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TRADE RELATION STRUCTURES IN BALTIC EUROPE

The paper analyses the international trade relation structures within Baltic Europe in the sense of the identification of relatively stronger ("closer") trade links between particular countries. A number of simple analyses are carried out with the use of cluster analysis for the 10 countries considered "Baltic", showing resilient structures, and their behaviour over time. It is shown that certain well justified conclusions concerning the structures can be drawn on both the level of subsets of countries and of the whole Baltic Europe. A discussion is offered concerning, on the one hand, the analysis of international trade relations, and on the other hand – the consequences and the adequacy of the simple definitions (e.g. of the "region") when applied to actual data.

1. INTRODUCTION

The paper takes up the data on trade between the countries which can be, under a very broad definition, treated as forming "Baltic Europe". These data are subject to analysis aimed at the identification of possibly stable ("resilient") structures in terms of subgroups of countries within Baltic Europe, and their potential evolution over time. Several analyses are carried out differing by the set of assumptions behind them, translated into simple numerical exercises. The paper considers, on the one hand, the prerequisites for such an analysis, and this at two levels, namely (i) the very sense of the basic notions referred to (like that of the "region"), and (ii) the (potential) interpretation of actual exercises carried out. On the other hand, the paper shows the results of these exercises and comments on them more amply. Indeed, these results, even if treated with appropriate caution, offer in themselves a definitely interesting insight into trade relations across Baltic Europe.

The present paper was indeed motivated by several reasons related to the issues pointed out before, namely, first, the recurring problem of the *definition of a region*, as seen against the more general question of *identification of spatial*

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structures. These questions are amply illustrated with the analyses carried out for the case of Baltic Europe, with emphasis placed upon the *methodological* and *definitional* aspects. The conclusions seem to confirm the opinion that while methods may exist which allow for uncovering of definite, well pronounced structures and their dynamics, the specific case of a "region" requires a better *a priori* specification in terms of both definitions and the range of their potential consequences before attempting "region identification".

We will consistently use throughout this paper the following general notations: t_{mn} will denote the value of trade flow from country m to country n, and it may possibly be accompanied by other superscripts, T_m will denote the trade sum for the country m, with the nature of the respective trade flows (exports, imports) either being additionally explicitly denoted, or resulting from the context, and finally s_{mn}will denote the proximity of the countries m and n, usually symmetric, i.e. $s_{mn} = s_{nm}$, and whose calculation will practically be based upon the values of the respective t_{nm}, that is, s_{nm} ($\{t_{mn}\}$), where $\{t_{mn}\}$ denotes the set of all the trade values pertinent to the given pair of countries (wherever applicable, d_{mn} will analogously denote the distance or dissimilarity).

2. THE TRADE, THE AFFINITY, AND THE REGION

2.1. Trade and affinity

The numbers expressing trade flows can be considered as indicative of economic affinity between two countries. This statement has, of course, to be accompanied by a number of reservations or questions. We will quote here just two essential of them:

(1) are we to consider the *absolute flows*, which tend to be clearly proportionate to some kind of GDP measure and to an inverse of geographical distance? The answer is usually a cautious "no", suggesting that a sort of *relative indicator* based upon trade flow be considered instead, this relative indicator trying to get rid of the proportionalities mentioned; note, though, that once we go away from absolute flows we are faced with the problem of choice, on the one hand (what kind of relative indicator?), and of interpretation (what the results obtained therefrom actually mean?) on the other hand; and

(2) while we tend to admit that trade flows are in fact indicative of the economic affinity between two spatial units, say – countries, we also tend to ask for other measures and the relations between the one based upon trade and the other ones; this particular question borders upon a much more general one: what do we mean by "affinity"?

Thus, with reference to the general version of question (2) above, we will assume for the purposes of this paper that we do not deal with affinity or even similarity of the economies in terms of economic structures, involving products turned out, technologies used, enterprise magnitudes etc. These can, at least in theory, be very similar in two countries that maintain very little, or even no, economic contacts in terms of trade and other flows. We are interested in the affinity or closeness which is expressed through the intensity of economic ties between two units, and also through the intensity of trade and the other kinds of flows. Hence, again with reference to question (2), the (other) measures we may have in mind also bear the character of flows, be it foreign direct investments (FDI), more general capital flows, labour force flows, or just simply travels between the two countries. Some of these are relatively easily observed (like trade), though, of course, with an error, while some others – are hardly observed at all. Yet, we will assume in our further considerations that there is indeed a decent degree of correlation between trade and FDI flows on the one hand (for the correlation between trade and FDI see: e.g., Morita 1998) and the other indicators that we can treat as indicative of an affinity in terms of economic ties. Hence, we would be justified in taking trade as a proxy for this kind of closeness.

2.2. Relation of affinity and region building

When looking for and analysing the spatial structures formed on the basis of relations existing between spatial elements or units we very often try to determine the region-like entities, which are contiguous sets of such spatial elements. The primary questions are: do such regions exist? And: what are they? While the answer may be of cognitive importance, it often brings quite practical consequences, like in Poland, where a major reshuffling of the administrative structure of the country has just recently taken place.

That spatial elements may or may not form coherent wholes called nominally regions is an intuitively obvious observation. Further, there is a number of simple intuitive precepts that correspond in a way to the definition of a region. How to employ, though, the simple intuitions in defining a region in a more formal and internally consistent manner?

We will not be repeating here the whole discussion, accompanied by the innumerable empirically-based exercises, which took place mainly in the 1960s, of the justification and merits of the formal definitions of a region, and the application of numerical methods, including those belonging exactly to the class that we refer to in the present paper. Instead, we will stop at a few definite points of discussion and then go on with the analysis that has a much more modest goal. We will start as indicated, with some basic intuitions which cannot be dismissed just out of hand.

Thus, it is quite usual to propose that a region be composed of (spatial) units which are more linked with each other than with the units outside of the region (see: e.g., Peschel 1998). This relatively obvious intuition is believed to lead to a simple and regular structure of well separated contiguous regions, being the subsets of the whole set of units considered. Yet, such a proposition is generally not true, and this because of a variety of reasons.

Ambiguity. First, the very "definition" of the region that we quoted is inherently ambiguous. It is namely ambiguous in two ways. First, we have to define further what we mean by "more linked ... than ...", that is, we have to formulate somehow the measure of internal and external linkage. The variety of possible definitions constitutes the first dimension of ambiguity. Assume though, that in order to measure internal linkage within a subset of spatial units we use the average of the respective s_{mn} within this subset, and analogously – the average of the outer s_{mn} to measure the external linkage of the subset. This seems to be intuitively quite admissible. If so, we can be sure that every disjoint pair of units m, n such that the s_{mn} between them attains its maximum simultaneously for both of them (i.e. at least one pair for which s_{mn} attains the maximum for the whole set of units) constitutes a region. This does not mean that within the same set of spatial units there cannot be larger subsets of units, including the previously mentioned pairs, which display the same feature and are therefore also the "regions". In fact, the definition referred to allows certain hierarchies of nested regions to arise. Which of them are to be admitted as proper "regions"? And this is the second dimension of ambiguity.

In our particular case additional ambiguity is introduced by the fact that we have decided to use the *relative* rather than *absolute* trade flows (or any other kinds of flows, for that matter). Once relative flows are used we have quite a choice of them and of their interpretations.

Asymmetry. In many cases (e.g. commuter flows) we deal with asymmetric relations between pairs of units, i.e. some $r_{mn} \neq r_{nm}$, at least in general. If we wish to preserve this asymmetricity while building constructs that can be referred to as regions, the only way to do it is by establishing hierarchical regions (again, like in the case of commuter flows: the hierarchy of centers). Hierarchy is based upon the asymmetric relation of "subordination" and "superordination", whatever this may mean (say, a unit n "belonging to the sphere [region] of influence of a unit m"). Within the domain of our interest it may also be pointed out that trade is essentially asymmetric, though this asymmetricity is not very significant (e.g. in terms of such indicator as $2|t_{mn} - t_{nm}|/(t_{mn} + t_{nm})$. Thus, the gravity models used to explain the trade flows are by virtue of principle asymmetric (see Section 3.5.5 of the paper).

Yet in the domain of trade (and similar flows) we are confronted with a degree of error which may easily exceed the value of the indicator mentioned above (see: Section 3 of the paper). If so, any exercise in asymmetricity is devoid of sense. (This, likewise, applies at least partly also to the gravity models.)

Definitions and methods. On top of the previous definition, but also in close connection with them we deal with a multiplicity of definitions, e.g. transforming t_{mn} into s_{mn}, and of the methods used to generate (spatial) structures, like regions (for instance numerous algorithms of cluster analysis). Again, we will not go into the details of discussion of these quite complex aspects of the analysis. Suffice to say that in our opinion it is possible to select a reasonable set of definitions and methods, where reasonability refers both to their interpretation (involving the simple intuitions previously criticized, after all) and to the technical (mathematical) rigour and correctness.

Thus, we perform a well designed analysis accounting for various points of view on the subject and the potential variability of thereby obtained results, we may altogether be able to gain a valuable insight, both in terms of determination of the very existence of any structures and of their character. This is exactly the rationale behind the present study.

3. THE METHODOLOGY AND THE EXERCISES

3.1. The analyses performed

A series of calculation exercises were carried out based upon the methodology of cluster analysis, for the data describing the trade and other economic aspects of the Baltic "region" of Europe. In each case the same set of trade tables was referred to, describing cross-Baltic trade in consecutive years of the 1990s. The particular exercises differed not just by the tuning of "parameters" of the clustering technique used, but by the more fundamental definitions, referring to the trade-wise "affinity", $s_{mn}(\{t_{mn}\})$, between pairs of countries, and thereby implicitly also among larger groups of countries as well. The kind of assumptions behind the particular calculations, together with the analytical quasi-models referred to, are presented and discussed in Section 3.5. We will start, though, with the presentation in Section 3.2 of the (samples of) data used in the analysis and the comments thereupon. Then, in Section 3.3, we will put forward some considerations based on the "raw" data presented, before passing over to the description of the proper analysis. In Section 3.4 we will shortly characterize the (cluster analysis) method used in the exercises.

3.2. The data used

As mentioned, we were using the trade tables for the Baltic countries for the years 1992 through to 1997. An example of such a table for just one country, here Denmark, is given in Table 1.

Table 1

The Baltic trade of Denmark, 1992–1997 (in millions of US dollars)

Country	1992	1993	1994	1995	1996	1997
Exports						
World	38,943	35,916	39,664	47,493	47,114	40,100
Baltic countries	*17,110*	*16,172*	*17,595*	*21,472*	*21,630*	*22,675*
	44%	*45%*	*44%*	*45%*	*46%*	*56%*
Estonia	16	33	42	64	94	103
Finland	774	686	950	1,220	1,228	1,304
Germany	9,218	8,537	8,800	11,031	10,368	10,437
Latvia	25	29	43	61	90	97
Lithuania	38	32	70	131	164	243
Norway	2,245	2,492	2,564	2,900	3,094	3,022
Poland	500	478	570	673	840	887
Russia	181	277	425	652	743	916
Sweden	4,113	3,608	4,131	4,470	5,009	5,666
Imports						
World	33,254	29,508	33,508	42,230	40,936	40,880
Baltic countries	*14,783*	*13,243*	*15,116*	*18,327*	*18,576*	*20,212*
	44%	*45%*	*45%*	*43%*	*45%*	*49%*
Estonia	23	30	39	64	73	75
Finland	891	846	1,044	1,246	1,155	1,284
Germany	7,681	6,686	7,327	9,624	8,862	9,629
Latvia	27	86	62	52	69	90
Lithuania	67	46	75	96	109	118
Norway	1,806	1,525	1,708	2,129	2,212	2,314
Poland	441	458	602	725	703	752
Russia	247	355	345	470	386	301
Sweden	3,600	3,211	3,911	5,167	5,007	5,649
Global balance	*5,689*	*6,408*	*6,156*	*5,263*	*6,178*	*- 710*
Baltic balance	*2,334*	*2,929*	*2,479*	*3,145*	*3,054*	*2,463*

Source: *Direction of Trade.* Statistical Yearbook 1997; *Statistisk Äborg 1997.* Statistical Yearbook Danmarks.

On the basis of such data for individual countries the trade flow tables for consecutive years were put together, as exemplified in Table 2 for the year 1996. Since the trade values for particular countries were taken from various (country-specific or international) sources, differences have resulted which are illustrated by the double entries $(t_{mn}^{\min}, t_{mn}^{\max})$ in Table 2. These differences, especially in relative terms, are particularly striking for the post-communist transition countries, and for small economies. Thus, if we take an excerpt from Table 2 for Latvia and Sweden, we obtain the following two-by-two table, with flows expressed, as in Table 2, in millions of US dollars:

Flow direction	Data from Latvia	Data from Sweden
Latvia → Sweden	94	386
Sweden → Latvia	166	207

Differences of these kinds are of little importance globally, as we shall see later on, but are of crucial significance for more detailed analysis (the balance in the above case being for Latvia either –72 million US dollars or +179 million US dollars), casting an empirical light on the question of potential asymmetry. A more complete illustration of the phenomenon is provided in Table 3, where minimum and maximum import and export values are provided. Let us also emphasize that consistency within the individual data sets (i.e. keeping to the maximum or, alternatively, to the minimum values) is not being quite well preserved, so that the problem is by no means an artificial one.

Here, again, we see the particularly wide margin of "error" or rather uncertainty for transforming post-communist states, especially the small ones (see the "clinical" case of Latvia). In reality the data for all post-communist countries must be taken with great care, even when there is an apparent conformity with the statistical registration routines (like in Poland), insofar as a high share of transactions go in fact unregistered, partly because of their natural character (e.g. shopping by Germans in western Poland – more than 30 million shopping visits *per annum* to 1998), and partly because of various kinds of evasion (taking also, in particular, the form of "tourist transport").

It must be noted that normalization, smoothing and other consistency-ensuring procedures have to account for the actual variety of reasons for which the differences illustrated in Tables 2 and 3 appear, as well as for the magnitude differences in export/import gaps. If these reasons and the variety of them for particular countries, are not explicitly accounted for, along with the magnitude of the phenomena, the respective procedures can do unexpected harm to data rather than improving them, especially if we want to draw far-reaching conclusions on the basis of the so "corrected" data. In our approach we try to counterbalance this effect by analysing a variety of results for a variety of assumptions.

Table 2

Trade flows in Baltic Europe in 1996 (exports along rows, imports along columns). Double entries show maximum and minimum values coming from various sources.All entries in millions of US dollars

Country	Denmark	Estonia	Finland	Lithuania	Latvia	Germany	Norway	Poland	Russia	Sweden
Denmark		94	1,228	164	90	10,368	3,094	840	743	5,009
	*	90	1,033	167	76	7,956	2,631	840	434	4,984
Estonia	74		380	119	171	147	31	24	341	240
	73	*	354	97	120	206	23	24	146	396
Finland	1,142	1,060		148	223	4,655	1,116	570	2,367	4,062
	1,155	935	*	164	194	4,168	1,226	570	1,659	3,755
Lithuania	84	82	32		304	427	15	104	780	56
	109	50	34	*	133	427	20	104	465	93
Latvia	51	53	34	107		199	10	20	330	94
	69	62	35	143	*	325	55	20	232	386
Germany	9,258	300	4,872	691	406		4,421	10,863	7,605	12,256
	8,862	319	4,393	691	292	*	4,595	9,166	5,130	12,499
Norway	2,216	30	1,076	54	73	5,569		344	278	4,493
	2,212	30	1,184	38	29	9,021	*	344	247	5,194
Poland	743	35	278	224	54	8,680	195		704	592
	703	35	278	224	54	8,680	195	*	704	592
Russia	282	489	2,569	1,816	1,037	6,726	363	1,439		995
	386	431	2,160	1145	426	10,220	571	1,439	*	446
Sweden	5187	263	4,304	145	207	9,884	7,144	1,068	724	
	5,007	261	3,432	138	166	9,217	5,855	1,068	554	*

Source: Various national statistical bulletins and yearbooks.

Table 3

Maximum and minimum export and import values appearing in the statistics for particular countries in 1993 (in millions US dollars)

Country	Exports maximum/minimum	Imports maximum/minimum
Denmark	16,175 / 12,035	13,342 / 12,434
Estonia	670 / 412	757 / 586
Finland	9,489 / 8,626	8,656 / 7,857
Germany	33,881 / 31,344	37,240 / 30,705
Latvia	809 / 332	798 / 519
Lithuania	564 / 528	910 / 832
Norway	11,099 / 9,279	11,005 / 9,308
Poland	6,965 / 6,965	8,872 / 8,872
Russia	11,399 / 9,208	9,678 / 7,147
Sweden	18,173 / 16,452	17,966 / 16,917

Source: own calculations.

3.3. Some preliminary analyses

Since we speak of trade structures it seems quite feasible to try to draw certain conclusions already on the basis of the "raw" data at hand before passing to the more technical analyses which will be presented further on. Thus, if we take the shares of the total Baltic trade of the ten considered countries in their total world trade in consecutive years, we obtain the image as in Table 4a.

Table 4a

Shares of Baltic trade of all the 10 countries in their global trade figures (in %)

Trade flow	1992	1993	1994	1995	1996	1997
Exports	16.93	18.34	18.41	18.48	19.20	19.62
Imports	18.49	20.49	21.34	21.68	21.94	22.08

Source: own calculations.

These numbers indicate that although nothing dramatic is happening to the Baltic-wise trade-defined cohesion, a very definite and consistently steady increase of "integration" degree can be observed for the whole period analysed. This unquestionable observation is essential for our further considerations not only because it plainly states the increasing integration trade-wise of the area under analysis, but also because the detailed analyses will only marginally set the Baltic rim against the background of the global trade system, and we will be primarily looking at the spatial trade structures within this group of countries. Hence, the above result sets the "moving horizon" for our later analyses related to the intra-regional structures.

Table 4b

Total exports and imports of the 10 Baltic countries among them and with respect to the whole world (in millions of US dollars)

Flows	1992	1993	1994	1995	1996	1997
Baltic exports	107,253	103,682	123,255	152,121	162,234	164,808
Baltic imports	108,418	100,563	122,180	150,477	154,871	162,452
World exports	633,574	565,375	669,614	823,103	844,806	839,997
World imports	586,445	490,894	572,476	694,221	705,883	735,837

Source: own calculations.

The disequilibrum of the in-Baltic trade, appearing in the two top rows of Table 4b, is again the result of differences in sources of data.

An illustration of the considerations from Section 2, concerning the linkages (in particular: outward vs. inward with respect to a hypothetical region) among countries or other spatial units, is provided by the instance of shares similar in their definitions to those shown in Table 4, but for just three countries, Germany, Sweden and Finland, given in Table 5.

Table 5
Shares of Germany, Sweden and Finland in Baltic and world trade of the 10 Baltic countries (in %)

Country – flow	1992	1993	1994	1995	1996	1997
Germany – Baltic exports	27.92	32.11	31.05	31.61	31.23	32.31
Germany – Baltic imports	30.86	34.41	33.54	30.50	32.43	30.00
Germany – world exports	67.03	64.43	62.76	61.84	60.78	60.91
Germany – world imports	68.75	67.18	64.90	63.91	63.04	60.03
Sweden – Baltic exports	19.39	17.05	17.61	18.05	17.83	17.32
Sweden – Baltic imports	18.93	16.84	17.22	18.29	18.30	16.80
Sweden – world exports	8.85	8.80	9.12	9.67	10.00	9.85
Sweden – world imports	8.44	8.59	9.00	9.30	9.43	8.90
Finland – Baltic exports	8.99	8.71	9.82	10.07	9.46	9.54
Finland – Baltic imports	8.72	8.01	8.42	8.35	8.33	8.13
Finland – world exports	3.79	4.15	4.43	4.81	4.55	4.68
Finland – world imports	3.91	3.68	4.05	4.05	4.15	4.05

Source: own calculations.

The very first, quasi-trivial, observation implied by Table 5 is that of the position of Germany. Although definitely declining, its share in world trade of the 10 Baltic countries is still at almost two thirds. Germany's share, however, in the in-Baltic trade is twice smaller (although relatively stable). This relation between the world and in-Baltic shares is quite opposite in the cases of both Sweden and Finland (and also, say, Denmark, not shown here): their in-Baltic shares are twice (or more) as big as those for world trade.

These observations have a bearing on both the interpretation of results obtained in terms of linkages, as referring to any potential definition of the spatial structures, and on the question of the proper selection of units subject to the definitional exercise. Here let us emphasize that even if such sub-units as Schleswig-Holstein and Meklemburg-Vorpommern in the case of Germany, and Kaliningrad as well as St.Petersburg districts in the case of Russia, were used in the analysis (which is anyway very difficult because of data problems), their status is entirely different from that of entire countries so that comparison or equal footing is not feasible.

3.4. The method

The analyses carried out were performed with the cluster analytic technique developed by two of the present authors, and described in appropriate detail elsewhere (Owsiński, 1984, 1990). The technique, by virtue of the very definition of cluster analysis, finds *the partition of a set of objects into subsets, such that the objects belonging to the same subsets are possibly similar or affine, while objects belonging to a different cluster are possibly dissimilar or distant.*

Note that we have avoided the intuitively appealing, and apparently constructive, but in fact tricky formulation from Section 2, involving the comparison: "more... than". Thus, we have to rely on the indirect definition of a region, being the result of the procedure rather than a directly definable entity. The above formulation is expressed in the method through a general form of an (objective) function that is being maximized or minimized, depending upon its particular shape.

In the case of our analysis the objects from the above formulation are the Baltic countries, and the proximities between them are measured with reference to the respective trade flows. These proximities are the basic information used by this (like by any other, anyway) clustering method to produce the partition into subsets (clusters).

Without describing the method in any deeper detail let us mention, its most important features:

– it accomodates almost any definition of distance and/or proximity between objects;

– it is based upon an explicit objective function, which is being (sub)optimized, so that any partition whatsoever can be evaluated in terms of this objective function, corresponding to the basic formulation of the clustering problem, formulated verbally above;

– it provides as a solution both the composition of subsets (clusters) *and* their number;

– the (sub)optimal solution is obtained with the use of a very simple aggregation algorithm, analogous to the classical progressive merger procedures, like the single linkage, average linkage, etc.;

– the working of the procedure is accompanied by the values of the merger parameter, denoted r, which start from 1 (when all objects are apart), and go down for each consecutive merger, so that the (sub)optimal solution is attained for the merger occurring at the lowest value of r not lower than 0.5 (which can also, though rather figuratively, be interpreted in the following manner: the mergers occurring for r lower than 0.5 associate the objects less similar than dissimilar, and therefore should not be included in the solution);

– owing to the simplicity of the procedure and the availability of the values of r we are capable of assessing the "strength" and "validity" of particular cluster structures obtained.

We would like to emphasize once again that the proximities s_{mn} used by the cluster analytic techniques must by virtue of definition be symmetric, while the trade relations may to some extent approach symmetricity (e.g. due to the wish of balancing the country's foreign trade), but under many aspects are indeed essentially asymmetric. We have already commented upon this feature in Section 2, and will return to it in the Conclusions, Section 5 of the paper.

3.5. The analytical exercises

We have carried out a series of clustering exercises differing by the assumptions behind, reflected in the way in which primarily the distances were defined in each case on the basis of the trade flows. For each kind of exercise the tables with results, given together in the subsequent section, are indicated.

3.5.1. The bare flows

This exercise was in a way a referential one. We clustered the countries on the basis of flows by taking their averages (see Table 2) and symmetrizing them, i.e. the proximity between country m and n (and vice versa) equalled

$$s_{mn} = \frac{1}{4}(t_{mn}^{\min} + t_{mn}^{\max} + t_{nm}^{\min} + t_{nm}^{\max}).$$

The results of this analysis are shown in Table 8.

3.5.2. The flows adjusted for (a)symmetricity

This, again, was a kind of reference exercise. We took the same proximity values as in the preceding case and deducted the average difference between the flows in two ($n \rightarrow m$ and $m \rightarrow n$) directions. Thereby, the larger the difference between the two flows, the bigger the deduction from the average-average value as defined in 3.5.1. Thus, the proximity used in this exercise was:

$$S_{mn} = \max\{0, \tfrac{1}{4}(t_{mn}^{\min} + t_{mn}^{\max} + t_{nm}^{\min} + t_{nm}^{\max}) - \left|\tfrac{1}{2}(t_{mn}^{\min} + t_{mn}^{\max}) - \tfrac{1}{2}(t_{nm}^{\min} + t_{nm}^{\max})\right|\},$$

where: maximum is taken in view of the possibility of obtaining the negative value of the difference in the case of very large relative flow differences, like in the instance of Latvia and Sweden, quoted before. Insofar as the results of this exercise largely followed those of the preceding one, they are not quoted here.

3.5.3. The relative flows: the Baltic horizon

Here the proximities between pairs of countries were calculated from the following formula:

$$s_{mn} = \frac{1}{4}\left(\frac{t_{mn}^{\min}}{T_m^{\min}} + \frac{t_{mn}^{\max}}{T_m^{\max}} + \frac{t_{nm}^{\min}}{T_n^{\min}} + \frac{t_{nm}^{\max}}{T_n^{\max}}\right),$$

which is an extended variant of the directional trade ratio of Smoker (1965), used in another – FDI – context also by Morita (1998). The ts appearing in this formula have the same meaning as before, while the Ts correspond to respective country-proper (m and n) sums of trade flows over the Baltic. The interpretation is that the s_{mn} will imply the structures *within* the Baltic region rather than against a broader background. We are therefore dealing with the intensity of linkages within the Baltic region rather than as seen against the world trade, and so the results do not pertain to the "regionality" of the Baltic trade either (see: also Section 2). The results are shown in Table 9.

3.5.4. The relative flows: the global horizon

In this exercise the same formula was used as in the preceding one, though this time the Ts appearing in the denominators reflect the trade sums for the whole world trade of the given countries (m and n). Thereby the trade flows and the resulting similarities are perceived, in a way, against the global perspective. It must be emphasized though that this is not a full ("quasi-absolute") global perspective exactly in the sense referred to in Section 2: the actual dispersion of trade flows in the global setting would hardly allow an identification of the Baltic-proper structures. Thus we again looked at the Baltic set of countries, though the background is the global one. We were especially interested in seeing the differences with respect to the previous exercise.

This series of calculations was complemented with two others, in which the minima and maxima of the trade flows were used rather than all the values available:

$$s_{mn} = \frac{1}{2}\left(\frac{t_{mn}^{\min}}{T_m^{\min}} + \frac{t_{nm}^{\min}}{T_n^{\min}}\right),$$

and

$$s_{mn} = \frac{1}{2}\left(\frac{t_{mn}^{\max}}{T_m^{\max}} + \frac{t_{nm}^{\max}}{T_n^{\max}}\right).$$

Although the very same sources of data do not provide consistently the minima or, alternatively, maxima, the role of these exercises is different from checking the results for the same sources: its main purpose is to test the sensitivity of the results obtained. The results of the three exercises conducted for the global background are shown in Tables 10, 11 and 12.

3.5.5. The relative flows: the gravity background

Trade is often – and quite effectively – represented with the gravity models (see: e.g., Cornett and Iversen 1993, 1997, or Fidrmuc 1998, who in general terms follow the classical formulations of Linder and Linnemann), which in view of their very good fit are also used for forecasting. The forecasts are obtained for definite changes in assumptions concerning the parameters of the model (the "scenarios"). The gravity model can be adequately illustrated by the following general form:

$$t_{mn} = a_0 + a_1 Y_m + a_2 Y_n + a_3 y_m + a_4 y_n - a_5 d_{mn} + a_6 \tau_{mn},$$

where: $a_0,...,a_6$ are model coefficients, usually obtained through a regression procedure, $Y_{m,n}$ are in the majority of studies the gross domestic product (GDP) values of countries m and n, $y_{m,n}$ are the *per capita* GDP values for these countries, d_{mn} is distance between them, and τ_{mn} is some other variable expressing a certain additional relation between the two countries (there may in fact be more variables, expressing, e.g., membership in the same trade agreement structure).

The model is, of course, identified not just for a pair of countries, but for a group of them, and for a certain period. Thus it is assumed that the coefficients $a_0,...,a_6$ preserve their validity over a broader spatial and temporal context, and so by applying appropriate values of the variables of the model (Ys, ys, d and τ) we can obtain trade estimates for a variety of situations.

The gravity model is a definitely directional (asymmetric) one, i.e. expression for t_{mn} differs with respect to the one for t_{nm}, unless $a_1 = a_2$ and $a_3 = a_4$, or the respective coefficients are the same for the two models, which seem indeed to be the least probable cases. Classical interpretations of these coefficients and the variables corresponding to them refer to the push-and-pull (gravity attraction and repulsion) of demand and supply, but once the GDPs and *per capita* GDPs (as well as populations) are used equally well in the various models identified, the very clear initial tang of asymmetricity is somewhat lost (that is given that any remained after the comparison of model errors in trade figures with the actual asymmetry of trade flows). Since in cluster analysis we refer to symmetric proximities s_{mn}, we effectively overlook whatever asymmetricity is left with the gravity models. The calculations carried out within our study were performed for two cases of definition of s_{mn}, given below:

$$s_{mn} = \frac{1}{4}\left(\frac{t_{mn}^{\min}}{T_m^{\min}} + \frac{t_{mn}^{\max}}{T_m^{\max}} + \frac{t_{nm}^{\min}}{T_n^{\min}} + \frac{t_{nm}^{\max}}{T_n^{\max}}\right) / (Y_m \cdot Y_n)^{1/2},$$

and

$$s_{mn} = \frac{1}{4}\left(\frac{t_{mn}^{\min}}{T_m^{\min}} + \frac{t_{mn}^{\max}}{T_m^{\max}} + \frac{t_{nm}^{\min}}{T_n^{\min}} + \frac{t_{nm}^{\max}}{T_n^{\max}}\right) / (y_m \cdot y_n)^{1/2}.$$

The geometric average appearing in the denominator is meant to compensate somehow for the effect of the wide disparities existing among the GDP and *per capita* GDP values for the various countries considered. The differences (in GDP) reach even two orders of magnitude (see: the following considerations), and this might essentially twist the nature and interpretation of results.

For the above outlined two series of runs of the cluster analysis algorithm we had therefore to look, in addition to the trade data, for the appropriate GDP and *per capita* GDP values. A good illustration of the kind of data available for this purpose is provided by Table 6. Irrespective of all the "deeper" criticisms of the GDP measure, let us add that on the top of what is shown in Table 6 we have the rather doubtful purchasing power parity (ppp) adjustment, which in a strikingly linear manner brings the highest values of *per capita* GDP down in a similar proportion as it moves the lowest ones upwards.

Table 6

Some data on GDP and *per capita* GDP in the Baltic countries

Countries	GDP in billions of US dollars	GDP *per capita* in US dollars
Denmark	174.9*	33,230*
Estonia	3.5**	2,188**
	4.5***	3,000***
Finland	125.1*	24,420*
Germany	2,353.5*	28,738*
Latvia	6.0* [1995]	2,399* [1995]
	4.2**	1,556**
	5.4***	2,160***
Lithuania	7.1* [1995]	1,908* [1995]
	5.1**	1,378**
	8.8***	2,378***
Norway	157.8*	36,020*
Poland	103.6*	3,484*
	129.0**	3,351**
	145.6***	3,756***
Russia	344.7* [1995]	2,331* [1995]
	497.0**	3,345**
	455.0***	3,076***
Sweden	251.8*	28,283*

* Source: Statistical Yearbook 1996 (1997). GUS, Warszawa.

** Source: *Independent Strategy* (1997). "Central European Economic Review", data for 1996.

*** Source: *Bank of America* (1998). "Central European Economic Review", data for 1997.

Thus, we decided to take for purposes of cluster analytic calculations the data from one source for the 10 countries considered and, in view of the high degree of uncertainty associated, keep them constant over time thereby limiting the meaning of dynamics of the analyses carried out to a relative one. The data adopted for the calculations are shown in Table 7.

Let us add at this point that we tried to establish the comparative basis for the gravity background by inspecting the gravity model coefficients for various models, especially with respect to the coefficients accompanying the GDP and *per capita* GDP variables. No consistent relation between particular coefficient values (e.g. a_1/a_2 or a_3/a_4) could be traced, though, across the models inspected, referred to before. Thus, also because of this, we adopted the simple definitions of proximities given here.

Table 7

GDP and *per capita* GDP data adopted for the calculations described in Section 3.5.5

Country	GDP (10^9 US dollars)	GDP *per capita* (10^3 US dollars)
Denmark	174.2	22.3
Estonia	4.2	4.4
Finland	124.0	18.7
Germany	2,353.2	21.1
Latvia	5.0	3.5
Lithuania	10.0	4.8
Norway	156.2	24.2
Poland	133.5	5.4
Russia	440.3	4.5
Sweden	250.3	19.1

Source: *The Economic Situation in the Baltic Sea Region* (1998). The Stockholm Chamber of Commerce, Stockholm.

4. THE RESULTS

This section is simply composed of a series of tables with very few comments other than those pertaining directly to the tables and their contents. Let us only note that the tables corresponding to individual exercises show first (tables a) the consecutive steps of aggregation leading ultimately to the formation of the suboptimal partition. Thus groups formed at earlier steps of the procedure can be regarded as "stronger" or "more pronounced" than those formed at the later stages, even if all of them enter the suboptimal solution structure.

Tables b show the ultimate partition corresponding to the (sub)optimal solution.

Table 8a

Clustering of the Baltic countries for the average trade flows between them

Merger step	1993	1994	1995	1996	1997
1. $r^1 =$	1.000 Germany-Sweden	1.000 Germany-Sweden	1.000 Germany-Sweden	1.000 Germany-Sweden	0.999 Germany-Sweden
2. $r^2 =$	0.922 Denmark-Germany-Sweden	0.910 Denmark-Germany-Sweden	0.914 Denmark-Germany-Sweden	0.905 Denmark-Germany-Sweden	0.918 Denmark-Germany-Sweden
3. $r^3 =$	0.787 Denmark-Germany-Sweden-Norway	0.776 Denmark-Germany-Sweden-Norway	0.775 Denmark-Germany-Sweden-Norway	0.797 Denmark-Germany-Sweden-Norway	0.790 Denmark-Germany-Sweden-Norway
4. $r^4 =$	0.627 Denmark-Germany-Sweden-Norway-Finland	0.640 Denmark-Germany-Sweden-Norway-Finland	0.645 Denmark-Germany-Sweden-Norway-Finland	0.642 Denmark-Germany-Sweden-Norway-Poland	0.662 Denmark-Germany-Sweden-Norway-Poland
5. $r^5 =$	0.601 Denmark-Germany-Sweden-Norway-Finland-Russia	0.599 Denmark-Germany-Sweden-Norway-Finland-Russia	0.575 Denmark-Germany-Sweden-Norway-Finland-Russia	0.571 Denmark-Germany-Sweden-Norway-Poland-Finland	0.594 Finland-Russia
6. $r^6 =$	0.541 Denmark-Germany-Sweden-Norway-Finland-Russia-Poland	0.529 Denmark-Germany-Sweden-Norway-Finland-Russia-Poland	0.529 Denmark-Germany-Sweden-Norway-Finland-Russia-Poland	0.543 Denmark-Germany-Sweden-Norway-Poland-Finland-Russia	0.567 Denmark-Germany-Sweden-Norway-Poland-Finland-Russia
7. $r^7 =$	*0.062	*0.105	*0.107	*0.130	*0.121

Table 8b

The suboptimal clusters

Sub-optimal partition	{Denmark-Germany-Sweden-Norway-Finland-Russia-Poland} {Estonia} {Lithuania} {Latvia}	{Denmark-Germany-Sweden-Norway-Finland-Russia-Poland} {Estonia} {Lithuania} {Latvia}	{Denmark-Germany-Sweden-Norway-Finland-Russia-Poland} {Estonia} {Lithuania} {Latvia}	{Denmark-Germany-Sweden-Norway-Poland-Finland-Russia} {Estonia} {Lithuania} {Latvia}	{Denmark-Germany-Sweden-Norway-Poland-Finland-Russia} {Estonia} {Lithuania} {Latvia}

Source: own calculations.

The tables provided here also give the clusters and partitions immediately following the suboptimal ones, in the situations where these non-optimal results are either close to the suboptimal ones and/or can provide important additional information. They are all denoted with asterisks (the respective values of r^t are ≤ 0.5, e.g. *0.499).

A comment concerning the values of r^t for the consecutive aggregation steps $t = 1, 2, 3, ...$, is also in place here. These values should be regarded in a manner as *relative* measures of robustness of particular structures, since their absolute magnitudes, ranging between 0 and 1 (or, more precisely, 1 and 0.5), also significantly depend upon the definitions of the proximity used in a particular calculation. Thus, if the definitions for two particular exercises are very similar to each other (as, for instance, is the case of relative calculations for the Baltic and the global horizons, Tables 9 and 10), then we can compare the results also in terms of the values of r^t. Otherwise the comparisons with this respect should be made very carefully, if at all.

***

We will now comment briefly on the results obtained for consecutive exercises, leaving the more in-depth considerations to the next section of the paper.

The results for the trade flows themselves (Table 8) are very characteristic in that there is just one dominant cluster built gradually from the "core" "outwards", this "core" being constituted by Germany and Sweden, to which other Scandinavian countries are linked, followed by Russia and Poland. Let us remind ourselves here of the possibility of appearance of the outward built "nested" structures of "regions", mentioned in Section 2 of the paper. The Baltic States (Estonia, Lithuania and Latvia) are left outside of this dominant cluster in view of the feeble trade flows to and from them, strictly connected with the magnitudes of these three economies. It is also interesting to note that since 1996 Poland has replaced Finland as the fifth consecutive member of the dominant cluster, meaning that it has thereby moved much closer to the "core".

While it is certainly interesting to look at the structures implied by absolute trade flows, it may also be argued that far more interesting are the analyses based upon the relative flow indicators, relating these flows to overall trade numbers, to the general economic indicators etc. Table 9 presents the results of clustering for proximities obtained from trade flows divided by the respective Baltic trade totals for particular (pairs of) countries. Thus the structures obtained refer to what we called the Baltic horizon. Now, in sharp distinction to the absolute image obtained before, we get clear pair-wise linkages, which then get expanded and eventually linked together. There are only very few "outliers" (clusters of single countries) which do not get linked with other countries. Attention is especially attracted to the strongest pairs of countries, which get repeatedly identified.

Let us emphasise that such structures, often exactly the same, will yet be identified in several other exercises.

Table 9a

Clustering of Baltic countries for the trade flows related to respective Baltic totals

Merger step	1993	1994	1995	1996	1997
1. $r^1 =$	0.719 Germany-Poland	0.709 Germany-Poland	0.692 Germany-Poland	0.732 Germany-Poland	0.723 Germany-Poland
2. $r^2 =$	0.584 Norway-Sweden	0.585 Norway-Sweden	0.593 Norway-Sweden	0.604 Norway-Sweden	0.599 Norway-Sweden
3. $r^3 =$	0.582 Germany-Poland-Russia	0.570 Lithuania-Russia	0.573 Germany-Poland-Russia	0.579 Lithuania-Russia	0.573 Germany-Poland-Russia
4. $r^4 =$	0.546 Denmark-Norway-Sweden	0.557 Germany-Poland-Denmark	0.545 Denmark-Norway-Sweden	0.551 Germany-Poland-Denmark	0.549 Denmark-Norway-Sweden
5. $r^5 =$	0.531 Estonia-Finland	0.539 Germany-Poland-Denmark-Norway-Sweden	0.536 Estonia-Finland	0.537 Germany-Poland-Denmark-Norway-Sweden	0.531 Estonia-Finland
6. $r^6 =$	0.513 Lithuania-Latvia	0.523 Estonia-Finland	0.514 Germany-Poland-Russia-Lithuania	0.534 Estonia-Finland	0.509 Germany-Poland-Russia-Lithuania
7. $r^7 =$	0.511 Germany-Poland-Russia-Denmark-Norway-Sweden	0.519 Lithuania-Russia-Latvia	n/a	0.517 Lithuania-Russia-Latvia	n/a

Table 9b

The suboptimal clusters

Sub-optimal partition	{Germany, Poland, Russia, Denmark, Norway, Sweden} {Estonia, Finland} {Lithuania, Latvia}	{Germany, Poland, Denmark, Norway, Sweden} {Estonia, Finland} {Lithuania, Russia, Latvia}	{Germany, Poland, Russia, Lithuania} {Estonia, Finland} {Denmark, Norway, Sweden} {Latvia}	{Germany, Poland, Denmark, Norway, Sweden} {Estonia, Finland} {Lithuania, Russia, Latvia}	{Germany, Poland, Russia, Lithuania} {Denmark, Norway, Sweden} {Estonia,Finland} {Latvia}

Source: own calculations.

Analogous results, but obtained for the "global horizon", are shown in Table 10. What can be observed here is the very similar character of clusters identified, with, however, very telling shifts along the value of r, and the similarly very telling switches of sequence of formation of these clusters. In particular, these pairs of countries whose trade is more concentrated on the Baltic are clustered now before some of the other ones.

Table 10a

Clustering of Baltic countries for trade flows related to respective trade totals

Merger step	1993	1994	1995	1996	1997
1. $r^1 =$	0.581 Germany-Poland	0.576 Germany-Poland	0.553 Germany-Poland	0.577 Germany-Poland	0.582 Germany-Poland
2. $r^2 =$	0.530 Estonia-Finland	0.542 Latvia-Russia	0.550 Latvia-Russia	0.531 Lithuania-Russia	0.529 Denmark-Sweden
3. $r^3 =$	0.527 Latvia-Russia	0.527 Estonia-Finland	0.534 Estonia-Finland	0.530 Estonia-Finland	0.525 Latvia-Russia
4. $r^4 =$	0.520 Norway-Sweden	0.521 Lithuania-Latvia-Russia	0.521 Norway-Sweden	0.524 Lithuania-Russia-Latvia	0.523 Estonia-Finland
5. $r^5 =$	0.512 Denmark-Norway-Sweden	0.519 Norway-Sweden	0.516 Lithuania-Latvia-Russia	0.523 Norway-Sweden	0.515 Denmark-Sweden-Norway
6. $r^6 =$	0.509 Lithuania-Germany-Poland	0.511 Denmark-Norway-Sweden	0.510 Denmark-Norway-Sweden	0.512 Denmark-Norway-Sweden	0.505 Germany-Poland-Denmark-Sweden-Norway
7. $r^7 =$	0.500 Lithuania-Germany-Poland-Latvia-Russia	0.503 Denmark-Norway-Sweden-Poland-Germany	0.502 Denmark-Norway-Sweden-Germany-Poland	0.502 Denmark-Norway-Sweden-Germany-Poland	0.504 Latvia-Russia-Lithuania

Table 10b

Suboptimal clustering

Sub-optimal partition	{Germany, Poland, Lithuania, Latvia, Russia} {Denmark, Norway, Sweden} {Estonia, Finland}	{Germany, Poland, Denmark, Norway, Sweden} {Estonia, Finland} {Lithuania, Russia, Latvia}	{Denmark, Norway, Sweden, Germany, Poland} {Estonia, Finland} {Lithuania, Latvia, Russia}	{Germany, Poland, Denmark, Norway, Sweden} {Estonia, Finland} {Lithuania, Russia, Latvia}	{Germany, Poland, Denmark, Sweden, Norway} {Estonia, Finland} {Latvia, Russia, Lithuania}

Source: own calculations.

Tables 11 and 12 present the results complementary to those shown in Table 10, meant mainly to test the sensitivity of the cluster structures shown before to changes in data of the nature considered here (e.g. trade data coming from various sources). It can be generally stated that the results from both Tables 9 and 10 are confirmed. The somewhat strange place of Latvia in Table 11 is well explained by the illustration of the respective data-related uncertainty, shown in Section 3. Although just in view of this phenomenon (bigger relative errors for smaller absolute values) the results from Table 11 should be regarded with special care, it is interesting to note such structures, on the top of those that get repetitively identified in the results, as, e.g. the large North-eastern Baltic cluster.

Table 11a

Clustering of Baltic countries for trade flows related to respective trade totals (minimum trade averages)

Merger step	1993	1994	1995	1996	1997
1. $r^1=$	0.579 Germany-Poland	0.576 Germany-Poland	0.558 Latvia-Sweden	0.576 Germany-Poland	0.581 Germany-Poland
2. $r^2=$	0.554 Latvia-Russia	0.553 Lithuania-Russia	0.551 Germany-Poland	0.547 Latvia-Sweden	0.543 Latvia-Sweden
3. $r^3=$	0.534 Estonia-Finland	0.536 Latvia-Sweden	0.535 Estonia-Finland	0.541 Lithuania-Russia	0.524 Estonia-Finland
4. $r^4=$	0.519 Denmark-Sweden	0.526 Estonia-Finland	0.531 Lithuania-Russia	0.529 Estonia-Finland	0.520 Germany-Poland-Denmark
5. $r^5=$	0.511 Denmark-Sweden-Norway	0.511 Denmark-Germany-Poland	0.512 Denmark-Germany-Poland	0.511 Denmark-Germany-Poland	0.507 Latvia-Sweden-Russia
6. $r^6=$	0.508 Lithuania-Germany-Poland	0.505 Lithuania-Russia-Latvia-Sweden	0.504 Latvia-Sweden-Norway	0.506 Estonia-Finland-Latvia-Sweden	0.502 Estonia-Finland-Latvia-Sweden-Russia
7. $r^7=$	0.503 Estonia-Finland-Latvia-Russia	*0.500 Estonia-Finland-Lithuania-Russia-Latvia-Sweden	0.501 Denmark-Germany-Poland-Latvia-Sweden-Norway	*0.499 Estonia-Finland-Latvia-Sweden-Lithuania-Russia	*0.497 Germany-Poland-Denmark-Norway

Table 11b

Suboptimal clustering

Sub-optimal partition	{Estonia, Finland, Latvia, Russia} {Germany, Poland, Lithuania} {Denmark, Sweden, Norway}	{Estonia, Finland} {Lithuania, Russia, Latvia, Sweden} {Denmark, Germany, Poland} {Norway}	{Denmark, Germany, Poland, Latvia, Sweden, Norway} {Estonia, Finland} {Lithuania, Russia}	{Denmark, Germany, Poland} {Estonia, Finland, Latvia, Sweden} {Lithuania, Russia} {Norway}	{Estonia, Finland, Latvia, Sweden, Russia} {Germany, Poland, Denmark} {Lithuania} {Norway}

Source: own calculations.

Quite in distinction to the results of Table 11, the ones provided in Table 12 show the structures which can be considered as very close to the most characteristic for the whole set of results from the study. This series of runs provides, in fact, a kind of a "model" structure determined from the whole analysis.

Table 12a

Clustering of Baltic countries for trade flows related to respective trade totals (maximum trade averages)

Merger step	1993	1994	1995	1996	1997
1. r^1 =	0.584	0.582	0.556	0.580	0.584
	Germany-Poland	Germany-Poland	Germany-Poland	Germany-Poland	Germany-Poland
2. r^2 =	0.527	0.534	0.546	0.532	0.527
	Estonia-Finland	Latvia-Russia	Latvia-Russia	Estonia-Finland	Denmark-Sweden
3. r^3 =	0.522	0.528	0.534	0.524	0.524
	Norway-Sweden	Estonia-Finland	Estonia-Finland	Latvia-Russia	Estonia-Finland
4. r^4 =	0.513	0.521	0.521	0.523	0.516
	Denmark-Norway-Sweden	Norway-Sweden	Norway-Sweden	Denmark-Sweden	Latvia-Russia
5. r^5 =	0.513	0.512	0.513	0.515	0.515
	Lithuania-Latvia	Denmark-Norway-Sweden	Denmark-Norway-Sweden	Lithuania-Latvia-Russia	Denmark-Sweden-Norway
6. r^6 =	0.506	0.511	0.511	0.514	0.505
	Germany-Poland-Russia	Lithuania-Latvia-Russia	Lithuania-Latvia-Russia	Denmark-Sweden-Norway	Latvia-Russia-Lithuania
7. r^7 =	*0.500	0.504	0.503	0.503	0.504
	Lithuania-Latvia-Germany-Poland-Russia	Denmark-Norway-Sweden-Germany-Poland	Denmark-Norway-Sweden-Germany-Poland	Denmark-Norway-Sweden-Germany-Poland	Denmark-Sweden-Norway-Germany-Poland

Table 12b

Suboptimal clustering

Sub-optimal partition	{Germany, Poland, Russia} {Lithuania, Latvia} {Denmark, Norway, Sweden} {Estonia, Finland}	{Denmark, Norway, Sweden, Germany, Poland} {Lithuania, Latvia, Russia} {Estonia, Finland}	{Denmark, Norway, Sweden, Germany, Poland} {Estonia, Finland} {Lithuania, Latvia, Russia}	{Denmark, Norway, Sweden, Germany, Poland} {Estonia, Finland} {Lithuania, Latvia, Russia}	{Denmark, Sweden, Norway, Germany, Poland} {Estonia, Finland} {Latvia, Russia, Lithuania}

Source: own calculations.

The two final groups of results presented in Tables 13 and 14 show the cluster structures obtained for the proximities calculated on the basis of trade flows divided by the geometrical averages of the appropriate *per capita* GDP and GDP values (for the respective pairs of countries).

Table 13a

Clustering of Baltic countries for trade flows related to respective GDPs

Merger step	1993	1994	1995	1996	1997
1. $r^1 =$	0.632 Norway-Sweden	0.578 Norway-Sweden	0.573 Estonia-Finland	0.572 Estonia-Finland	0.576 Estonia-Finland
2. $r^2 =$	0.601 Denmark-Norway-Sweden	0.568 Estonia-Finland	0.563 Norway-Sweden	0.568 Norway-Sweden	0.550 Norway-Sweden
3. $r^3 =$	0.562 Germany-Poland	0.555 Denmark-Norway-Sweden	0.541 Denmark-Norway-Sweden	0.553 Lithuania-Latvia	0.531 Lithuania-Latvia
4. $r^4 =$	0.560 Lithuania-Latvia	0.542 Lithuania-Latvia	0.533 Lithuania-Latvia	0.538 Denmark-Norway-Sweden	0.531 Denmark-Norway-Sweden
5. $r^5 =$	0.559 Estonia-Finland	0.532 Germany-Poland	0.521 Germany-Poland	0.527 Germany-Poland	0.524 Germany-Poland
6. $r^6 =$	0.514 Denmark-Norway-Sweden-Germany-Poland	0.516 Lithuania-Latvia-Russia	0.511 Lithuania-Latvia-Russia	0.516 Lithuania-Latvia-Russia	0.510 Estonia-Finland-Lithuania-Latvia
7. $r^7 =$	*0.493 Estonia-Finland-Russia	0.504 Denmark-Norway-Sweden-Germany-Poland	0.503 Estonia-Finland-Lithuania-Latvia-Russia	0.505 Estonia-Finland-Lithuania-Latvia-Russia	*0.500 Estonia-Finland-Lithuania-Latvia-Russia
7. $r^8 =$	n/a	0.502 Estonia-Finland-Lithuania-Latvia-Russia	0.501 Denmark-Norway-Sweden-Germany-Poland	*0.499 Denmark-Norway-Sweden-Germany-Poland	*0.498 Denmark-Norway-Sweden-Germany-Poland

Table 13b

Suboptimal clustering

Sub-optimal partition	{Denmark, Norway, Sweden, Germany, Poland} {Lithuania, Latvia} {Estonia, Finland} {Russia}	{Denmark, Norway, Sweden, Germany, Poland} {Estonia, Finland} {Lithuania, Latvia} {Russia}	{Denmark, Norway, Sweden, Germany, Poland} {Estonia, Finland} {Lithuania, Latvia, Russia}	{Estonia, Finland, Lithuania, Latvia, Russia} {Denmark, Norway, Sweden} {Germany, Poland}	{Estonia, Finland, Lithuania, Latvia} {Denmark, Norway, Sweden} {Germany, Poland} {Russia}

Source: own calculations.

In Table 14 we see again an "outward" growth of the dominating cluster, this fact resulting clearly from the relatively weak influence of the *per-capita*-GDP- defined denominator on the dissimilarity measure, which is therefore much like the "bare flow" measure leading to the results from Table 8.

Table 14a

Clustering of Baltic countries for trade flows related to respective *per capita* GDP's

Merger step	1993	1994	1995	1996	1997
1. $r^1 =$	1.000	1.000	1.000	0.999	0.999
	Germany-Russia	Germany-Russia	Germany-Russia	Germany-Poland	Germany-Poland
2. $r^2 =$	0.903	0.893	0.913	0.881	0.911
	Germany-Russia-Poland	Germany-Russia-Poland	Germany-Russia-Poland	Germany-Poland-Russia	Germany-Poland-Russia
3. $r^3 =$	0.707	0.701	0.707	0.716	0.690
	Denmark-Sweden	Denmark-Sweden	Denmark-Sweden	Norway-Sweden	Denmark-Sweden
4. $r^4 =$	0.670	0.660	0.666	0.601	0.629
	Denmark-Sweden-Germany-Russia-Poland	Denmark-Sweden-Germany-Russia-Poland	Denmark-Sweden-Germany-Poland-Russia	Denmark-Germany-Poland-Russia	Denmark-Sweden-Germany-Poland-Russia
5. $r^5 =$	0.551	0.576	0.571	0.588	0.551
	Denmark-Sweden-Germany-Russia-Poland-Finland	Denmark-Sweden-Germany-Russia-Poland-Finland	Denmark-Sweden-Germany-Poland-Russia-Finland	Denmark-Germany-Poland-Russia-Norway-Sweden	Denmark-Sweden-Germany-Poland-Russia-Finland
6. $r^6 =$	0.502	*0.486	*0.480	0.521	*0.473
	Denmark-Sweden-Germany-Russia-Poland-Finland-Norway	Denmark-Sweden-Germany-Russia-Poland-Finland-Norway	Denmark-Sweden-Germany-Poland-Russia-Finland-Norway	Denmark-Germany-Poland-Russia-Norway-Sweden-Finland	Denmark-Sweden-Germany-Poland-Russia-Finland-Norway
7. $r^7 =$	*0.159	*0.220	*0.218	*0.262	*0.220

Table 14b

Suboptimal clustering

Sub-optimal partition	{Denmark, Sweden, Germany, Russia, Poland, Finland, Norway} {Estonia} {Lithuania} {Latvia}	{Denmark, Sweden, Germany, Russia, Poland, Finland} {Estonia} {Lithuania} {Latvia} {Norway}	{Denmark, Sweden, Germany, Poland, Russia, Finland} {Estonia} {Latvia} {Norway} {Lithuania}	{Denmark, Germany, Poland, Russia, Norway, Sweden, Finland} {Lithuania} {Latvia} {Estonia}	{Denmark, Sweden, Germany, Poland, Russia, Finland} {Estonia} {Latvia} {Lithuania} {Norway}

Source: own calculations.

5. CONCLUSIONS

5.1. General conclusions

Let us first emphasize that the approach taken, involving a variety of points of view represented by different definitions of the trade-related linkages between countries, did not result in a complete chaos, as it could be feared. Certain resilient geographical trade structures emerged, appearing in all, or almost all, results. In addition, some features of change over time of these structures can also be identified, although the dynamics is far less visible.

As expected, however, there is a definite difficulty in interpreting the structures obtained, in view of several factors intervening, of which we will mention here just three: (i) the already mentioned variety of assumptions behind particular calculations; (ii) the decreasingly intuitive nature of results as the mergers lead to bigger clusters (appearance of pairs is usually related to the respective maxima among the s_{mn}); (iii) the sensitivity of (some) results to the inherent errors (see the explained case of Latvia in Table 11, where the very high relative error in data intervened). A certain interpretative difficulty, though, does not imply a lesser significance of results. It is simply closely related to the nature of the analysis, and must be accepted as its inherent feature. The search for explanations of the results can anyway lead to a deeper understanding of the system considered.

Finally, the "technical" method applied proved to be effective in producing clear results of hierarchical form, accompanied by the values of the merger coefficient r, providing additional information on the structures obtained. Some more detailed methodological comments will be forwarded in Section 5.4.

5.2. The structures obtained

It is usual when critically assessing this kind of results to voice two kinds of reservations: "These results are trivial and do not require application of any refined methodology to obtain", and/or "These results are so much in disagreement with the common opinion that there must be something wrong with them". It seems that the results here presented are sufficiently close to the midpoint between these two kinds of criticism to be psychologically (if not substantially, which they apparently are) acceptable.

And so, some country-wise structures obtained are quite obvious, while other ones require an additional explanation. Likewise, some of them are very strong and appear unavoidably in virtually all solutions, some are less, though are also very pronounced, and some are barely visible (to say nothing of such that do not appear at all).

The strongest structures are the pairs of {*Germany, Poland*}, followed by {*Estonia, Finland*}, as well as the Scandinavian triangle of {*Denmark, Sweden, Norway*}. In the latter case Sweden plays the "pivotal" role, since the first pair identified within this triangle always involved Sweden (i.e. either {Norway, Sweden} or, more frequently, {Denmark, Sweden}). The strength of the linkage between Germany and Poland is exceptional. It appears at the very initial stages of the procedure and in virtually all the runs. Yet this most often does not inhibit the creation of larger structures around this pair. The case is different with Estonia and Finland, whose pair enters much less frequently into larger structures.

Thus, these strongest structures leave aside Russia, Lithuania and Latvia, although the three countries happen to form relatively strong linkages in some of the results. In fact Norway is in several cases also either left alone or enters into some structures at the later stages of the procedure.

When we look at the suboptimal solutions, i.e. the maximum structures shown in tables b, we obtain a broader picture, which, though, in view of the fact that we remain within the "moving horizon" of the Baltic Sea region, does not so much speak of *integration* of the region as of the *internal structure* within this region (we have already spoken of the progressing integration of the whole in the preliminary analysis of data in Section 3 of the paper).

First, let us note that the larger clusters appearing in the suboptimal solutions usually contain Germany and Poland as the core, which is then extended by the addition of either Russia (potentially also with Lithuania and very rarely Latvia) or the Scandinavian countries, or both. The three Scandinavian countries mentioned before often form a separate group in the solution. Likewise, Estonia and Finland very often appear as a separate pair in the solution. Russia, Lithuania and Latvia are (in this sequence in terms of frequency) either included in some large cluster being formed (as noted before), or may form a structure themselves. They frequently appear as quite separate entities (e.g. Russia alone, Lithuania and Latvia together, or in some other combination). The runs relating trade flows to GDPs (though not quite exclusively those runs) make the North-Eastern cluster appear consisting of Estonia, Finland, Latvial, Lithuania and Russia, even if only in few of the solutions.

The countries which never appear alone in the suboptimal solution are: Germany, Poland, Sweden and Denmark. Estonia and Finland, as mentioned already, almost always appear together. It was also noted that although Germany and Poland form the strongest pair, they almost always appear in the suboptimal solution in a larger cluster. On the other hand, the countries appearing alone in the solutions (we except here the runs for the bare trade flows, as providing a very specific, "nested" character of clusters, with the rest being "outliers") are: Latvia, Lithuania, Norway, and Russia. Thus, although we can hardly conclude within this part of the study on the degree of integration of the whole region, we can put forward well justified conclusions on the degree of trade-wise integration of particular economies within the region.

In a similar vein, we can cite the pairs that never occur in the same cluster in the solutions, e.g. Poland-Estonia, Poland-Latvia, Norway-Estonia, Norway-Latvia, Germany-Estonia. Note that we deal here on the one hand with the very well trade-wise integrated economies along with the ones that are the least integrated. It is these "breaks" that indicate the shape of the larger, "weak" structures forming around the Baltic Rim: (i) the rather more pronounced Scandinavian-Southern structure, involving the three Scandinavian countries, Germany and Poland, (ii) the Southern-Eastern structure, with Germany, Poland, Russia, sometimes Lithuania, and perhaps Latvia, and (iii) the Northern-Eastern structure, with Finland, the Baltic States, Russia, and often Sweden.

A separate question may be asked concerning the very "integrated" position of Germany, as seen against the background of data from Table 5, pointing at the "outward" orientation of this country with respect to the Baltic region. Thus, although the latter statement holds true for the "bare" flows, the situation changes when we turn (as we did) to the relative measures. Apparently the countries of the Baltic region, with which Germany trades most, occupy in its trade spectrum an over-proportional position.

5.3. The dynamics

All of the exercises are carried out for the five consecutive years, 1993-1997. This allows, at least in principle, to identify certain features of dynamics of the structures uncovered. The dynamics would be reflected through the essential and systematic changes over time. Obviously, in distinction to the structures as such, it is not easy to track such changes in the results. In many cases, see for instance, Table 9, we deal with two or three solution structures which occur intermittently in consecutive years, indicating that there is no, or perhaps very little, evolution from a given point of view. Indeed, it can be generally concluded that over the period in question the strong structures previously commented upon preserve their validity (the time period of study being perhaps too short to speak of "stability").

Yet, we can very carefully put forward certain propositions concerning the more systematic changes. One of them concerns the closer association of Poland with the Western-and-Scandinavian setting (and not just with

Germany), see Table 8. On the other hand, a definite disassociation of Russia (Tables 11, 13, 14) can also be traced. To a certain extent the same can be said of Finland (Table 8) and Norway (Tables 11 and 12). The latter statements, though, should perhaps be seen against the background of a more general "flattening" of structures, causing that the larger structures go down along r below the threshold of optimality (e.g. Tables 13 and 14). This is equivalent, given the "moving horizon" of progressing regional integration, to a more uniform distribution of trade flows around the region. Essentially a very good phenomenon.

5.4. The methodological conclusions

A very simple exercise has been performed for a variety of viewpoints, giving rise to results of interest in several aspects.

First, we can refer to the considerations concerning the very definition of a region. To what extent can the "strong" structures identified be treated as *sui generis* regions within the Baltic Europe? A proper answer to this question could be provided by a similar kind of analysis, but conducted for a wider geographical environment, but even at this level we can attempt partial answers. This statement is valid in spite of the appearance in some runs (Tables 8 and 14) of the "nested" structures, for which it is definitely hard to establish a threshold of "regionality".

Quite a different problem is constituted by the very different economic settings observed in the countries subject to analysis. We can quote here two factors of essential difference having a definite impact on the results: (i) the gap in GDP (especially *per capita* GDP) values, of an order or two order of magnitudes, which is important in view of the existing connection between the GDP and the trade flow volumes, and (ii) the very different share of foreign trade in the economies of particular countries (it being usually much lower in post-communist economies). If, however, we are able to observe the strong structures stretching across such differences, this means on the one hand that perhaps our indicators are good enough to deal with such situations (e.g. Tables 9, 10, 11 and 12), and that maybe also the actual economic ties are important enough to form such solution structures irrespective of the differences.

A further study should consist in (1) identification of a trade model, preferably of a gravity kind, and, assuming its fit is appropriate, (2) determination of the divergences from the model-determined flows, and (3) performance of the similar clustering exercise on the basis of such divergences. We would then be more assured that we have gotten rid of the variables which drive the trade "in general". Still, although such a study would yield results more convincing than the present, we must remember that identification of a model (of a gravity model) is also done on the basis of a number of arbitrary choices, and that in some cases interpretation is by no means straightforward.

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