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STRUCTURAL CHANGES OF THE ECONOMIC REGIONS IN POLAND: A STUDY BY FACTOR ANALYSIS OF COMMODITY FLOWS

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INTRODUCTION

Between the elements of spatial economic structure there are various types of linkage. Among these, of particular areal significance, are those revealing the spatial links which occur between various phases of the production process as well as between production and consumption. These are expressed above all in the exchange of all kinds of goods and services. Such exchanges are reflected most strikingly in commodity flows. These flows establish a basic measure of the links, i.e., interregional links binding together the fundamental structural elements of space economy; these elements are the economic regions. That the phenomenon of commodity flows is a measure of inter-regional connections is substantiated by the fact that such flows reveal the magnitude of goods exchanged which, in turn, expresses a geographical division of labour seen in the specialization and complexity of individual economic regions.

The inter-regional exchange is deeply rooted in the chain of basic relations of economic processes. Essentially, it is the inequality within the regions between the level and structure of production and the level and structure of consumption which forms the basis for inter-regional exchange.

The breakthrough in research on inter-regional connections based on commodity flows was achieved by E. Ullman (1957) who worked out for the United States the pattern of commodity flows between states, and presented the characteristics of certain states from an interpretation of flow phenomena. However, it was only later through the efforts of W. Isard (1954, 1961) that the theoretical conclusions resulting from such analyses were applied to the investigation of regional patterns. According to W. Isard, investigations of commodity flows establish the essential contents of inter-regional dependence which are not taken into account in the Lösch's (1940) regional model. Commodity flows also throw light on the existence of regions of different order in a hierarchical arrangement of regional structure.

This type of research was undertaken in Poland by Z. Chojnicki (1961, 1964) and W. Morawski (1968 a, b).

Z. Chojnicki determined the degree of integration and differentiation of the nation's spatial structure based on the rail traffic flows between the voivodships for 1958. This study revealed that Poland is one region, its economic centre being Upper Silesia. Only within this primary transport region some additional subareas can be distinguished. Within the core area of industrial production conceived on a national scale there are — outside the Upper Silesian conurbation — two subcentres: Wrocław strongly related to the north-western part of the whole country and Cracow related to the south-eastern part. Moreover, there are several subregions characterized by more intensive exchange of some products within them than with other areas. To these belong the north-eastern part of the country with Warsaw at its main economic centre and the west-northern part with Poznań and the main seaports. The importance of this is however reduced because the author, having limited statistical data at his disposal, discusses these inter-regional flows only in terms of tonnage and not of monetary value.

W. Morawski continued the research of inter-regional flows using value data for 1962. The results confirm that the whole regional system of Poland exhibits a conspicuous orientation towards the region of Upper Silesia.

A somewhat different approach, but perhaps the most promising for the structure of flow patterns, was adopted by B. J. L. Berry (1966, 1967, 1968). His methods is based on the extraction of redundancies in the $m \times m$ correlation of commodity flows using factor analysis. In R-mode analysis, the (column) correlation matrix is factored, yielding groups of destinations (factor loadings) similar in terms of the manner in which their needs are assembled. The factor scores identify those origins important in shipping to each group. Q-mode analysis results in essentially the same information for origins. Berry's analysis of Indian commodity flows between 36 trade blocks follow this methodology.

The concept of the flow matrix is further employed by B. J. L. Berry (1966, 1968) in his general field theory of spatial structure and spatial behaviour. This theory considers a system that consists of places, attributes of places, and interactions between places, all seen through time. Factoring the $n \times a$ attribute matrix yields a structural dimension, and an $n \times s$ structure matrix can be created. Similarly, various forms of interaction, including commodity flows of different kinds, can be used to build an $(n^2-n) \times y$ interaction matrix, where (n^2-n) dyads are treated as individual observations. This matrix can be reduced to an $(n^2-n) \times b$ behaviour matrix, again by factor analysis. Cannonical correlation analysis provides the means of observing the similarity between places and groups of places in terms of their scores on the structural and behavioral dimensions.

THE SCOPE OF THE STUDY

This study will analyse the structural changes of economic regions in Poland based on railroad commodity flows during the period 1958-1966.

Railroad transport in Poland plays a major role in the inter-regional exchange of goods. In Poland the railways share the largest part of the total freight tonnage moved (82,1%) and of all transportation movements (95,3%). This justifies to a high degree the representative character of railway transport as an indicator of commodity flows.

Data from the official state statistics of commodity flows by railways between 17 voivodships in 1958 and 1966 served as the starting-point. These data are published in the form of matrices, the volume of the flows being recorded in physical units of measurement, i.e., in tons. The matrices contain commodity flows for the following 17 freight groups:

(1) bituminous coal,
(2) brown coal and coke,
(3) ores and pyrites,
(4) stones,

(5) sands and gravels,
(6) crude and refined petroleum,
(7) metals and metal manufactures,
(8) bricks,
(9) cement,
(10) artificial fertilizers,
(11) chemical products,
(12) grains,
(13) potatoes,
(14) sugar beets,
(15) other crops and processed agricultural products,
(16) timber and timber manufactures,
(17) other freight.

However, there are obvious limitations to the scope of the conclusions and estimates resulting from the regional implications of the physical volume of commodity flow. Thus, those data on the physical volumes of the flows have been processed so as to achieve their (estimated) value size. This processing has been completed on the basis of a value index of the particular 17 groups of commodities, which was estimated by W. Morawski (1967). These indices are presented in Table 1.

TABLE 1. Index of value of one ton of commodities dispatched by railways based on the 1962 structure of production and dispatches

Group number	Categories of commodities	Value of one ton in zl (in factory prices)
(1)	Bituminous coal	350
(2)	Brown coal and coke	555
(3)	Ores and pyrites	450
(4)	Stones	95
(5)	Sands and gravels	45
(6)	Crude and refined petroleum	1985
(7)	Metals and metal manufactures	4580
(8)	Bricks	235
(9)	Cement	450
(10)	Artificial fertilizers	1060
(11)	Other chemical products	5310
(12)	Grains	3200
(13)	Potatoes	837
(14)	Sugar beets	505
(15)	Other crops and processed agricultural products	3800
(16)	Timber and timber manufactures	2040
(17)	Other freight	7540

The value of commodity flows based on the statistics of railway freight haulage, from the point of view of their application to regional analysis, is limited with respect to the following:

(1) The 17 voivodships as the consigning-receiving units provide too little spatial detail and permit an analysis of commodity flows only on a macro-regional scale. This limits analysis to higher order regions only.

(2) There is insufficient differentiation in generic grouping of freight in the 16 classified groups. From the economic point of view these do not have an homogeneous character and this makes impossible any differentiation in the individual types of raw materials and finished products. This also applies to any introduction of economic accounting in terms of monetary value.

(3) Other limitations result from the existence of crosshauls, extenuated hauls and back-hauls which do not represent true economic links.

Despite this, however, a comparison of railway freight flows on the inter-regional scale does show the existence of basic regional contrasts which, from the point of view of regional analysis, possess fundamental significance: they permit one to grasp the chief inequalities in the distribution of the output of raw materials and mass products, and they reflect the major elements of the geographical division of labour.

The definition of Poland's regional structure on the basis of the statistical material characterized above is limited to the existing voivodship framework. There is no possibility of achieving a correction of this division and as a result, one can only approximate reality.

Recognition of this fact limits the investigation of regional structure to the voivodship as the basic element, therefore establishing the administrative-economic units as the economic regions. It must be emphasized that the degree to which such an analysis is adequate is closely defined by the suitability of this initial system; only to that extent can one accept this analysis of the regional economic structure of the country.

Analysing the structure of the system of economic regions in this form is an exercise in definition based on flows, types of commodities of the economic regions, as well as on the links occurring between them. Investigation of the system's structure depends on the elaboration of the kind of relationships arising between the system's elements. The complex of these relationships can be named according to the nature of the connecting elements. This establishes a substitute for research on the regional structure because it permits the recognition of the whole feature of these structural elements as well as the existing relations between them. This emerges only from the investigation of regional peculiarities, and results from the individual features which distinguish one region from other regions.

Referring the investigation of regional structure to that of the spatial regional structure as given, the analysis can proceed to the first important problem, that of the complexity of the system of economic regions regarding their character as elements of that system, and the links between them.

THE ANALYSIS

The analysis of regional structure of Poland in this paper is based on the application of two methods:

(1) principal factor method introduced by H. Hotelling (1933),

(2) grouping algorithm presented by J. D. Nystuen and M. F. Dacey (1961).

The mathematical procedure starts from an interaction matrix of the order 272×17, in which the (17^2-17) possible pairs of voivodship-regions (dyads) occupy the rows and 17 kinds of interaction (commodities) occupy the columns. Dyads are treated as individual observations. The types of commodity become the variables in this analysis.

This matrix is transformed into a matrix of standardized data, also of type 272×17, which consists of the values of the particular standardized variables expressed in units of standard deviation.

Normalization is completed on the basis of the formula:

$$z_{ij} = \frac{x_{ij}-\bar{x}_j}{s_j} \qquad \begin{array}{l} i = 1, 2, \dots N, \\ j = 1, 2, \dots n, \end{array} \tag{1}$$

where:

x_{ij} = value of variable j of dyad i,

$\bar{x}_j$ = mean of N values of variable j (N denotes the number of dyads),

s_j = standard deviation of variable j.

The relationships between variables are expressed by help of the coefficient of correlation:

$$r_{jk} = \frac{\sum_{i=1}^{N} z_{ij} z_{ik}}{N}. \tag{2}$$

The correlation matrix of order n is a symmetrical matrix.

Multiple factor analysis extracts the factor (hypothetical variables), which constitutes the basis of correlations observed in a given set variables (x_1, x_2,... x_n). These factors may be treated as causes of the variation observed; it is then possible to interpret them as being of considerable importance in the measurement and explanation of variation. Factor analysis helps to reduce a primary set of variables that are characteristic of the objects under observation to a considerably smaller number of factors. In this manner, the number of dimensions of the objects diminishes and analysis becomes simpler.

In factor analysis n observed variables characterizing a set of N dyads is linear function of m unknown "common factors" (F_1, F_2, ... F_n), where $m < n$ and a "unique factor" for each of the variables (U_1, U_2,... U_n):

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \dots a_{jm}F_m + a_j U_j, \tag{3}$$

where a' s are called factor loadings.

If we assume that both the observed variables and the factors are at standard form (i.e. with the mean equal to zero and the variance equal to unity) and if we further assume that the factors are uncorrelated, then the variance of the observed variables, z_j, can be computed from

$$s^2_{zj} = 1 = a^2_{j1} + a^2_{j2} + \dots + a^2_{jm} + a^2_j = h^2_j + a^2_j; \tag{4}$$

h^2_j is called the communality and it is that part of the variance of the observed variable, which is due to the common factors, while a^2_j the uniqueness is that part of the variance, which is due to the unique factor.

Factor analysis, as D. N. Lawley and A. E. Maxwell (1963) emphasize, usually implies some hypothesis as to the number of common factors underlying the set of variables in the research problem.

Factor analysis, which consists in examing the communality of features resulting from the operation of common factors, is carried out on reduced correlation matrix in the form:

$$R = \begin{bmatrix} h^2_1 & r_{12} & \cdots & r_{1n} \\ r_{21} & h^2_2 & \cdots & r_{2n} \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ r_{n1} & r_{n2} & \cdots & h^2_n \end{bmatrix} \tag{5}$$

h_j^2 denotes the communality of variable j and is approximated from the formula:

$$h_j^2 = \frac{r_{jk} r_{jl}}{r_{kl}} \qquad j = 1, 2, \dots n, \tag{6}$$

where r_{jk} and r_{jl} are maxima coefficients of correlation of variable j.

The basic problem of factor analysis is to determine the coefficients $a_{j1}, \dots a_{jm}$ of the common factors. This determination can be made by principal factor method.

The principal factor method makes possible the extraction of factors, which explain the maximum communality and give the smallest possible residuals in the correlation matrix. This means, that the sum of squares of the factor loadings is the largest possible for each variable.

The analysis begins with a factor F_1 whose contribution to the communality of the variables has as great a total as possible. Then the first — factor residual correlation is obtained, including the residual communalities. A second factor F_2, independent of F_1, with a maximum contribution to the residual communality is next found. This process is continued until the total communality is analysed.

If the composition of a statistical variable is taken to be

$$z_j = a_{j1} F_1 + a_{j2} F_2 + \dots + a_{jm} F_m \qquad j = 1, 2, \dots n, \tag{7}$$

with the unique factor omitted, the communality of z_j is then given by:

$$h_j^2 = a_{j1}^2 + a_{j2}^2 + \dots a_{jm}^2. \tag{8}$$

The sum of the contribution of factor F_1 to the communalities of the n variables is

$$A_1 = a_{11}^2 + a_{21}^2 + \dots + a_{n1}^2. \tag{9}$$

The solution of the problem consists in finding such values of the coefficients a_{j1} for which A_1, assumes the maximum value, the following condition being fulfilled:

$$r_{jk} = r'_{jk} = \sum_{t=1}^{m} a_{jt} a_{kt} \qquad j, k = 1, 2, \dots m. \tag{10}$$

We have here a problem involving the maximization of A_1, a function of several variables which in turn are connected by a set of relationships. The mathematical procedure as outlined in H. H. Harman (1960) involves the use of Lagrangian multipliers to obtain a set of n equations of the form

$$\begin{bmatrix} h_1^2-\lambda & r_{12} & \cdots & r_{1n} \\ r_{21} & h_2^2-\lambda & \cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & h_n^2-\lambda \end{bmatrix} \begin{bmatrix} a_{11} \\ a_{21} \\ \vdots \\ a_{n1} \end{bmatrix} = 0 \tag{11}$$

These equations constitute the bass for the calculation of the unknown coefficients a_{j1}.

A necessary condition for the solution of this set of equations is that the determinant of the coefficients a_{j1} must be equal to 0.

$$\begin{vmatrix} h_1^2-\lambda & r_{12} & \cdots & r_{1n} \\ r_{21} & h_2^2-\lambda & \cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & h_n^2-\lambda \end{vmatrix} = 0 \tag{12}$$

This is a characteristic equation, in which all roots are real.

Corresponding to the first root or eigenvalue of this equation is a column vector or eigenvector $(\alpha_{11}, \alpha_{21}, \dots \alpha_{n1})$, which when scaled by the factor yields the coefficients $a_{11}, a_{21}, \dots a_{n1}$.

$$\left(\frac{\lambda_1}{\alpha_{11}^2 + \alpha_{21}^2 + \alpha_{n1}^2} \right)^{1/2} \tag{13}$$

The residual correlation matrix $[R']$ can then be computed as and the solution could proceed with finding the largest eigenvalue of this residual matrix, and so on.

$$[R'] = [R] - [a_{j1}][a_{j1}]^T \tag{14}$$

H. Hotelling introduced a simplified method of calculating factor loadings in solving the main factor. He used an approximate determination of the characteristic roots by the iteration process method without the previous unfolding of the characteristic determinant (H. H. Harman, 1960).

In this paper H. Hotelling's iterative method is used. The solution was based on a programme in Gier Algol IV language using the Gier computer.

The computer-derived solution in our example yields the following eigenvalues:

for 1958 $\lambda_1 = 7{,}9695$, $\lambda_2 = 2{,}8342$,

for 1966 $\lambda_1 = 5{,}2469$, $\lambda_2 = 3{,}1879$.

Each eigenvalue accounts for a percentage of the total common variance.

The question of how many factors should be interpreted is difficult. A convenient rule of thumb seems to be to evaluate all factors with an eigenvalue equal to or greater than one or, alternately to evaluate each one which accounts for a sufficiently high proportion of this communality.

In this example, factor analysis carried out by the principal factor method yields the factorial matrices of type 17×2 for 1958 and 1966, which contain the loadings of two factors in 17 variables (Table 2 and 3). Two factors accounted for 95% of a total common variance in 1958 and 75% in 1966.

The interpretation of the factors is usually important in a research problem. This interpretation is done mainly with reference to the factor loadings, which have the form of a coefficient of correlation between the variable and a given factor.

On any factor some variables will have low loadings and consequently will be ignored in the process of giving an interpretation to the factor.

We assume, that the regional structure is a linear function of some simple patterns and the factors in the linear model should illustrate the simple structure.

In 1958 an underlying two-factor structure was revealed. Factor I, accounting for 70.32% of common variance, consist of three groups: (1) raw materials of mineral origin (bituminous coal, brown coal and coke, ores, stones,

TABLE 2. Factor structure
Dyadic analysis of 17 commodities in Poland, 1958

Group number	Categories of commodities	Factor loadings I	Factor loadings II
(1)	Bituminous coal	0.6958	−0.4241
(2)	Brown coal and coke	0.8649	−0.3570
(3)	Ores	0.8221	−0.3998
(4)	Stones	0.5925	0.0087
(5)	Sands and gravels	0.9033	−0.1220
(6)	Crude and refined petroleum	0.4266	0.0561
(7)	Metals and metal manufactures	0.7814	−0.3945
(8)	Bricks	0.7623	0.3239
(9)	Cement	0.5963	−0.2578
(10)	Artificial fertilizers	0.4901	0.1274
(11)	Other chemical products	0.8900	−0.3023
(12)	Grains	0.4901	0.1274
(13)	Potatoes	0.2709	0.5307
(14)	Sugar beets	0.4304	0.7131
(15)	Other crops and processed agricultural products	0.3144	0.4502
(16)	Timber and timber manufactures	0.7683	0.4523
(17)	Other freight	0.9477	0.0455
	λ	7.9695	2.8342
	Per cent of common variance explained by the factor	70.32	25.01

sands and graves), (2) industrial goods (metals and metal manufactures, bricks, cement, artificial fertilizers, other freight), (3) timber and timber manufactures. Accounting for 25% of communality, Factor II represent agricultural products. Strong loadings are recorded by the commodities: grains, potatoes, sugar beets.

In 1966 situation changed very much. The identification of factors is not so clear. Factor I explains only 46% of the total common variance of the variables and comprises mainly industrial products and ores (ores, metals and metal manufactures, other chemical products, other freight), agricultural products (grains, sugar beets, other crops and processed agricultural products), timber and timber manufactures. Factor II is based primarily on the loadings by the raw materials for fuel and building (brown coal and coke, stones, bricks). This factor explains about 28 per cent of the communality of features.

Then the factor scores for dyads were evaluated according to the equation

$$[F] = [Z][A], \quad (15)$$

where

$[F]$ = matrix of factor score,
$[Z]$ = an observation matrix,
$[A]$ = matrix of factor loadings.

This factor scores matrix of type 272×2 was transformed into two matrices for every year (1958 and 1966) of order 17, being a starting-point for the spatial

TABLE 3. Factor structure
Dyadic analysis of commodities in Poland, 1966

Group Number	Categories of commodities	Factor loadings I	Factor loadings II
(1)	Bituminous coal	−0.0003	0.1868
(2)	Brown coal and coke	0.4951	0.7492
(3)	Ores	0.6580	0.6498
(4)	Stones	0.5530	0.7135
(5)	Sands and gravels	0.4488	0.0563
(6)	Crude and refined petroleum	0.1928	−0.1293
(7)	Metals and metal manufactures	0.5610	−0.2515
(8)	Bricks	0.4700	0.7355
(9)	Cement	0.3290	−0.0017
(10)	Artificial fertilizers	0.3993	0.0961
(11)	Other chemical products	0.5629	−0.3587
(12)	Grains	0.8197	0.0882
(13)	Potatoes	0.3303	0.0704
(14)	Sugar beets	0.6983	−0.4895
(15)	Other crops and processed agricultural products	0.7201	−0.5430
(16)	Timber and timber manufactures	0.7392	−0.2677
(17)	Other freight	0.7547	−0.5283
λ		5.2469	3.1879
Per cent of common variance explained by the factor		46.07	27.99

grouping, which we can call "latent structure matrix" or using the term of B. J. L. Berry "the behaviour matrix".

Each cell of the matrix corresponds to a different element of interregional exchange, i.e., to a different inter-regional connection. The cells on the main diagonal referring to connection within each of the particular regions were omitted.

In the rows of the matrix for every factor we read outflows in the term of factor score from the particular regions i.e. their active connections, whereas in the colums we read the inflows, i.e., the passive connections (Tables 4—7).*

FACTOR INTERPRETATION

The second step of our analysis is associated with the problem of generalizing two basic factors into a system of regional structure, changing in time. This analysis requires the grouping together of voivodships on the basis flows in the term of dyad factor scores.

As the method of grouping dyads for each factor we used the method described by J. D. Nystuen and M. F. Dacey (1961), applied originally to telephone traffic in Washington. The application of basic theorems of graph theory interpretation by J. D. Nystuen and M. F. Dacey, permits hierarchical relations between voivodships to be established in two aspects: outflows (active connections) and inflows (passive connections). If the connections in terms of factor

* Tables 4—7 at the end of the volume

scores are ranked according to their magnitudes in the rows and columns, it is possible to determine the dominant and subordinate voivodships. The dominant voivodship is one which records its largest flow to a lower order voivodship. The subordinate voivodship is one for which the largest flow is to a higher order voivodship (Fig. 1).

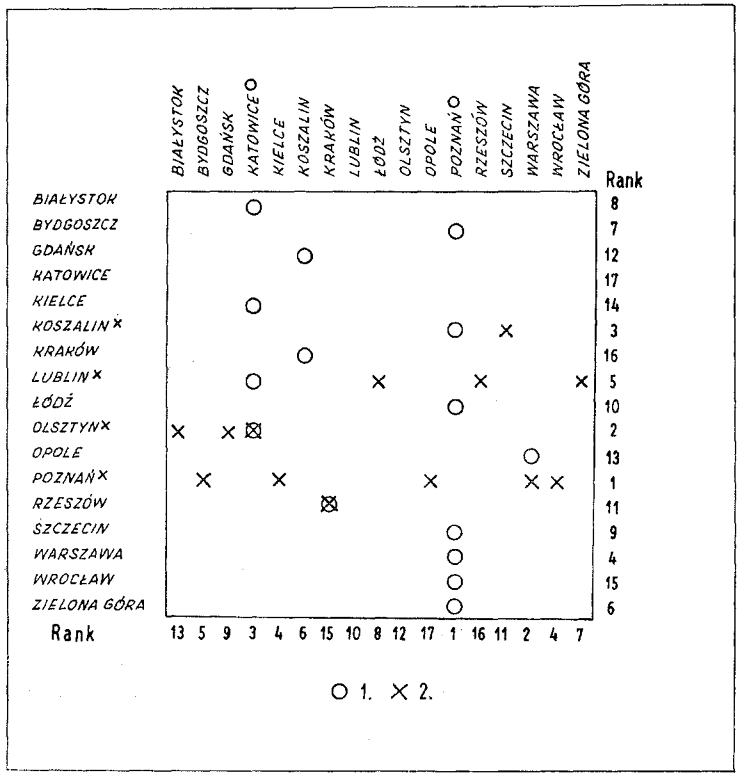

Fig. 1. Adjacency matrix of graph F_2 (1958)
1 — largest outflow; 2 — largest inflow

The resulting hierarchy structure describing the regional pattern for each factor in both years is presented on 8 graphs for passive and active connections (Figs. 2–9).

The structure established by isolating the largest flows in the same manner as was described on graphs permit maps to be drawn of regional structure. The pattern of connection presented on maps establishes a synthetic description of the complexities of the country's regional structure. That complexity is expressed in the differentiation of various forces integrating the inter-regional links.

The main descriptive conclusions concerning regional structure, can be drawn from a comparative analysis of changes in time of factor one, which identified the mining and manufacturing industry. First of all the whole regional system of country exhibits the most intensive connections with Katowice. The connections with Katowice occupy first place in the inter-regional flows of all other regions, endowing Katowice with a focal character on the national scale. This defines the role of Katowice (The Upper Silesian Industrial District) as that area upon which are focussed the productive-industrial activities of the country, the basic sections of heavy industry: coal-mining, metallurgy, engineering and

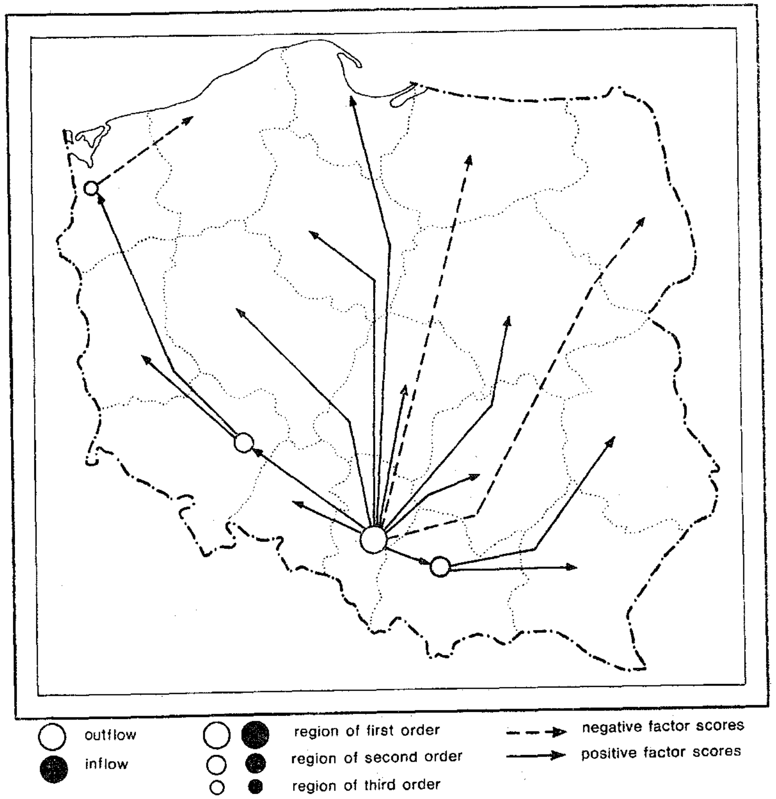

Fig. 2. Factor I. Interregional active connections, 1958

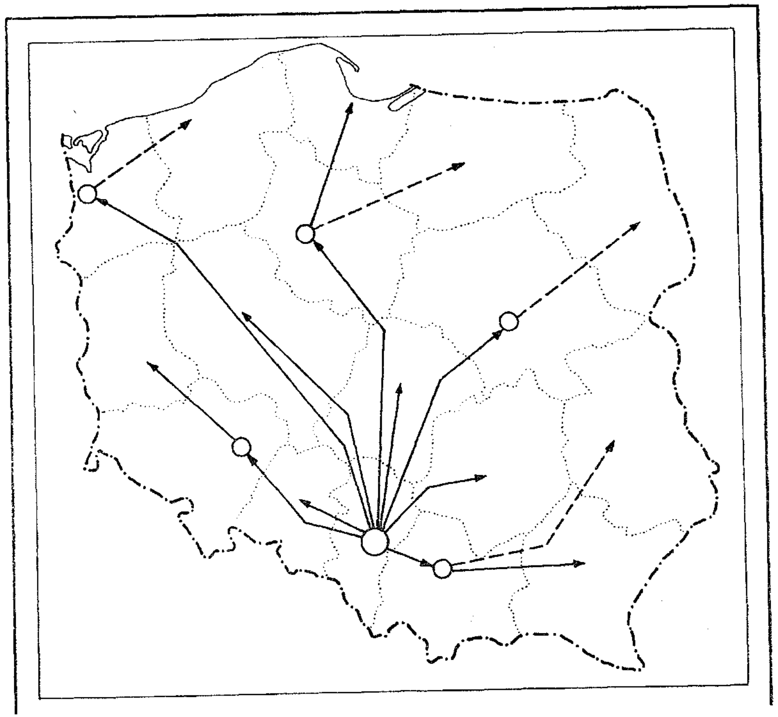

TABLE 8. Regional structure of Poland

Factor	Kind of connections	1958			1966		
		I order	II order	III order	I order	II order	III order
	active connections	(1) Katowice (whole country)	(1) Wrocław (Zielona Góra, Szczecin, Koszalin) (2) Kraków (Rzeszów, Lublin)	(1) Szczecin (Koszalin)	(1) Katowice (whole country)	(1) Wrocław (Zielona Góra) (2) Szczecin (Koszalin) (3) Bydgoszcz (Gdańsk, Olsztyn) (4) Warszawa (Białystok) (5) Kraków (Lublin, Rzeszów)	
Factor I	passive connections	(1) Katowice (whole country)	(1) Bydgoszcz (Gdańsk) (2) Warszawa (Poznań, Zielona Góra, Szczecin, Olsztyn, Białystok, Lublin) (3) Kraków (Rzeszów)	(1) Poznań (Zielona Góra)	(1) Katowice (Opole, Wrocław, Zielona Góra, Bydgoszcz, Gdańsk, Warszawa, Białystok, Kielce, Kraków, Rzeszów, Lublin) (2) Poznań (Koszalin, Łódź)	(1) Wrocław (Zielona Góra) (2) Bydgoszcz (Gdańsk) (3) Warszawa (Białystok) (4) Kraków (Rzeszów, Lublin)	(1) Rzeszów (Lublin)
	active connections	(1) Olsztyn (Gdańsk, Białystok, Katowice) (2) Koszalin (Szczecin) (3) Poznań (Wrocław, Opole Kielce, Bydgoszcz, Warszawa) (4) Lublin (Zielona Góra, Rzeszów, Łódź, Kraków)	(1) Rzeszów (Kraków)		(1) Katowice (whole country)	(1) Wrocław (Zielona Góra)	
Factor II	passive connections	(1) Poznań (Zielona Góra, Szczecin, Koszalin, Bydgoszcz, Warszawa, Gdańsk, Wrocław, Opole, Łódź, Kraków, Rzeszów) (2) Katowice (Lublin, Kielce, Olsztyn, Białystok)	(1) Koszalin (Gdańsk, Kraków, Rzeszów) (2) Warszawa (Opole)	(1) Kraków (Rzeszów)	(1) Wrocław (Warszawa, Zielona Góra, Katowice, Poznań, Szczecin, Rzeszów) (2) Kraków (Koszalin, Białystok) (3) Łódź (Lublin, Bydgoszcz) (4) Kielce (Gdańsk, Opole)	(1) Rzeszów (Poznań) (2) Warszawa (Szczecin) (3) Koszalin (Białystok) (4) Lublin (Bydgoszcz) (5) Opole (Olsztyn)	

chemicals. The high degree of its specialization links it with a wide area, and as a result, gives a unity which is the functional basis of its ability for full complex economic development; thus simultaneously it also establishes its own inner coherence. The high intensity of the commodity flows of Katowice, the uniformity of links, the active and passive type of dependence and its character as an open economic region reflect the predominant role played by the raw materials and industry of this region in the structure of the national economy. As a result of its nodal organization, therefore, Katowice can be considered as the focal economic region in the national system with no changes in active connections in time. (Table 8).

Second order pattern is different for active and passive connections. The active connections constitute two regions: Wrocław and Kraków voivodship, the passive connections — three: Bydgoszcz, Warszawa, Kraków voivodship. The changes in time in the second order patterns show the further differentiation and origin of new regional centres: active — Szczecin, Bydgoszcz, Warszawa voivodship; passive — Wrocław voivodship.

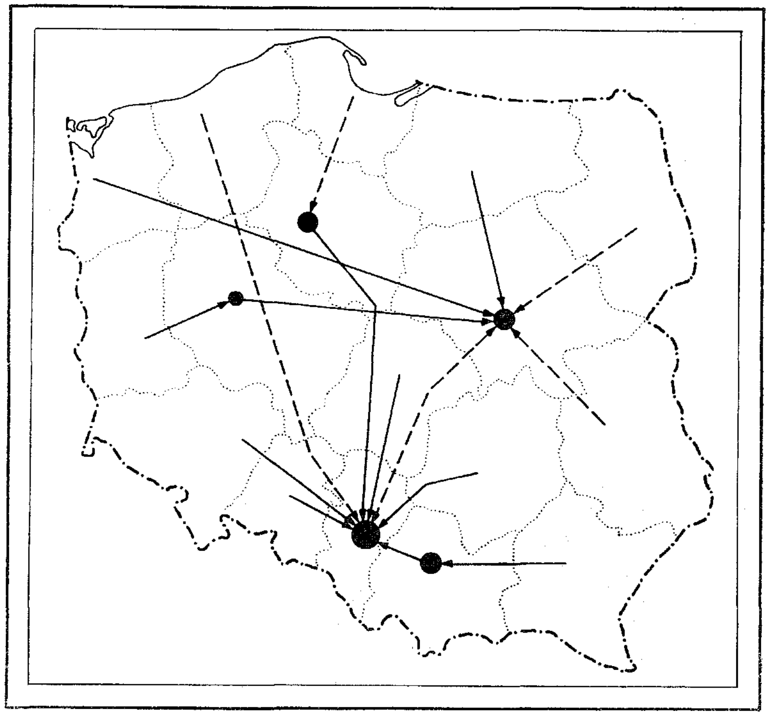

Fig. 4. Factor I. Interregional passive connections, 1958

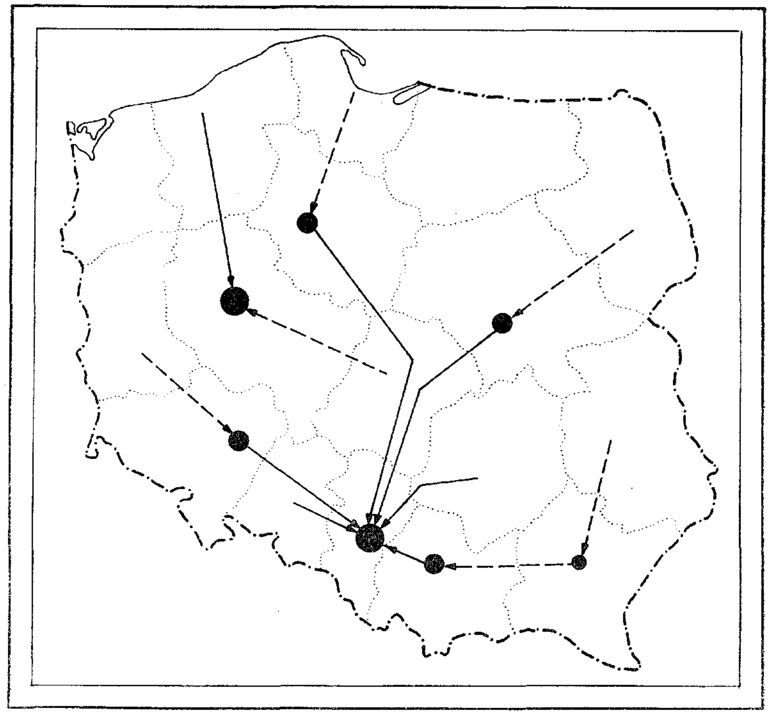

Fig. 5. Factor I. Interregional passive connections, 1966

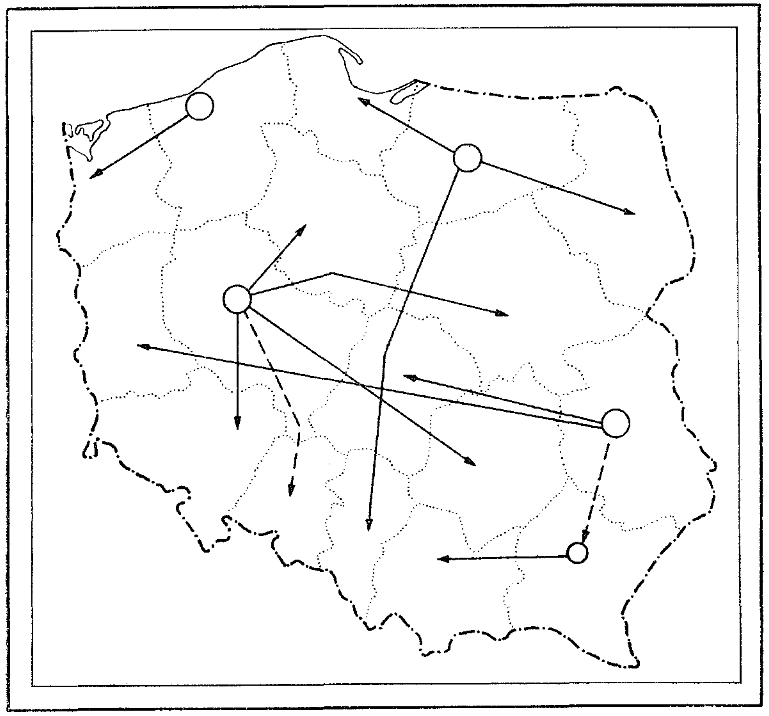

Fig. 6. Factor II. Interregional active connections, 1958

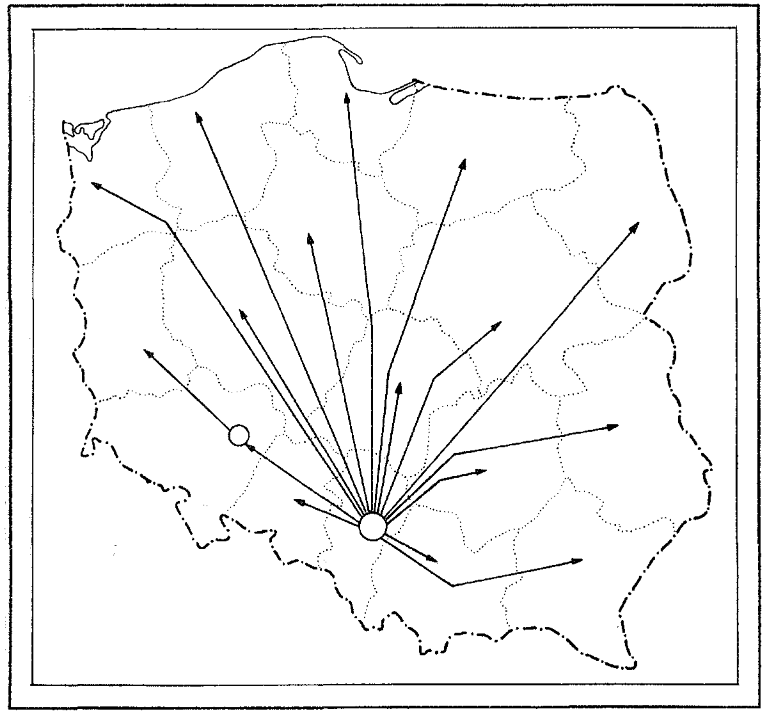

Fig. 7. Factor II. Interregional active connections, 1966

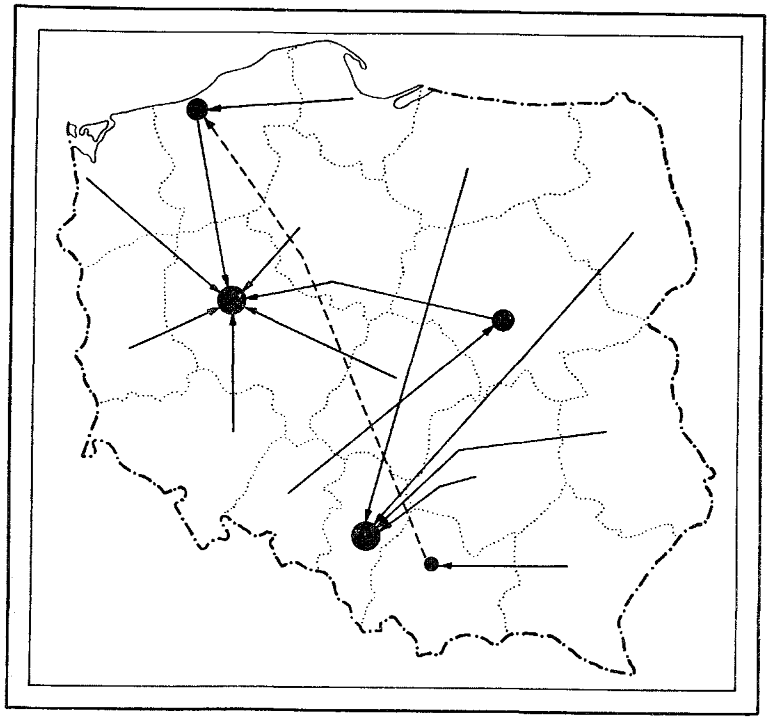

Fig. 8. Factor II. Interregional passive connections, 1958

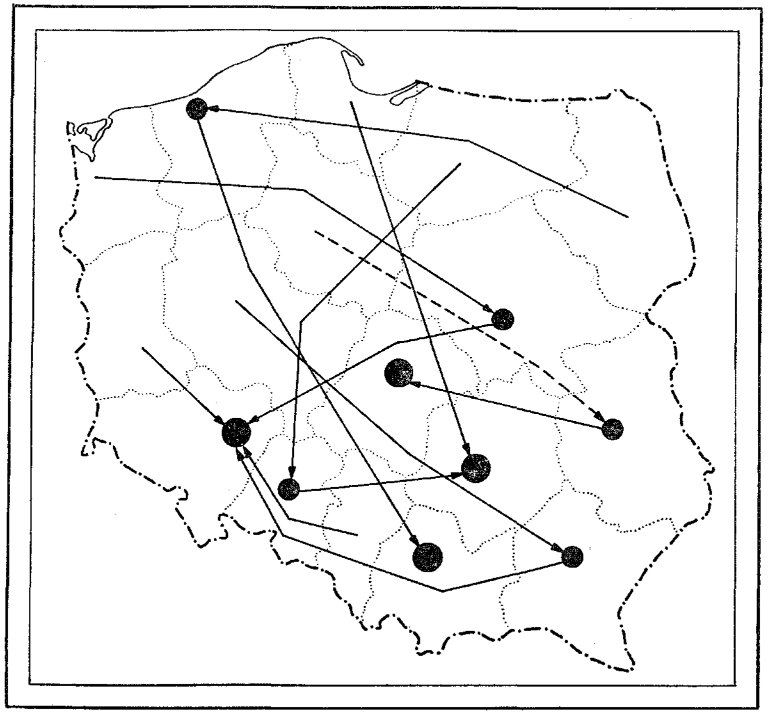

Fig. 9. Factor II. Interregional passive connections, 1966

The system is much more complicated and some subordinated regions are not continuous to its superior regions. This is probably partly attributable however to the some changes in the nature of the factor including also agricultural flows.

Factor two in 1958 picks out mainly agricultural patterns. These relations permit one to find certain elements for division into structure of more uniform regional organization. The nature of the second factor is not the same in 1966. This is why we can not compare the resulting structure in time. In 1966 second factor identifies the raw materials for fuel and building.

In the analysis of commodity flows for the purpose of organization of regions into a hierarchy one must emphasize that the different types of connections give varied organization, which is insufficiently integrated to establish the clear functional regional system.

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BIBLIOGRAPHY

Berry, B.J.L., 1966, *Essays on commodity flows and the spatial structure of the Indian economy*, University of Chicago, Dept. of Geography, Research Paper 111.

Berry, B. J. L., 1967, The mathematics of economic regionalization, in *Proceedings of the 4th General Meeting of the Commission on Methods of Economic Regionalization of the International Geographical Union*, September 7–12, 1965 in Brno, Prague, 77–106.

Berry, B. J. L., 1968, Interdependence of spatial structure and spatial behavior: A general field theory formulation, *Papers, Reg. Sci, Ass.*, 21, 205–227.

Chojnicki, Z., 1961, *Analiza przepływów towarowych w Polsce w układzie międzywojewódzkim* (The analysis of commodity flows in Poland in an intervoivodship pattern), Studia KPZK PAN, 1, Warszawa.

Chojnicki, Z., 1964, The structure of economic regions in Poland analysed by commodity flows, *Geogr. Pol.*, 1, 213–230.

Harman, H. H., 1960 *Modern factor analysis*, The University of Chicago, Chicago.

Hotelling, H., 1933, Analysis of a complex of statistical variables into principal components, *J. Educ. Psychol.*, 24, 417–441, 498–520.

Isard, W., Freutel G., 1954, Regional and national product projections and their interrelations, in *Studies in income and wealth*, 16, 427–471.

Isard, W., 1961, *Methods of regional analysis: An introduction to regional science*, New York, 132–181.

Lawley, D. N., Maxwell, A. E., 1963, *Factor analysis as a statistical method*, London.

Lösch, A., 1940, *Die räumliche Ordnung der Wirtschaft*, Jena, 64–142.

Morawski, W., 1967, Studium wartości jednej tony towarów przemieszczanych transportem kolejowym i problem integracji klasyfikacji (A study of the value of one ton of commodities transported by railways and the problem of integration of classification) (typescript).

Morawski, W., 1968 a, *Przepływy towarowe i powiązania międzyregionalne na obszarze Polski* (Sum.: Commodity flows and interregional connections in Poland. A value approach), Studia KPZK PAN, 25, Warszawa.

Morawski, W., 1968 b, Balances of interregional commodity flows in Poland: A value approach, *Papers, Reg. Sci. Ass.*, 20, 29–41.

Nystuen, J. D., Dacey, M. F., 1961, A graph theory interpretation of nodal regions, *Papers, Reg. Sci. Ass.*, 7, 29–42.

Ullman, E., 1957, *American commodity flow*, Seattle.

TABLE 4. The behaviour matrix scores on dyadic factor I
The result of the application of factor analysis to a dyadic matrix of Polish commodity flows, by value in 1958

Destination voivodship / Origin voivodship	Białystok	Bydgoszcz	Gdańsk	Katowice	Kielce	Koszalin	Kraków	Lublin	Łódź	Olsztyn	Opole	Poznań	Rzeszów	Szczecin	Warszawa	Wrocław	Zielona Góra	Total	rank
Białystok	0	−2.9725	−3.2169	−1.5293	−3.0773	−3.5063	−2.8661	−2.4166	−3.1898	−2.5975	−3.4658	−3.2080	−3.4082	−2.8833	−0.3371	−3.1821	−3.5157	−45.3725	17
Bydgoszcz	−3.0131	0	−0.7875	4.4609	−2.7201	−2.4739	−1.7191	−2.5961	−1.0426	−2.6983	−2.2865	0.1056	−3.2968	−2.1974	−0.0475	−1.4096	−2.9363	−24.6583	6
Gdańsk	−2.8093	−0.7012	0	−1.8872	−3.3851	−2.2842	−3.1950	−3.3489	−3.1217	−2.1196	−3.2967	−2.4683	−3.2966	−2.9294	−1.9540	−2.8193	−3.3801	−42.9966	15
Katowice	−1.0274	3.0888	4.7860	0	2.7946	−1.7137	20.3550	0.5127	4.3752	−1.0046	11.9505	5.5255	2.2827	−0.3101	11.5167	8.3166	−0.9341	70.5144	1
Kielce	−3.2136	−2.2783	−2.8734	5.0005	0	−3.4644	2.3929	−1.9735	−0.5470	−2.9074	−2.5165	−2.1762	−2.0541	−3.1895	0.5303	−1.5741	−3.1383	−23.9828	5
Koszalin	−3.4416	−1.6716	−2.0344	−0.5470	−3.0936	0	−3.3764	−3.4623	−2.8177	−3.4837	−3.2360	−0.7236	−3.4582	−2.1115	−1.4903	−2.9591	−3.3111	−41.2181	14
Kraków	−2.5366	−1.2804	−0.9781	20.9774	1.4251	−2.7482	0	3.0014	1.2412	−2.7059	0.6194	2.6344	4.1012	−1.7520	3.7296	1.3208	−2.6324	24.4169	4
Lublin	−2.5624	−2.1228	−2.2994	−1.2636	−2.9375	−3.3342	−2.6840	0	−2.5086	−2.9983	−3.3140	−1.4856	−1.9112	−3.0516	−0.3105	−2.7253	−2.7177	−38.2267	12
Łódź	−3.2981	−2.9927	−3.1607	−1.4705	−2.7062	−3.4649	−2.7212	−3.2495	0	−3.4330	−3.3006	−1.5769	−3.4034	−3.3287	−1.5667	−2.3533	−3.3327	−45.3591	16
Olsztyn	−2.2890	−1.5473	−1.7432	−0.8538	−2,9113	−3.3816	−3.0127	−2.1458	−2.5998	0	−3.3493	−2.6022	−3.4647	−3.1813	1.0131	−3.1415	−3.3861	−38.5965	13
Opole	−2.7539	−0.4908	−0.2270	22.0963	−1.3957	2.4389	2.2781	−1.2071	0.3016	−2.7856	0	4.2663	1.2983	−0.1535	4.0815	3.3043	−1.8825	26.5726	3
Poznań	−2.9433	−1.0083	−2.2229	1.0056	−1.9620	−2.7746	−1.6307	−2.3383	−1.2717	−2.7814	−2.5276	0	−3.0633	−2.4752	2.9859	−0.8764	−1.2539	−25.1381	7
Rzeszów	−3.2712	−2.9665	−2.7026	−0.9614	−1.9796	−3.2833	2.1085	−1.3026	−2.6820	−3.2095	−2.7286	−2.0657	0	−3.2308	−1.8624	−2.4543	−3.3283	−35.9203	10
Szczecin	−3.1863	−1.7201	−2.4806	−1.1427	−3.0318	−1.4160	−2.9172	−3.1196	−1.3657	−3.1869	−3.0560	0.0107	−3.3746	0	0.6118	−2.5976	−1.9973	−33.9699	9
Warszawa	−2.3550	−1.4721	−2.5877	−0.2635	−2.5761	−3.3268	−2.6065	−0.8404	−2.1981	−2.5524	−3.2263	−0.8970	−3.0403	−3.0843	0	−2.4911	−3.2986	−36.8162	11
Wrocław	−2.9769	0.3565	−1.6812	17.5776	0.2248	−1.9012	4.5666	−1.0460	3.5608	−2.9518	2.3677	5.3229	−0.5260	0.7479	3.8556	0	0.1586	27.6559	2
Zielona Góra	−3.4628	−2.4890	−2.8674	0.4255	−3.0662	−3.2803	−2.6435	−3.2930	−2.2002	−3.1322	−2.8941	1.1849	−3.3210	−2.4532	0.2492	2.3314	0	−30.9119	8
Total	−45.1405	−22.2683	−27.0770	61.6248	−30.3980	−39.9147	2.3285	−28.8256	−16.0661	−44.5481	−24.2604	1.8468	−32.5328	−35.5839	21.0052	−13.3106	−40.8865	−314.0072	
rank	17	7	9	1	11	14	3	10	6	16	8	4	12	13	2	5	15		

TABLE 5. The behaviour matrix scores on dyadic factor II
The result of the application of factor analysis to a dyadic matrix of Polish commodity flows, by value in 1958

Destination voivodship / Origin voivodship	Białystok	Bydgoszcz	Gdańsk	Katowice	Kielce	Koszalin	Kraków	Lublin	Łódź	Olsztyn	Opole	Poznań	Rzeszów	Szczecin	Warszawa	Wrocław	Zielona Góra	Total	rank
Białystok	0	−0.2806	−0.4876	1.4558	−0.3395	−0.6316	−0.2405	−0.1630	−0.4987	0.1151	−0.5266	−0.1994	−0.5703	0.6342	0.2982	−0.1841	−0.6033	−2.2219	8
Bydgoszcz	−0.4592	0	0.7038	−1.2095	−0.5583	0.3744	−0.7042	−0.3220	−0.5674	−0.3051	−0.1105	2.1922	−0.6046	−0.0016	0.3496	−0.3230	−0.5407	−2.0861	7
Gdańsk	−0.3271	0.1075	0	−0.5006	−0.5978	0.5017	−0.4786	−0.5688	−0.4496	0.0749	−0.5211	0.3105	−0.6047	−0.2793	−0.1900	−0.6303	−0.5557	−4.7090	12
Katowice	−1.2811	−2.7656	−3.1200	0	−2.0120	−1.0726	−6.4865	−0.9433	−2.6100	−1.3748	−5.5319	−3.3757	−1.8299	−1.7089	−5.7192	−4.6583	−1.5428	−46.0326	17
Kielce	−0.6289	−0.7321	−0.6901	0.0851	0	−0.6285	−1.2320	−0.4219	−0.8618	−0.6162	−0.5698	−0.4758	−0.7062	−0.6826	−1.2017	−0.5290	−0.3796	−10.2711	14
Koszalin	−0.6016	0.5192	0.4599	1.1912	−0.3851	0	−0.5499	−0.5972	−0.1565	−0.6325	−0.3976	2.2882	−0.5939	0.6898	0.1992	−0.0319	−0.4040	0.9973	3
Kraków	−0.6721	−0.6806	−0.6752	−4.4351	−1.4431	−0.5513	0	−1.4185	−1.0593	−0.5825	−1.3171	−1.6437	−1.2057	−0.9738	−1.5154	−1.1596	−0.6297	−19.9627	16
Lublin	−0.8762	−0.5855	0.8960	1.6460	−0.3996	−0.6828	0.2051	0	0.6477	−0.7569	−0.2763	1.3308	−0.4845	−0.7566	−0.7782	0.6632	0.6695	−1.3303	5
Łódź	−0.5565	−0.3589	−0.6000	0.6800	−0.4695	−0.6284	−0.7179	−0.5618	0	−0.6231	−0.5608	1.7995	−0.6273	−0.4965	0.4747	−0.0726	−0.5294	−3.8485	10
Olsztyn	0.0713	0.4541	1.1292	2.1598	−0.3002	−0.4783	−0.3233	−0.0429	−0.2410	0	−0.4485	0.6757	−0.6009	−0.0938	1.4556	−0.2291	−0.4935	2.6942	2
Opole	−0.4526	−1.2878	−0.5973	0.1764	−0.8408	0.3589	−0.2628	−0.0176	−0.5501	−0.6133	0	−1.2571	−0.8694	−1.3543	0.9405	0.0102	−0.8212	−7.4383	13
Poznań	−0.4769	0.8194	−0.2432	1.4800	0.0039	−0.4412	−0.1011	−0.2928	0.1143	−0.4409	−0.0136	0	−0.5459	−0.3662	6.7983	0.7000	0.4581	7.4522	1
Rzeszów	−0.5981	−0.5474	−0.5520	0.0850	−0.4242	−0.6099	1.8091	−0.3353	−0.5162	−0.5961	−0.4144	−0.0939	0	−0.6006	−0.4087	0.0200	−0.5730	−4.3557	11
Szczecin	−0.5737	−0.3506	−0.4937	0.1353	−0.5327	0.0670	−0.4719	−0.5475	0.0131	−0.5863	−0.4138	1.4090	−0.5824	0	0.5214	−0.2252	0.3380	−2.2940	9
Warszawa	−0.7659	0.5554	−0.7498	2.1329	−0.6463	−0.5379	−0.3442	−0.8752	−0.3409	−0.4515	−0.5919	3.2384	−0.5812	−0.1735	0	0.3529	−0.4555	−0.2342	4
Wrocław	−0.6525	−0.7826	−0.7515	−4.0680	−0.1326	−0.7088	−0.7070	−0.4673	−0.2010	−0.6864	−0.5549	0.5475	−0.6455	−1.6345	0.4969	0	−0.8338	−11.7820	15
Zielona Góra	−0.6357	−0.2543	−0.3287	1.1594	−0.4256	−0.6248	−0.2521	−0.5675	0.0191	−0.5233	−0.3768	1.4430	−0.5837	−0.4042	0.6771	0.1318	0	−1.5463	6
Total	−9.4868	−6.1704	−7.8922	2.1737	−9.5052	−6.2941	−10.8578	−8.1426	−7.2583	−8.5989	−12.6256	8.1292	−11.6361	−8.2024	2.3983	−6.1650	−6.8966	−106.9708	
rank	13	5	9	3	14	6	15	10	8	12	17	1	16	11	2	4	7		

TABLE 6. The behaviour matrix scores on dyadic factor I
The result of the application of factor analysis to a dyadic matrix of Polish commodity flows, by value in 1966

Destination voivodship / Origin voivodship	Białystok	Bydgoszcz	Gdańsk	Katowice	Kielce	Koszalin	Kraków	Lublin	Łódź	Olsztyn	Opole	Poznań	Rzeszów	Szczecin	Warszawa	Wrocław	Zielona Góra	Total	rank
Białystok	0	−1.7659	−1.2971	−1.1592	−2.3468	−2.6252	−2.2408	−1.7603	−2.2862	−0.8109	−2.2155	−2.1863	−2.3006	−2.4414	−0.7031	−2.2634	−2.3117	−30.7114	11
Bydgoszcz	−2.1971	0	1.6142	3.0122	−1.5665	−1.3208	0.6668	−2.1197	0.0373	−0.7025	−0.8641	1.2602	−2.1105	−1.3875	1.2606	−0.5431	−1.7634	−6.7239	4
Gdańsk	−2.3494	−0.8954	0	−1.0027	−2.5474	−1.8078	−2.1769	−2.6229	−2.2926	−1.0466	−2.6268	−1.9033	−2.6191	−2.4720	−1.5678	−2.3267	−2.4918	−32.7492	13
Katowice	−1.7258	1.9965	1.0289	0	1.4670	−1.9404	11.8524	−0.8312	3.6732	−1.0508	8.7946	2.8932	0.2661	0.2934	4.0303	8.9390	−1.2182	38.4682	1
Kielce	−2.5662	−2.1103	−2.5520	1.6350	0	−2.6122	−0.3581	−1.5367	−1.2171	−2.1800	−2.1582	−1.8760	−2.2485	−2.3182	−0.9760	−1.9151	−2.3803	−27.3699	9
Koszalin	−2.5248	−1.9648	−2.1746	−2.0104	−2.5174	0	−2.3594	−2.6292	−2.3692	−2.6254	−2.5086	−1.6125	−2.6170	−2.0843	−2.3355	−1.9637	−2.4429	−36.7397	16
Kraków	−1.5812	0.0122	−1.6983	7.9578	−0.0542	−2.3265	0	−0.2643	0.1227	−2.1247	1.6142	−0.7072	2.4582	−2.0350	0.9524	−0.0074	−2.0786	0.2401	2
Lublin	−2.1069	−1.8561	−1.8411	−1.3397	−1.9702	−2.3065	−1.2005	0	−2.3764	−2.0097	−2.2210	−0.6959	−0.0550	−2.4213	−0.7589	−1.9126	−2.2665	−27.3383	8
Łódź	−2.6313	−1.4726	−2.0132	−0.9576	−2.1388	−2.2692	−2.1072	−2.5485	0	−2.4892	−2.3264	−0.6635	−2.4185	−2.2008	−1.6339	−2.0943	−2.5577	−32.5227	12
Olsztyn	−1.5386	−2.4211	−1.5491	−2.2177	−2.6001	−2.5702	−2.1248	−2.5201	−2.5945	0	−2.5010	−2.1389	−2.4061	−2.6882	−1.9181	−2.4792	−2.6646	−36.9263	17
Opole	−2.3069	−0.9648	−2.2142	7.3926	−1.6525	−1.7452	0.0841	−1.2911	−1.4373	−2.2488	0	1.6896	−1.3683	−1.2397	−0.4873	1.3611	−1.8150	−8.2437	5
Poznań	−2.5898	0.8790	−1.8382	0.0438	−1.6730	−1.6357	−1.2159	−2.4890	−0.6963	−2.4991	−1.6444	0	−2.3760	−1.5856	−1.3965	−0.2296	−0.2616	−21.2079	7
Rzeszów	−2.3242	−1.6697	−1.7323	−1.5962	−2.0506	−2.6540	−1.1941	−1.2012	−1.5281	−2.3966	−2.5213	−1.5275	0	−2.3259	−1.6259	−1.6788	−2.3928	−30.4192	10
Szczecin	−2.6598	−2.0988	−2.0116	−1.8094	−2.4816	−1.2213	−2.3948	−2.5445	−2.4647	−2.6546	−2.4631	−1.2815	−2.5380	0	−2.3801	−2.3112	−1.7522	−35.0672	14
Warszawa	−1.5367	−1.0612	−0.3981	3.4070	−2.1558	−2.3382	−1.3867	−2.1445	−1.8498	−2.1928	−2.1932	0.1294	−2.2328	−0.8675	0	−1.6051	−2.3374	−20.7634	6
Wrocław	−2.5376	−0.6742	−1.5060	6.1196	−1.5974	−1.5506	1.0615	−2.0030	−0.6686	−2.3250	2.9833	1.9707	−1.7913	−0.6235	−0.4029	0	0.9881	−2.5569	3
Zielona Góra	−2.4995	−2.3176	−2.3582	−1.8908	−2.6094	−2.5565	−2.2872	−2.4824	−2.3843	−2.7082	−2.4887	−1.1302	−2.9527	−2.3625	−2.5038	−1.0165	0	−36.1885	15
Total	−35.6758	−18.3848	−22.5409	15.5903	−28.4947	−33.4803	−7.3816	−30.9886	−20.3319	−32.0649	−15.3402	−7.7797	−26.9501	−28.7600	−12.4465	−12.0466	−29.7466	−346.8229	
rank	17	7	9	1	11	16	2	14	8	15	6	3	10	12	5	4	13		

TABLE 7. The behaviour matrix scores on dyadic factor II
The result of the application of factor analysis to a dyadic matrix of Polish commodity flows, by value in 1966

Destination voivodship / Origin voivodship	Białystok	Bydgoszcz	Gdańsk	Katowice	Kielce	Koszalin	Kraków	Lublin	Łódź	Olsztyn	Opole	Poznań	Rzeszów	Szczecin	Warszawa	Wrocław	Zielona Góra	Total	rank
Białystok	0	−0.2018	−0.6714	−0.2399	0.0687	0.1847	0.0540	−0.0894	−0.0214	−0.7571	0.0244	−0.1150	0.1009	0.0589	−0.6124	−0.0309	−0.0538	−2.3015	16
Bydgoszcz	−0.0799	0	−1.5363	−2.4174	−0.3702	−0.2616	−0.1135	−0.0561	−1.4324	−0.1091	−0.7259	−1.7976	−0.0967	−0.4846	−1.5324	−0.9733	−0.3352	−12.3222	17
Gdańsk	−0.0004	−0.7433	0	0.1581	0.3127	−0.0174	0.2797	0.2432	0.2091	−0.1208	0.2692	0.0026	0.2530	0.1935	0.1120	0.2355	0.2233	1.6080	13
Katowice	0.9315	3.6990	3.5088	0	6.4000	0.9296	11.7153	2.7189	5.4081	1.6341	8.0365	5.1416	2.6556	3.2140	7.0569	13.1752	1.8879	78.1130	1
Kielce	0.3256	0.5433	0.3149	1.3773	0	0.7648	0.3772	0.6610	0.5738	0.3835	0.3355	0.4119	0.3960	0.4653	0.6252	0.8392	0.3630	8.7575	4
Koszalin	0.2979	−0.0055	0.0684	0.1727	0.1671	0	0.6364	0.2488	0.1449	0.2361	0.1586	−0.0807	0.2227	0.0427	0.2253	0.0369	0.1288	2.7011	10
Kraków	0.3933	0.8073	0.4532	6.2360	1.9128	0.4358	0	1.9109	1.0329	0.3953	2.4579	0.4717	0.8557	0.6521	1.1210	1.0696	0.6427	20.8482	2
Lublin	0.0334	0.0825	0.2181	−0.1535	0.1421	0.2161	−0.1230	0	1.1845	0.1617	0.1412	−0.4604	−0.4199	0.2131	0.0742	0.1746	0.1080	1.5927	14
Łódź	0.2377	0.1888	0.3290	0.4074	0.2672	0.2490	0.2187	0.2659	0	0.7336	0.1829	−0.3458	0.2669	0.5301	0.1949	0.3202	0.2905	4.3370	7
Olsztyn	−0.1543	0.1734	0.1548	0.0624	0.2195	0.2164	−0.0171	0.2400	0.2264	0	0.4809	−0.0614	0.1561	0.2237	0.0037	0.1814	0.2021	2.3080	11
Opole	0.3847	0.3092	0.3420	1.6008	1.7493	0.4862	0.1728	0.8774	0.1668	0.2965	0	−0.4504	0.1260	0.6730	1.4605	0.0666	0.4572	8.7186	5
Poznań	0.2969	−1.0676	0.2391	−0.0701	0.1874	−0.0470	−0.0362	0.4210	−0.1333	0.2804	0.0894	0	1.3238	0.1564	0.1591	0.2989	−0.1770	1.9212	12
Rzeszów	0.1836	0.2214	0.0701	0.3399	0.0522	0.2673	−0.0291	−0.2797	0.2978	0.1514	0.2254	0.2284	0	0.5756	0.0297	0.7406	0.1542	3.2288	9
Szczecin	0.2367	0.1054	0.1863	0.2481	0.4101	−0.0384	0.3545	0.2360	0.2109	0.2276	0.1420	−0.0241	0.2563	0	0.5922	0.3321	−0.1058	3.3699	8
Warszawa	0.0250	−0.3384	−0.5949	−1.6420	0.5366	0.1752	−0.0755	0.2681	0.2687	0.2579	0.2070	−1.0781	0.3018	−0.5195	0	0.7778	0.1521	−1.2782	15
Wrocław	0.2980	1.0640	0.5518	2.3547	1.4295	0.5911	0.8122	0.5414	0.6345	0.5903	0.5078	0.9748	0.6117	0.8025	1.0329	0	3.5231	16.3203	3
Zielona Góra	0.4432	0.3175	0.1979	0.0561	0.2763	0.2872	0.1742	0.2766	0.2386	0.2745	0.2207	0.1591	0.3497	0.2188	0.2839	1.0901	0	4.8644	6
Total	3.8529	5.1552	3.8318	8.4906	13.7613	4.4390	14.3986	8.4840	9.0099	4.6359	12.7535	2.9766	7.3596	7.0156	10.8267	18.3345	7.4611	142.7868	
rank	15	12	16	7	3	14	2	8	6	13	4	17	10	11	5	1	9		