

**INDUSTRIAL SPECIALISATION AND GEOGRAPHIC
CONCENTRATION: TWO SIDES OF THE SAME COIN?
NOT FOR THE EUROPEAN UNION**

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Some recent studies have shown that specialisation of countries has tended to increase, while regional concentration of countries has tended to decrease. This seems to be counterintuitive at first glance. In this paper, we use the entropy index - as the indicator of structural change with the neatest aggregation properties - to show how this divergence can happen. The main purpose of the paper is methodological, but we also apply the methodology to a specific case study: Manufacturing in the European Union since 1985. We confirm for this interesting period that increasing industrial specialisation has been offset by faster growth in the smaller Member States, with the net effect that industries have become somewhat less geographically concentrated. In terms of economic geography the evidence is in line with the second part of the inverted U-curve (where decreasing transport costs eventually foster de-concentration). This is no contradiction to increasing specialisation of countries in specific industries as predicted by many models in the old as well as the new trade theory.

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I. Introduction

European manufacturing has been and is currently facing dramatic changes in its business environment. The process of European integration has abolished trade barriers, created a single market and now a single currency. Meanwhile, globalisation has widened the horizons for production, consumption and competition and accelerated the diffusion of knowledge, information and technology. It has also increased the world-wide impact of national and regional economic and political shocks. New technologies, based in telecom, electronics and biotechnology, are changing production patterns and consumer choices.

Against this backdrop, this paper addresses the relationship between two dimensions of structural change: shifts in the specialisation of countries and shifts in the regional concentration of industries (and of total economic activity). The two dimensions both look at the same data set, namely industry/country market shares, but from different perspectives. They are often loosely defined, and sometimes implicitly assumed to move in the same direction. The main objective of this paper is to investigate the specific relationship in statistical terms to see whether, and under which circumstances, indicators of specialisation and concentration can move in different directions. Then we illustrate that this divergence actually happened for European manufacturing over a recent 15 year period. In particular, we see that the Member States are becoming more specialised in their industrial structures, but the industries are becoming more geographically dispersed. At the heart of our work is the formal statistical relationship between industrial specialisation and geographical concentration. The empirical trends are an illustration that what can be the case theoretically did actually happen in an interesting period of structural change.

These two aspects of structural change have policy significance for various reasons. Exploitation of scale economies and deeper division of labour were expected to be the driving forces of Europe's increased competitiveness flowing from the Single Market Programme; and, given differences in factor endowments, one would expect this to lead to increasing specialisation. However, this raises the concern that an extreme degree of specialisation of individual countries might render them over-exposed to asymmetric shocks, thereby endangering stability within the common currency area. There is also

the concern that integration might lead to an over-agglomeration of activities in a preferred core, at the expense of a disadvantaged periphery.

Turning briefly to previous related literature, traditional trade theory, new trade theory and economic geography each yields some insights, although, taken together, they do not provide unambiguous predictions that specialisation and concentration will inevitably increase as a result of integration, especially over the long-run. Nevertheless, comparing the regional structures of Europe and the USA, one might anticipate the potential for dramatic change: regions are far more specialised in the USA (Krugman, 1991), and some economists have forecast that high levels of regional concentration will emerge in Europe following the creation of a single market.

Empirical studies on structural shifts in Europe are not conclusive in all respects and this is not the place to summarize them in detail. However, we note that several studies have shown differences between trends in specialisation and concentration, typically, the former may be rising while the latter was stagnating or declining (European Commission, 1999; Midelfart-Knarvik et al., 2000; Aiginger and Leitner, 2002; Aiginger and Pfaffermayr, 2004). In earlier studies such as the seminal book of Krugman (1991), and in Kim (1995), indices on specialisation of regions had been used as evidence for trends in regional concentration.¹

The rest of the paper is organised in six sections. Section II briefly describes our data base. Section III uses the Entropy index to derive a formal relationship between specialisation and concentration. Section IV estimates this relationship and presents our main finding: countries have become more specialised, but industries have tended to become less geographically concentrated. We explain this seemingly paradoxical result statistically in terms of the Entropy indices, then heuristically showing which industries and countries are behind the trend. To increase the economic intuition behind the results, we refer in Section V to a theoretical model of Fujita, Krugman, Venables (1999) in which this divergence is predicted, without claiming that this particular model necessarily explains the behaviour of 99 industries in 14

¹ Empirical studies focusing on one or the other of the two dimensions are Bruelhart (1995), Amiti (1999), Braunerhjelm et al. (2000), Molle (1996), Hallet (2002). For a theoretical survey on determinants of specialisation and concentration see Wolfmayr-Schnitzer (1999).

countries. Section VI summarises. In an appendix we indicate that a similar decomposition applies to indicators of relative concentration.

II. Data

Our paper focuses exclusively on European manufacturing; the unit of observation is the individual three-digit industry, of which there are 99. The variable used to measure size is the nominal value added. The European Union is defined as the 14 (Belgium and Luxembourg are consolidated) members in 1998; the activity of the countries which joined in 1995 is included for the whole period. The period analysed is 1985 to 1998. 1985 is selected as a starting point which is sufficiently in advance of the enactment of the single market in 1992; 1998 was the most recent year for which comprehensive data were available. Fortunately, these two years are not particularly extreme points in the business cycle. In the middle of the period, Europe faced a severe recession with devaluations in some member countries. Additional country specific shocks during these years were the unification of Germany, the transition of the Central and Eastern European Countries, and political turmoil in the Balkan region. Each of these shocks affected member countries differently and technically speaking increased the noise in the data set.

III. Measuring Specialisation and Concentration using the Entropy Index

There are many standard statistical indices of dispersion which might be employed to measure these two concepts. We choose the entropy index for two reasons. The primary reason is that the entropy index has desirable decomposition properties: this index generates an exact and meaningful relationship between changes in the individual industries and the aggregate change for industry as a whole. Similarly, we can add up changes in individual countries to give an overall change. This adding up property is, for example, not shared by concentration rates (shares of the largest n industries), the Herfindahl index (squared shares of industries or countries), or Gini coefficients. A second desirable feature of the entropy index is that it uses the complete distribution of industry or country shares, not only the top entities,

and therefore does not put all the emphasis on the very largest shares. Concentration rates would explicitly and Herfindahls would implicitly replicate primarily the developments in the big European economies and the big industries (e.g. chemicals).²

A. Notation and Definitions

Let X_{ij} = output of industry i in country j , $i = 1, \dots, n$; $j = 1, \dots, k$; $S_i X_{ij} = X_j$ = total output of all industries in country j ; $S_j X_{ij} = X_i$ = total EU output (i.e. for all countries) in industry i ; $X = S_i X_j = S_j X_i$ = aggregate EU output in manufacturing.

Industrial specialisation is the extent to which a given country specialises its activities in a small number of industries: we talk of the production structure of a country being highly specialised if only a few industries account for a large share of its total production. A traditional example in the EU context might be the Nordic countries, which were highly specialised in timber, pulp and paper.

For a given country, j , the Entropy index of specialisation is defined by the summation of the products of the shares and log shares of each industry in the country's aggregate manufacturing:

$$\text{SPEC}_j = - S_i (X_{ij} / X_j) \ln (X_{ij} / X_j) \quad (1)$$

Note that, if the country has equal sized operations in all n industries, $(X_{ij} / X_j) = 1/n$ for all i , and $\text{SPEC} = \ln(n)$. Alternatively, if it is completely specialised in just one industry, $\text{SPEC} = \ln 1 = 0$. More generally, SPEC increases the more evenly the country spreads its activities across the n industries; it is therefore an inverse measure of specialisation.

Sometimes it is convenient to use the numbers equivalent form of the index. This is its antilog, and will be denoted by NSPEC_j . This effectively converts the country's actual distribution of industry shares into a hypothetical equivalent number of equal sized industries: its bounds are 1 and n .

² See Cowell (1995), for example, for a comparison of the comparative properties of alternative measures of inequality. See also Encaoua and Jacquemin (1980) for an economic application.

Geographic concentration is defined as the extent to which EU activity in a given industry is concentrated in just a few member states. Again, pulp and paper would be a good example: this industry is concentrated in a few countries; and similarly pasta. For a given industry i , in the EU as a whole, the entropy is defined analogously to the above. In this case, the shares refer to each country's share of EU aggregate output for that industry (X_{ij}/X_i).

$$\text{CONC}_i = - \sum_j (X_{ij}/X_i) \cdot \ln (X_{ij}/X_i) \quad (2)$$

Analogously to SPEC, CONC must lie between $\ln(k)$ and 0, corresponding to equal dispersion and total concentration respectively. The numbers equivalent, NCONC, is the antilog of CONC.

B. Typical Levels of Specialisation and Concentration

In what follows, we shall want to refer to typical, or average, levels of specialisation of countries and concentration of industries. These are defined as weighted averages, with the weights being, respectively, the country and industry shares of EU aggregate manufacturing. Thus,

$$\text{TYPESPEC} = \sum_j w_j \cdot \text{SPEC}_j, \quad (3)$$

$$\text{TYPCONC} = \sum_i v_i \cdot \text{CONC}_i \quad (4)$$

where

$$w_j = X_j/X, \quad v_i = X_i/X \quad (5)$$

Substituting (1) and (2), along with (5), into (3) and (4) gives:

$$\text{TYPESPEC} = - \sum_j (X_j/X) \cdot \ln (X_{ij}/X_j) \quad (6)$$

$$\text{TYPCONC} = - \sum_i (X_i/X) \cdot \ln (X_{ij}/X_i) \quad (7)$$

C. The Relationship between Concentration and Specialisation

At an intuitive level, one can see that concentration and specialisation will be closely related. Indeed, at first sight, they might almost seem to be two sides of the same coin. For example, suppose that each country becomes more specialised, concentrating more of its activity in those industries in which it is comparatively larger, and less in those in which it is comparatively smaller. In a world where all countries were of the same size, and likewise all industries, such increased specialisation must mean that industries will also become more concentrated - because the larger players would become larger, and the smaller players smaller.

To put the same point statistically, specialisation and concentration are two perspectives to be derived from a matrix with the columns referring to countries, and the rows to industries. Specialisation is observed by reading down each column, whilst concentration is observed by reading along each row. One might expect that if inequalities tend to increase down the columns, so they should also increase along the rows. We now explore this intuition, first in the hypothetical symmetric case, and then allowing for asymmetries.

The Symmetric Case

Suppose all countries were equal sized, and that all industries were equal sized: $X_j = X/k$ for all j , and $X_i = X/n$ for all i . Substituting into (6) and into (7) yields:

$$\text{TYPESPEC} = \{- \text{SS} (X_{ij} / X) \cdot \ln (X_{ij} / X)\} - \ln (k) \quad (8)$$

$$\text{TYPCONC} = \{- \text{SS} (X_{ij} / X) \cdot \ln (X_{ij} / X)\} - \ln (n) \quad (9)$$

Thus, both indices depend identically on the overall entropy (the first RHS term, which reflects overall inequalities across rows and columns). So, in a symmetric world (with fixed n and k), any change over time in typical specialisation will be identical to the change in typical concentration.

The Asymmetric Case

Leaving aside the symmetric case, the two indices may be re-expressed more generally as:

$$\text{TYPESPEC} = \{- \sum_j (X_{ij}/X) \cdot \ln (X_{ij}/X)\} - \{- s (X_j/X) \cdot \ln (X_j/X)\} \quad (10)$$

$$\text{TYPCONC} = \{- \sum_j (X_{ij}/X) \cdot \ln (X_{ij}/X)\} - \{- s (X_i/X) \cdot \ln (X_i/X)\} \quad (11)$$

In this general case, the second terms in the two equations are also entropies, and they both have natural interpretations. In (10), this is the entropy of aggregate country sizes, and we refer to this as the geographical concentration of EU manufacturing as a whole - EUCONC. In (11), it is the entropy of industry sizes for the EU as a single entity, and we refer to this as the industrial specialisation of the EU - EUSPEC. Combining (10) and (11) provides the desired formal relationship between typical specialisation and concentration:

$$\text{TYPESPEC} = \text{TYPCONC} - \text{EUCONC} + \text{EUSPEC} \quad (12)$$

So, in an asymmetric world, it remains the case that any change over time in typical specialisation will exactly mirror the change in typical concentration - but only so long as the distribution of countries' shares in total manufacturing and the distribution of industries' shares in total manufacturing remain unchanged. Where this condition is not fulfilled, average specialisation of countries (TYPESPEC) and average concentration of industries (TYPCONC) can follow different paths.

IV. Results for EU Member Countries

Table 1 reports the results of estimating the identity (12) for each year between 1985 and 1998. It also shows the numbers equivalents (in which case, the identity becomes multiplicative).

Table 1. Time Series for Specialisation and Concentration

	Entropies				Numbers equivalent			
	TYPESPEC	TYPCONC	EUSPEC	EUCONC	NTYPESPEC	NTYPCONC	NEUSPEC	NEUONC
1985	4.071	1.966	4.190	2.086	58.6	7.15	66.0	8.05
1986	4.063	1.960	4.180	2.078	58.1	7.10	65.4	7.99
1987	4.058	1.960	4.173	2.075	57.8	7.10	64.9	7.96
1988	4.052	1.967	4.167	2.082	57.5	7.15	64.5	8.02
1989	4.047	1.983	4.164	2.100	57.2	7.265	64.3	8.16
1990	4.062	1.962	4.178	2.078	58.1	7.12	65.2	7.99
1991	4.070	1.955	4.181	2.067	58.5	7.07	65.4	7.90
1992	4.062	1.949	4.178	2.065	58.1	7.02	65.2	7.88
1993	4.061	1.952	4.179	2.070	58.0	7.04	65.3	7.92
1994	4.050	1.962	4.171	2.083	57.4	7.11	64.8	8.03
1995	4.032	1.975	4.157	2.100	56.4	7.21	63.9	8.17
1996	4.028	1.992	4.150	2.114	56.2	7.33	63.45	8.28
1997	4.018	1.996	4.148	2.126	55.6	7.36	63.3	8.38
1998	4.011	1.991	4.143	2.122	55.2	7.32	63.0	8.35
1985-98	-0.059	0.025	-0.047	0.036	-3.4	0.17	-3.0	0.30
1985-92	-0.009	-0.017	-0.012	-0.021	-0.5	-0.13	-0.8	-0.17
1992-98	-0.050	0.042	-0.035	0.057	-2.9	0.30	-2.2	0.47

Source: EUROSTAT (SBS)

A. Changes 1985-1998

Focusing first merely on the changes over the period as a whole, Table 1 shows that:

- Typically, member states became more specialised: TYPSPPEC declined from 4.071 to 4.011, that is, the hypothetical equivalent number of identical industries declined from 58.6 to 55.2. Since entropy is an inverse indicator, this means specialisation increased in most countries. Although the magnitude of the change seems relatively small, it is significant.

- On the other hand, typically, industries became geographically less

concentrated: TYPCONC increased from 1.966 to 1.991; that is, the equivalent number of equal sized countries rose from 7.15 to 7.32. This result - a decrease in geographical concentration - is also significant at the 5% level (t value = 2.25).

Superficially, this combination of increased specialisation and declining concentration is surprising, and even counter-intuitive. As we have just shown, it would be impossible in a world where the (equivalent) numbers of countries and industries are both fixed over time. The explanation is, of course, that the two other components in identity (12) did not remain constant. In fact, the (equivalent) number of countries increased from 8.05 to 8.35, whilst the (equivalent) number of industries decreased from 66 to 63. Both factors pulled in the same direction in allowing typical concentration to decline, in spite of increasing specialisation. In turn, the interpretation of these changes lies with differential growth rates of countries and industries. A decrease in an entropy numbers equivalent indicates increasing inequalities, and so the implication here must be that, at the EU level, the larger industries have tended to grow more rapidly than the smaller industries, whilst the smaller member states have tended to grow more rapidly than the larger member states. This is indeed confirmed in Table 2 (at this point, just the comparison between 1985 and 1998), which shows that, the ten largest industries increased their share of EU aggregate manufacturing production from 30.9% to 35.2%; and the combined share of small countries within the EU increased from 19.1% to 20.3%.

B. Changes within the Time Period

Closer inspection of the individual time series within Table 1 reveals that neither typical concentration nor specialisation followed steady monotonic paths over the whole of this period. In the case of TYPSPEC, there was certainly a prevailing tendency for year-on-year declines, but this was interrupted by quite sharp increases in 1990 and 1991. TYPCONC, on the other hand, showed no discernible trend, 1985-1992, but then increased steadily for most of the remainder of the period. This leads to an interesting pattern when the two variables are plotted against each other (Figure 1). As can be seen, although the general trend was a move in the north-westerly

Table 2. Shares of Large and Small Member States and Industries

	Shares of EU total manufacturing			Changes in shares	
	1985	1992	1998	1985-1992	1992-1998
Large industries total	30.9	32.7	35.2	1.8	2.5
Small member states total	19.1	18.3	20.3	-0.8	2.0
Small member states' share in:					
Large industries	17.3	16.3	18.5	-1.0	2.2
Small industries	19.5	19.2	21.3	-0.3	2.1

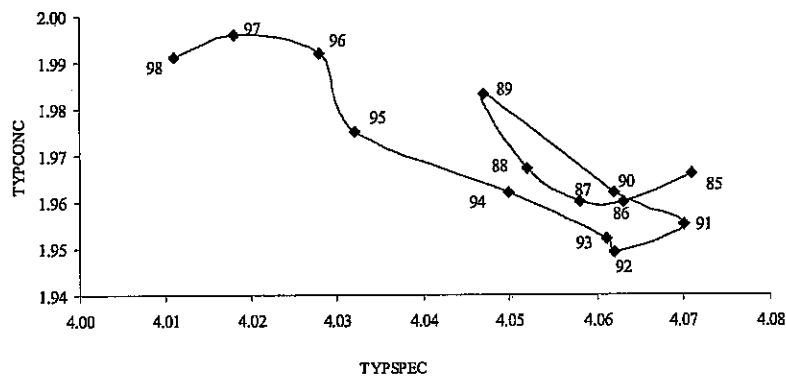
Notes: Large countries: Germany, Spain, France, Italy, United Kingdom. Small countries: Belgium, Denmark, Greece, Ireland, Netherlands, Austria, Portugal, Finland, Sweden. Large industries: Top 10 industries in value added in the EU 1998. Source: EUROSTAT (SBS).

direction, this was subject to a reversal between 1989 and 1991, giving rise to a distinctive loop shape. In fact, the effect of the loop was to return TYPSPPEC in 1991 to a magnitude almost identical to its 1985 starting point, and to leave TYPCONC slightly lower than its starting point. The reason for this loop was a combination of events. On the geographical side, there were the immediate effects of German reunification,³ and severe structural problems and devaluation in two of the smaller countries, Sweden and Finland. On the

³ The effect of the German unification was the following: it first statistically made Germany larger (about two percentage points of EU value added), then the post unification boom stabilized Germany's share (compensating restructuring in the eastern countries), which then declines from 1994 on. The extra loop in Figure 1 towards south east between 1989 and 1991 shows the first part of this effect. The unification effect was not strong enough between 1991 and 1994 to revert the general trend towards northeast. Finally decreasing market shares of German manufacturing accelerated the trend towards northeast. Taken together the trend from 1992 to 1998 some part of the revealed tendency is due to the development of Germany (maybe aggravated by the Single Market but not due to it alone). We acknowledge that the data refer to the manufacturing sector which only amount to one fifth of total GDP. However manufacturing is the sector with the strongest impact of international restructuring and relocation. The evidence that the large European countries (with the exception of the United Kingdom) are underperforming in growth in the nineties, indicates that some of the forces determining the trends for manufacturing might also work if we included service sectors into the investigation.

specialisation side, the motor vehicle industry, which increased its overall share in manufacturing by 1.5 % over the period as a whole, lost half a percentage point in this sub period. Combined with a similar drastic decline in the large basic chemicals industry, this produced a temporary decline in the share of large industries, which, nevertheless, expanded their shares, both before and thereafter.

Figure 1: Specialisation and Concentration over Time



Notes: Entropy indices are inverse measures of concentration and specialisation, movement in the direction north west as in this picture implies increasing specialisation and decreasing concentration. Source: EUROSTAT (SBS).

In view of this short run disruption, we now explore the data in more detail for the two sub-periods, 1985-1992 and 1992-1998. As can be seen from the growth rates at the foot of Table 1, this allows us to refine the two previous bullet point findings as follows:

- Typically, there was little net change in the specialisation of member states between 1985 and 1992: the number of equivalent industries in the typical member state declined only marginally from 58.6 to 58.1. But, 1992-1998 saw a much larger fall from 58.1 to 55.2.
- Typically, industries became slightly more concentrated between 1985 and 1992: NTYPCONC falling from 7.14 to 7.02. However, this was reversed, and easily outweighed, 1992-1998, when the equivalent number of equal sized countries for the typical industry rose from 7.02 to 7.32.

Thus it becomes very clear that most of the net change in both specialisation and concentration occurred during the nineties, after the full introduction of the single market legislation - both variables changed by roughly 5% over just a 6 year period, 1992-1998.

Returning to Table 2, and now focusing on the figures for the two sub-periods, we see that the smaller member states actually lost ground between 1985 and 1992. This was most pronounced in larger industries, which were increasing their share of total manufacturing. However, since 1992, the smaller member states have increased their shares across the board - in large and small industries alike. Specific examples of significant inroads by small countries (decreasing concentration) include telecom industries, medical equipment, recorded media and computers, as well as basic chemicals and steel.

V. Explanation in Terms of a Model of Economic Geography

A deeper explanation of the economic forces behind the diverging trends is beyond the scope of this article. It is however interesting that one of the models presented in Fujita, Krugman, Venables (1999, p. 338ff) yields predictions in line with our empirical result. This model refers to three countries (the outside world and two inside countries) and two industries. At high trade costs, there is a stable equilibrium in which one country (country 1) has a large share of population (activity) and it produces in both industries, while the smaller country has only the smaller part of the second industry.

Given a reduction in external trade costs (i.e. the trade costs of the inside countries with the outside world) the larger inside country now loses population to the smaller (deconcentration) and at the same time the larger region becomes more specialised. The reason for the deconcentration of population is that exports (to the outside country) now make up a larger share of demand, so that backward linkages from consumer expenditure to production lose importance. External demand is in equal distance to both regions. Two major advantages of the larger economy now become less important: proximity to demand, and inter industry linkages (since a larger share of the inputs is sourced from abroad). The larger region loses in general, specifically some part of industry 2 shifts to the smaller country. The smaller country remains completely

specialised, but now with a higher share of industry 2 as well as of total output. Using FKV's (different) terminology (p. 340): "external trade liberalisation brings dispersion of population but concentration of industry". In our terms, dispersion of population is equivalent to deconcentration, and concentration of industries is equivalent to specialisation, so their model predicts, in our terminology, declining TYPPEC and increasing TYPCONC.⁴

We do not suggest that this particular model necessarily provides a complete explanation of the facts unearthed in our paper. Nevertheless it is interesting to note the relative importance of linkages as amongst the driving forces of their results. We have found empirically that there is persistently high specialisation of the larger countries in large industries, and this may be the result of increasing intra industry linkages in the large industries, which are already located in large countries. These may outweigh the somewhat decreasing importance of demand proximity. However, at the same time, the large countries have lost market share in general, and particularly in smaller industries. In these they were advantaged, initially, by closeness of demand and by their better ability to exploit economies of scale (relative to the importance of borders for small countries). But now the smaller countries are able to exploit their relative advantages, having lost their disadvantage in industries where economies of scale and/or complementary inputs are necessary. Thus, the smaller countries can increase shares in their favourite industries and in some new ones exploiting economies of scale (this effect is of course not included in the FKV model).

VI. Summary

This paper shows that greater specialisation in the structures of individual countries does not necessarily mean that industries will become more geographically concentrated. The main focus is on the statistical relation, specifically under which circumstances the two tendencies can diverge. We then show that this is not merely a theoretical possible curiosity, but that empirically specialisation of countries has increased and the concentration of

⁴ A spatial model predicting increasing specialisation and decreasing concentration is Rossi-Hansberg (2004).

industries has decreased in the nineties for the members of the European Union. Neither statistically nor economically, are these two measures of change merely different sides of the same coin.

The intuition of a parallel movement is only correct if countries and industries are equalled sized. To show this, we have derived an exact statistical relation between specialisation and concentration using the entropy index. This also reveals, conceptually, how it is possible for specialisation and concentration to move in opposite directions. In this particular case, this happens because, during recent years in Europe, larger industries have grown relatively to smaller industries, whilst smaller countries have grown relative to larger countries. A close look at the data reveals that, in nearly all the member states, specialisation has increased. In the larger countries, this is the result of strengthening their position in existing strongholds (cars in Germany, machinery in Italy, chemicals in France and food in the United Kingdom). The smaller countries, however, have gained market shares more generally, particularly in some fast growing industries like telecom, medical equipment, but also in some capital intensive industries like basic chemicals and steel.

Appendix: Absolute vs. Relative Measures

The decomposition used in the paper refers to absolute measures of specialisation and concentration. A country is specialised according to our absolute measure if a few industries together have a high share, and an industry is concentrated if a few countries have a large share of production. We believe that the importance of an industry shock on an economy and on the spatial concentration of an industry in very few countries is best assessed by looking at absolute measures.

For some other questions, however measures of relative specialisation may be more appropriate, this is specialisation of a country, relative to specialisation of the larger region, or concentration of an industry, relative to concentration of overall economic activity. If a very small country is very successful in some high tech industries this is an important achievement, even if the overall share of this country remains small relative to a country of much larger population. If the labour-intensive industries in a specific country are larger than in Europe, this is said to reveal a comparative advantage in Heckscher

Ohlin trade theory. Therefore relative measures are important for some question, absolute for others. See Haaland et al. (1999) and Midelfart-Knarvik et al. (2000) for a discussion of relative vs. absolute measures.

An obvious question to ask is whether it is still possible for specialisation and concentration to move in opposite direction when they are measured in relative terms. To investigate, we now derive relative measures by deflating X_{ij} by total country size when computing concentration, and by total EU industry size when computing specialisation, i.e.:

$$\text{RELSPEC}_j = -s_i \{(X_{ij}/X_j)/(X_i/X)\} \ln \{(X_{ij}/X_j)/(X_i/X)\}, \quad (1A)$$

$$\text{RELCONC}_i = -s_j \{(X_{ij}/X_i)/(X_j/X)\} \ln \{(X_{ij}/X_i)/(X_j/X)\} \quad (2A)$$

It is now easy to show that the sum of these two indices, across countries and industries respectively, are identical - but only so long as we employ unweighted sums.

Thus summing (1A) across countries (unweighted = UW) and (2A) across industries (unweighted),

$$\text{UWSUMRELPEC} = \text{sRELSPEC}_j \quad (3A)$$

$$\text{UWSUMRELCONC} = \text{sRELCONC}_i \quad (4A)$$

then

$$\text{UWSUMRELPEC} = \text{UWSUMRELCONC} = \quad (5A)$$

$$= -s \{(X_{ij}X)/(X_iX_j)\} \ln \{(X_{ij}X)/(X_iX_j)\}$$

In this special case, then there is no possibility that concentration and specialisation might move in opposite direction. However merely summing specialisation coefficients, attaching identical weights to small and large industries gives us no typical coefficients. Alternatively, if we would weight relative specialisation indicators by the industry shares and the concentration rates by country shares (as in equation 5), this opens the potential for

concentration and specialisation to move in different directions, if not all industries are of equal size and if not all countries are of the same size. The underlying economic force is the same: (changes in) industry shares in countries and (changes in) country shares in total EU may drive typical indicators in different directions.

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