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Supply and demand factors explaining exports in health care products:

Interdependencies between export specialisation, health care expenditures, and research activities

by

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The purpose of this paper is to investigate the causes of variation across countries in the export specialisation in health care products. The traditional explanation of competitive advantage as a matter of resource endowments apparently yields little insights in the study of the health care. It is hard to believe that the availability of a particular natural resource would have any major influence on the production of such products as X-ray scanners, syringes or ulcer drugs. A more likely story about the international patterns of production of health care products involves both the emergence of man-made, immobile resources such as skills and infra-structure and an element of chance which – if coupled to economies of scale – may have had a decisive influence on the allocation of production. Furthermore, since many health care products are very special and tailored to specific uses, searching for common explanations for success should involve also factors that relate more to the user-side than to the technology applied in the products.

No simple models capture such complex relationships. This paper approaches the problem of explaining competitive advantage from a reductionist perspective. Simply put, we try to relate the comparative advantage in the production of health care products to two elements in the institutional environment of the industry, namely the health care sector and the research in medicine. The underlying assumption is that these three parts of the individual national system of innovation to some degree "co-evolve" (Nelson, 1995), pushing and pulling each other toward still more advanced stages. The hypothesis tries to explain a nation's comparative advantage in health care products by its standing in health care and in medical research.

It is tempting to think of health care products only as pharmaceuticals. In this paper, however, all industries which produce physical items for the health care sector (hospitals, general practitioneers, nursing homes and – of course – sick and disabled persons) are combined into one industry. In terms of trade statistics, therefore health care products comprise four SITC productgroups: Pharmaceuticals; electromedical equipment; non-electric medical equipment; and orthopaedic equipment and hearing aids. The products themselves are very different in both product and process technology, ranging from mechanical products aiding handicapped people to mass-produced disposables for use care of hospitalised patients to the wide range of medicines.

Comparative advantage in health care products

This paper applies the "revealed comparative advantage" index or the export specialisation index as a measure of comparative advantage. This Balassa index is described in more detail elsewhere (e.g. Fagerberg, 1992), suffice here to mention that the RCA index for a particular product is a relative measure that expresses the weight of this product in a country's total export, compared to the same product's weight in total OECD exports. The value of the index therefore tells nothing about the absolute size of a country's export, but indicates how the country's export structure differs from the average export structure in the OECD. Small countries typically divert more from the standard export structure than does large countries that is, the variance of a small country's RCAs is typically higher than a large country's. This is a fact that should be born in mind when RCA indices are compared across countries.

As shown in Figure 1[1] below, there is both stability and changes in the relative positions of OECD countries in health care products.

1 Please find data and sources in the appendix.

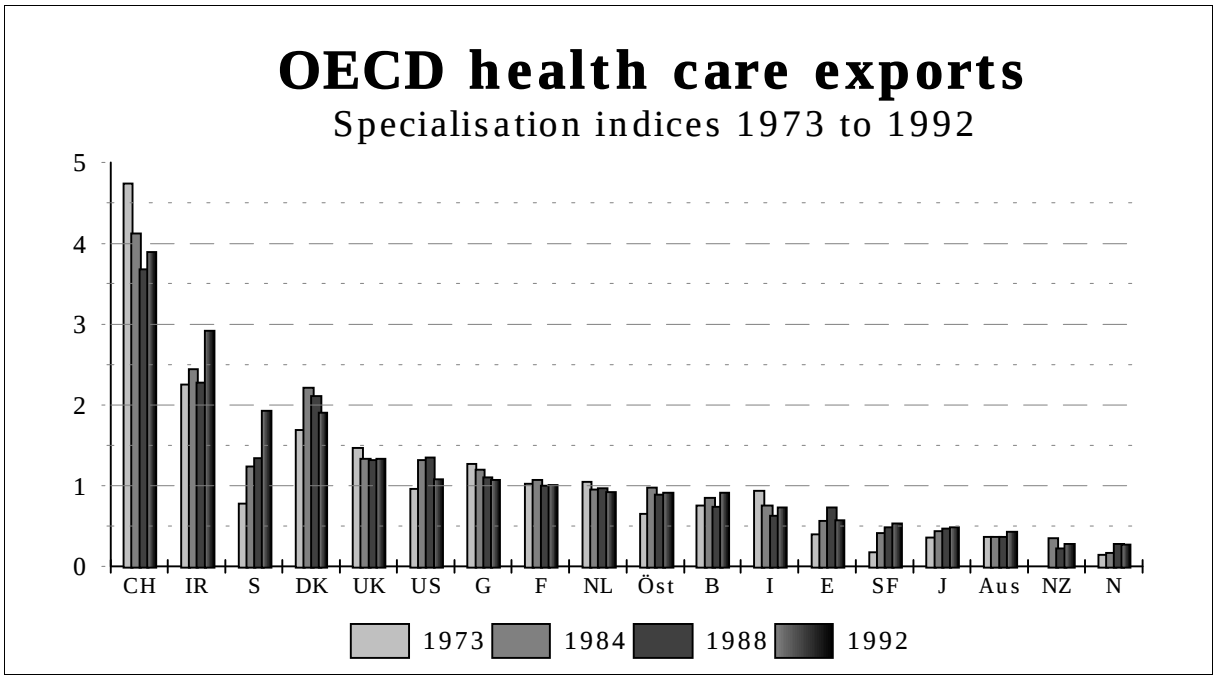

Figure 1

Switzerland stands out as extremely specialised in health care products, notably pharmaceuticals and orthopaedic equipment & hearing aids. Three other small countries, namely Ireland, Sweden and Denmark, were by 1992 also very specialised in health care. Denmark has over the last 20 years maintained a high degree of specialisation in a broad range of health care products, and Ireland has been strong in non-electrical equipment (disposables) and increasingly in pharmaceuticals, while the Swedish position is achieved through a rapid growth in the production of especially pharmaceuticals. For all of these countries only very few companies produce the majority of the exports.

Of the large OECD countries only the UK shows a persistent specialisation in health care products. 20 years ago Germany was moderately specialised in health care products, but is now on the average. The same is the US, after a "bubble" in the 1980s , and France has over the entire period been on the specialisation average. In 1973 Italy was close to the average, but is despecialising, whereas Japan from a very low specialisation over the last 20 years has been moving somewhat towards the average.

None of the remaining OECD countries are specialised health care, even though Belgium, Austria, Spain, Norway and in particular Finland are increasing their export of these products.

The overall picture of specialisation is one of stability coupled with slow despecialization. Specialized countries like Switzerland, the UK, Germany are despecializing whereas formerly unspecialized countries like Belgium, Austria, Spain, Finland, Japan, Australia and New Zealand are catching up. The OECD countries seem slowly to be approaching a common mean. Exceptions to this pattern of convergence are first of all Sweden, but also Ireland and Denmark with their high

and stable (for Ireland even increasing) levels of specialization seem to deviate from this pattern.[2]

This paper proceeds by – in turn – assessing the importance of health care expenditures and medical research. First, however, a view at the theoretical framework.

The origins of comparative advantage

Per definition, a country cannot hold comparative advantages in the production of all products. If it is strong in some industries, it must be weak in others. Therefore, comparative advantage (RCA) figures tell nothing about the overall wealth of a country. But relative wealth can, on the other hand, very well be a major explanatory factor for the comparative advantages in specific products. This is basically the idea of the product life cycle applied to trade (Vernon, 1966, Hirsch, 1972) which asserts that many new products first appear in wealthy countries and only after some time will spread both in consumption and in production to less developed countries. More specifically, Linder (1961) has emphasised the relation to an advanced user sector as an important driving force in the development of new products in the supplying sector.

Recently, Fagerberg (1992, 1995) has tested this relationship empirically and found clearly significant correlations between the comparative advantage in user and producer sectors respectively. That is, if one sector has a high RCA-score, it is likely that its vertically adjacent sectors have high RCA-scores as well. However, Fagerberg found the correlation between his measure of comparative advantage in the health care sector (hospitals etc.) and its supplying industries (pharmaceuticals, instruments, etc.) weaker than most other relations.

From a completely different point of view, the traditional theories of trade emphasises the supply of input factors as the major determinants of trade. The natural endowments of resources (land, minerals etc.) certainly explain a significant part of the global trade, especially trade between developed and developing countries (North-South trade). The growing importance of trade between developed countries (North-North trade) and especially the intra-industry trade has lead, however, to the reformulation of trade theory. One strand of theory has broadened the perspective on input factors to include man-made factors explicitly, and stressing the importance of skills, institutions and infra-structure in general. Another, complementary, strand has focused on the existence of scale economies which both on a company level and on the level of e.g. regions may confer comparative advantages to incumbents in specific industries.

This supply-oriented perspective may have numerous implications for the study of comparative advantage, since every industry exhibits idiosyncratic characteristics: One may be dependent on a particular skill and another on specific transportation possibilities.

The importance of science for overall growth has been studied in many contexts (for a recent overview of the particular effects of R&D and patents on growth, see Griliches 1994), but the

2 It is important to note that convergence on this level does not preclude divergence on a more disaggregated level. Evidence on industry structure for specific products seems to suggest that companies are specialising in core activities, cutting off marginal product lines. The observation of convergence should therefore not be interpreted as a tendency for all countries to become more alike in terms of product portfolio range, but only that on this general level, countries are approaching a common mean in the amount of exports.

implication for trade specialisation of national strengths in particular sciences is much less thoroughly examined. Grupp (1995) takes a first step in relating the national R&D-intensity, patenting activity and scientific activity to the export performance of two classes of high-tech products, "leading edge products" capturing the top-tier products and "high-level technology" the second layer of high-tech products. The results indicate that "technological" activities as performed in business companies support the second-tier high-tech products, whereas scientific activities measured by scientific publications and citations benefits the top-tier products. Unfortunately, the analysis is very aggregated and does not probe into the relation between specific technological or scientific disciplines and trade specialisation in related products. And, disappointingly for the perspective of this analysis, the author *a priori* discard biomedical science and other life sciences as having any influence on the production of health care products.

It should be generally accepted, nonetheless, that the exclusive characteristics of the production of goods for the health care sector almost invariably include science as an important factor. However, it is important to realise that scientific inputs take two configurations in this context: Medical science and technical science. While technical science – by providing new ways to construct and produce goods – is the standard reference in the discussions of science-based industries, in health care medical science is as – or rather more – important by allowing producers to enhance their understanding of the human body and thereby allow for new and better products. The most important and generally applied type of science used in the production of health care products therefore is medical science.

The present analysis is an attempt to combine the two hypothesised influences (one demand factor and one supply factor) on the production of health care goods in one analysis. In doing so it covers (aspects of) two of the four "determinants of national competitive advantage" proposed by Porter (1990). Scientific activities constitutes an important element of what Porter terms Factor Conditions, and the health care sector surely is a determining factor in Demand Conditions. The two remaining determinants, Firm Strategy, Structure, and Rivalry as well as Related and Supporting Industries will not be included in this analysis.

Demand conditions: The health care sector

The most frequently applied measure of the size of the health care sector is the total (public and private) health care expenditures as percent of gross domestic product.[3] Despite its popularity, total expenditures on health is frequently criticized (see e.g. OECD, 1990) for being incomparable over time and especially across countries, which hold many different opinions on what to include in health care. An example is care of elderly, which in some countries is included and in others not. Nonetheless, no other single measure seem to be better.

3 This measure is conceptually comparable to the export specialisation measure in that it captures a country's relative position in a specific field (a product category or an expenditure category). It could be brought into the exact same functional format as the RCA-measure by dividing every country's percentage score with the average percentage score of all countries included in the analysis, thereby assigning the value 1 to countries with average expenditures. But as this numerical transformation probably would only obscure the picture, the percentages are retained.

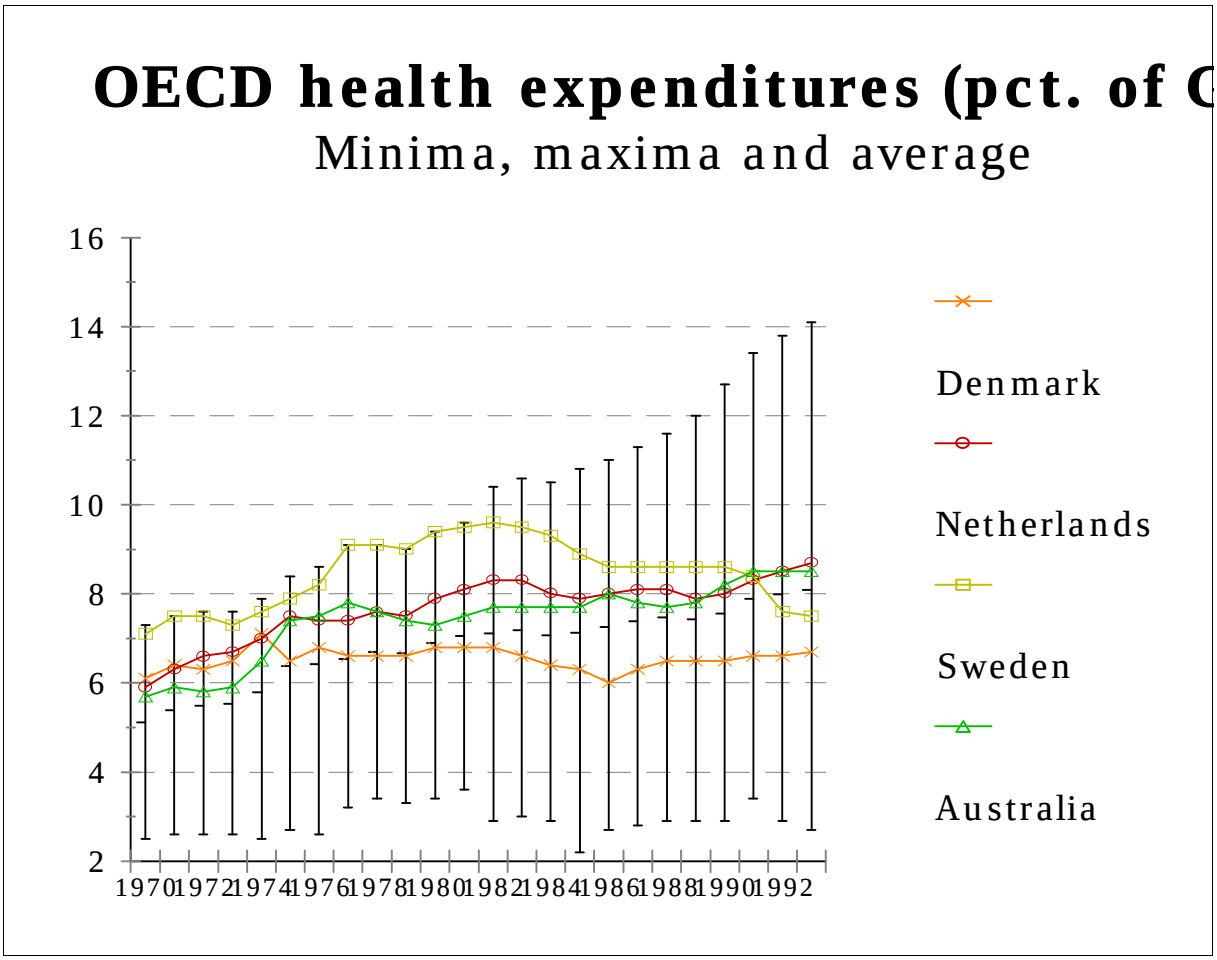

Figure 2

Health care spending and welfare states

Figure 2 illustrates the development over time in all OECD countries' health care spending with maxima and minima shown as solid, vertical bars, with the unweighted average ticked on each bar. Also, the development in health care spending in four small countries are included. The figure shows that on average, the expenditures on health care has gone up from about 5 pct. in 1970 to 8 pct. in 1993, but that for the four small countries, basically the same share of GDP has been spent on health care since the mid 1970. Noteworthy is the invariably low Danish share at between 6 and 7 pct. and the Swedish containment of costs in the 1980s. Until the end of the 1970s, all of these small countries spent more than the OECD-mean, but thereafter they fell to a more average position.

The implication of this development is that while these small countries once may have been labelled "welfare states" on the basis of their health care spending, it is now more doubtful whether the sheer size of health care expenditures has any bearing on the definition of welfare states, or – to put it more radically – whether the theoretical concept of welfare states still has an empirical parallel.

It is clearly the case that the difference between OECD-countries has narrowed over the last 25 years, at least if the US is excluded. As figure 3 shows, the coefficient of variation (i.e. standard deviation over average) has dropped markedly for the group of OECD-countries exclusive of the US. The US exhibits such an extreme behaviour, that it can safely be placed in its own group. (Only now (mid 1990's), the American expenditures on health seem to stagnate or even fall.)

Health care spending and export performance

Returning to the idea of the demand conditions influencing the comparative advantage of nations we now can relate demand conditions measured by the weight of health care expenditures in each nation's total expenditures and our RCA measure of comparative advantage. The hypothesis is that a high share in expenditures should lead to comparative advantages.

There is, however, nothing in the results that points in that direction. With data on export specialisation and on health care expenditures covering the entire period from 1970 to 1993,[4] a series of regression analyses (ordinary least squares) has been performed with simultaneous and lagged relations, but none of them turned out to be significant.[5]

The best correlation between health care expenditures and exports specialisation (in terms of t-value and coefficient) was the lagged relation between expenditures in 1982 (HCE82)[6] and exports in 1992 (RCA92) (t-statistics in parenthesis):

$$\mathbf{RCA92} = \underset{(-0.02)}{-0.03} + \underset{(0.81)}{0.15}\mathbf{HCE82} \qquad R^2 = 0.04$$

Even if the coefficient has the expected (positive) sign, it is clearly not significant, and furthermore the expenditure variable explains only very little of the variance. Health care expenditures in 1970 is negatively correlated (with very small and very insignificant coefficients) to export specialisation in both 1973, 1982 and 1992. It has thus not been possible to improve the analyses performed by Fagerberg (1992, 1995).

Before squarely rejecting the idea of an relation between demand conditions and comparative advantage, however, the concrete representation of "demand conditions" need to be discussed. It is important to realize that health care expenditures is a measure of only one dimension of the demand conditions, namely the relative size of the national marked. The basic idea is that a country that emphasises health care in its consumption pattern somehow should facilitate not only a larger,

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4 The number of observations is limited to 19 OECD countries (Portugal and Greece are missing).

5 Balassa indices are very skewed in their distribution (a long right tail). Their can be trimmed into a more normal-like, symmetric distribution by the following transformation: RSCA = (1-RCA)/(1+RCA). Most of the statistical analysis in the paper have been run also on RSCAs with only minor differences from the RCA-analyses as a result.

6 Compared to Fagerberg's (1992,1995) measure of health care expenditures, this measure is a shere percentage (total health care expenditures over GDP), which is not turned into a RCA-like measure (like the one in Fagerberg's analyses).

but also a more competitive industry.

That hypothesis may very well be seriously flawed, though. Porter (1990) rejects the absolute size of the home market as a major determinant of comparative advantage. Only in specific situations of economies of scale or learning absolute size may matter. And to Porter's requirements one may add that somehow the foreign companies should have more difficulties in entering the home market than has the home country's company in entering foreign markets after capacity has been built or learning has taken place. The requirement could be fulfilled by the removal of some trade barrier at the relevant point in time, but the relevance of this particular incidence probably is limited.

Similarly, the relative size of the home market can hardly be of any significance for comparative advantage. Demand quantity does not in itself influence competitiveness, but certainly the quality of the demand may have an impact. The degree of "competitive pressure" on the user side probably is a more important factor in explaining the degree of technological development in the producer sector. For example, the US health care sector, while large in quantity, has not been very competitive, whereas the UK and Scandinavian health care systems have developed under tight financial control, and therefore, maybe, in some ways have been more demanding customers to serve.

An example may underscore this conjecture (even though it involves a comparison of Danish demand to UK and not US demand). The success of Danish hearing aids producers has frequently been contributed to the political decision around 1950 to include hearings aids in the "package" of free (i.e. tax-paid) health care, thereby overnight creating a new and quantitatively significant market. It should be emphasised that the same decision was made in the UK without any lasting effect on the British hearing aids industry. What made the difference probably was the way hearings aids were procured. In the UK, a medical research council design of hearing aids were put out for production in tender, whereas the Danish tender did not specify a specific design, but included only a range of minimum specification to be met. In the first couple of Danish tenders, the British producers gained also relatively large shares, but as soon as the Danish companies had built design capabilities in hearings aids, the British producers were out competed. Still, one might wonder why the British producers did not develop the same capabilities. Probably the answer is first that they did not realise the importance of the capability since they were focused at their British home market, and second that the arms-length interaction between producers and procurement agencies in the UK did not allow for the exchange of information needed to build such capabilities.

Many other examples of the irrelevance of the size of the home market are striking. From the more important product group of pharmaceuticals, one might for example wonder why two countries like the UK and France perform so differently in global competition. The two countries are at about the same size in population, but health care expenditures has for a long time been somewhat higher in France than in the UK. Despite this, British companies fare much better in international markets. Many explanations offer themselves here (and we will return to scientific activities below), suffice now to mention the suggestion by Thomas (1989), who highlighted the differences in the reimbursement and regulation schemes in the two countries. While the British scheme favoured radically new products, the French scheme did not to the same degree distinguish between new drugs. As a result, British companies turned their attention toward the development

of innovative drugs which paid off not only at the home market, but (perhaps initially unintended) also internationally.

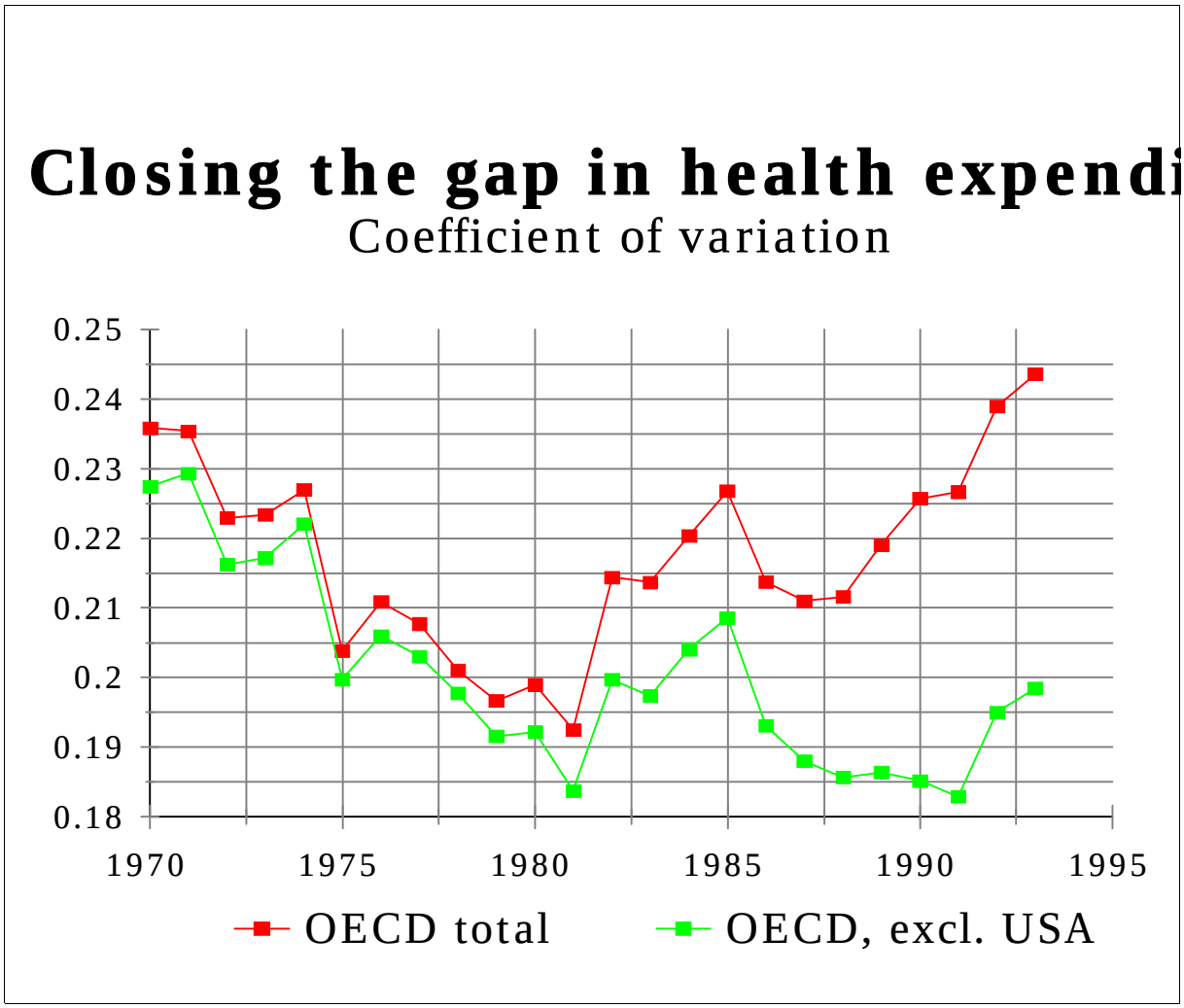

Figure 3

These two examples stress the importance of the match/mismatch between home market needs and global market needs. If the home market has its own idiosyncratic characteristics, it is of no help for the national producers in their internationalisation efforts. If the home market on the other hand foreshadows international developments, national companies may gain first-mover advantages towards foreign competitors. [Linder, von Hippel]

There is, however, an additional dimension in the local demand conditions that influences comparative advantage (and competitiveness). Even if local needs do not differ, the communication between national users and producers may vary from country to country according to the mode of communication. Institutions, traditions and legal regulations as well as the competitive environment govern the way information about user needs and producer capabilities flow between the two parties. Pure market-based transactions will favour focus on the price of the product, whereas a more informal – if not hierarchical – communications will allow for a richer exchange of information. Countries in which communication between users and producers is more eficient

may therefore benefit, but this aspect (efficiency of communication) is apparently very diffucult so measure.

All in all, the findings on the relation between competitiveness and the home market seem to support the view that neither absolute nor relative market size matters in health care competitiveness, but this is no reason to reject the general idea of demand conditions as a determining force in comparative advantage. The problem is to find an adequate measure of the other dimensions of Demand Conditions.

Supply Conditions

As stated above, there are two relevant types of research inputs to the health care complex: Technical research and medical research. Since the health care industry is draws upon a very heterogenous technological base, it hardly makes any sense to test the correlation between any particular technical science. Even though for example pharmaceuticals may depend on chemical science, it will draw upon almost all kinds of technical sciences, including mathematics and computing, biology and engineering. A reasonable hypothesis is therefore whether total national research influences specialisation in health care.

The test of a relationship between total research in the period 1981 to 1992 (RES8192)[7] and exports in 1992 (RCA92) shows that there may indeed be a positive relation (t-statistics in parenthesis):[8]

$$\mathbf{RCA92} = 0.07 + 0.0017\mathbf{RES8192} \qquad R^2 = 0.20$$
$$(0.12)\ (2.04)$$

The coefficient is hardly significant at the 5% level, however. Next step is to split total sciences into two groups, one consisting of medical research and the other a residual group. A test of a relation between the residual group shows no significant relations whatsoever, even though the sign of the coefficient is still positive. It is therefore hard to believe that a high level of scientific activity in general has any bearing on specialisation in health care products.

7 There are two possible formats for the measure of research: Publications pr. capita and a Balassa-type index. Even though the two correlate strongly, they are not identical. In these regressions, publications pr. capita is applied.

8 Please refer to the appendix for data and sources.

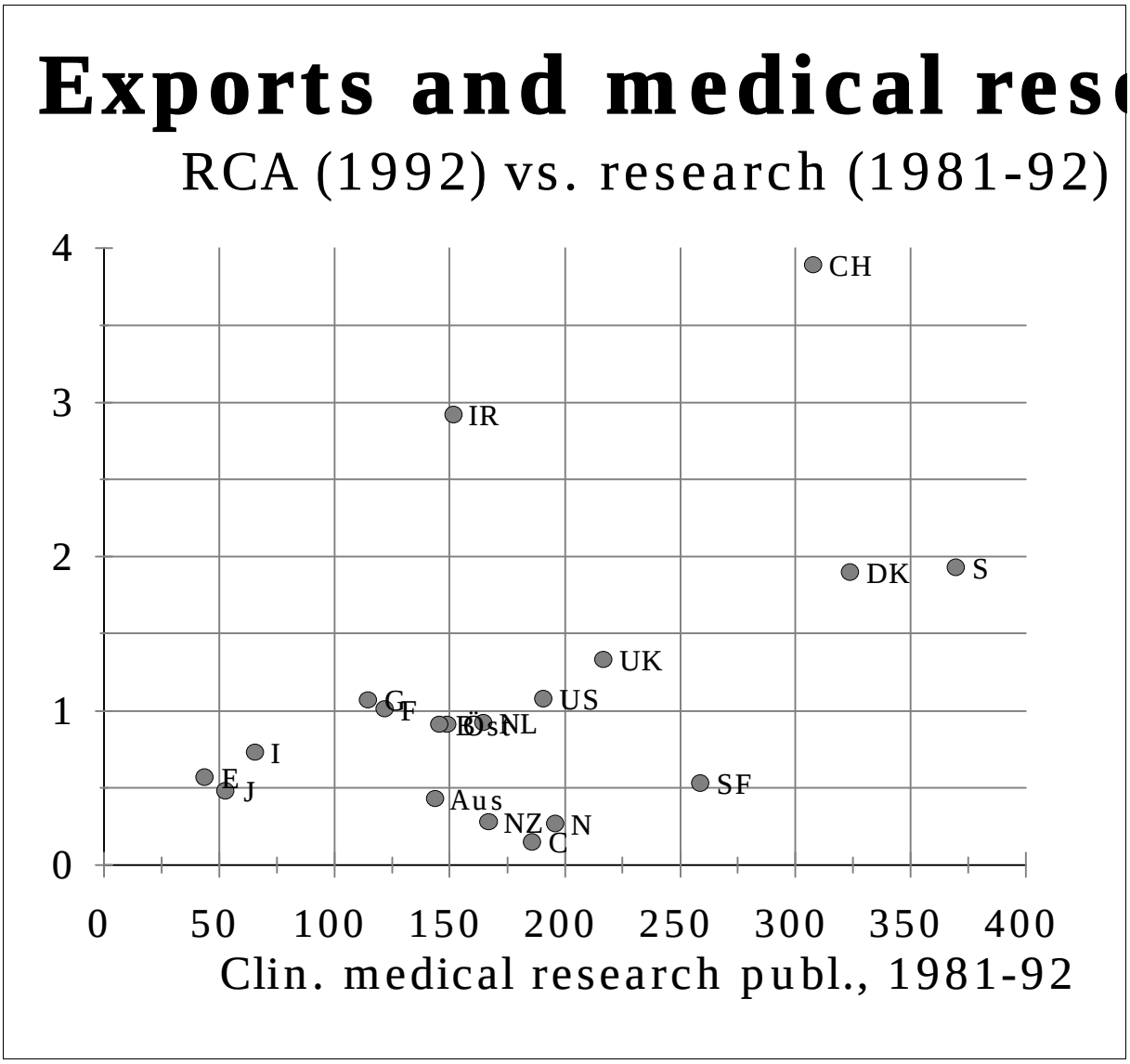

Figure 4

The data allows for a distinction of medical research into clinical medical research on the one hand and biomedical research on the other. The two disciplines are strongly correlated, but when regressed on export specialisation, clinical medical research shows the strongest correlation. Figure 4 shows clinical medical research in the period 1981 to 1992 (CMR8192) plotted against exports in 1992, and the regression yields the following result (t-statistics in parenthesis):

$$\mathbf{RCA92} = -0.15 + 0.0055\mathbf{CMR8192} \qquad R^2 = 0.26$$
$$(0.33)\ (2.44)$$

Certainly, this linear relationship is not satisfying as a full explanation, but the coefficient is clearly significant at the 5% level, and of course other explanatory factors are at work here, so a 100% explanation should not be expected anyway.

On this basis in may be concluded that medical research does have an impact on export specialization in medical product. Further analyses may improve the results by applying other

measures of research such as citations instead of publications, and possibly also by including patenting and R&D as indicators of the "technology infrastructure" of a country.

Summing up the statistical analyses and pointing at future research

Clearly, we found no support for the hypothesis that demand in terms of relative or absolut quantity should have any impact on export specialisation in health care products. Neither did scientific activity in non-medical areas contribute to explanation. Only medical research was found to have an influence.

However, the actual mechanisms relating medical science to exports that are at work at the micro-level cannot surface in a statistical analysis. A next step in this area of research may therefore be a more hands-on analysis of the individual cases in order to establish a deeper understanding of the relationship between export specialisation and the institutional environment of the industries. In this respect, it is interesting to note that some of the outliers in Figure 4 (Ireland especially) is dependent on a massive inflow of foreign direct investments which yields a high level of export without the need for indigenous research. Other countries, such as Sweden, may be underestimated in terms of exports, as Swedish companies have large royalty incomes on patents and licences.

Also, it should be noted as a curiosity and appatizer for this line of research that even when industries with both high exports and a strong research base, the relation between the two may not be as obvious as expected. For example, the Danish hearing aids industry is a very strong exporter and at the same time the related Danish medical research (in audiology) is vigorous as well. Nontheless, Danish hearing aids producers may be quoted for critique of the "useless" and far too academic Danish research in audiology!

Clearly, the link between research and exports is not a straightforward one, and just a Fagerberg (1992) found differences in the impact of health care expenditures on export specialization in different subfields of the health care industry, also the impact of research may vary comsiderably between industries, even within the health care field.

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