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STUDIECENTRUM VOOR ECONOMISCH EN SOCIAAL ONDERZOEK

Intra-European Inland Transportation during the crisis years 1974-1978, a shift-share statistical investigation.

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Rapport 82/126

May 1982

With special thanks to L. Baudez, G. Blauwens, G. De Brabander, W. Nonneman and F. Suykens for suggestive comments, and to H. Pauwels for computational assistance.

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D/1982/1169/09

Abstract

Shift-share analysis is regularly used in decomposing trends in a "structural" and a "local component". Apart from some marketing applications, the procedure has for long been applied to regional and port statistics where structural growth and local deviation do readily correspond to the position of the single port or region in respectively a typical port-range or national economy.

This paper applies a similar procedure to inland transportation flows between the members of the continental Common Market . Over-all trends are decomposed according to the structural growth on the transport market on a particular relation, and a "modal deviation" indicating the evolution of modal market share. The analysis runs from 1974 to 1978 which spans an important crisis period on the world trade markets. In order to catch the relevant competitive shifts on the intra-community transport market, the research covers road, rail, inland and sea navigation.

The empirical results clearly identify important modal shifts on relations where structural·infrastructural changes have changed the competitive balance of inland transport modes. The procedure also enables to analyse whether modal growth results from the situation on the transport market or from changes in modal configuration. The discussion concludes with selective addresses to the effects of aggregation (over space and commodity classification) and base-year selection upon the results. The conclusion qualifies shift-share analysis in this particular application as a readily applicable exercise of market-intelligence which provides quick insight in market development by a number of informative snapshots over time.

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INTRODUCTION

Since the early seventies the national as well as the Common Market authorities have established a comprehensive system of market observations in inland transportation between the various member states (1). The system aims to follow up the short term trade fluctuations and market expectations. These observations do provide a sufficient detail by good classification and route, and as such they are perfectly tuned to back various regulatory measures in the field of operating capacity- and pricing policy.

On larger time horizons one is rather concerned with strategic options, such as infrastructural planning, market structure and the link between transportation and sectorial activity. There is still further need for comparative statistics on the structural evolution and modal configuration of transport markets, which are readily available and progressively adapted to annual market information. In port planning and regional analysis there has been a large use of the so called "Shift Share" technique. Shift share analysis associates an actual growth figure to a structural (market) and a regional (local) component. In any of those applications the technique is known to be a rough-and-ready method which, however, performs well if properly used for the purpose it is designed for (2).

This note applies the shift-share analysis to the intra-European inland transport flows, in order to separate the "structural trends" (related to traffic generation) from the modal shifts (related to the competitive conduct). The analysis spans the years 1974-1978, known as a period of structural slowdown. The discussion successively deals with the method and objectives, the available data, and the empirical results. The conclusion reveals that this kind of analysis is well suited to provide a medium run insight into the market structure of inland transportation. As such, it is a vital intermedeate stage in the specification of more sophisticated models of market conduct.

1. Intra-European freight flows

The structure of intra-European transport flows has been molded through one and a half century of economic and industrial growth. The postwar prosperous growth of world trade went together with a rising share of intra-European trade (see Figure 1). The treaties of Paris (ECSC) and Rome (EEC & Euratom) have progressively consolidated the partnership between the West European industry. At the end of the sixties the main transport flows between the original six members of the Common Market (EUR6) shape a map which is reproduced in Figure 2.

Each inter-state relation shows the total freight flow in tonnage and the relative position of the dominant carrier. The picture reveals some general features on inter-modal competition and over all traffic generation which will be tested on their stability in the next discussion.

First, all flows between the Netherlands and their neighbours are dominated by inland navigation. This follows from the geographic position of the Rhine artery and the recently widened Rhine-Scheldt connection between the Rhine-mouth and Antwerp.

Second, all outbound flows from France (except those to the Netherlands) show a railway dominance. This is especially clear in the triangle (France-Luxembourg-F.R. Germany) which pictures the industrial heart of the Treaty of Paris. There the traffic is mainly composed of products of the heavy industry. Nevertheless, also the outbound flows to Belgium and Italy reveal a marked railway patronage. The fact that the latter flows have a more diversified distribution among the groups of the current classification suggest that the French are successful railway dispatchers.

Third, the Italian outbound traffic runs mainly by rail to Germany (Gotthard and Brenner passes), by road to Luxembourg and oversea to France, Belgium and the Netherlands.

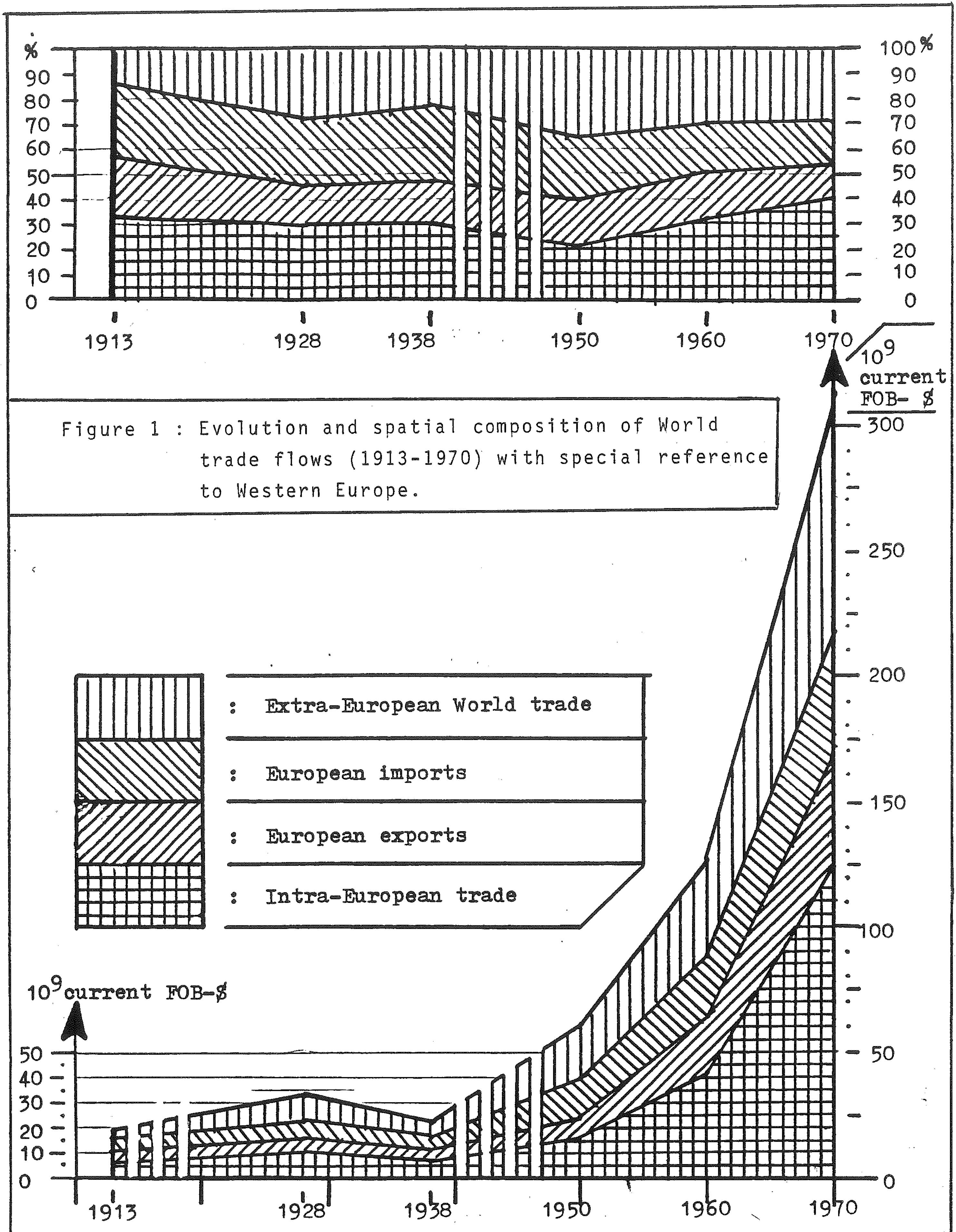


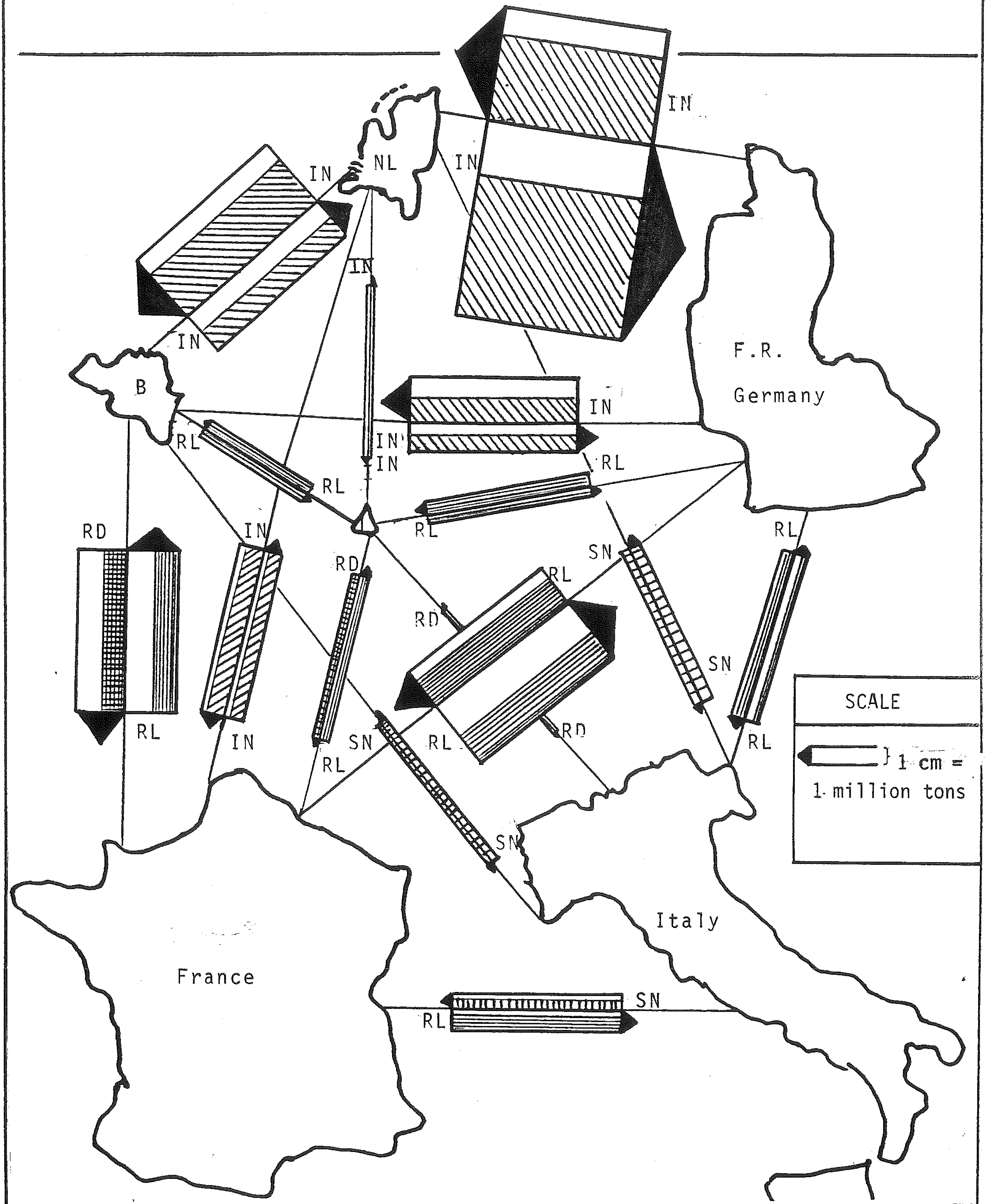
Figure 1 : Evolution and spatial composition of World trade flows (1913-1970) with special reference to Western Europe.

source: UNCTAD statistics, published in ZACCHIA, 1976, p,595

Fourth, other relations show more variety in modal positions. Luxembourg has major railway connections with Belgium and Germany, whereas inland navigation leads the links to the Netherlands. The trade from Belgium and Luxembourg to France is mainly hauled by road (for further comments, see /3/, chapter 1.3).

It is beyond the aim of this discussion to give further detail on the good classification over the various relations which (partly) explain the relative modal position. This analysis will rather concentrate on the changes that occurred during the turbulent period of the 1974-1978 crisis years.

Figure 2.: Intra-Community (EUR6) inland transport flows in 1970 with special reference to the dominant carrier.



source: graph drawn on EUROSTAT, Transport Statistics, 1970

2. Shift - share analysis

The freight flows "x" are observed in 1,000 tons and follow an indexation according to:

1/ country of origin and destination (i,j), being the six members of the former "EUR6" Common Market configuration, Germany (D), France (F), Italy (I), the Netherlands (NL), Belgium (B) and Luxembourg (L). Domestic traffic flows are omitted (thus $x_{ij} = 0$ if $i = j$). Intra-Community traffic ($i \neq j$) is accounted on basis of the "carrier trip" and not according to the route of the carriage. This means that when goods are transshipped along their route, they are counted twice or more times, each time for a successive carrier/route combination.

2/ commodity classification (k), being the 10 groups of the NST/R one-digit-classification (see annexe). The present analysis runs from 1974 to 1978 and follows the standard annual EUROSTAT publications of "transport statistics". The 'N' index denotes the total freight flow of the ten commodity groups ($N = \Sigma k$).

3/ the carriers (m), railways, road, inland waterways and sea navigation (including coastal shipping). The 'T' index stands for the total over the four modes ($T = \Sigma m$).

The real growth of a particular mode in a relation 'i,j' is defined:

$$g^{m}_{ij} = \left[\frac{x^{m,1978}_{ij}}{x^{m,1974}_{ij}} - 1 \right] \times 100 \qquad [2.1]$$

and is further on abbreviated by "g_r".

Relation [2.1.] is obviously equivalent to the weighted growth by commodity class 'k':

$$g_r = g^m_{ij} = \sum_k g^m_{ij,k} \cdot \frac{x^m_{ijk}}{x^m_{ijN}} \qquad [2.2]$$

by relation "ij", and mode "m".

in which :

- the ratio (x^m_{ijk} / x^m_{ijN}) gives the share of a particular commodity-class in the total carriage by mode and relation.

- $g^m_{ij,k}$ stands for the growth-percentage of commodity class 'k' by mode 'm', and relation 'ij' between 1974 and 1978,

  or: $g^m_{ij,k} = \left(\frac{x^{m,1978}_{ij,k}}{x^{m,1974}_{ij,k}} - 1 \right) \times 100$ by mode 'm', relation 'ij', and class 'k'.

The structural growth (hereafter abbreviated by "g_s") measures the traffic growth of a transport mode, purely resulting from the market evolution, i.e. assuming that the modal share does not change for any commodity. Thus:

$$g_s = \sum_k g^T_{ij,k} \cdot \frac{x^m_{ijk}}{x^m_{ijN}} , \qquad [2.3.]$$

in which "$g^T_{ij,k}$" stands for the traffic growth by relation and commodity class for all traffic modes. The "g_s" formula thus distributes the total growth "g^T_{ijk}" of a commodity class among the various carriers, according to the share that class takes in the modal carriage on a particular relation during the base year (1974) "x^m_{ijk}/x^m_{ijN}".

<u>The modal deviation</u> ("g_m") calculates the growth deviation of a mode to the total, with negative/positive deviations respectively meaning slower/faster growth than indicated by the structural component. Then, deviations are added through weighting over the commodity shares (x^m_{ijk}/x^m_{ijN}).

By definition, the structural and modal component add up to the real growth, or:

$$g_r = g_s + g_m$$

The eventual formula then becomes

$$\sum_k g^m_{ijk} \frac{x^m_{ijk}}{x^m_{ijN}} = \sum_k g^T_{ijk} \frac{x^m_{ijk}}{x^m_{ijN}} + \sum_k \left[g^m_{ijk} - g^T_{ijk}\right] \frac{x^m_{ijk}}{x^m_{ijN}}$$

$$g_r = g_s + g_m$$

real growth = structural growth + modal deviation

3. Empirical results

The results of the calculus are given in Tables 3 through 5, respectively for railways, inland and sea navigation. For road transportation the structural components were all zero, thus reducing modal growth apparently to the skimming of existing markets. Since the analysis of such behaviour needs more detail than the present aggregates, the discussion is now confined to the three bulk modes.

The figures of Tables 3, 4 and 5 are now classified according to the relative position of the real, structural and modal component. The results of that procedure are summarized in Tables 6 and 7. Those tables actually classify the inland transport relations into ten groups, which each come up for a different market situation. The next discussion will particularly address the fact whether the 1970 situation (see Figure 2) is structurally changed or further consolidated.

Only 8 out of the 30 railway routes show a positive real growth. Railway traffic grows structurally with a minor modal gain on the routes from France, Belgium and the Netherlands to Italy, whereas between Germany and Italy railway traffic witnesses a structural decline (all components negative). On the northbound direction of those four routes railways loose some market share but still gain traffic by virtue of the structural growth in the market. Further drastic decline of traditional railway markets are observed on most of the links from France to Germany, Belgium and Luxembourg. Given the present policy of the European Coal and Steel Community with respect to specialisation instead of output-maximization, it is rather doubtful whether a changing pattern can be expected in the heavy industrial triangle. Moreover, in spite of the negative structural component, also the modal component is mostly negative, thus indicating that the railway crisis is much more than a steel crisis!

Table 3 : Shift-share components for railways (1974-1978)

i \ j	D	F	I	NL	B	L	
	0.00	-17.66	-2.37	8.66	9.75	-34.39	g_s
D	0.00	-14.10	-14.76	-36.72	-17.78	-.47	g_m
	0.00	-31.75	-17.13	-28.07	-8.03	-34.86	g_r
	-31.63	0.00	20.59	6.74	-10.73	-81.17	g_s
F	-13.77	0.00	10.11	-40.66	-28.62	-.63	g_m
	-45.40	0.00	30.70	-33.92	-39.35	-81.80	g_r
	70.73	67.96	0.00	48.01	36.72	-60.00	g_s
I	-54.47	-31.44	0.00	-10.21	-23.88	0.00	g_m
	16.26	36.52	0.00	37.80	12.83	-60.00	g_r
	-6.46	7.89	20.72	0.00	-17.60	205.65	g_s
NL	-18.79	-18.27	12.96	0.00	-17.61	-255.65	g_m
	-25.25	-10.38	33.68	0.00	-35.22	-50.00	g_r
	6.32	-9.34	49.56	61.38	0.00	-21.42	g_s
B	-27.66	3.42	44.91	-89.57	0.00	.85	g_m
	-21.33	-5.92	94.47	-28.19	0.00	-20.57	g_r
	-15.83	-20.30	-25.40	-32.52	-60.74	0.00	g_s
L	2.77	-.50	0.00	-18.87	0.00	0.00	g_m
	-13.07	-20.80	-25.40	-51.39	-60.74	0.00	g_r

Table 4 : Shift-share components for inland navigation (Italy is only accessible through sea and coastal navigation)

i \ j	D	F	I	NL	B	L	
D	0.00	-18.03	0.00	14.41	13.88	-27.41	g_s
	0.00	6.76	0.00	-2.50	-17.52	4.15	g_m
	0.00	-11.27	0.00	11.91	-3.64	-23.26	g_r
F	-13.06	0.00	0.00	24.01	1.20	-68.73	g_s
	-.79	0.00	0.00	-2.38	-22.61	-4.17	g_m
	-13.85	0.00	0.00	21.64	-21.41	-72.89	g_r
I	0.00	0.00	0.00	0.00	0.00	0.00	g_s
	0.00	0.00	0.00	0.00	0.00	0.00	g_m
	0.00	0.00	0.00	0.00	0.00	0.00	g_r
NL	-4.53	-11.75	0.00	0.00	-7.81	-10.35	g_s
	8.73	-17.45	0.00	0.00	3.23	-14.65	g_m
	4.20	-29.20	0.00	0.00	-4.58	-25.00	g_r
B	23.27	-8.12	0.00	65.47	0.00	-29.95	g_s
	5.00	-10.88	0.00	-70.18	0.00	-35.27	g_m
	28.27	-19.00	0.00	-4.71	0.00	-65.22	g_r
L	32.89	38.17	0.00	-25.28	0.00	0.00	g_s
	40.97	45.16	0.00	6.53	0.00	0.00	g_m
	73.86	83.33	0.00	-18.75	0.00	0.00	g_r

Table 5 : Shift-share components for sea navigation
(Luxembourg has no access to any sea port)

i \ j	D	F	I	NL	B	L	
D	0.00	-10.05	1.85	-23.12	9.22	0.00	g_s
	0.00	43.21	-29.74	-3.39	-51.88	0.00	g_m
	0.00	33.16	-27.90	-26.50	-42.66	0.00	g_r
F	-7.82	0.00	-8.36	29.57	25.34	0.00	g_s
	-35.70	0.00	-9.31	18.68	-4.83	0.00	g_m
	-43.52	0.00	-17.67	48.25	20.51	0.00	g_r
I	-25.82	54.41	0.00	-14.08	-57.22	0.00	g_s
	2.02	3.91	0.00	-2.11	-4.27	0.00	g_m
	-23.80	58.32	0.00	-16.19	-61.50	0.00	g_r
NL	5.30	3.95	-23.23	0.00	-15.48	0.00	g_s
	-43.11	32.00	-2.95	0.00	4.85	0.00	g_m
	-37.81	35.95	-26.18	0.00	-10.63	0.00	g_r
B	58.17	17.19	-10.59	119.19	0.00	0.00	g_s
	-55.14	-37.53	1.29	73.07	0.00	0.00	g_m
	3.03	-20.34	-9.30	192.26	0.00	0.00	g_r
L	0.00	0.00	0.00	0.00	0.00	0.00	
	0.00	0.00	0.00	0.00	0.00	0.00	
	0.00	0.00	0.00	0.00	0.00	0.00	

Table 7 : Relations showing a negative real growth

real (g_r)	-	-	-	-	-
struct. (g_s)	+	-	-	-	-
modal (g_m)	-	+	0	-	-
with	$g_s < \|g_m\|$	$\|g_s\| > g_m$		$\|g_s\| > \|g_m\|$	$\|g_s\| < \|g_m\|$
a: Railways	D - NL D - B F - NL NL - F NL - L B - NL B - D	B - F **B - L**	I - L L - I **L - B**	**D - F** **D - L** **F - D** **F - L** L - F L - NL	**D - I** **F - B** NL - D NL - B
22(73%)	7(23%)	2(7%)	3(10%)	6(20%)	4(13%)
b: Inland Navigation	**D - NL** **D - B** F - B **B - NL**	D - F D - L **NL - B** **L - NL**		F - D F - L	**NL - F** **NL - L** B - F B - L
14(70%)	4(20%)	4(20%)		2(10%)	4(20%)
c: Sea Navigation	D - I NL - D B - F	I - D NL - B **B - I**		D - NL **I - NL** **I - B** **NL - I**	D - B F - D F - I
13(65%)	3(15%)	3(15%)		4(20%)	3(15%)

key : **i j** relation with a dominant modal patronage in 1970 (cfr. Figure 2)

Inland navigation again stresses the dominant position of Rhine navigation. The channelization of the Mosel to the Euro-draft of 1,350 tons has improved the INshares from Luxembourg to Germany and France. Also the newly adapted Scheldt-Rhine connection similarly improved barging between Belgium and Germany. Both infrastructural interventions did fortunately happen on markets which already reveal a positive structural growth. Even on the traditional Rhine traffic market between the Netherlands and Germany the IN-share still improved, in spite of some structural decline in the market.

Sea navigation was known to be the dominant mode on the links from Italy to France, Belgium and the Netherlands (see Fig.2). In the 1974-78 period it still improves its position on the growing market to France. On the contrary, it looses modal patronage on the declining markets from Italy to Belgium and the Netherlands. Very typical too is the transport relation between Italy and Germany. There, the railways witnessed structural growth and modal decline, whereas sea navigation shows structural decline and modal growth. This means that the traditional shipping markets (i.e. commodities) had bad prospects and that shipping may take some cargo from the railway Alp routes. Parts of the above examples can be associated to the more intensive use of the upstream Rhone river by coastal vessels. Instead of a transhipment in a Belgian or Dutch port on the routes to Germany, the carriage is now transshipped near Lyons and further forwarded to Germany by road or rail.

In general, only 20 relations witness a positive real growth on which 7 (ie 35%) cases of a "dominant carrier". On the opposite 49 relations show a market decline, of which 19 (ie 39%) concern cases of a dominant carier. In terms of the modal component (g_m), 22 relations show modal growth of which 9 (ie 41%) cases where a dominant carrier consolidates its position. Modal decline occurs (g_m<o) on 39 relations, of which 16 (ie also 41%) apply to carriers who gradually loose their dominant position. Thus, the inland transportation market is more volatile than might have been expected.

5. Further comments

Any statistical analysis raises questions on the neutrality and robustness of its results. In particular, one may wonder to which extent the results are sensitive to changes in the used dimensions or the detail of indexation. Those arguments apply to the period of observation, the spatial detail in the zoning of origins and destinations and level of aggregation in the commodity classification.

1/ Changing the span and position of the observation period is a major source of variation. The base year of the present case study, 1974, happened to be the top year of the ECSC steel production as well as for railway traffic on the major trunk routes. Not surprisingly the structural shift-share coefficients were negative on most relations where steel products make the dominant commodity group. Nevertheless, the virtue of the shift-share procedure is that the structural tendencies are separated from the modal components. Now also the modal deviations were observed to be negative for the railways on their traditional routes. Thus changing the base year or the span of the period of observation obviously influences the results, as it does in any calculus based on growth analysis. The interpretation of the results can thus be appropriately balanced by enlarging or partioning the period of observation.

2/ The detail of origins and destinations by country has been sufficient to provide evidence on the main border-crossing capacity problems. Those are either formulated in terms of infrastructural endowment or in regulatory measures (e.g. licensing road capacity or roasters in inland navigation). In terms of infrastructural capacity the analysis sufficiently marked the urgent priorities over time. For example, the steady growth (both structural and modal) of the cross alpine traffic of the cross Alpine railway traffic from the Low Countries and France to Italy relatively emphasizes the western Alp routes (Mont Cénis,Simplon,Loetschberg & Gotthard) rather than the eastern Brenner route. This is fully compatible with recent investment studies. In France, the modernization of the "Mont Cénis" connection (Modane-Turin) has up to now been the only railway project financed by a European Investment Bank loan. Also in Switzerland, all proposals to pierce additional North-South railway tunnels at the East of the Gotthard (in order to make Engadin more accessible to international trade routes) have been cancelled on the basis of detailed origin-destination studies and predictions.

Apart from the above cases where nationwide destinations are sufficiently informative, some applications might call for a finer detail (eg the "EEC Transport Regions" for larger countries). It remains in any case a matter of judgment to scale the detail of the observation appropriately to the purpose of the investigation.

3/ The commodity classification follows the one-digit NST/R nomenclature giving only 10 major groups. A two-digit classification would have provided the detail of 24 commodities. Now, the relative detail of the commodity classification may influence the relative growth, attributed to structural and modal components. To clarify this statement, let us assume one relation, two modes (eg road & rail) and two commodities, semi-finished (SM) and finished (FP) products. Further detail on the example and traffic figures are given below:

flow	traffic(t°)	share	traffic(t_1)	growth(%)
rail (SM)	21 tons	81 %	14 tons	- 33 %
road (SM)	3 tons	50 %	2 tons	- 33 %
total (SM)	24 tons	--	16 tons	- 33 %
rail (FP)	5 tons	19 %	5 tons	00 %
road (FP)	3 tons	50 %	8 tons	+ 167 %
total (FP)	8 tons	--	13 tons	+ 63 %
tot.(SM+FP)	32 tons		29 tons	- 11 %

Now, if the shift-share components are calculated for the weighted commodity classes (SM and FP) the results are:

	struct. growth	modal deviation	real growth
rail	- 14.76 %	- 11.97 %	- 26.7 %
road	15. %	52. %	+ 67.0 %

whereas, when the SM and FP products are aggregated to one commodity class the results become:

rail	- 11. %	- 16. %	- 26.7 %
road	- 11. %	+ 78. %	+ 67.0 %

The example evidently results in the same weighted real growth, but the modal switches become relatively more important when aggregation increases. The reason for those results is a structural switch in the market for transport services from semi-finished toward finished products, at the same time reducing total volume by 11%.

For semi-finished products both road and rail had stable market shares and their real decline was identical to market decline (-33%). For finished products, rail holds a constant tonnage but looses its modal share by virtue of the sharp rise in FP-traffic by road. When both products are put separately, road obtains a positive structural coefficient since the 167% growth of FP is for 50% attributed to the road market and only for 19% to railways. In other words, road is assumed to penetrate on a new market whereas railways are relatively more concentrated on a declining market. At the same time, the railways modal share on the FP-market declines, resulting in a negative modal deviation. When both products are aggregated, the difference between 'new' and 'old' markets vanishes, and the switch from much SM-traffic by rail toward more FP-traffic by road is entirely attributed to modal choice.

The example is relevant in that exactly the same situation occurs in the heavy industry where one progressively notices a switch from semi-finished products (comm.class 5) toward finished products & machinery (comm.class 9).

The discussion nevertheless remains open, whether sectorial shifts in the type of traffic should be completely considered as a structural or a modal component. It is clear, however, that various shift-share studies, using different disaggregation, cannot be compared.

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6. Conclusion

Shift-share analysis is useful in analyzing trends in inland transportation markets. As any statistical method, it is sensitive to the used indexation over time, space and commodity classification. Exagerate detail may overwork the purpose of the method at the expense of the quick interpretation of the results. It seems also irrelevant to put extreme detail in one dimension (eg. commodity groups) while leaving space in an aggregated form. Rather, the art consists in balancing the dimensions approproately in order to obtain comparative market 'snapshots' over time.

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annexe: NST/R classification

0 : agricultural products & live animals
1 : foodstuffs & animal fodder
2 : solid mineral fuels
3 : petroleum products
4 : ores & metal waste
5 : metal products
6 : crude & manufactured minerals; building materials
7 : fertilizers
8 : chemicals
9 : machinery, transport equipment, manufactured and miscellaneous articles.

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references (sources, including text references)

1/ EUROPEAN COMMUNITIES, Europa Transport, Observations on the transport market, Brussels, E.C., regular publications from 1978 on five themes:

a/ market development,
b/ results of quaterly surveys carried out among transporters,
c/ annual reports on the transport sector activity including short term forecasts,
d/ reports on the evolution of price and cost indices,
e/ analyses of the medium-term developments in the transport marker,

2/ PERLOFF H.S., E.S. DUNN, E.E. LAMPARD, R.F. MUTH, Regions, Resources & Economic Growth, Baltimore, 1960, Resources for the future; and E.S. DUNN, "A Statistical Technique for Regional Analysis, in Papers & Proceedings of the R.S.A., 1960, p. 97-112; for further discussion and references see: G.L. DE BRABANDER, Regional Specialization, Employment and Economic Growth in Belgium, New York, 1981, Arno Press, viii + 275 p; pp. 26-30.

3/ CLAESSENS E.M., Methods of applied railway-economics; the case of the E.E.C., Ph.D. diss., Antwerp, 1980, 1022 p.

4/ ZACCHIA C., International trade and capital movements, in CIPOLLA (editor), Economic History of Europe, "The twentieth Century", Pelican, 1976, pp. 509-602.

5/ EUROPEAN COMMUNITIES, Eurostat, Transport Statistics, Brussels/Luxembourg, 1974-1981, EC publications office.

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