EXTRA-TERRITORIAL CLUSTER DEVELOPMENT IN EUROPE

Searching for evidence of supranational industrial activity

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ABSTRACT

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Though multi-regional modelling has been a part of input-output studies for several decades, analysis of industrial clustering has been traditionally focused on the internal dynamics of identified single region clusters, be they sub-national jurisdictions or nation-states. Particularly, within the systems of innovation research field the focus has been on the user-producer product flows and knowledge flows within clusters, including some analysis of their relative performance. From this perspective, exports are seen as indicators of performance, not necessarily indicators of industrial linkages. Imports have not been seriously examined from the perspective of their importance to a trans-border cluster. Though understanding within-border user-producer flows better is of course important, it seems to be a serious oversight to not pay attention to the outward oriented relationships of clusters.

The current paper is a first step in a wider project that aims to improve the understanding of clusters, including national, state or territorial implications, by analysing some aspects of their trans-border linkages. It does this by examining value added flows across national boundaries, seeking to identify cases where these flows are greater than could be attributed to standard "non-cluster" business relationships and hence pointing to evidence of cross border linkages which may be deserving of further examination.

The paper utilises the 1995 European input-output tables together with bilateral OECD trade data to construct an inter-country input-output model that forms the basis of the analysis. The focus on the European Union allows an examination of trans-border linkages between mixes of large and small economies with (relatively) minimal distortion based on political or other non-economic considerations.

INTRODUCTION

The economic geography of trade and development has been a hot topic of the last quarter of a century. Globalisation, triadisation, economic interdependence and other concepts are constant themes in the economic journals. In contrast the innovation literature has not been as focussed on this issue. But that is admittedly beginning to change.

The current paper is concerned with building a bridge between the two worlds of domestic specialisation and innovation and growing international interdependence.

Wixted (2000) suggested three observations from the literature that raised interesting questions of international trade developments that were worth exploring with input-output data.

- Innovation typically develops from the interactions of industrial suppliers and users (at an aggregate level these interactions have been called clusters);
- Intermediate trade is reported to be on the increase;
- Trade in general at significant levels appears to be specific between countries and relatively long lived.

This in turn led to three reasons (p21) for focusing on linked cross border industrial systems, which in that paper were called supranational clusters.

- consideration of the industrial systems that import intermediate goods (as well as those that produce the exports);
- the need to assess whether knowledge and innovation are being transmitted across national borders through the channels of interdependency;
- and then finally the proposal that significant trade linkages between countries are few, specific and long lived.

The current paper utilises the Eurostat 1995 European input-output database to generate an analysis of intra-European territorially based indirect value added spillovers. The results are suggestive of the existence of cross-border industrial systems. Where these appear to exist it seems reasonable to conclude that examination of future possible innovation potential will require a trans-national model for analysis.

This paper combines the research fields of national cluster development with international trade, analysed through the use of inter-country input-output data for Europe.

A CONCEPTUAL MAP OF INDUSTRIAL GLOBALISATION

Chains, networks and the division of labour

The research for the current paper is, though quite relevant to a number of research topics, not aligned to any particular field, except through the methodology of input-output analysis.

A number of fields of research are concerned with international production activity but are interested in the supply chains of individual businesses. 'Global Production Network' theory (Zysman, Doherty and Schwartz 1996, Ernst 2000 and Coe 2000) has a tendency to focus on high technology or complex product chains. Thus Ernst points out that the assembly of an individual computer may involve products from a number of firms in a number of countries. The 'Global Commodity Chains' approach promoted by Gereffi (1998) has a similar interest but is closer to a political economy approach in that it incorporates power relationships between purchasing corporations and their suppliers. Probably in view of their political importance, Gereffi is interested in specific sectors such as textiles, clothing and the auto industry.

At the other end of the spectrum lies research that emphasizes the international division of labour. Fontagne and Freudenberg (1997 p7) have shown that at high levels of data disaggregation intra-industry trade disappears and is replaced by vertical product differentiation:

> Using a dataset embodying data flows of 11 European countries facing 10 partners for around 10,000 products, the methodology emphasises that the recent increase in IIT in Europe is entirely due to trade in vertically differentiated products. To better apprehend the countries' specialization along the quality ranges, it is assumed that differences in prices reflect quality differences.

The closest field to the current work with an emphasis on international intermediate product flows has been labeled 'Value Chain Fragmentation' analysis. The authors in this area are interested in the empirical and theoretical dynamics of trade in intermediate goods (Jones and Kierzkowski 2001, Feenstra 1998, Hummels, Rapoport, and Yi 1998) and the impact on wages of so-called manufacturing 'outsourcing' (Egger, Pfaffermayr and Wolfmayr-Schnitzer 2001). However, the approach relies heavily on neo-classical trade theory of specialisation (Arndt 1998) rather than on developing an understanding of the technological and business environments.

Innovation systems and innovative clusters.

In a curious twist within the international literature there is one area that has not pursued trade issues with as much scrutiny as might be expected. That research field is broadly termed ‘Innovation Systems’. For most of the 1990s there was a concentration of effort on the impact of ‘National Innovation Systems’ on the general innovativeness (generation and transmission) and economic growth of particular countries. Freeman (2002) and Lundvall, Johnson, Andersen and Dalum (2002) continue to strongly argue for the concentration of effort on *national* innovation systems as the human arrangements in which learning and capability development largely occur. This literature continues to emphasise that production in a static economic framework is not the relevant area of concern, but it is knowledge, technology and innovation (Lundvall et al 2002) that is of interest. However, many of the indicators used to develop the picture of these national innovation systems have an industrial focus[1].

This is not to say that there has been no work on internationalisation. Whilst the link between export specialisation patterns and technology development has received considerable attention (see in particular the work of Guerrieri (1999) bilateral trade relations has received less (Laursen 1998a and 1998b). The integration of innovations systems has been explored from a number of perspectives including patents utilisation (Verspagen and Schoemakers 2000) research and development internationalisation in multinational corporations.

The other approach that has been used utilises the concept of ‘embodied technology’. Put simply embodied technology is the term given to the concept of developing a model of the R&D content of intermediate goods and then tracing the flows between industries. This has been done by During and Schnabl (2000) and Drejer (2000) for domestic flows and Papaconstantinou, Sakurai and Wyckoff (1996) and Laursen and Meliciani (2001) for international flows, though the analysis of this latter study goes on to indicate the significance of these international acquisitions for competitiveness.

[1] The difficulty of accessing appropriate innovation and technology indicators is not a topic for this paper. However, interested readers should look at Freeman (2002) OECD (2001a) for the selection of industrial indicators and OECD (2001b) for the particularly strong focus on information computing and telecommunications equipment and Smith (2001) in reply to the ICT thesis.

These studies are important and the methodology useful. However, with the international studies there is the difficulty that there is a gap in the analysis of the flows. Essentially, country exports can be multiplied by an R&D content measure (industry R&D intensity) and with OECD data[2] there is a measure of imported intermediate goods. However, there is no measure of intermediate exports by each country, nor is there an indication of a subgroup of countries from which intermediate imports are coming. Whilst the issue of broad trade direction can be overcome with the use of the bilateral trade database, not having an indication of intermediate trade is a more serious problem. The assumptions made on this issue could provide radically different outcomes.

Therefore, due to the nature of the data used for these studies being from an open[3] system the papers can only conclude with general points regarding the importance of imported technology. The closed model of the EU on which the current paper is based would allow for more conclusive analysis of embodied technology transfer between countries (at least between EU countries).

Though there are arguments to retain the focus on national systems, in recent years this emphasis as broken down to some extent with the emergence of 'clusters' as a significant part of the literature and introducing the idea of 'reduced systems' of innovation. The clusters literature though focussed on sectors or regional blocks of economies has largely continued the tradition of examining the endogenous characteristics that produce and diffuse innovations.

It has been recognised for some time that businesses in similar activities have tended to co-locate. The recent emphasis on clusters has been in part relying on the co-location effects on innovativeness. The importance of the clusters research derives from the emerging understanding that innovation is most frequently generated at the interface between users and producers. Von Hippel (1988) and later DeBresson's work (1996 and 1999) which emphasises that innovation is not the activity of the individual entrepreneur. Therefore, if relevant businesses are co-located, there is not just the value of user-producer connections but the added dimension of local and tacit knowledge. Therefore the concept

[2] The OECD Input-output database (1996) includes a matrix for each country that covers imported intermediate goods.

of gains from individual businesses 'networking' and particular places generating externalities (though this term is rarely used) from clustering is a solid component of the literature.

Interestingly, though 'clusters' are discussed at various levels of aggregation, they are not really ever developed within a multi-regional framework. There are just a few references to extra-territorial developments in the literature. One of these is in Bergman, Charles and den Hertog (2001: 9).

> International trade among cluster members has completely different implications for large vs small country clusters. A recent study of trade in OECD member countries (Hammels, Rapoport and Yi, 1998) shows that vertical trade among international members of a value chain is a much higher proportion of total trade in small vs large countries. For example, vertical trade is 25% and 42% for Denmark and Netherlands vs 7% and 14% for the United States and Japan, respectively. The authors consider that these findings reveal a greater likelihood that a cluster's trading partners are within and therefore responsive to a large home country's national and regional policies, Paradoxically, however, it also means that supra-national innovation systems (S-NIS) may be essential to sound cluster policies, particularly for small countries. Thus it could well be the case that relevant elements of cluster or innovation policy might logically migrate to the policy frameworks of relevant OECD Member customs unions, such as the EU or NAFTA.

While this clearly identifies the issue of the potential importance of S-NIS, the analytical approach suggested in this quotation continues the tradition of considering the importance of the S-NIS from a politically defined territorial perspective. Although this is understandable from the viewpoint of policy makers who are ultimately answerable to some politically defined constituency, it potentially misses the opportunity to uncover the existence of clusters of relevance to economic territories that are not immediately or apparently coincident with political territories at some relatively obvious level of aggregation, it also overlooks research questions relevant to the small countries identified. Thus it is likely to contribute to a continuation of the enthusiasm of innovation researchers for systems that are politically defined rather than looking to the value chains themselves for definition. It is an approach that is similar to that suggested by Rugman and D'Cruz (1993) and fits the triadisation approach to understanding world trade.

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[3] In contrast to the European model where the total size of both the complete system and the intermediate trade is known in other analysis all that is known is the imports from the world and the trade propensities between countries.

Two criticisms of this approach can be made. First trade is generally not triad in nature. Poon, Thompson and Kelly (2000) show that at the very best there are four significant groups. These are the Americas, East Asia, Germany (capturing most of southern and western Europe) and the United Kingdom (which includes some of Africa and Northern Europe). So on this analysis Europe is split in terms of its trade preferences. However, even this grouping of activity does not reveal the complexity of arrangements for any particular industry. The main empirical problem faced when supra-state boundaries are defined either politically or through aggregate trade zones is that they do not account adequately for the reality of international value chains and the technological flows they imply.

Given this background, the rationale for this study is to map the value flows to assist in developing a framework for considering an economically driven approach to industry and country groupings. This paper tries to understand cluster development within the wider context of multi-country development. It does this because the cluster literature is beginning to make valuable contributions to our understanding of industry development – but the lack of external linkages is an important blind-spot.

Inter-country input-output analysis

The disadvantage of relying upon trade data (as is the standard practice) is that it does not integrate domestic use together with international supply (imports). This limits the studies of international supply chains to only considering industry trade as, at best, assumed direct inputs (intra-industry trade). Traditional trade analysis therefore tends to focus simply on the increasing amount of trade, particularly intra-industry trade, and also on changes in market share. However, this may not be as informative about the operation of the entire industrial system as analysts would hope.

The multiple matrices in an inter-country input-output system combined with the additional information of value added allow for the analysis of horizontal and vertical trade flows to be understood within the total context of value flows. Whilst trade analysis is typically interested in specialisation through factor analysis and the direction of trade, input-output analysis is better suited for understanding the patterns of interdependency and value chains.

Recently, a number of studies have utilized inter-country input-output models of member countries of the European Union. We highlight two studies which are based upon a similar background model to that which we develop, which have a similar interest in the structure of economic interdependence between industries and countries, but which nevertheless follow a different methodology in their analysis.

Dietzenbacher and van der Linden (1997) employ a modified Strassert method which enables the "hypothetical extraction" approach to separately identify backward and forward linkages. As is usual with these methods, the results are reported in terms of output effects. In our work, we intend to trace through the inter-country spillovers of value added which arise from particular sectoral and regional activity. By its nature this is most readily compared with backward linkages. Probably the key finding from the application of the Dietzenbacher and van der linden methodology to backward linkages is the strong dependence on Germany.

Using a different technique, van der Linden, Oosterhaven, Cuello, Hewings and Sonis (2000) aim to identify propulsive, reactive and dependent sectors. An important point which they make is that despite the apparent integration of the European Union, inter-country spillover effects are quite small. Although the "fields of influence" approach which they employ is quite different in technique to the hypothetical extraction method, it also concentrates on measurement of production effects. An additional common feature is that it is possible to concentrate upon either backward or forward linkages, although as the authors point out they are more interested in their particular application in tracing the effects of technological change through these linkages than in actually measuring the strength of the linkages.

Both of the above approaches should be capable in principle of identifying trans-border clusters. The hypothetical extraction method should be able to indicate which sectors and countries will be most affected by the lack of a sector which would otherwise provide a market for their products as intermediate goods and services. Nevertheless, because of the sheer size of production effects, the number of sectors in a multi-sector and multi-country model which one would need to sequentially extract and the smallness of inter-country spillovers relative to domestic output effects, there is a case for considering other approaches both in terms of the methodology and the effects which are measured. Similar points apply to the fields of influence approach. In addition, there is a case to examine the existence of trans-border clusters quite independently of what might be the case under alternative technology scenarios. Since we are primarily interested in searching for "above normal" inter-country spillovers, we construct measures which are "normalised" in a manner to be described and which do not allow the small inter-country spillovers to be dominated by the naturally larger intra-country effects.

Extra-territorial cluster model strategy

The methodology used for our research on trans-border clusters in the European Union is therefore different to the applications of input-output analysis to multi-country EU models currently in the literature. We concentrate on tracing flows of value added arising indirectly through inter-industry and inter-country linkages. Our interest in tracing value added flows may be seen as employing backward linkages to provide the channel for measurement of the effect we are investigating. Essentially, we need to obtain partial sums of backward indirect production multipliers using value added coefficients as insights. We construct measures based on indirect value added flows to examine the strengths of linkages between a sector and a region (not necessarily the home region of the sector). One measure of the importance of a sector to a region is its contribution to indirect value added. Clearly, the fact that a sector purchases intermediate inputs from outside its own home region means that there will be some transfer of value added. But should we expect the ultimate pattern of indirect value added transferred across regions to be similar to the pattern of intermediate input purchases?

We can show theoretically that the difference between the pattern of indirect value added transfers and the pattern of intermediate input purchases is a zero sum game. To the extent that there are " big winners" there must correspondingly be either big losers or a sizeable number of small losers. Big winners in this sense imply the existence of some force of agglomeration within subsequent rounds of added processing that leads to a substantially larger degree of value added going indirectly to certain regions than would be apparent from examination of the direct intermediate transactions pattern in isolation. If big winners in these terms are in fact present we interpret this as prima facie evidence that there is some cluster effect of significance in the winner region. A winner region or regions by definition contain sectors that are substantially linked (through valued added chains) to each other and to the initiating sector. We can highlight these big winners by comparing the accumulated indirect value added accruing to any sector against the intermediate input coefficients which generate the trade link for that sector. This comparison is most revealingly made as a share of the available *indirect value added* (the total value of intermediate inputs which are available for distribution indirectly as value added).

In this paper we do not attempt to actually identify the sectors that must be part of this 'value spillover' cluster. But we do begin the preliminary research task of identifying the regions from which such sectors would be drawn. We also note that the grouping of regions that contain sectors that would be part of a cluster will of course be itself conditional on the nature of the initiating sector. For this reason, we present results for various initiating sectors (that is, for various initial recipients of a final demand injection).

CONSTRUCTING THE INTER-COUNTRY MODEL OF EUROPE

The data

Eurostat publishes a series of input-output tables for 14 European Countries and a combined set for the European Union 15 (Greece does not provide I-O tables but is estimated by Eurostat – see appendix 3 notes). The base year for national data is around 1990-92 with the data being projected forward to the standardised year of 1995 by Eurostat. Of the full set of fifteen tables, we employ 11 full country tables and form an aggregate for the remaining countries. In addition to overall EU table, those countries that are separately identified in our modelling are:

- Denmark
- Finland
- France
- Germany
- Ireland
- Italy
- Netherlands
- Spain
- Sweden
- UK

For shorthand reasons these countries have been referred to in this paper as Nation-State European Economies (NEEs).

Data for each country is in the form of four tables: domestic transactions (intra-country intermediate input flows and value added components), intra-European imports (in 25 sector detail but aggregated across the other 14 EU import source countries), non-European imports (25 sector detail) and total imports. The exception to this format is the full EU tables, which by definition has intra-European trade embodied within the domestic transactions matrix.

Data for the following countries was not directly utilized and a composite data table was calculated residually for this group. In this paper this residual group of countries is referred to as the Rest of Europe (RoE):

- Austria
- Belgium
- Luxembourg
- Portugal.
- Greece

The European Union transactions table

Developing the transactions matrix was done in a two-step procedure. The first was to work on separating out intra-European trade from all partner regions for the ten countries for which we bought original tables. The second step required the construction of a domestic table and an intra-European imports table for the RoE region before we could then use the method adopted in step one to calculate its trade spread.

Step one – trade preferences for NEE countries

The bilateral import propensities of the NEEs were calculated at an industry level using the OECD Bilateral Trade Database (BTD). Though, the BTD uses the International Standard Industry Classification ISIC rev 2 classification and the EU I-O tables are classified using the European industry classification system (NACE), at high levels of aggregation the two classifications are not too dissimilar. The industries in the BTD upon which the interindustry import calculations were based are provided in Appendix 1. For many of the manufacturing industries there was quite a reasonable correspondence. Further, because of the construction of the BTD it was straightforward in ensuring that the total for all the trade propensities of NEE import partner contributions, including the RoE group of countries, in a particular sector equalled 100 per cent of imports.

One serious difficulty is that there is not yet any readily available services trade data on a bilateral basis. This is mitigated somewhat in the current project by the very small levels of trade, though with increasing services trade, future research would benefit from access to such data. The simplifying assumption used in this model was that the direction of services would flow in the same proportions as the entire manufacturing sector. This is the best assumption possible at present and due to this uncertainty we have not analysed the services flows directly. Bilateral trade data for agricultural, forestry and fishery products do exist but was not available for this project. The simplifying assumption employed here was to use the same trade direction ratios as those applicable for the food, beverages and tobacco sector. This latter assumption is probably not inappropriate, as evidence on Australian exports (AFFA 2001, 2002) would seem to support such an assumption.

Having derived import propensities, these were then applied to the total intra-Europe intermediate imports data for a particular country to construct separate implied intermediate trade tables for each import partner. The import propensities were applied on a row[4] basis. The NEE blocks incorporate trade from the ROE countries. As an example of this approach, Denmark imports agricultural and industrial machinery at a different rate between the UK and Germany. These different rates are then used to calculate the proportion of intermediate trade in this sector accounted for by those two countries. The following table provides a sample of how this works in a three-country model where Denmark had a 60 – 40 preference in favour of German products. The resulting trade imports would appear as: (the numbers chosen are simply random to highlight the approach):

[4] At present there doesn't appear to be a logical approach to calculating appropriate propensities on a column basis or for each cell. At present it is straightforward to calculate the overall trade preferences (total imports divided by imports from Country A). There is no information that informs us of the purchasing preference of individual industries in a particular country. Presumably, in the absence of actual information some assumptions could be devised on the basis of quality, for example. There are interesting possibilities, but these need to be explored in the context of a more detailed assessment of trade theory.

Table 1: Example of intermediate trade distribution

	Denmark Food	Denmark Transport
Denmark domestic ag machinery	50	80
Imports from Germany – ag & indust machinery	4.8	6
Imports from UK – ag & indust machinery	3.2	4
Imports from Germany & UK – ag & indust machinery	8	10
Total intermediate ag & indust machinery	58	90

Step two – the RoE countries

To calculate the Rest of Europe (RoE), matrices requires a number of calculations and some assumptions that though justifiable are more extended that the simple ones applied to the trade distribution for the 'known' countries.

a) Because we have a total EU 15 table as well as the ten individual tables, it is possible to create a table of the entire activity of RoE. This was calculated as follows, where T is domestic inter-industry transactions and M is imports.

RoE (T + M) = EU 15 (T + M) – EU 10 (T + M).

b) The next need is to split domestic transactions from intra-European imports. Here an average ratio of domestic to imports transactions is applied to the RoE.

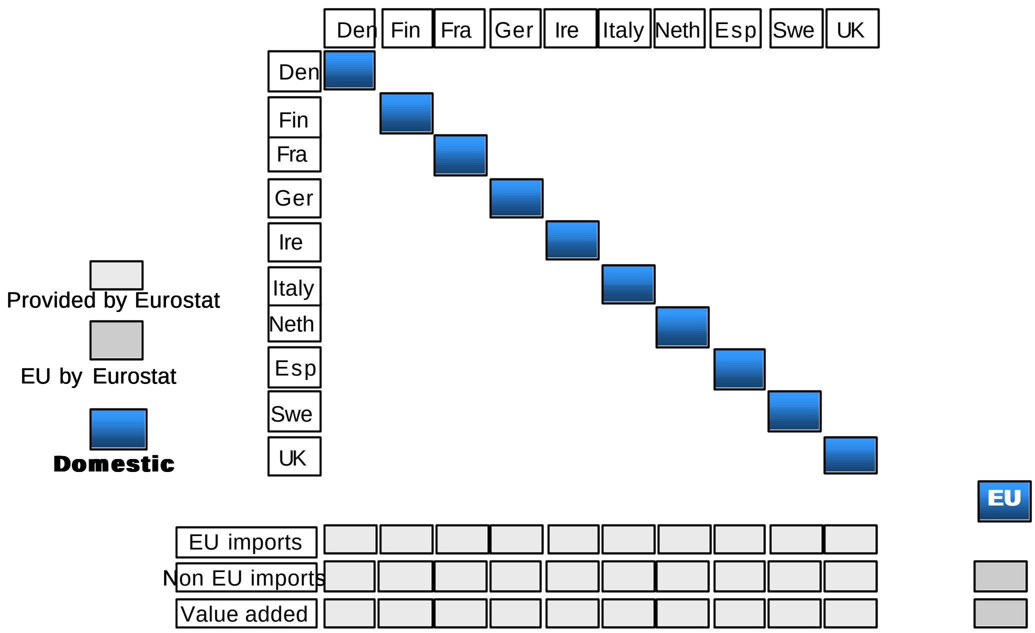
RoE ratio = EU 10 (M) / EU 10 (E).

c) Finally, a similar methodology as applied for the EU 10 countries is applied to the RoE block to distribute imports from EU countries. The exception is that the RoE countries need to be combined first before the ratio for import country splits can be calculated.

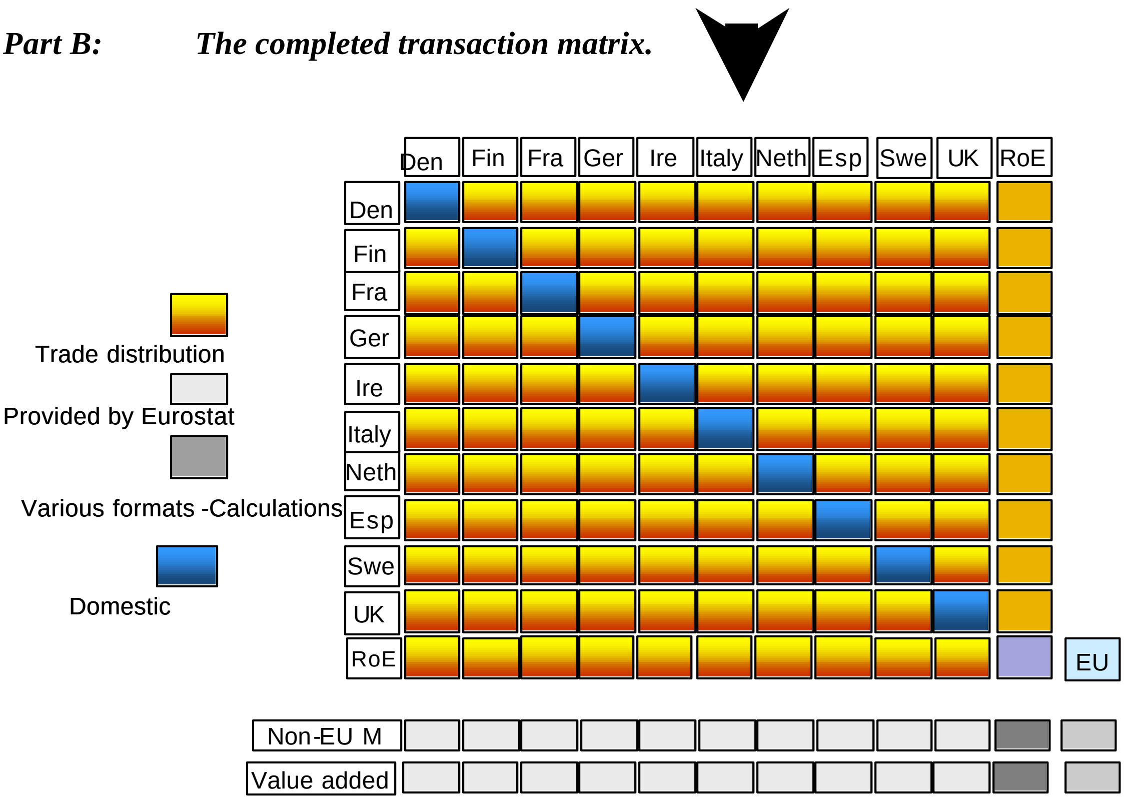
A schematic diagram of the multi-country EU transaction table construction process is in Figure 1.

Figure 1: A schematic of the intra-EU I-O transactions table construction

Part A: The purchased EU tables



Part B: The completed transaction matrix.



The square matrix consists of 121 region blocks (11 * 11) each with 25 industry columns and rows (a total cell count of 25*25*121=75625).

The model

Following assembly of the (11 times 25) x (11 times 25) transactions table for the multi-regional multi-sectoral EU economy, a mirror coefficients matrix was constructed by dividing elements in each column by the total value of the sectoral output. The input-output model itself is standard. However, in analysing results from the model emphasis is placed here upon the flow of value added effects rather than the multipliers. This paper also develops specific non-standard measures related to indirect value added which are designed to help in the search for supra-national cluster activity. These specialised measures need to be discussed. To do this efficiently it will be useful to summarise the analytical model and introduce relevant notation.

The 11 country model has the basic structure:

$$\begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix} = \begin{bmatrix} A_{11} & \cdots & A_{1n} \\ \vdots & & \vdots \\ A_{n1} & \cdots & A_{nn} \end{bmatrix} \begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix} + \begin{pmatrix} f_1 \\ \vdots \\ f_n \end{pmatrix} \tag{1}$$

where $n = 11$, x_i is a 25 element vector of the sectoral output levels for country i, f_i is a 25 element vector of final demands for the products of country i and A_{ij} is a 25 x 25 matrix of coefficients showing the flow of per-unit intermediate purchases of the products of country i by the sectors of country j. For current purposes we define value added as all input value other than that contained in the intermediate input purchases within the multi-country system. Hence, writing (1) in summary form as:

$$x = Ax + f \tag{2}$$

then a (25 times 11) element vector of (direct) value added coefficients (per unit of output) may be defined as:

$$v' = i' - i'A \tag{3}$$

where i' is a 1 x (25 times 11) unit row vector. It will be useful for later discussion to write this out in country by country detail, corresponding to the level of detail in (1), as:

$$\begin{pmatrix} v_1{}' & \cdots & v_n{}' \end{pmatrix} = \begin{pmatrix} i_1{}' & \cdots & i_n{}' \end{pmatrix} - \begin{pmatrix} i'A_{11} & & i'A_{1n} \\ + & & + \\ \vdots & \cdots & \vdots \\ + & & + \\ i'A_{n1} & & i'A_{nn} \end{pmatrix} \tag{4}$$

Given (3), we note the identity:

$$v'(I-A)^{-1} = i' \tag{5}$$

Since interest is in country-specific detail, it is useful to write a version of this for the block partitioned 11 country system. In general, for an n block partition, we employ the notation and general result (see eg Cooper (2000)):

$$(I-A)^{-1} = I + A^{(n)} \tag{6}$$

where $A^{(n)}$ is constructed recursively by successive addition of blocks, viz.:

$$A^{(i)} = A^{(i-1)} + A_{\bullet i}^{(i-1)}(I - A_{ii}^{(i-1)})^{-1} A_{i\bullet}^{(i-1)}, \quad i = 1,\dots,n \tag{7}$$

starting from $A^{(0)} = A$, where $A_{\bullet i} \equiv \begin{bmatrix} A_{1i} \\ \vdots \\ A_{ni} \end{bmatrix}$ and $A_{i\bullet} \equiv \begin{bmatrix} A_{i1} & \cdots & A_{in} \end{bmatrix}$.

Apart from computational advantages in multi-country/sector cases and the analytical advantage of being able to compute the Leontief inverse for sub-groups of countries along the way, the main advantage of this formulation for present purposes is an interpretational one. To develop this aspect, note that (6) and (5) imply:

$$v' + v'A^{(n)} = i' \tag{8}$$

Now $A^{(n)}$ is by definition the matrix of sectoral multipliers abstracting from an initial unit injection to final demand and since the double entry accounting ensures that a unit of final demand eventually finds its way to a unit of value added, $v'A^{(n)}$ measures indirect value added. Equivalently, by comparison of (8) with (3) we have:

$$i'A = v'A^{(n)} \tag{9}$$

so that indirect value added when fully accounted for is nothing more than the total value of intermediate inputs. Utilizing the detail in (4) we may define an 11 x (11 times 25) matrix of partial intermediate sums:

$$B = \begin{bmatrix} i'A_{11} & \cdots & i'A_{1n} \\ \vdots & & \\ i'A_{n1} & \cdots & i'A_{nn} \end{bmatrix} \tag{10}$$

where the unit vectors in (10) are each 25 element. Thus the matrix B summarises the direct intermediate input value flows from sectors (in columns) to whole regions/countries in rows and is simply a partial aggregation of the A matrix with the same column totals. Then the LHS (9) is $i'B$ where i' is here an 11 unit vector. On the other hand, given that $A^{(n)}$ is constructed from a $n = 11$ block partitioned system, we can represent it in block detail as:

$$A^{(n)} = \begin{bmatrix} A_{11}^{(n)} & \cdots & A_{1n}^{(n)} \\ \vdots & & \vdots \\ A_{n1}^{(n)} & \cdots & A_{nn}^{(n)} \end{bmatrix} \tag{11}$$

and we now wish to use this to define an 11 x (11 times 25) matrix of partial indirect value added sums:

$$B^{(n)} = \begin{bmatrix} v_1'A_{11}^{(n)} & \cdots & v_1'A_{1n}^{(n)} \\ \vdots & & \vdots \\ v_n'A_{n1}^{(n)} & \cdots & v_n'A_{nn}^{(n)} \end{bmatrix} \tag{12}$$

Thus the matrix $B^{(n)}$ is a partially aggregated variant of $A^{(n)}$ with value added coefficient weights employed in the aggregation across sectors in any given region. By construction $i'B^{(n)} = v'A^{(n)}$. Given (9) and the definitions (10) and (12) it is also obvious that:

$$i'B = i'B^{(n)} \tag{13}$$

which emphasises the identity that total indirect value added is equal to the value of intermediate inputs. However, what is equally clear is that there is no necessary reason why the individual (region/country specific) elements within (10) and (12) should be equal. In fact, it is the differences between these elements with which we are especially concerned in this paper. Consider a typical (row vector) element in both matrices, say the 1 x 25 row vector $i'A_{ij}$ in the B matrix (10) compared to $v_i'A_{ij}^{(n)}$ in the $B^{(n)}$ matrix (12).

A particular element of these vectors, say the k^{th}, relates to the effect of activity within sector k in country j. The k^{th} element in $i'A_{ij}$ measures the extent to which sector k in country j has business links (in the form of purchasing relationships) with the country i. The value of these intermediate purchases ultimately become value added to some sectors in some countries. However, subject to the overall restriction (13), there is no reason for the indirect value added flow resulting from the chain of interactions set off by these intermediate purchases to necessarily favour country i. Of particular interest, in fact, are cases where the k^{th} element in $v_i'A_{ij}^{(n)}$ is substantially greater than the corresponding element in $i'A_{ij}$. This can only arise from a further chain of activity that has some degree of focus within country i, which then results in country i accumulating additional indirect value added as a result of a chain of activity which has begun in sector k of country j but has now switched to interactions within country i.

To investigate these types of effects we can construct the difference matrix:

$$D = B^{(n)} - B \tag{14}$$

Of course, the restriction (13) means that there is a zero sum game with respect to the columns of D - viz. $i'D = 0'$; final demand for the output of sector k in country j does have to ultimately translate to value added somewhere and the elements of any column of $B^{(n)}$ must simply represent a reallocation of the values in the corresponding column of B.

Our particular interest is in elements of D which are atypically large in size (and positive in sign). To pre-empt the results of our analysis somewhat, we should note that typically the row vector elements that make up the block diagonal in (14) will be negative (and typically relatively large - this is invariably true for our results and would commonly be expected although it need not necessarily be so). To see why this result is likely and to investigate its implications it is useful to exhibit a detailed variant of (14), viz.:

$$D = \begin{bmatrix} v_1'A_{11}^{(n)} - i'A_{11} & \cdots & v_1'A_{1n}^{(n)} - i'A_{1n} \\ \vdots & & \vdots \\ v_n'A_{n1}^{(n)} - i'A_{n1} & \cdots & v_n'A_{nn}^{(n)} - i'A_{nn} \end{bmatrix} \tag{15}$$

The typical block diagonal row vector in D is $v_j ' A_{jj}^{(n)} - i' A_{jj}$. The reason why this is likely to be a row vector of negative numbers is as follows. The second term $i' A_{jj}$ represents the sum of within country direct intermediate inputs for each sector. For the most part, these are large compared to cross country intermediate input coefficients (which represent trade in intermediate inputs). Then, as second and third round effects are calculated to determine the eventual location of the value added, it is clear with an 11 country model that there will be dispersion of value added from any country to the 10 other countries with only a small flow back to the originating country in general. Thus $v_j ' A_{jj}^{(n)}$ will tend to be smaller than $i' A_{jj}$ unless there are very unusual cross-border inter-sectoral relationships. This, of course, should not be seen as a problem for country j. After all, sectoral final demand increases originating in country j provide direct value added per unit of output as indicated in the row vector $v_j '$. As pointed out, the value of within-country-j direct intermediate inputs $i' A_{jj}$ is likely to be quite large relative to cross border intermediate inputs such as $i' A_{ij}$ and in subsequent rounds of interindustry relationships indirect value added is likely to be transferred from country j to other countries such as i through a process of depletion of the value implied by $i' A_{jj}$ and addition to the value implied by $i' A_{ij}$ (for $i \neq j$).

This line of reasoning also suggests that the block off-diagonal row vectors in D are likely to consist predominantly of positive elements, and it is the relative sizes of these that will be of particular interest. We normalize each column of D by calculating the indirect value added flows as percentage changes relative to a base level of indirect value added. For the base level we take the value of intermediate inputs (that is, based on direct business purchasing agreements), since this is the source of indirect value added in subsequent rounds of interactions. Let $D*$ denote the 11 x (25 times 11) table of these results. Then:

$$D* = 100 * \left(B^{(n)} - B \right) * \widehat{(i' B)}^{-1} \tag{16}$$

where $\widehat{i' B}$ denotes a diagonal matrix formed from the vector $i' B$.

The information contained in the matrix D^* will be useful for identifying particular countries which need to be examined in greater sectoral detail when attempting to determine whether a particular sector, wherever located, is linked through value added flows to other sectors to such an extent as to be suggestive of a cluster relationship. To support the development of this interpretation consider the detailed representation:

$$D^* = 100 * \begin{bmatrix} v_1{}'A_{11}^{(n)} - i'A_{11} & \cdots & v_1{}'A_{1n}^{(n)} - i'A_{1n} \\ \vdots & & \vdots \\ v_n{}'A_{n1}^{(n)} - i'A_{n1} & \cdots & v_n{}'A_{nn}^{(n)} - i'A_{nn} \end{bmatrix} \begin{bmatrix} \widehat{i'A_{\bullet 1}}^{-1} & & \\ & \ddots & \\ & & \widehat{i'A_{\bullet n}}^{-1} \end{bmatrix} \tag{17}$$

In the j^{th} column block, the k^{th} element of the j^{th} row vector block, $100*\left(v_j{}'A_{jj}^{(n)} - i'A_{jj}\right)_k / \left(i'A_{\bullet j}\right)_k$ say, is likely to be negative. Correspondingly, most elements of the remainder of this column are likely to be positive since the entire column must sum to zero. A typical such element (the k^{th} element of the j^{th} row vector block in row i of D^*, for example) is $100*\left(v_i{}'A_{ij}^{(n)} - i'A_{ij}\right)_k / \left(i'A_{\bullet j}\right)_k$. In fact, the interpretation of these elements off the block diagonal is that they represent the proportional increase in indirect value added created spilling over into other countries as a result of activity in sector k of country j creating flow-on activity in those countries. Since there are ten such countries in this model and the sum of these effects exactly balances the (typically) negative term $100*\left(v_j{}'A_{jj}^{(n)} - i'A_{jj}\right)_k / \left(i'A_{\bullet j}\right)_k$, the average value of these off diagonal elements must be $-(1/10)*100*\left(v_j{}'A_{jj}^{(n)} - i'A_{jj}\right)_k / \left(i'A_{\bullet j}\right)_k$. As also argued above, it will only be in exceptional circumstances that these terms are negative. Therefore, in the standard case they will take values in the range:

$$0 \le 100*\left(v_i{}'A_{ij}^{(n)} - i'A_{ij}\right)_k / \left(i'A_{\bullet j}\right)_k \le -(2/10)*100*\left(v_j{}'A_{jj}^{(n)} - i'A_{jj}\right)_k / \left(i'A_{\bullet j}\right)_k \tag{18}$$

Because countries will naturally have developed trade links with particular partners, it is not likely that the values of $100*\left(v_i{}'A_{ij}^{(n)} - i'A_{ij}\right)_k / \left(i'A_{\bullet j}\right)_k$ for $i = 1,...,n,\ i \ne j$ will be spread evenly along the continuum $[0\ ,\ -(2/10)*100*\left(v_j{}'A_{jj}^{(n)} - i'A_{jj}\right)_k / \left(i'A_{\bullet j}\right)_k]$. It is likely that some (major trading partners) will be located near the upper end of this continuum and others (less closely linked) will be positioned near zero. However, with successive rounds of interindustry relationships modifying the primary trading relationships, it would be expected that there would be some tendency for these "trading partner" effects to be ameliorated and for a greater spread in indirect value added adjustments to be evident along the continuum. What is much less likely, without the need for special explanation, would be to observe elements of $D*$ with the property:

$$-(2/10)*100*\left(v_j\,'A_{jj}^{(n)} - i\,'A_{jj}\right)_k / \left(i\,'A_{.j}\right)_k \; < \; 100*\left(v_i\,'A_{ij}^{(n)} - i\,'A_{ij}\right)_k / \left(i\,'A_{.j}\right)_k \qquad (19)$$

Any observations of where indirect value added is more than the intermediate coefficients and then more than twice the average of available indirect value added would require the complementary existence of balancing lower values for other observations. Moreover, they would imply that country i has captured an abnormally large proportion of the available indirect value added arising from the chain of activities originating in sector k of country j. This would suggest that sector k of country j may well be connected to a cluster of industries within country i. There could in fact be several *such supra-critical-value* entries for sector k of country j, suggesting the existence of a multi-country trans-border cluster.

RESULTS

Output from the European model is presented in the form of several tables of different variations on the value spillovers (as identified above) for 25 industries each with *121 flows* [11 regions (10 countries plus the RoE block) * 11 value spillover zones {10 partner regions + 1 intra-country indirect value added effect – the latter consisting of extra-sectoral spillovers and some intra-sectoral indirect effects arising from the interrelationships with all other sectors)]. Together, these make up a series of analyses of indirect value added effects flowing to each of the 11 countries (including RoE) in the model. The last table of results are presented in the form of percentage changes in indirect value added from what could have been expected based on the usage of direct intermediate inputs as the source of indirect value added under a base case assumption in which no modelling of further interindustry relationships were to occur, viz. the matrix $D*$ described in the previous section.

A complete compilation of this large table of results is available from the authors on request. In this paper we present highlights from this table, in particular noting those cases for which criterion (19) is satisfied for more than one country in the transformation sectors (agriculture, fuels, metals and ores and all manufacturing sectors). These represent cases where a particular country captures a share of the indirect value added which is disproportionately large relative to what could have been expected by examination of the direct trade linkages. Such cases are strongly suggestive of the existence of industries (in the country that has captured the indirect value added) that are of special importance, as indirect suppliers of inputs, to an industry from another country. We take this as prima facie evidence of the existence of a trans-border cluster. The table is presented as Appendix 2.

Value flows

In the following section we present the results of our research for just *the Office and data processing machines* sector as an exemplar of the analysis conducted. There are four representations of the sector.

Figure 2 provides a relatively traditional perspective revealing the concentration of export partner patterns. The data for the chart is normalised by analysing trade volumes as a percentage of GDP for the exporting country. Thus Ireland exports a significant amount of computer equipment for the size of its economy and is focussed (within Europe) on the UK market.

Figure 3 reveals the levels of absolute indirect value added flows accruing to the various countries calculated by the model. A number of moderate level links between countries is apparent along with the strong value spillovers between Ireland and the UK. In this instance the Irish ‘office and data processing machines cluster’ is heavily dependent on imports from the UK.

Figure 4 focuses on the level (represented as percentages) of value added flows that are above the trade input values. In this figure it is possible to see that the UK does not capture very much additional value added in its trade with Ireland above that which is accounted for by the direct trade alone. Germany on the other hand is clearly capturing additional benefit.

Figure 5 reveals the supra-critical value flows between European economies in the ‘office and data processing machines’ sector. The number of flows is very small and Germany is the principal recipient. Each of these flows is normalised by subtracting the critical value from the actual value for each country. These values represent percentages above the critical values defined by LHS (19).

Figure 2: Computer exports (as percentage of GDP) to export destinations [OECD Bilateral Trade Database]

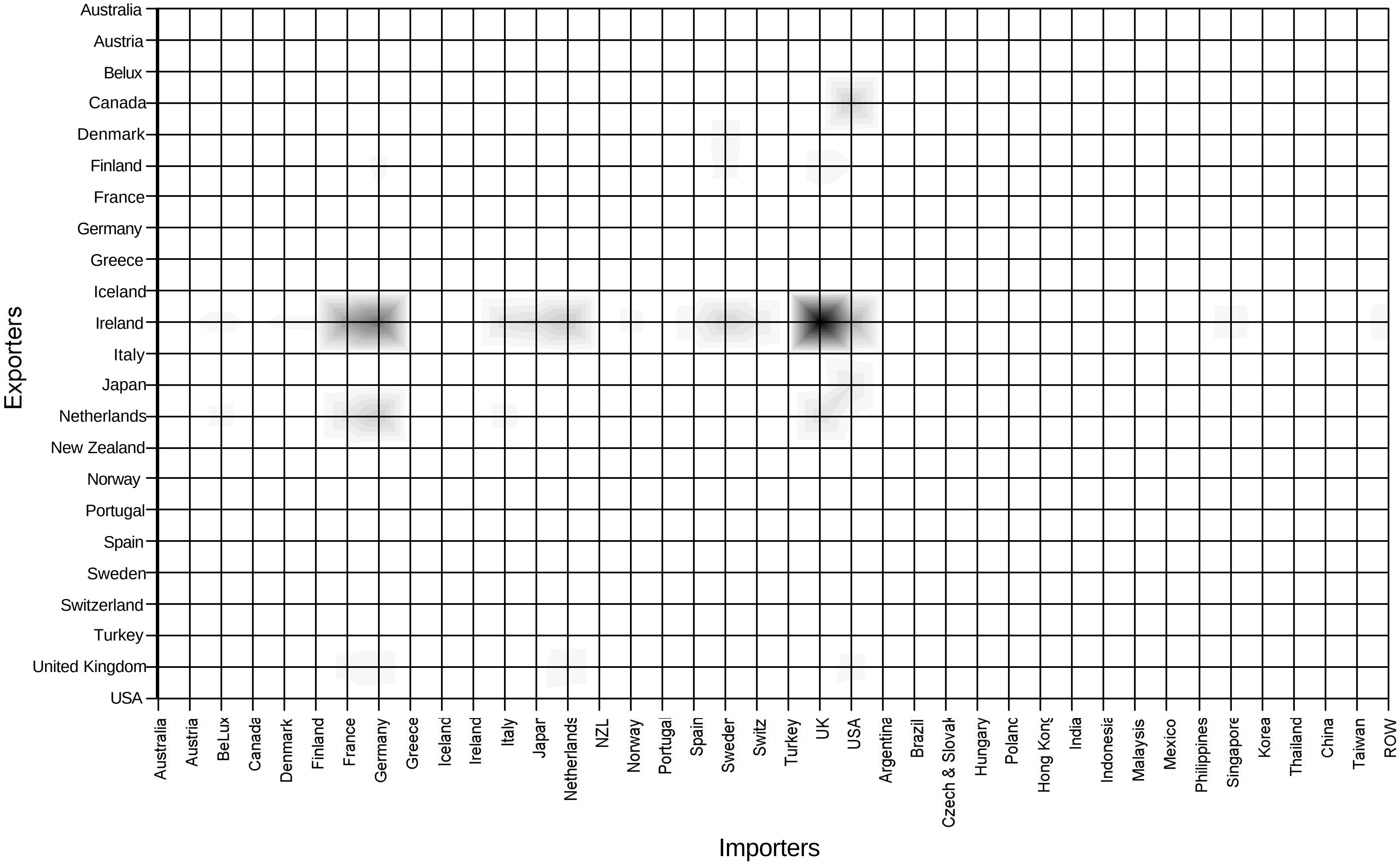


Figure 3: Inter-country indirect value spillovers: Office and data processing machines

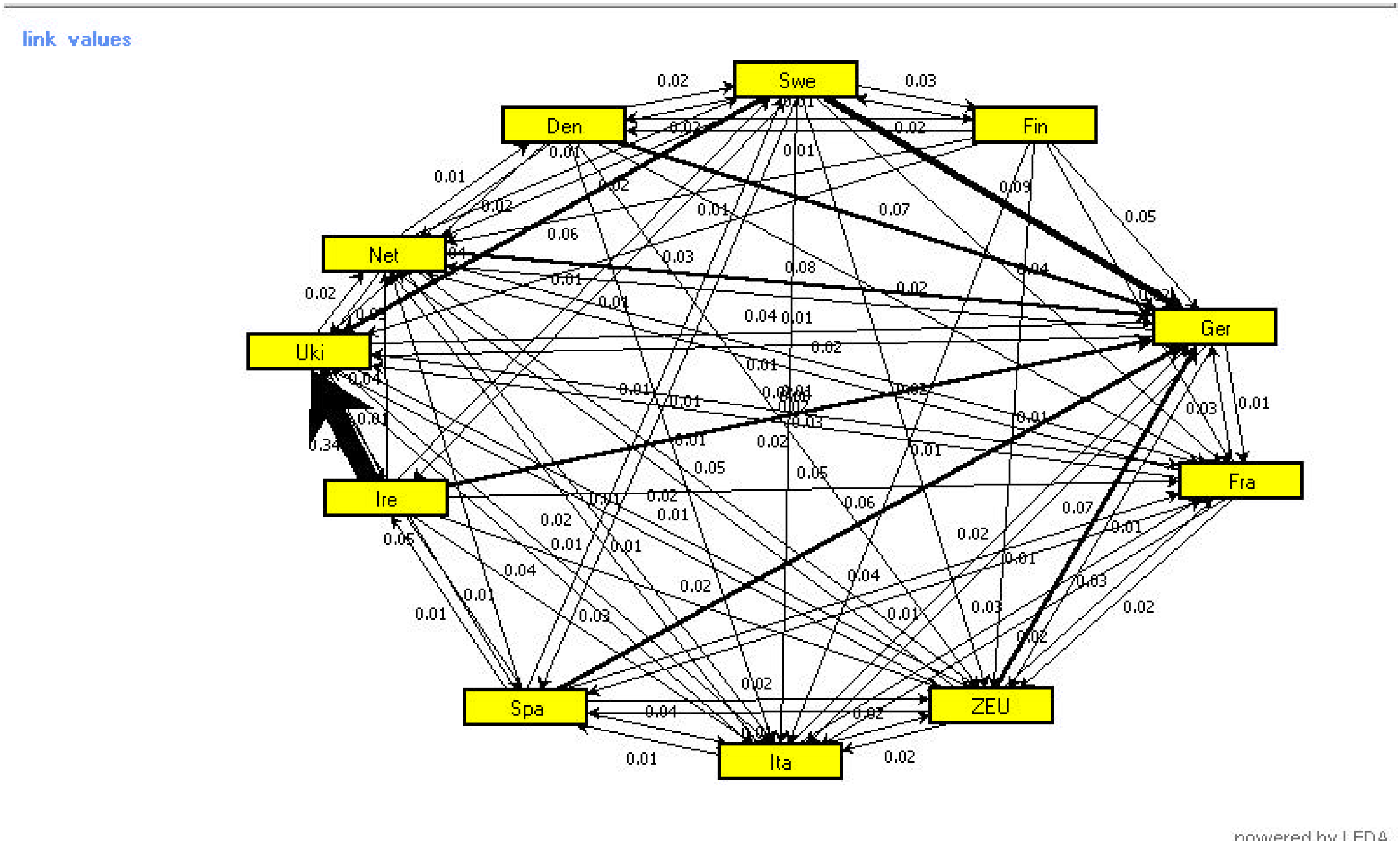


Figure 4: Office and data processing machines – percentage indirect value flows above import coefficients

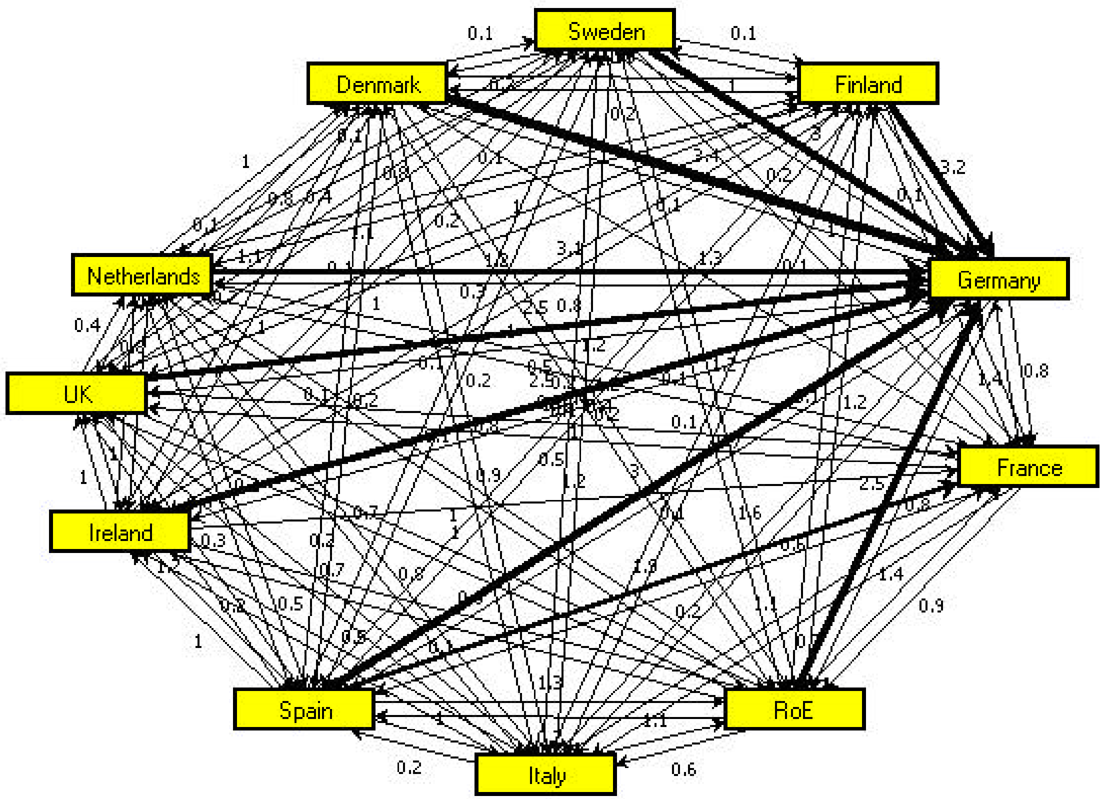
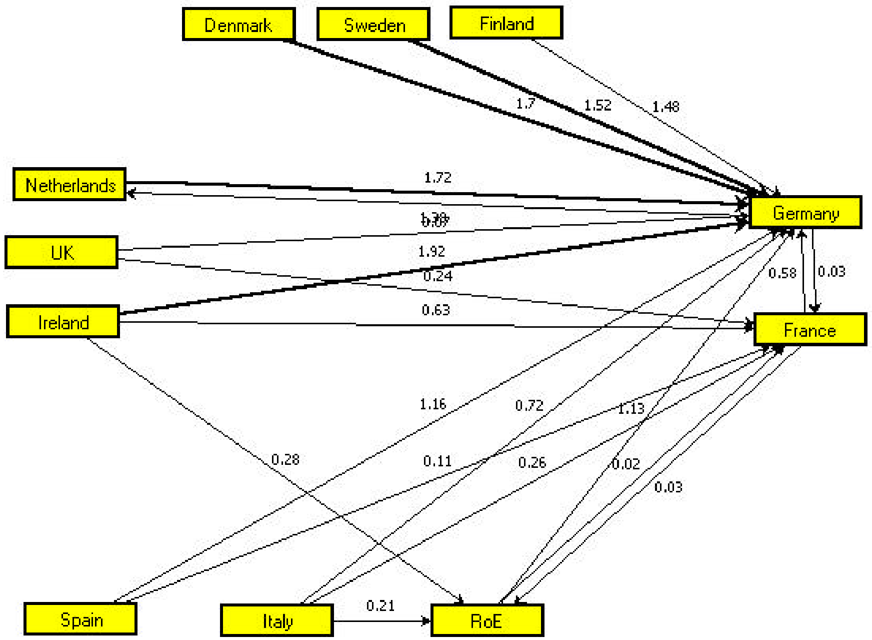


Figure 5: Office and data processing machines - supra-critical value flows



DISCUSSION AND CONCLUSIONS

With only a few exceptions, the results can be interpreted in two quite different ways. Firstly, the analysis reveals that within the EU most benefit, for all industries, in all countries is predominantly retained by the home country. In almost all cases the benefit to wider home industries exceeds that which is transferred to other countries. In the majority of cases the benefit captured by cross border transactions is surprisingly small. The principal exception to this is the indirect value added flow from Ireland to the UK. This result seems to be largely attributable to the very high trade direction concentration. For most countries trade is more evenly distributed between a larger number of countries.

However, the results do reveal that significant benefits do flow across borders. Further, the flows do apparently represent identifiable and specific systems between countries in particular industries and these patterns do change between industries.

Extra-territorial development

The broad conclusions of this paper are:

1. The methodology appears to provide useable and valid data for assessing the individual clustering links between nations.

2. National demand in particular industries in particular countries does significantly flow across borders.

Indirect cross border value added

The current research appears to support the conclusions in Hewings, Okuyama and Sonis (2001) arising from a multi-regional analysis of the Chicago metropolitan area. The authors of that study made a number of interesting findings using a Miyazawa methodology. First of these is that "while the interindustry relationship generates circulation of economic activity and hence creates impacts outside the region of original stimulus, the size of these impacts is relatively small" (p214). This is generally supportive of the results emerging from this study of inter-country intermediate demand. This appears to strongly imply that though there is evidence for greater trade in intermediate goods this category still represents a small percentage of overall inputs into any production structure.

Another conclusion in the Hewings et al (2001) paper is also of interest.

> Furthermore, there is a strong implication from the findings of this paper for interregional and international trade theory. As discussed in sections 4 and 5, interindustry interactions, namely trade, among four regions in the Chicago metropolitan area are fairly weak with only small external multipliers; however, overall economic interdependence is very strong, originating mainly from journey-to-work trips. In providing a connection with the hollowing out phenomenon in the Chicago metropolitan area by Hewings et al (1998), the findings in this paper raise an interesting question: Does geographic size matter for trade? In order to answer this, a comparative analysis between intrametropolitan, interregional trade and international trade will be an important next step to begin this exploration.

The current work not only being broadly comparable as an input-output study but also analysing inter-country flows (international trade) can address some of these points. Industrial scale does seem to matter for spillovers between countries. The top three countries in Europe; UK, France and Germany do have the smallest demand spillovers. On the hand Germany in particular benefits almost universally across changes in sector and country demand patterns, whilst the rest of Europe seems to benefit very little from changes inside Germany. However, our work suggests that, what might be the current norm of weak links between countries, does not always hold. The evidence on Ireland's economic development points to very strong links, but also there does appear to be room to introduce the two other categories - moderate real indirect value added and supra-critical value flows. Countries such as Sweden and Denmark in particular sectors appear to have a limited number of moderate sized links, which taken together appear to be reasonably significant.

Supra-critical value analysis

When the test of critical value is adopted, a number of strong extra-territorial flows are discovered. Germany features very strongly in these systems but other countries are significant for particular sectors.

Implications for the concept of supranational clustering

We started this paper with the research question of whether there were significant inter-country flows arising from intermediate trade that might be considered as evidence for the notion of supranational clustering.

The evidence, it has to be said, is somewhat equivocal. The links between countries, as has already been discussed are generally small. On the other hand there are examples of strong links and a number of examples of multiple moderate links. It is these latter cases that are of the most interest. They provide limited evidence for industrial transformation, of scale, that cross borders and thus provide prima facie evidence for the existence of supranational clusters.

One interpretation that could be placed on this is that true globalisation of *production* may still be somewhat distant, and the flipside of this is that trans-border systems are particular cases rather that general cases. It is also worth pointing out that an interesting aspect of the modelling, not presented here, was that it revealed some evidence for particular high, medium and low technology sectors in the top four sectors for cross-border indirect value spillovers. From this perspective, the results do support a continuing effort to explore supranational clusters as an empirical concept for understanding industry development patterns.

It has also been a key element of this paper to argue that the innovation systems approach has not to the present time incorporated a framework that considers inter-country interdependency. Based on the evidence in this paper, this does indeed look like an important oversight. There are examples where technological imports appear to play a critical role in the development and success of domestic industry. In particular, the strength of Germany for secondary imports (thus the supra-critical values) needs to be the focus of specific studies. Ignoring this phenomenon constrains the ability to understand the division of technological labour.

Avenues for further research

This paper has been able to measure the intra-European flows of benefits between countries. As such it has been able to highlight the specific cases where there is significant extra-territorial activity. Therefore the following appear to be interesting lines of future research.

1. This paper has only presented very aggregated results and has only used one of the capabilities on the input-output methodology. Two possible extensions are immediately obvious. The first is to integrate extra-European trade as an output line for spillovers. Clearly, this would not be completely endogenous to the

model but it would produce interesting results. The second extension is to incorporate final consumption into the model. The EU matrices do extend as far as providing data on trade for final consumption and capital. This could highlight important results for better understanding innovation processes. Hewings et al (2001) used a Miyazawa framework to analyse flows between regions in Chicago beyond those of merely intermediate goods. It would be possible to adapt this approach in analysing the flows within Europe.

2. The focus of this paper has been on industry patterns. It is also possible to do more with the general flow of benefits at the country level and compare this approach with the results appearing in the trade literature.

3. The University of Groningen and in particular Oosterhaven and van der Linden have developed a set of EU tables that backcast European Input-Output tables back to the mid 1960s. It was not possible to compare results from this work; thus looking more closely at the results they achieved is on the agenda.

4. The current model has generated results that should be compared with the next round of EU I-O tables due out within the next couple of years. As has already been noted the case of Ireland will be an important one to watch. The data here has it origins pre the economic boom and shifts in cross border structure will make an interesting study.

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APPENDIX 1: TRADE DIRECTION BTD & NACE

Concordance between the NACE input-output data classification and the trade data ISIC classification used to calculate trade direction.

Eurostat NACE sector (I-O model sector)	The OECD BTD industries used for calculating trade direction propensities
Agriculture, forestry and fishery products	Food, beverages, tobacco
Fuel and power products	Petroleum refining
Ferrous and non-ferrous ores and metals	Combination of ferrous and non-ferrous mfg
Non-metallic mineral products	Stone, clay & glass
Chemical products	Industrial chemicals
Metal products except machinery	Fabricated metal products
Agricultural and industrial machinery	Non-electrical machinery
Office and data processing machines	Computers & office machinery
Electrical goods	Electrical machinery
Transport equipment	Transport
Food, beverages, tobacco	Food, beverages, tobacco
Textiles and clothing, leather and footwear	Textiles, footwear & leather
Paper and printing products	Paper, print & publishing
Rubber and plastic products	Rubber & plastic products
Other manufacturing products	Other manufacturing
Building and construction	Manufacturing (default value)
Recovery, repair services, wholesale, retail	Manufacturing (default value)
Lodging and catering services	Manufacturing (default value)
Inland transport services	Manufacturing (default value)
Maritime and air transport services	Manufacturing (default value)
Auxiliary transport services	Manufacturing (default value)
Communication services	Manufacturing (default value)
Services of credit and insurance institutions	Manufacturing (default value)
Other market services	Manufacturing (default value)
Non-market services	Manufacturing (default value)

APPENDIX 2: HIGHLIGHTS OF THE D^* MATRIX – SUPRA-CRITICAL VALUES

Originating country	Originating Sector	Critical Value	Countries Obtaining Indirect Value Added in Excess of Critical Value (Up to 3 main countries)		
Finland	Electrical goods	1.14		France 1.16	Germany 2.86
France	Ferrous & non- ferrous metal	1.52		RoE 1.73	Germany 2.43
France	Metal products	1.45		RoE 1.66	Germany 2.33
France	Ag & industrial machinery	1.06		RoE 1.21	Germany 1.75
France	Office & data processing machines	0.85		RoE 0.86	Germany 1.43
France	Electrical goods	1.07		RoE 1.12	Germany 1.77
France	Transport equipment	1.36		RoE 1.44	Germany 2.37
France	Food, beverages and tobacco	0.95		RoE 0.95	Germany 1.38
Germany	Metal products	1.06		RoE 1.10	Netherlands 1.21
Germany	Ag & industrial machinery	0.96		RoE 0.99	Netherlands 0.98
Germany	Office & data processing machines	0.78		France 0.81	Netherlands 0.85
Germany	Electrical goods	1.01		France 1.02	Netherlands 1.06
Germany	Food, beverages and tobacco	1.23	RoE 1.23	France 1.25	Netherlands 1.39
Germany	Textiles, clothing and footwear	1.26		RoE 1.26	France 1.35
Ireland	Ferrous & non- ferrous metal	1.85		UK 2.04	Germany 2.45
Ireland	Chemical products	1.24		France 1.39	Germany 1.76
Ireland	Office & data processing machines	0.59	RoE 0.87	France 1.22	Germany 2.51
Ireland	Electrical goods	0.87	RoE 1.06	France 1.43	Germany 2.62
Ireland	Transport equipment	1.74		Germany 2.47	UK 2.55
Ireland	Textiles, clothing and footwear	1.42		France 1.49	Germany 1.87
Ireland	Paper and printing	1.69		UK 1.83	Germany 1.96
Ireland	Rubber and plastic products	1.13		France 1.54	Germany2.30
Italy	Ferrous & non- ferrous metal	1.05		RoE 1.06	Germany 1.38
Italy	Non-metallic mineral products	1.07		RoE 1.11	France 1.30
Italy	Chemical products	1.45		Germany 1.70	France 1.73
Italy	Metal products	1.51		RoE 1.79	France 1.92

Italy	Ag &industrial machinery	1.35	Germany 1.39	RoE 1.49	France 1.70
Italy	Office & data processing machines	0.88	RoE 1.09	France 1.14	Germany 1.60
Italy	Electrical goods	1.32		France 1.59	Germany 1.63
Italy	Transport equipment	1.42	RoE 1.48	Germany 1.62	France 1.69
Italy	Textiles, clothing and footwear	1.50		Germany 1.57	France 1.99
Italy	Paper and printing	1.28		Germany 1.35	France 1.43
Italy	Rubber and plastic products	1.38		France 1.56	Germany 1.79
Italy	Other manufacturing	1.45	Germany 1.45	RoE 1.52	France 1.72
Netherlands	Agriculture, forestry and fishery products	2.45		RoE 3.35	Germany 4.11
Netherlands	Fuel and power products	1.25		RoE 1.51	Germany 1.91
Netherlands	Ferrous & non- ferrous metal	1.47		RoE 1.48	Germany 2.55
Netherlands	Non-metallic mineral products	1.45		RoE 1.46	Germany 2.49
Netherlands	Chemical products	1.69		RoE 1.71	Germany 2.74
Netherlands	Ag &industrial machinery	1.83		RoE 1.85	Germany 3.67
Netherlands	Food, beverages and tobacco	1.74		RoE .09	Germany 2.84
Netherlands	Textiles, clothing and footwear	1.53		France 1.78	Germany 1.89
Netherlands	Rubber and plastic products	1.22		France 1.41	Germany 1.78
Spain	Agriculture, forestry and fishery products	1.73		Germany 1.95	France 2.02
Spain	Fuel and power products	1.04		France 1.10	Germany 1.14
Spain	Non-metallic mineral products	1.52		France 1.61	Germany 1.82
Spain	Chemical products	1.00		Germany 1.03	France 1.04
Spain	Metal products	2.07		France 2.21	Germany 2.80
Spain	Ag &industrial machinery	1.84		France 2.08	Germany 2.59
Spain	Office & data processing machines	1.80		France 1.91	Germany 2.97
Spain	Electrical goods	1.60		France 1.80	Germany 2.49
Spain	Food, beverages and tobacco	1.42		France 1.58	Germany 1.71
Spain	Textiles, clothing and footwear	1.74		France 2.02	Germany 2.14
Spain	Paper and printing	1.64		France 1.76	Germany 2.05
Spain	Rubber and plastic products	1.18		France 1.21	Germany 1.42
Spain	Other manufacturing	1.60		France 1.76	Germany 1.98
United Kingdom	Chemical products	1.25		France 1.25	Germany 1.81

United Kingdom	Office & data processing machines	1.13		France 1.37	Germany 2.51
United Kingdom	Electrical goods	1.17		France 1.19	Germany 2.06
United Kingdom	Textiles, clothing and footwear	1.10		France 1.35	Germany 1.87
United Kingdom	Rubber and plastic products	1.18		France 1.23	Germany 1.80
Rest of Europe	Agriculture, forestry and fishery products	1.49	France 1.50	Netherlands 1.71	Germany 2.16
Rest of Europe	Fuel and power products	1.43		Germany 1.58	Netherlands 2.50
Rest of Europe	Ferrous & non- ferrous metal	1.74		Netherlands 2.09	Germany 2.76
Rest of Europe	Non-metallic mineral products	1.44		Netherlands 1.69	Germany 2.21
Rest of Europe	Office & data processing machines	1.37		France 1.39	Germany 2.51
Rest of Europe	Food, beverages and tobacco	1.32	France 1.38	Netherlands 1.38	Germany 1.97
Rest of Europe	Textiles, clothing and footwear	1.67		France 1.80	Germany 2.60
Rest of Europe	Rubber and plastic products	1.63		France 1.68	Germany 2.70
Rest of Europe	Other manufacturing	1.43		France 1.43	Germany 2.34

Notes:

(a) The table contains up to three key rows of the transpose of the first column block in D^*.

(b) The critical value is twice the average size of the indirect value added acquired over and above what would be implied from the direct intermediate input relationships.

(c) In the case of Denmark and Sweden only Germany contains sectors that have attracted supra-critical-value indirect value added.

(d) All Danish industries appear to have trans-border cluster relationships with Germany.

APPENDIX 3: DATA NOTES: EUROSTAT INPUT-OUTPUT TABLES

Country Code	Country	Base year	Notes
B	Belgium	1990	estimated
DK	Denmark	1992	
D	Germany	1991	
EL	Greece	NA	NA
E	Spain	1991	
F	France	1992	
IRL	Ireland	1990	
I	Italy	1988	
L	Luxemburg	1990	estimated
NL	Netherlands	1995	
A	Austria	1983	
P	Portugal	1993	
FIN	Finland	1993	
S	Sweden	1985	
UK	UK	1990	
Aggregate	EU		

Source: Datashop Handbook Part 6.2.7.

Note: Input-output tables values are at producer prices net of all VAT

Note: Domestic production, Imports from EC member countries, Imports from third countries, Total imports.

Eurostats warning

Until now only 10 Member States have been compiling and publishing input-output tables (IOT) on a more or less regular basis. Of course, being established individually by each Member State without a real common methodological basis, these national tables are not harmonised concerning the classifications (breakdown by branches), the concepts and the reference years used.

In order to satisfy the needs of the Commission services, Eurostat has tried, in a recent past, to establish an aggregated EU-15 table. Two steps were necessary to reach this objective: on the one hand to estimate the tables for the missing countries and on the other hand to convert the available national tables to the same reference year (1995) and the same breakdown (25 branches).

The only objective followed by Eurostat in harmonising the national input-output tables and in producing itself the missing tables was thus to establish an aggregated input-output table for EU-15 and nothing else. Therefore some inconsistencies may appear in the transformed or in-house produced national tables. One should always be aware of this when using them.

They should never be compared with the 'true' 'national tables and they should never be used without bearing in mind the purpose they follow and the way they are established.