The role of technology in market shares dynamics

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Abstract

The paper presents the estimation of an empirical model of market share dynamics for five industrialized countries and eighteen industries. The emphasis is put on the importance of non-price factors of competitiveness, whereas most traditional explanations rest on the influence of relative prices. Among the former type of factors, the role of variables reflecting technological advantage is privileged. In particular, the role of innovations has received considerable attention in the literature on international trade as well as the literature on endogenous growth. In this spirit, the paper introduces patent counts and investment as explanatory variables for the exports market share. The results show that non-price variables have an important impact on the determination of long run competitiveness.

Keywords: innovation, foreign trade, competitiveness.

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First Draft

1. Introduction

The relationship between technology and competitiveness has recently become a major topic for both theoritical and empirical analyses[1], and raised the interest of political decision makers too (Clinton and Gore, 1993). Strictly speaking, traditional neo-classical trade theory hardly took into account differences in technological performance in explaining trade flows between countries, supposing that every country had access to the same technology set and concentrating on factor endowments and hence on factor prices instead. However, it is well known that testing 'traditional' trade equations (i.e. with income and prices as explanatory variables) often leads to weak price effects, when significant[2]. In most cases, it seems hard to relate precisely changes in competitiveness with price differentials. Some other influences, not directly related to the price of traded goods, are at work.

Some authors have stressed the importance of non-price factors in international competition, particularly in connection with technological change. On the neo-classical side, the various works of the 'new international economics' with authors such as Krugman (1990) insist on product differentiation and increasing returns to scale on the supply side, and preference for variety on the demand side rather than on factor endowments. Innovation leads to the generation of new products and R&D expenditures are a strategic variable manipulated by firms to secure monopoly positions. R&D and trade specialization also play a role in economic growth when one considers endogenous growth models in an open economy context (Grossman and Helpman, 1991). Comparative advantage may become endogenous, and trade and research policy measures can have an effect on trade specialization and growth rates.

Related themes are present in the post-keynesian literature (Thirlwall, 1979 ; Kaldor, 1981), where the emphasis lies on non-price factors of competitiveness (Amable, 1992). Neo-technology (Soete, 1987) or 'evolutionary' approaches to technological change and growth (Dosi, Pavitt and Soete, 1990 ; Verspagen, 1992 ; Amendola, Dosi and Papagni, 1992) also stress that international technological differences can provide a basis for trade, which is treated as a dynamic process of competition.

The aim of this paper is to provide an empirical study of the determinants of exports market shares at a disaggregated level, taking account of international differences in technological performance and other non-price factors. The paper is organized as follows. Section 2 reviews the price and non-price factors behind international competitiveness. Section 3 proposes an empirical model of exports market shares incorporating both price and non price effects. The estimation of the model is made on eighteen industries for five industrialized countries on twenty-two years. The model, inspired by Magnier and Toujas-Bernatte (1992), accounts for both country- and industry-specific effects for each explanatory variable, and for country specific effects on the dynamic adjustment term. Results are presented in section 4. The results of the estimations are compared to some other work which has tried to develop a sectoral taxonomy, among others things based on the importance of various modes of competition. This is one in section 5.

2. Price and non-price factors of competitiveness

A number of studies have incorporated non-price factors along with price factors in trade models. To recall, a common approach to modelling trade flows takes price and income differentials as explanatory variables (Goldstein and Khan, 1985). A typical equation incorporating such effects would be of the following form:

$$X = Y^{\eta} \left[\frac{P}{P^{*}}\right]^{\epsilon} \tag{1}$$

where X and P are the country's exports and price level, and Y and P^* are the income and price level of the rest of the world. Imperfect substitutability, and hence imperfect competition, between goods allows for the existence of non infinite price elasticities ε so that the law of one price does not hold. A country's exports are then more or less sensitive to price differentials according to the value of ε. Sensitivity to price variations depends very much on the type of goods exported, so that one expects different price elasticities according to the industry of origin of the exported goods. Therefore, the value of a country's price elasticity of exports reflects to some extent the product mix of this country's exports.

Price differences are the most obvious influences of trade competitiveness. Nevertheless, the 'Kaldor paradox' (Kaldor, 1978) comes from the observation that the fastest growing countries in terms of GDP and exports have experienced a faster growth in relative unit labour costs. Therefore relative prices, when taken alone, cannot be the major determinants of competitiveness. In the long-term, a country cannot expect to see its exports growing because of a continuous decrease in relative prices. The post-keynesian explanation of growth in an open economy framework relies mostly on the 'Thirlwall formula'[3], i.e. the ratio between the exports and imports income elasticities. Competitiveness and growth in the long run depend on non-price factors alone.

Other influences than price competitiveness are then summed up in the income elasticities of imports and exports η. A higher η means that all other things being held equal, a country will benefit more than others from the growth of world income. Several interpretations may be related to a high η (McCombie, 1992; Amable, 1993). It may reflect the sectoral orientation of the country's exports. Some industries enjoy a higher income elasticity because their products tend to be substituted to the products of other industries as income rises. For instance, the high technology goods generally have a higher than average demand growth. The value of the elasticity may also reflect the quality of the exported goods. *Ceteris paribus* countries with high quality products will gain market shares over other countries. All in all, the income elasticity usually represents the bulk of non-price factors. It has also been used as an indicator for industrial policy. In Japan for instance, a MITI white paper recommended in the 1960s to reorient the international specialization of Japan towards industries with a high rate of productivity growth and a high income elasticity (Itoh and Kiyono, 1988).

In such a perspective, an explanation to what determines non-price competitiveness is lacking since income elasticities are given exogenously in theoretical models and estimated directly in applied works[4]. It is then possible to introduce additional factors in trade equations such as (1). Introducing a broad 'schumpeterian' aspect, one can think of differences in technological capability as one of the main influences behind non-price competitiveness. Hughes (1986) proposed a model for the exports of the UK where non-price factors in the form of relative R&D expenditures represented non-price effects. The model also took account of cumulative causation through the influence of exports on R&D intensity. Fagerberg (1988) proposed a multi-equation model including a technology variable constructed with patents counts and R&D expenditure. Trade equations also took into account the effects of investment in order to reflect the international differences in the ability to meet demand and escape from capacity constraints. Amable (1991) tested a multi-equation model of growth and competitiveness, with an endogenous determination of technological change in addition, on a sample of 8 industrialized countries over the period 1961-1987. Greenhalgh (1990) tested trade equations on time series with a product quality variable, quality being a function of technological innovation and supply reliability. The former is represented by the number of innovations taken from the SPRU innovation database and the latter by strike incidence. In an evolutionary spirit, Verspagen (1992) tested several models of competitiveness with variables reflecting price as well as technological competitiveness.

Neo-classical supply side explanations may also account for the role of technology in trade. Magnier and Toujas-Bernatte (1992), making reference to the 'new international economics' considered that countries can expand their world market shares by expanding the range of goods that they produce. New goods being discovered with the help of R&D expenditures, they introduced an R&D variable in their trade equations, along with an investment term, reflecting the ability to deliver. Whilst not sticking to their theoritical references, this paper will adapt the model of Magnier and Toujas-Bernatte to provide an estimation of non-price effects on international competitiveness.

3. A model of international competitiveness

The empirical model will be tested on pooled time series and cross-section data for five countries (Germany, Italy, Great Britain, Japan and the United States), eighteen industries over the period 1970-1991. Three factors of competitiveness will be considered: price, investment and technology. Following Magnier and Toujas-Bernatte, it will not be assumed that the same coefficients apply to every country and every sector of the sample. Since the sample covers the whole industry, some sectors are likely to be more sensitive than others to technological advantage, to price differentials or to investment. One may expect for instance technology-intensive sectors to be more dependent on the technology variable than other sectors.

Similarly, countries specificities will be taken into account. In the post-keynesian explanation of growth in the context of an open economy, the differences in country's ability to be technologically competitive were summed up in the differences in the values for the income elasticities of trade. The determinations of these elasticities implicitely include both industry- and country-specific influences[5]. The latter are interpreted as reflecting unequal competitiveness related to the particularities of the national systems of innovation (Freeman, 1987). Several factors, related to the accumulation of individual competence and the mechanisms of collective learning, come into play: the efficiency of the education system, the quality of intra- and inter-firm cooperation, the infrastructure policy, the relations between firms and the Public Authority, etc[6]. Industry differences with respect to technology or non-price influences in general are more widely recognized. Some industries, i.e. the goods produced by these industries, are held to be more 'mature' than others in the product life cycle theory. Some industries are more sensitive to the competition of less advanced countries that tend to base their competitiveness on low wage costs. More generally, the technological content varies widely accross industries and so is expected to do the sensitivity to technological competitiveness.

Therefore, the coefficients of the model will be both country and industry specific, but the coefficients will not be specific to each pair of country and industry. In fact, the differences between countries are assumed to be same accross industries, and the differences accross industries are assumed to be the same accross countries. A higher elasticity is therefore attached to a particular industry, whatever the country. The coefficients of the explanatory variables are therefore the sum of an average effect, a country effect and an industry-specific effect.

The determination of the long-run value of the market share is the following:

$$X_{ij}^{*} = k_{ij} + a_{ij}\, PC_{ij} + b_{ij}\, IN_{ij} + c_{ij}\, PT_{ij} \qquad (2)$$

and $x_{ij} = x + x_i + x_j$, $\Sigma_i x_i = \Sigma_j x_j = 0$ for country i and sector j, x = a,b,c.

Three types of determinants influence the long run market share of each country for each sector: price, investment and technology. The first factor in the equation, PC, reflects the influence of price competitiveness. It was not possible to obtain price indices at the level of disaggregation adopted in this paper from the STAN (OECD) database. A proxy is used instead, defined as the share of wages in production relative to the average for the other countries in the sample. This variable has the drawback of being limited to the wage aspect of production costs, whereas other costs would be interesting to consider. The second variable, IN, is the ratio of investment to production divided by the average value of this ratio for the other countries. This variable accounts for non-price factors not directly related to an innovation. For instance learning effects or the accumulation of competence can be thought as being represented in this variable. Technological ability is not limited to the strict innovation point of view. Education or skills of the labour force, infrastructures or public goods are also factors of competitiveness. The introduction of variables reflecting the influence of these factors would have been preferable, but data availability restricted the choice. PT, the technological variable, is defined as the share of each country in the total patents for each sector relative to the mean of the other countries' shares. It represents the direct effect of innovation on competitiveness. The count is made on patents granted in the U.S. and a fractional count is adopted. This means that if a patent is common to several sectors, it is supposed that it benefits each sector so that the patent is equally 'split' between these sectors.

Explanatory variables considered in the model are smoothed by averaging over three years:

$A = (A(-1))^{0.3} (A(-2))^{0.4} (A(-3))^{0.3}$

for A = PC, IN, PT. All variables are taken in log and in difference with respect to the sample average. All variables are taken from OECD, DSTI (Stan/industrial database) except for the patent date that come from the USPTO database.

The basic model is based on an error correction mechanism:

$$\Delta X_{ij} = (\mu + \mu_i)\left[X_{ij}^* - X_{ij}(-1)\right] \qquad (3)$$

X_{ij} is the current exports (OECD) market share of country i for sector j. X_{ij}^* is the long run target market share defined in (2). $\Sigma_i\mu_i = 0$.

The model is similar to that of Magnier and Toujas-Bernatte with a few differences[7]: (i) the dynamic adjustment coefficients are country specific, i.e. the sum of an average μ and a country specific affect μ_i, so that countries may adjust to their long run targets at their own pace; (ii) these coefficients are estimated and not assigned a specific value, therefore the estimation is made with non-linear least squares; (iii) the technology variable makes use of patents data, not of R&D expenditures. Patents have the advantage that they represent an output of an innovation process, but this does not imply that it is the only possible variable. Both R&D expenditures and patent counts have their defaults as indicators of technological competitiveness. Some R&D-intensive industries patent very little whereas some other industries patent very much. There are international differences between the tendency to patent as well. It is possible to compute a specific indicator mixing patents with R&D as in Fagerberg (1988), but it rqises the problem of the basis on which it would be computed. Limiting ourselves to innovations leading to a legal protection, we adopt here a patent-based indicator.

This model does not take account of the technological spillovers between sectors or between countries. Each country and industry's competitiveness is based on the own country and sector's factors of competitiveness. The investigation of such spillover effects is left for further research.

The estimation of the model is carried out with variables taken as log deviations from the sample's average for each sector. The estimations are made with non linear least squares and are heteroskedasticity-consistent.

4. Estimation results

This section reports the results of the estimation of the model presented above. The expectations for the signs of the variables are as follows. For patenting and investment variables, a positive sign is expected. For wages, the expected signs on the estimated parameters are a bit ambiguous. From the point of view of production costs, one would expect that high wages lead to low competitiveness, and hence that the parameters should turn up negative. However, as high wages might also be connected to high skill-levels, low wages might also be connected to low competitiveness. Therefore, it is likely that the exact expectation on the sign of wage variable differs between sectors. In sectors with high skill-requirements, the sign might turn up positive, while in sectors where labour input has a low skill-level, the sign is expected to be negative.

The expectations concerning the results for the adjustment coefficients (specific to countries) do not result in any clear way from the theoretical framework put forward above. This framework is aimed at explaining the relationship between long-run competitiveness and various factors, such as wages, investment and technology. A dynamic adjustment model was thus specified, taking account of the fact that country adjust only slowly to the position defined by (2). On the other hand, the process of adjustment has not been precisely specified, and countries characteristics in this respect are summed up in the adjustment terms. These characteristics are related to the particularities of the national institutional arrangements, for instance trade policy measures, wage bargaining procedures, or macroeconomic influences concerning the exporting countries.

The results for the estimation are documented in Table 1. The country-specific adjustment parameters are all very significant and positive. Germany and the US both have relatively low values (around 0.3), and Japan and Italy have high values (around 0.55). The UK is an intermediate case with a value of 0.48. This indicates that the general institutional arrangements in Japan or Italy differ substantially from those of Germany, the US or the UK.

Moving to the average effects per variable, it appears that wages and patents turn up with an expected sign (negative for wages, positive for patents) that is significant. The investment output ratio has a positive sign as expected, but is not significant. This pattern is more or less repeated for the case of the country-specific effects per variable. For wages, three of these are (very) significant: for Italy, Japan and the US. All signs for this variable are negative, as expected. For investment, all the signs are positive, but a p-value of 0.12 (for Germany and the UK) is the best result obtained. For patents, there are four positive and significant parameters (UK, Italy, Japan and the US), and one negative but insignificant effect (Germany). In the latter case, it is important to keep in mind that since the patent dataset used applies to patents taken out in the US, one might expect a bias for American firms to patent more than proportional (see among others Dosi *et al.* 1990). This would lead to the expectation that the estimated coefficient for the US-specific patenting effect would be relatively small as compared to the other countries. The results, however, seem to indicate the opposite.

Next, the results for sector-specific effects per variable are discussed. For wages, 15 out of 18 estimated coefficients are negative. Seven of these 15 are significant at a level smaller than 10%. These significant and negative parameters are found in chemicals, electronics, food products, textiles, metal products, ferrous and nonferrous metals. Three sectors have a positive sign. The only one for which the positive sign is signficant is other transport. Thus, it turns out that the wage cost variable has a significant (negative) influence in a quite broad range of sectors, including low-tech (and homogenous products) sectors such as textiles and metal products, but also high- and medium-tech sectors, such as electronics and chemicals.

For investment, there are 12 sectors with a positive sign. Five of these are significant: pharmaceuticals, electronics, nonelectrical machinery, computers and office machinery, nonferrous metals. One sector, other transport, has a significantly negative sign. While the performance of this variable is not as good as the previous one (in terms of significant results), it is quite remarkable that the majority of sectors for a significant positive influence is found has a high technology-content. This supports the hypothesis that investment is a means of quickly renewing the technological content of the capital stock.

The results for the patent variable are quite good: 14 sectors have a significantly positive sign, while the four others have a positive, but insignificant, sign. Two of the latter sectors, however, are sectors which are commonly ranked among the high-tech ones: electronics and pharmaceuticals. Thus, while the patenting results seem to be quite good overall, they are a bit hard to interpret for some of the high-tech sectors. With regard to the other high-tech sectors (aerospace, instruments, computers and office machinery), it appears that they all have quite high values of the estimated coefficients.

In general, these results point to the conclusion that technology is an important determinant of international competitiveness. This conclusion is based upon the results for the patenting variable, as well as (some of) the results for the investment variable. Wages (i.e., production costs) are also important for competitiveness. Thus, it appears that price-factors as well as non-price-factors are important determinants of international competitiveness. An analysis leaving out either one of these two factors is therefore likely to suffer from a bias due to misspecification.

However, there seem to be important differences between sectors, as well as countries, with regard to the importance of the factors in the regressions. As far as differences between countries are concernced, the paper will not discuss these in further detail. They are just taken as implications of the (institutional, structural) differences between countries in the sample. The sectoral differences, however, will be the basis for some further discussion.

5. Interpreting the sectoral differences in the estimations

The discussion of the theory of international trade related to price and non-price factors has already mentioned the fact that different sectors can be expected to show different patterns with regard to the determination of competitiveness. This conclusion links up closely with some of the work with a more institutional background. For example, Dosi *et al.* (1990) and Pavitt (1984) have proposed a sectoral taxonomy based upon an in-depth study of technological activities. After a review of the literature on differences in sectoral patterns of technical change, they propose the following trichotomy.

First, there are *supplier-dominated* sectors. Firms in these sectors rely mostly on suppliers of materials and equipment for the development of new technology. Process innovation is more important than product innovation. Dosi *et al.* mention textiles, printing and publishing, agriculture and construction as supplier-dominated sectors.

The second type of sectors are called *production intensive.* In these sectors, production is organized according to Adam Smith's principle of the division of labour, or in more modern terms, *Taylorism.* Scale economies and the availibility of sophisticated machinery are important in these sectors. Innovation is mainly of the process type. The main source of innovation are specialized supplier firms. Standard materials, durable consumer goods, instruments, machinery and automobiles are found in this category.

The third group of sectors is called *science-based.* The main source of innovation in these sectors are own R&D, and innovation is mainly of the product type. New products, which in most cases are applied in other industries, are the most important mode of competition in these sectors. Chemicals, electrical goods and electronics are found here.

Although the formal statistical analysis in this paper cannot compete on the ground of detailedness with the institutional approach from which this taxonomy arises, it might be useful to interpret the results obtained from the estimations in light of this taxonomy. The way to do this is to compare the significance and values of the estimated sectoral coefficients between the three groups of sectors.

The first step is to classify the sectors into the three groups. Since Dosi *et al.* do not use the ISIC-logic that has been used here, this classification is not readily available. However, the following seems to be a reasonable approximation.

Supplier dominated sectors: food products and textiles.

Production-intensive sectors: instruments; nonelectrical machinery; rubber and plastic; metal products; ferrous metals; nonferrous metals; stone, clay, glass; shipbuilding; motor vehicles, other transport.

Science-based sectors: aerospace; chemicals; pharmaceuticals; electronics; electrical machinery; computers and office machinery.

On the basis of the above description of the groups of sectors, one would expect the wage cost variable to play a prominent role in the supplier-based sectors, and a significant although less prominent role in the production-intensive sectors. The reason for this is that in these sectors, price factors are an important mode of competition, although the production-intensive sectors rely more on scale economies and machinery than on cheap labour.

Looking at the results in Table 1 above, it appears that the two supplier based sectors (textiles and food products) are ranked at positions two and three in terms of the absolute size of the parameter on the wage variable (out of 15 sectors with a negative sign). The production intensive sectors are ranked lower: position six (ferrous metals) is the highest attained. While these results are in broad accordance with the expectations, it is surprising to see that some of the science based sectors (aerospace, electronics, chemicals) also rank quite high with respect to the absolute size of the wage variable.

Turning to the non-price factors in the regression, one would expect that the investment variable plays a prominent role in the production-intensive industries. To the extent that rapid investment is a means to implement the results of the R&D process, one would also expect this variable to be important in the science-based sectors. The results seem to support the last conclusion more than the first: three of the significantly positive investment effects are found in science-based sectors (pharmaceuticals, electronics, computers and office machinery). The other two significantly positive signs are (indeed) found in production-intensive sectors (nonelectrical machinery and nonferrous metals). However, five production-intensive sectors have shown negative signs on the investment variable.

Turning finally to the patenting variable, one would expect that this effect is important in the science-based sectors. It is important to note that patents have been attributed to ISIC-classes on the basis of the principle of the 'sector of origin', e.g., a wood-working machine is classified in machinery rather than wood products. This is important, since the taxonomy introduced above is based to an important extent on user-producer relations in the field of technical change.

As the results show, the science-based sectors indeed have a number of significantly positive signs on the patent variable. Some of these sectors (aerospace, chemicals, computers and office machinery) also rank high in terms of the size of the parameter. However, it is notable that the importance of patents is much broader than just the science-based sectors. In fact, the two supplier-dominated sectors have significantly positive signs, and so do most of the production-intensive sectors. For the latter category, this is not so surprising in the case of for example machinery and instruments, since these sectors are the 'supplying' ones inside the broad cluster of interrelated sectors. For others, like basic metals or stone, clay and glass, the results are more surprising on the basis of *a priori* expectations from the taxonomy.

The conclusion of this comparison between the sectoral taxonomy and the results obtained above is therefore twofold. First, there are a number of cases where the results seem to support the taxonomy proposed by Dosi *et al.* (1990) and Pavitt (1984). However, there are also a number of cases where the results seem to indicate that the proposed differences between sectors are much too sharp to be reproduced in a formal test of the determinants of competitiveness. This latter argument relates primarily to the non-price-factors in the determination of international trade (investment and patenting). To some extent, this conclusion is probably due to the problems connected to the approach adopted (lack of detail and ability to account for specific institutional factors). However, the general character of the test and its outcomes also seem to indicate the limited usefulness of the specific taxonomy outside the field of institutional economics. This means there may not (yet) be strong reasons to subsitute to the more traditional taxonomies of high-, low- and medium-tech the one discussed in this section.

6. Summary and conclusions

This paper has attempted to quantify the importance of price- and non-price-factors in the determination of international competitiveness. A model adapted from Magnier and Toujas-Bernatte (1992) has been applied to a dataset consisting of OECD-export market shares, wages, investment and patenting for a sample of five industrialized countries. The estimation results show that both price- and non-price factors matter in the explanation of export markets shares.

The model that was used distinguishes between sectoral, country-wise and general effects in the determination of the influence of each independent variable. In general, it was found that this approach adds significantly to the explanatory power of the estimations. The results show that patents are an important factor in the majority of sectors and countries. Wages (as a share of value added) are also important in most countries and about one third of the sectors. Investment is the variable which is least significant, although it still plays a significant role in some sectors.

The sectoral differences in the estimation results were applied to a sectoral taxonomy proposed by Dosi *et al.* (1990) and Pavitt (1984). Since this taxonomy is (partly) based upon difference modes of competitiveness, it was expected that the results obtained would in some way correspond to the taxonomy. The outcome of this comparison was that for the distinction between price- and non-price-factors, the taxonomy and the results obtained correspond reasonably well. However, for non-price-factors, the correspondence was largely absent. This leads to the conclusion that there is still a need for a theory leading to a sectoral taxonomy that can be applied in the broad field of formal econometric estimations, at least at the 4-digit ISIC level.

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Table 1. Estimation results

Regression statistics

SD of dep var = 0.121	SE of the regression = 0.106	Adj. R^2 = 0.23

Adjustment parameters

	estimate	t
μ	0.45	10.70
$\mu+\mu_i$	estimate	p-value
DEU	0.30	0.00
GBR	0.48	0.00
ITA	0.56	0.00
JPN	0.57	0.00
USA	0.34	0.00

Average effects per variable

	estimate	t
Wages	-0.61	3.60
Investment	0.07	1.10
Patents	0.43	5.60

Country Effects

Long-run effects per country (sum of the average effect and the country specific effect)

	DEU	GBR	ITA	JPN	USA
Price	-0.52	-0.37	-0.64	-0.58	-0.97
p-value	0.27	0.15	0.00	0.00	0.00
Investment	0.27	0.20	-0.14	-0.03	0.04
p-value	0.12	0.12	0.18	0.79	0.77
Patents	-0.03	0.56	0.20	0.28	1.17
p-value	0.76	0.00	0.00	0.00	0.00

Average effects per sector (sum of the average effect and the sector specific effect)

	Wages	p-value	Investment	p-value	Patents	p-value
Aerospace	-0.57	0.12	-0.22	0.59	1.03	0.00
Chemicals	-1.25	0.00	0.22	0.27	0.74	0.02
Pharmaceuticals	-0.23	0.64	0.53	0.10	0.04	0.86
Electronics	-1.25	0.01	0.37	0.03	0.12	0.44
Electrical machinery	-0.38	0.50	0.26	0.30	0.50	0.06
Instruments	-0.27	0.35	0.08	0.59	0.90	0.00
Nonelectrical machinery	-0.65	0.11	0.57	0.01	0.50	0.01
Computers and office machinery	-0.08	0.67	0.58	0.00	0.71	0.00
Food products	-2.03	0.00	0.25	0.23	0.23	0.02
Rubber and plastic	0.13	0.57	0.00	0.99	0.28	0.02
Textiles	-1.95	0.00	0.02	0.92	0.24	0.04
Metal products	-2.09	0.00	-0.03	0.84	0.32	0.01
Ferrous metals	-1.10	0.00	-0.17	0.16	0.27	0.01
Nonferrous metals	-0.50	0.02	0.23	0.06	0.43	0.07
Stone, clay, glass	-0.19	0.43	0.09	0.60	0.37	0.07
Shipbuilding	-0.38	0.75	-0.56	0.25	0.62	0.27
Motor vehicles	0.46	0.13	-0.29	0.31	0.43	0.00
Other transport	1.17	0.03	-0.94	0.02	0.38	0.22

NOTES

1. See for instance Archibugi and Pianta (1992).

2. See Bairam (1988) for instance.

3. See McCombie (1992) for an exposition of 'Thirwall's Law' as well as the debate on it.

4. The value of the income elasticity may change over time, reflecting improvements or worsening of a country in non-price competitiveness (Landesmann and Snell, 1989).

5. This point is developed in Amable (1992).

6. See Lundvall (1992).

7. Verspagen and Wakelin (1993) have also used a model inspired by Magnier and Toujas-Bernatte (1992).