6
Northward EU Enlargement		
Austria	61, 62, 64, 71, 73, 76, 77	7
Finland	61, 64, 76	3
Norway	3	1
Sweden	64, 71, 73, 76, 78	5
Eastward EU Enlargement		
Bulgaria	62, 73	2
Czechoslovakia	3, 62, 64	3
Hungary	3, 62, 77	3
Poland	3, 61, 62, 71	4
Romania	5	1
Third Countries		
Japan	62, 64, 71, 73, 76, 77, 78	7
United States	5, 61, 71, 73, 77	5

[a] As measured by the index of technological specialization (TS);
[b] only the SITC code number of those subgroups is reported here, in which the corresponding country shows a positive TS index;
[c] total number of subgroups is 10.

Source: Own calculations with OECD trade data.

Table A4. Europe: International Specialization[a] in Standard-Technology Goods, 1992

Countries	Standard-Technology Goods[b]	No. of Subgroups[c]
Old EU Member Countries		
Belgium/Luxembourg	0, 4, 63, 65, 66, 67, 68, 81	8
Denmark	0, 2, 63, 66, 79, 81, 82, 9	8
France	0, 1, 67, 79, 81, 83, 9	7
Germany	65, 67, 69, 79, 89	5
Greece	0, 1, 2, 4, 66, 67, 68, 84, 9	9
Ireland	0, 1, 2, 89, 9	5
Italy	65, 66, 69, 79, 81, 82, 83, 84, 85, 89	10
Netherlands	0, 1, 2, 4, 65, 68, 79, 9	8
Portugal	1, 2, 4, 63, 65, 66, 69, 79, 82, 84, 85, 9	12
Spain	0, 1, 4, 63, 65, 66, 67, 68, 69, 79, 82, 85, 9	13
United Kingdom	1, 66, 67, 79, 9	5
Northward EU Enlargement		
Austria	1, 63, 65, 66, 67, 69, 81, 89, 9	9
Finland	2, 63, 67, 68, 79, 81, 9	7
Norway	0, 68	2
Sweden	2, 63, 67, 69, 82	5
Eastward EU Enlargement		
Bulgaria	0, 1, 2, 4, 63, 66, 67, 68, 81, 82, 83, 84, 85	13
Czechoslovakia	0, 2, 63, 65, 66, 67, 68, 69, 81, 82, 83, 84, 85, 9	14
Hungary	0, 1, 2, 4, 63, 66, 67, 68, 69, 81, 82, 83, 84, 85	14
Poland	0, 2, 63, 66, 67, 68, 69, 81, 82, 83, 84, 85	12
Romania	63, 66, 67, 68, 69, 81, 82, 83, 84, 85	10
Third Countries		
Japan	65, 67, 69, 79, 9	5
United States	0, 1, 2, 4, 79, 9	6

[a] As measured by the index of technological specialization (TS);
[b] only the SITC code number of those subgroups is reported here, in which the corresponding country shows a positive TS index;
[c] total number of subgroups is 18.

Source: Own calculations with OECD trade data.

Table A5. Europe: Real Effective Exchange Rates, 1985 - 1993 (1990 = 100)

	Country				
	Austria	Belgium	Denmark	France	United Kingdom
Year	REER Index[a]				
1985	93.5612	93.2777	88.8086	96.2038	96.0095
1986	97.6285	97.1989	94.4442	99.6413	89.3464
1987	100.3057	100.2030	98.7503	100.8755	89.2438
1988	99.7347	97.5209	98.2502	98.5614	96.3471
1989	98.4206	96.1628	96.3930	96.5071	96.7251
1990	100.0000	100.0000	100.0000	100.0000	100.0000
1991	98.5125	98.7231	96.2184	97.0084	101.8850
1992	100.4697	99.5331	97.5440	98.8884	98.5858
1993	102.8555	99.6365	98.8917	99.5632	88.5353

[a] Based on consumer price index.

	Country				
	Germany	Italy	Luxembourg	Netherlands	Norway
Year	REER Index[a]				
1985	93.7331	85.5809	98.5451	97.2763	98.4884
1986	99.2216	91.6339	99.2931	102.8385	97.0270
1987	102.4915	94.3602	99.0187	104.7065	99.0287
1988	99.9434	93.1541	98.3235	102.2389	101.3858
1989	97.5390	95.3382	98.0482	98.1949	100.7307
1990	100.0000	100.0000	100.0000	100.0000	100.0000
1991	97.8595	100.6297	99.7909	98.7106	96.4521
1992	101.4788	99.5055	100.3780	101.2265	97.1505
1993	105.7597	83.6386	100.7954	102.4248	93.6734

[a] Based on consumer price index.

Table A5. (continued)

	Country				
	Sweden	Finland	Greece	Ireland	Portugal
Year	REER Index[a]				
1985	92.4660	88.7675	94.8398	96.6388	91.3424
1986	91.8235	88.7518	88.8367	103.5445	90.4617
1987	91.6602	90.5875	90.8541	102.1919	89.2332
1988	94.9444	93.0127	93.2023	98.6656	89.7807
1989	96.3610	97.9918	94.2021	96.4796	93.8077
1990	100.0000	100.0000	100.0000	100.0000	100.0000
1991	104.6717	95.1743	101.1974	96.8765	106.7952
1992	105.4219	82.6607	104.4428	99.9178	116.5241
1993	87.0168	71.5604	103.9713	94.0469	111.6217

[a] Based on consumer price index.

	Country				
	Spain	Japan	United States	Hungary	Poland
Year	REER Index[a]				
1985	75.8704	85.5395	143.6889	114.8654	203.15976
1986	80.7912	109.7175	120.7765	103.4251	159.4158
1987	84.0685	115.6186	108.8342	93.3024	115.9900
1988	87.4960	122.0385	102.3059	94.8276	105.0534
1989	92.7940	111.8902	105.8577	96.0398	118.6428
1990	100.0000	100.0000	100.0000	100.0000	100.0000
1991	101.2111	107.4159	98.2950	113.3681	153.9018
1992	101.9936	111.3245	95.9348	122.3072	152.1922
1993	89.0522	130.6208	99.0736	134.7821	162.8741

[a] Based on consumer price index.

Source: International Monetary Fund, International Financial Statistics Online Databank.

Appendix B: The Real Effective Exchange Rate

The real effective exchange rate (REER) used in this paper as an indicator of policy advantage is taken from the IMF's International Financial Statistics. The IMF's REER is defined as the MERM-weighted nominal effective exchange rate adjusted for relative prices. MERM-weights are derived from the IMF's multilateral exchange rate model (MERM) of 17 countries: each weight represents the MERM's "estimate of the effect on the trade balance of the country in question of a 1 percent change in the domestic currency price of each of the other currencies, taken one at the time" (IMF 1985, p. x). The MERM-weighted nominal effective exchange rate (NEER) obtains from

(B1) $$NEER_{j*t} = \prod_{\substack{j=1 \\ j \neq j*}}^{17} \left(\frac{NE_{j*t}}{NE_{jt}} \right)^{w_{j*j}} , j* = 1,2,\ldots,17$$

where: NE_{j*t} = the US dollar price of one unit of the currency of country j* in period t relative to its price in the base period (1980)

w_{j*j} = effect of a 1 percent change in the price of currency j* in terms of currency j on the trade balance of country j*, measured in its own currency and deflated by the induced change in the average of its export and import prices in its own currency in 1980. The weights w_{j*j} are obtained by simulating the MERM and observing the impact on the trade balance.

The NEER is then calculated by dividing a country j*'s relative nominal exchange rate (NE_{j*t}) by the weighted product or geometric average of the other 16 countries' relative nominal exchange rates. The figure resulting from this computation is then multiplied by 100 and transformed into an index number with 1990 as its base period.

The IMF's REER represents the product of the NEER and the index of the ratio of a price or cost indicator of the country j* in its own currency to a weighted geometric average of the corresponding price or cost indicator for 16 other countries in their respective currencies. The IMF publishes REERs on the basis of six different price or cost indicators (relative unit labour costs, relative normalized unit labour costs, relative value-added deflators, relative wholesale prices, relative export unit values, relative consumer prices). Since not all concepts are available for all countries, in this paper preference was given to relative consumer prices, which are generally available, although they can be criticized for giving too much weight to indirect taxes.

More generally, the REER can be derived following Durand, Simon and Webb (1992), and Turner and Van't dack (1993) as a measure of overall policy advantage composed of two partial measures, a measure of import policy advantage and one of export policy advantage. Overall policy advantage is then calculated as a weighted average of import and export policy advantage.

Omitting time indices, import policy advantage (IPA) is based on the following price differential:

$$\text{(B2)}\quad p_{j*} - \bar{p}_{j*} = p_{j*} - \sum_{\substack{j \\ j \neq j*}} \hat{p}_{jj*}\, m_{jj*}$$

which represents the difference between the country j*'s domestic price (p_{j*}) and the import price in country j* $(\bar{p}_{j*})$, both expressed in US$. The import price measure can be also written as the export prices of country j*'s trading partners $(\hat{p}_{jj*})$ weighted by the share of imports of country j* originating in country j (m_{jj*}). Taking natural logarithmus and converting the dollar prices in (B2) to national currencies using a simple nominal exchange rate (N_j) (US$ per unit of national currency) yields

$$\text{(B3)}\quad IPA_{j*} = \ln\left(\frac{p_{j*}\, N_{j*}}{\prod_{\substack{j \\ j \neq j*}} \left(\hat{p}_{jj*} N_j\right)^{m_{jj*}}} \right) = \ln\left[\prod_{\substack{j \\ j \neq j*}} \left(\frac{p_{j*}}{\hat{p}_{jj*}}\right)^{m_{jj*}} \prod_{\substack{j \\ j \neq j*}} \left(\frac{N_{j*}}{N_j}\right)^{m_{jj*}} \right]$$

due to $\sum_{\substack{j \\ j \neq j*}} m_{jj*} = 1$. Making use of the bilateral exchange rate $N_{jj*} = N_{j*}/N_j$ we get a single-weighted measure

$$\text{(B4)}\quad IPA_{j*} = \ln\left[\prod_{\substack{j \\ j \neq j*}} \left(\frac{p_{j*}}{\hat{p}_{jj*}}\right)^{m_{jj*}} \prod_{\substack{j \\ j \neq j*}} N_{jj*}^{m_{jj*}} \right] = \ln\left[\frac{\prod_{j} N_{jj*}^{m_{jj*}}}{\prod_{\substack{j \\ j \neq j*}} \left(\frac{\hat{p}_{jj*}}{p_{j*}}\right)^{m_{jj*}}} \right]$$

While the IPA focusses on the country j*'s home market, the measure of export policy advantage focusses on country j*'s export markets. Accordingly, EPA is based on the following price differential:

$$\text{(B5)} \quad \hat{p}_{j^*} - \sum_{\substack{j \\ j \neq j^*}} x_{jj^*} \left(\sum_{\substack{i \\ i \neq j^*}} \left(\frac{s_{ij}}{1 - s_{jj^*}} \right) \hat{p}_i \right)$$

representing the difference between the country j*'s export price $(\hat{p}_{j*})$ and the export prices of country j*'s competitors i in the foreign market j $(\hat{p}_i)$, weighted by the share of the exports of country j* to country j in country j*'s total exports (x_{jj*}) and the share of imports of country j originating in country i in total supply in country j (excluding imports from country j*) ($s_{ij} / (1 - s_{jj*})$).[5] Taking logarithmus and substituting the term $s_{ij} / (1 - s_{jj*})$ for the simpler a_{ijj*}, we obtain

$$\text{(B6)} \quad EPA_{j*} = \ln \hat{p}_{j*} - \ln \left(\prod_{\substack{j \\ j \neq j^*}} \left(\prod_{\substack{i \\ i \neq j^*}} \hat{p}_i^{\,a_{ijj^*}} \right)^{x_{jj^*}} \right)$$

and using national currency prices instead of US$ prices and introducing exchange rates as in (B3) above, (B6) develops into

$$\text{(B7)} \quad EPA_{j*} = \ln \left[\hat{p}_{j*} N_{j*} \;/\; \prod_{\substack{j \\ j \neq j^*}} \left(\prod_{\substack{i \\ i \neq j^*}} \left(\hat{p}_i N_i \right)^{a_{ijj^*}} \right)^{x_{jj^*}} \right]$$

Taking advantage of $\sum_{\substack{j \\ j \neq j^*}} x_{jj*} = 1$ and $\sum_{\substack{i \\ i \neq j^*}} a_{ijj*} = 1$ as well as of bilateral exchange rates as in (B4) above, we get

5 It should be noted that "total supply" includes import-competing domestic production in country j and imports from all other countries.

(B8)

$$EPA_{j*} = \ln\left[\prod_{\substack{j \\ j \neq j*}}\left(\prod_{i \neq j*}\left(\frac{\hat{p}_{j*}}{\hat{p}_i}\right)^{a_{ijj*}}\right)^{x_{jj*}} \prod_{\substack{j \\ j \neq j*}}\left(\prod_{\substack{i \\ i \neq j*}} N_{j*i}{}^{a_{ijj*}}\right)^{x_{jj*}}\right] = \ln\left[\frac{\prod_{\substack{j \\ j \neq j*}} \prod_{\substack{i \\ i \neq j*}} N_{j*i}{}^{a_{ijj*} x_{jj*}}}{\prod_{\substack{j \\ j \neq j*}} \prod_{\substack{i \\ i \neq j*}} \left(\frac{\hat{p}_i}{\hat{p}_{j*}}\right)^{a_{ijj*} x_{jj*}}}\right]$$

It is easy to see that - in contrast to (B4) - (B8) represents a double-weighted measure of export policy advantage, which combines the export shares of the country under study (j*) with the market shares of j*'s competitors (i) in country j.

Now the derivation of the real effective exchange rate (REER) as a measure of overall policy advantage simply consists in calculating the trade-weighted average of the import and export policy advantage measures in the following way:

(B9) $$REER_{j*} = \left(\frac{M_{j*}}{M_{j*} + X_{j*}}\right) IPA_{j*} + \left(\frac{X_{j*}}{M_{j*} + X_{j*}}\right) EPA_{j*}$$

where: M_{j*} = country j*'s total imports, and
X_{j*} = country j*'s total exports.