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Regional Differentiation of Business Cycles in Poland, 1999 - 2003

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Abstract

The paper aims at analysis of business cycles in 16 Polish voivodships. This analysis was based on methodology applied for surveys of international business cycles synchronization. This methodology assumes that business cycle fluctuations can be identified by decomposition of time series on a trend and deviation from such a trend. Calculations were based on industrial sales and unemployment time series for 16 regions and entire Poland. In order to eliminate seasonality the X-11-ARIMA procedure was applied.

Next, in order to identify trend in time series, Hodrick - Prescott (HP) filter was applied. Four groups of regions with similar course of business cycles fluctuations were identified. Two of them are characterized by similar fluctuations of industry production levels and two other - with unemployment rate convergence. The regions in the identified groups are also located in close geographical neighborhood. In three of four groups of regions, the analysis of some macroeconomic indicators allowed authors to indicate the hypothetical leader (leaders) of each "macro-region".

Key Words: Business Cycles; Regional Economic Activity

JEL Classification: E32; R12

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1. Introduction

The paper aims at analysis of business cycles in 16 Polish regions (voivodships). Groups of regions with similar pattern of business cycles developments and fluctuations were identified. It was assumed that regional business cycles fluctuations in Poland are significantly differentiated.

Interconnections between business cycles on national and regional levels are complex. On the one hand, regions of higher economic potential influence domestic macroeconomic situation and on the other hand, regions with weaker economic potential normally react with a delay to domestic macroeconomic changes. Pattern of dispersion of business cycle impulses from stronger regions to weaker regions is another research issues analyzed in the paper.

Administrative reform of 1999 has reduced a number of voivodships from 49 to 16 and therefore the period of observation only covers 1999 – 2004 (March). One of reasons for such reform was to create regions large enough to be able to conduct effective and independent regional policy. Population of new regions varies from 1,0 to 5,1 million people, GDP from 8,4 to 75,5 billion euro (PPS) in 2001[1]. Little is known about the nature of regional business cycles developments in Poland. Few pioneer surveys were undertaken in this area[2].

As far as business cycle dispersion is concerned, regions within a country can not be regarded as countries within a continent like, for example European Union and individual countries within EU-15 or EU-25. Economic connections are stronger between regions within a country than between countries. On the other hand, regions in Poland are historically biased. Such factors as the level of industrialization, regional dependence on agriculture and low propensity to liberal (or non-liberal) behavior are historically or geographically rooted. Therefore, regions in Poland react differently on business cycles developments.

2. Data and methodology

Analysis of links between regional business cycles fluctuations was based on methodology applied for surveys of international business cycles synchronization. This methodology assumes that business cycle fluctuations can be identified by decomposition of time series on a trend and deviation from such a trend. Such methodology is characteristic for the real business cycle approach. It is also applied in eclectic models which unifies features of classic models and ones belonging to so called new classical economics. Oscillations around the trend represent the path of business cycles fluctuations while correlation coefficients between deviations from trends in regions – the convergence level of business cycles fluctuations between regions.

Due to the 1999 reform of administrative division in Poland which reduced the number of regions from 49 to 16, the analysis covers comparable data from January 1999 to March 2004. It has to be remarked, that the survey focus on links (ties) between medium-term regional business cycles fluctuations and not the course of business cycles. So far, during economic and system transformation in Poland only one full business cycle covering 1991 – 2001 has been identified[3].

The main variable describing the course of business cycle fluctuations is gross domestic product. Regional quarterly GDP estimates do not exist for Poland and annual time series are too short to look for statistically significant relationships. For this reasons the survey was conducted on two available monthly series: on regional industrial sales and on unemployment rates.

[1] Eurostat data.
[2] Michal Domanski, Wiktoria Parchomienko, Marcin Peterlik, Bohdan Wyznikiewicz (2001), Realizacja oczekiwan przedsiebiorcow w badaniach metoda testu koniunktury, [in:] Koniunktura na rynku uslug finansowych w Polsce, Akademia Ekonomiczna, Poznan.
[3] Bohdan Wyznikiewicz (ed.) (2004), Stan gospodarki Polski w IV kwartale 2003 roku, prognozy kwartalne na rok 2004 i prognozy roczne do 2006 roku, Biuletyn IBnGR No. 41, Warsaw.

In the case of industrial sales the attempt was undertaken to use data in constant prices. Producers Price Indices (PPI) were regionally differentiated. The Central Statistical Office (GUS) does not publish regional PPI, but publishes regional Consumer Price Indices. Regional PPI were estimated for regions using a pattern of regional CPI proportions.

Another factor of distortion for the description of business cycles relationships using industrial sales data is the regional differentiation of industrialization in Poland. This issue is important since in transition economies the industry diminishes its contribution to the GDP. Such distortion was eliminated by applying constant-base (January 1999=100) indices of industrial sales for each region. The analysis was conducted with the data compiled in such a way, which reflected real changes of output.

Both dynamics of regional industrial production and changes in unemployment rates depend on seasonality. The strength of seasonal factors is similar in individual regions, however it is not identical. Analysis on seasonally unadjusted time series could cause interference to similarity between regions as related to real connections between them. In order to eliminate seasonality the X-11-ARIMA procedure was applied. This procedure was developed in the mid sixties by the US Bureau of the Census. Currently the majority of econometric and statistical software has option of adjusting time series with ARIMA related methods[4].

The next stage of analysis was the identification of medium-term trends for industrial sales and unemployment in each region and later deviations from the trends expressed in percentages. It was assumed that such deviations represent the course of business cycles fluctuations.

In order to identify trend in time series free from seasonality and price effects, Hodrick – Prescott (HP) filter was applied[5]. The methodology of HP filter relies on time series decomposition to growth element representing a trend and to cyclical element[6]. It can be presented as:

$$y_t = g_t + c_t, \qquad \text{for } t = 1, \ldots, T, \tag{1}$$

where: y_t – empirical time series,

g_t – growth element,

c_t – cyclical element.

Finding series (g_t) and (c_t) is reduced to solving:

$$\min_{g_t} \left\{ \sum_{t=1}^{T} (y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2 \right\}, \tag{2}$$

where λ is so called "smoothing parameter" which is positive. Expression $(y_t - g_t)$ is a cyclical element ($c_t = y_t - g_t$). When $\lambda \to 0$, trend moves to the initial series $(c_t \to y_t)$, when $\lambda \to \infty$, then trend is linear. Since in literature there is no unanimity on optimal value of parameter λ, the values proposed by Hodrick and Prescott are commonly accepted:

- $\lambda = 100$ for annual time series,
- $\lambda = 1600$ for quarterly time series,

[4] Jacek Kotlowski (2002), Metody wygladzania szeregow czasowych za pomoca modeli klasy ARIMA, Prace i Materialy Instytutu Rozwoju Gospodarczego, No. 73, Warsaw.

[5] R. J. Hodrick, E. C. Prescott (1980), Postwar US Business Cycles: An Empirical Investigation, Working Paper, No. 451, Carnegie – Mellon University, Pittsburg; reprinted [in:] Journal of Money, Credit and Banking, Vol. 29, No. 1, February 1997, p. 1 – 16.

[6] In the paper a cyclical element concerns medium-term fluctuation, which means that the term "cyclical" was used in traditional meaning.

- $\lambda = 14400$ for monthly time series.

Consequently, in this paper the value of 14400. was adopted for parameter λ. The results in this stage of calculations were time series of deviations from the trend presented as:

$$\theta_{it}^{I} = \frac{c_{it}^{I}}{g_{it}^{I}} * 100\% \qquad \text{and} \tag{3}$$

$$\theta_{it}^{U} = \frac{c_{it}^{U}}{g_{it}^{U}} * 100\%, \tag{4}$$

where θ^{I} are series of deviations for industrial sales, and a θ^{U} – series of deviations for unemployment rates. Sub-indices *i* are for regions and entire Poland (then *i = 1, 2, ..., 17)*.

The next step of calculation was cross correlation coefficients between percentage shares of deviations in a growth element. This procedure was applied for both industrial sales and unemployment rates. As a final output two matrices were received:

$$I = \begin{pmatrix} cor\theta_{1,1}^{I} & & & \\ cor\theta_{2,1}^{I} & cor\theta_{2,2}^{I} & & \\ \ldots & \ldots & \ldots & \\ cor\theta_{17,1}^{I} & cor\theta_{17,2}^{I} & \ldots & cor\theta_{17,17}^{I} \end{pmatrix}, \tag{5}$$

$$U = \begin{pmatrix} cor\theta_{1,1}^{U} & & & \\ cor\theta_{2,1}^{U} & cor\theta_{2,2}^{U} & & \\ \ldots & \ldots & \ldots & \\ cor\theta_{17,1}^{U} & cor\theta_{17,2}^{U} & \ldots & cor\theta_{17,17}^{U} \end{pmatrix}. \tag{6}$$

The results were presented in the Appendix in the Tables A1 – A2.

3. Regional business cycles fluctuations

3.1. Results of analysis

Four groups of regions with similar course of business cycles fluctuations were identified using described above research methodology. Calculations were based on industrial sales and unemployment time series for 16 regions and entire Poland. Graphs showing seasonally adjusted time series and deviations from trends were presented in the Figures A1 – A4 in the Appendix. Correlation coefficient between regional deviations from trends are presented in tables A1 – A2.

The main feature differentiating the course of two time series is higher volatility of seasonally adjusted industrial sales growth rates than unemployment rates. In the case of unemployment rates, average variation coefficient for 16 regions was 0,15 and changed from 0,08 to 0,22. In the case of industrial sales, growths rates average level of variation coefficient was 0,44 and changed from 0,27 to 0,84.

Such differences can be explained by nature of two variables. Industrial output is a typical economic stream. Its dynamics depends on current conditionalities and may vary from one period to another.

The level of unemployment rate is more stable. First reason is connected with low elasticity of labor market in Poland. Labor market regulations make impossible fast adjustment of labor demand to changes in business conditions. Second reason of lower flexibility on labor market than that of industrial production is connected to the fact, that changes in output result from changes in demand, which are independent from companies. They affect all companies in the same time (if sector differences are not taken into account). Changes in employment level depend from companies decisions and therefore they do not taken in the same time. Due to different employment policy in companies, changes in employment level appear with time lags and are not uniform. Therefore the unemployment variability is smaller.

It should be pointed out that both analyzed variables are sensitive toward business cycle factors, however, as shown above, with different elasticity.

The consequence of the described differences is higher synchronization level of business cycles fluctuations of the unemployment rates than of the industrial sales. It is reflected in correlation coefficients of deviations from trends. Correlation coefficients for unemployment deviations change between 0,43 and 0,95 with average 0,77. Corresponding values for industrial sales are between -0,09 and 0,89 with average 0,35. Table 1. shows main parameters.

Table 1 Correlation coefficients for regional unemployment rates and industrial sales

	Unemployment rates		Industrial sales	
	Correlation coefficients, seasonally adjusted time series	Correlation coefficients deviations from the trend	Correlation coefficients, seasonally adjusted time series	Correlation coefficients deviations from the trend
MIN	0,08	0,43	0,27	-0,09
MAX	0,22	0,95	0,84	0,89
Average	0,15	0,77	0,40	0,35

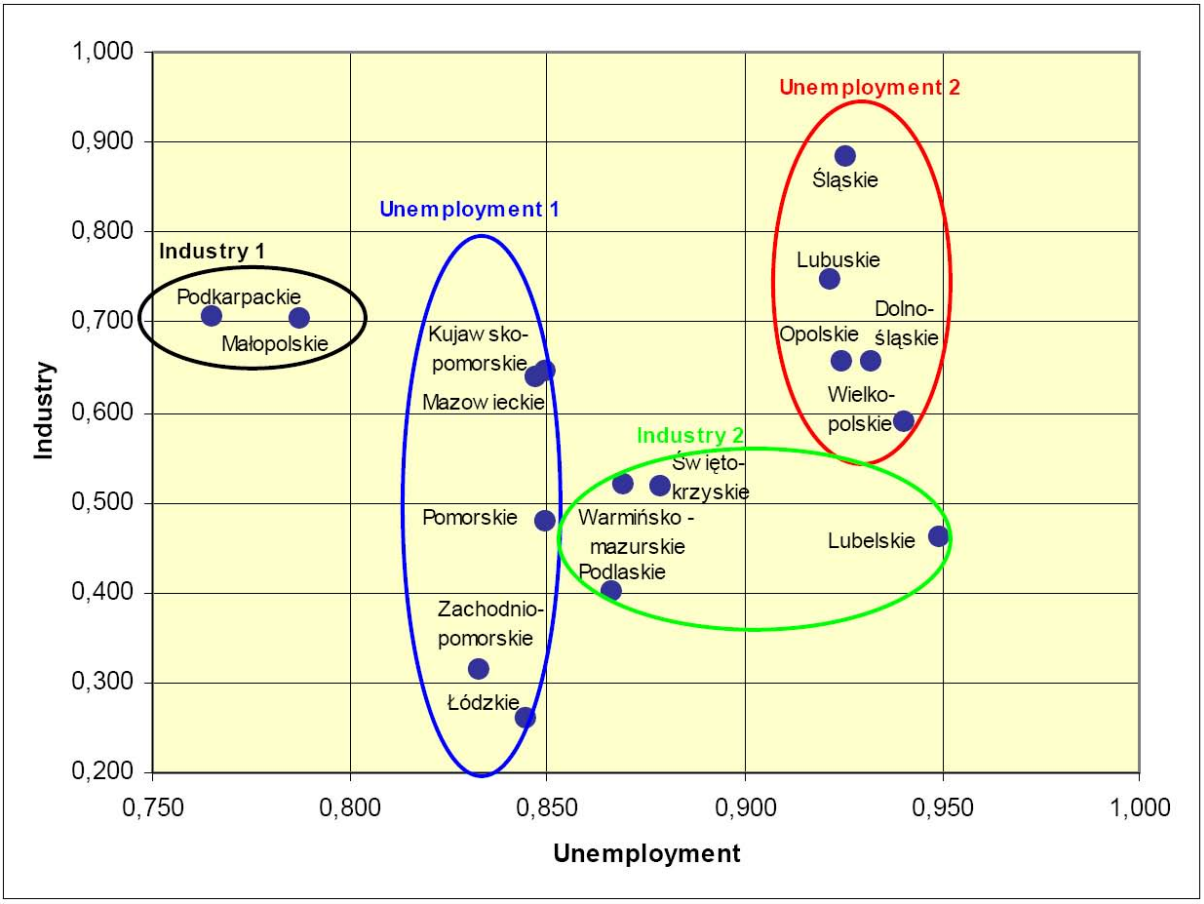
Source: Authors' calculations.

3.2. Groups of regions

Graph 1 illustrates the distribution of correlation coefficients between 16 regions and entire Poland for two variables. There are correlations between unemployment rates in regions and entire Poland on horizontal axis presented, and correlations of industrial sales on vertical axis. The higher the correlation coefficient, the higher level of business cycles convergence. Low correlations mean differences between fluctuation patterns.

The closer position of a given region to the upper right corner of the graph, the biggest similarity of regional business cycles fluctuation to national pattern. Close position of two regions (in both dimensions) shows relative synchronization of business cycle fluctuations.

Figure 1 Correlation coefficients between regional and national unemployment rates and industrial sales, January 1999 – March 2004



Source: Authors' calculations.

Two-dimension presentation of results was widened by identification of four groups of regions with similar pattern of medium term business cycle fluctuation. Inclusion of regions to groups Industry 1 and Industry 2 were due to similarity of business cycles fluctuations of industry production, while groups Unemployment 1 and Unemployment 2 were formed when fluctuation similarity of unemployment rates appeared. Identified groups were marked with ellipses.

It should be pointed out, that regions in the identified groups are located in close geographical neighborhood. In other words, regions in one group create geographical "macro-regions". It is shown on the Map 1.

Map 1 Groups of regions with similar course of business cycles fluctuations

Source: Authors' calculations.

Two regions of south-eastern Poland, Malopolskie and Podkarpackie, form the group Industry 1. The group Industry 2 is created by regions from so called "eastern wall of Poland" (Warminsko-Mazurskie, Podlaskie, Lubelskie) and region Swietokrzyskie. The group Unemployment 1 includes regions of northern Poland (Zachodniopomorskie, Pomorskie, Kujawsko-Pomorskie) and two centrally situated regions (Mazowieckie i Lodzkie). The fourth group, Unemployment 2, is composed by south-western Polish regions: Lubuskie, Wielkopolskie, Dolnoslaskie, Opolskie and Slaskie.

Criteria for regions grouping are related to the course of medium-term business cycles fluctuations in the period under consideration. Such grouping requires *ex post* analysis of structural similarities among regions in groups and differences between groups. Table 2 contains basic characteristics of four groups.

Table 2 Basic characteristics of four groups of regions, 2001

	GDP per capita	Share in Polish GDP	Share of industry in Gross Value Added	Share of agriculture in Gross Value Added
Unemployment 1	117,8	41,7	21,9	3,6
Unemployment 2	104,8	35,4	28,7	3,4
Industry 1	81,0	11,2	24,6	2,5
Industry 2	74,5	11,8	21,0	6,4
Poland	100,0	100,0	24,5	3,8

Source: Authors' calculations based on Central Statistical Office data.

The names of four groups of regions may be misleading. The grouping made on the base of business cycles synchronization does not reflect a variety of structural features of the regions. Econometric and statistical procedures presented in the section 2 do not take into consideration structural characteristics of the regions. However, it is plausible to find *ex post* common features of regions identified as similar in the undertaken procedure.

The group Industry 1 is composed by two regions with common historical roots. They are belonged to the former Austro-Hungarian Galicia. Historical economic relations are probably strengthened by close geographical location.

Regions located in the group Industry 2 are characterized by a relatively low economic potential. Share of agriculture in value added is high. For this reason these regions are known as "Poland B". Consequently, share of industry is the lowest in this group of regions. This fact may explain why medium-term business cycle divergence appears: low share of industry leads to higher sensibility to business cycles impulses. Such finding seems to be supported by elimination of industrialization effect from business cycles.

It is difficult to find common characteristics for the regions in the group Unemployment 1. The largest and therefore the most influential Polish region is Mazowieckie. It has strong economic ties with Lodzkie. Regions Zachodniopomorskie and Pomorskie have similar economic structures: maritime economy and tourism. Region Kujawsko-Pomorskie is a "bridge" between two former pairs of regions in the group Unemployment 1.

Regions of the fourth group Unemployment 2 are located in the south-western Poland. All regions in this group have strong economic relations with German economy and apparently their business cycles are influenced more by such ties than by signals from Polish regions.

3.3. Patterns of dispersion of business cycles impulses in the identified groups of regions

The research methodology applied in the paper did not allow for direct identification of channels of regional business cycles impulses in the four groups of regions. However, the results of above described analysis and general knowledge makes it possible to formulate hypothesis on the most probable ways of dispersion of business cycles impulses within four distinguished groups of regions.

In the case of the group Industry 2 all four regions are similar: high dependence on agriculture and low economic potential. In addition, none region can be considered as a leading region in the group. Such pattern suggests that regions in this group are all "receivers" of the

business cycles impulses from other regions and do not generate such signals themselves. In other words, regions in the group Industry 2 depend mainly on business cycles in Poland.

The smallest group of regions Industry 1 has a leader, which is region Malopolskie. Large agglomeration of Cracow is a reason why the region Malopolskie dominates over the region Podkarpackie as far as business conditions and economic impulses are concerned.

In the group Unemployment 1 with no doubt the leading region is Mazowieckie. This region influences economic situation of Lodzkie region due to the geographical location. Among three northern regions in this group the strongest region is Pomorskie which dominates over the other two regions.

In the group Unemployment 2 composed of five regions, three of them (Wielkopolskie, Dolnoslaskie and Slaskie) have large agglomerations and therefore their economic potential is important. None of the three regions can be considered as a leading region which could be able to send business cycles impulses to other regions in this group.

4. Conclusions

The main result of conducted research is identification of four groups of regions with similar business cycle fluctuations. Two of them are characterized by similar fluctuations of industry production levels and two other – with unemployment rate convergence. The regions in the identified groups are located in close geographical neighborhood. Such pattern of transmission of business cycles impulses seems to be typical for the present stage of transformation.

The research methodology applied in the paper did not allow for direct identification of channels of regional business cycles impulses in the four groups of regions. However, in three of four groups of regions, the analysis of some macroeconomic indicators allowed authors to indicate the hypothetical leader (leaders) of “macro-regions”. It should be pointed out that described in the paper ways of impulses dispersion have to be treated only as a hypothetical ones.

The main obstacle for the more advanced researches is the lack of regional data which could be used for analysis. Undoubtedly the problem is substantial and requires further analyses and researches.

References

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Appendix

Figure A1 Unemployment – Seasonally adjusted series in voivodships and Poland

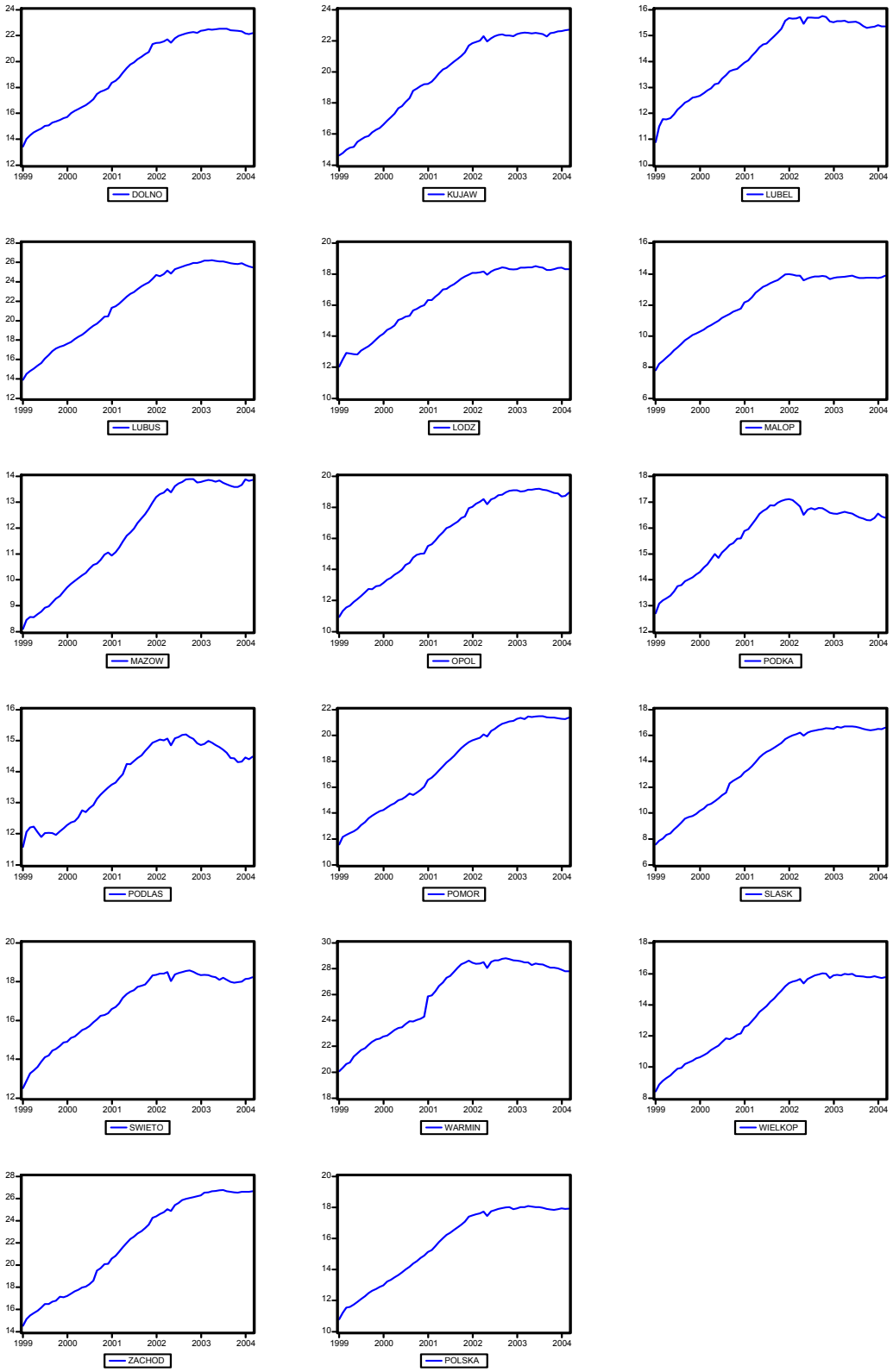

Figure A2 Unemployment – Deviations from trend in voivodships and Poland

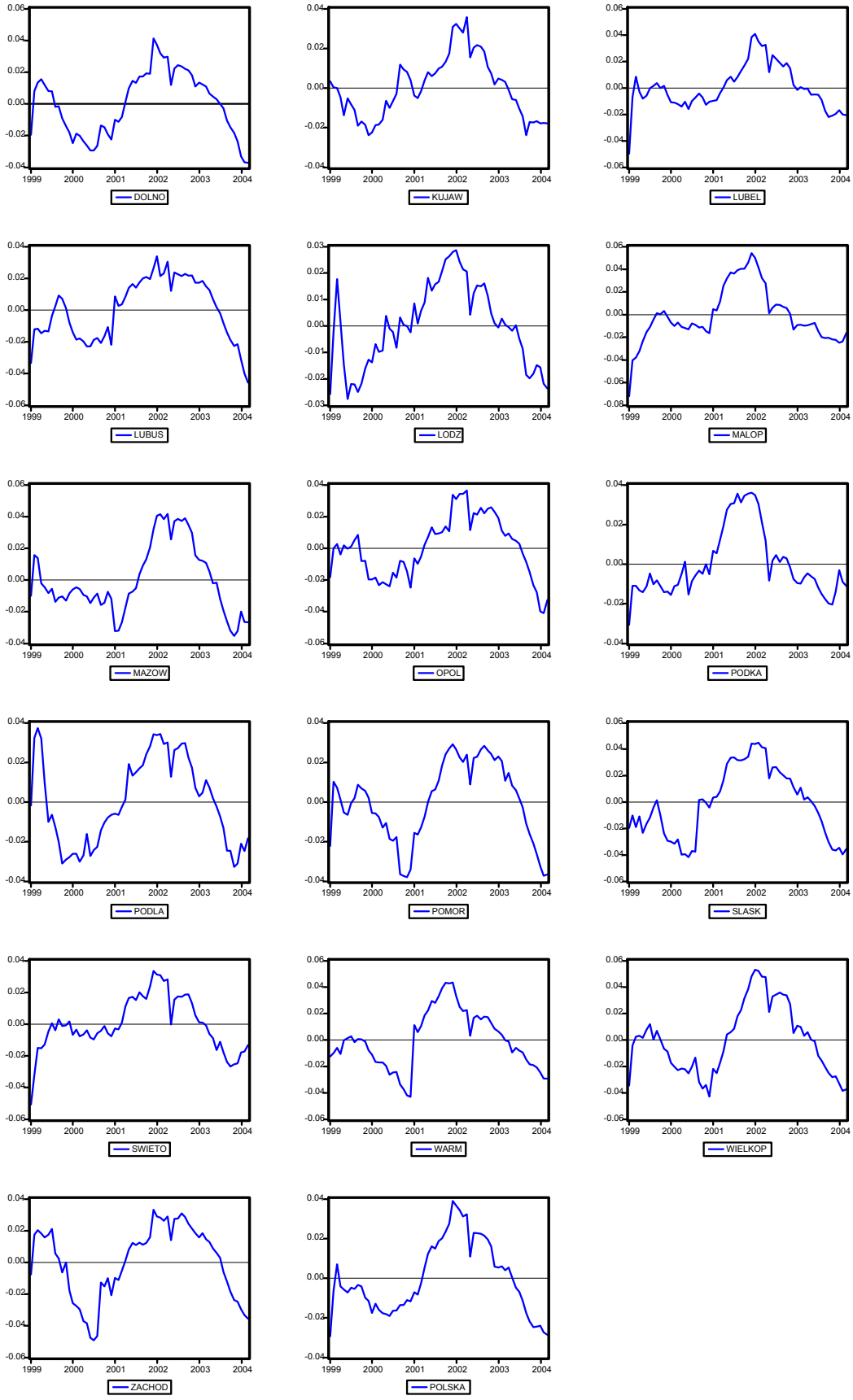

Figure A3 Industry – Seasonally adjusted series in voivodships and Poland

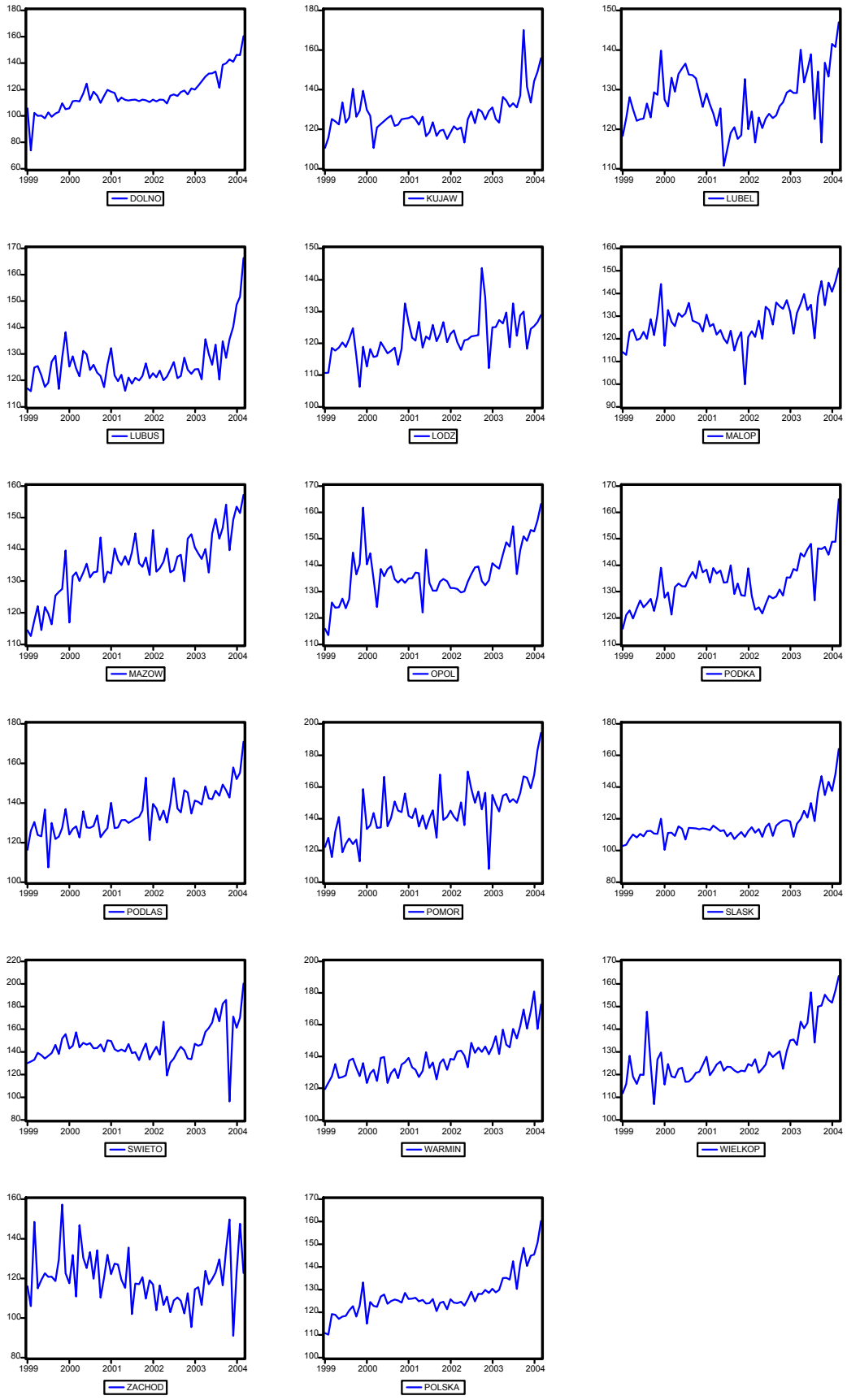

Figure A4 Industry – Deviations from trend in voivodships and Poland

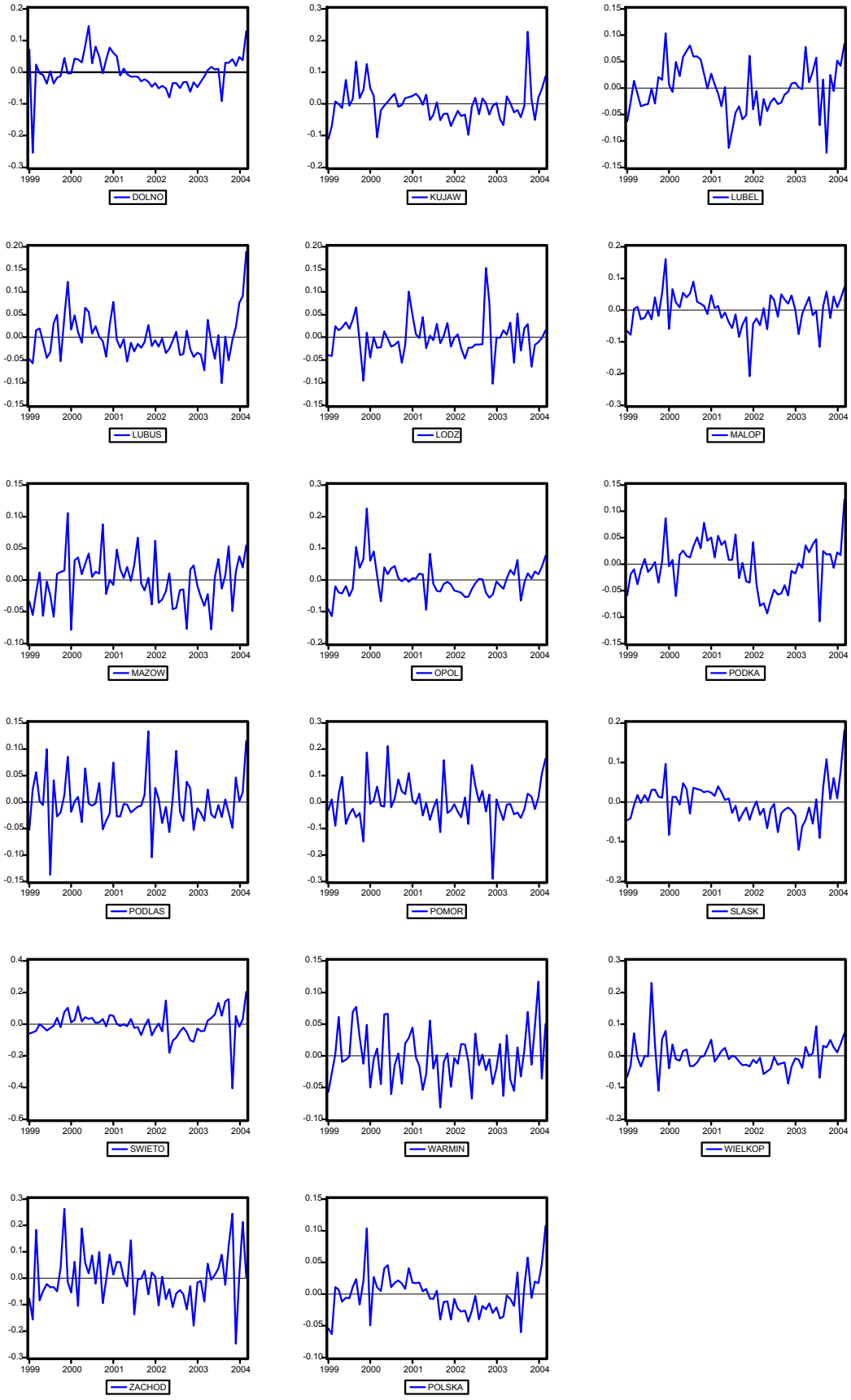

Table A1 Unemployment – Correlation coefficients

	Dolnoslaskie	Kujawsko - pomorskie	Lubelskie	Lubuskie	Lodzkie	Malopolskie	Mazowieckie	Opolskie	Podkarpackie	Podlaskie	Pomorskie	Slaskie	Swietokrzyskie	Warminsko - mazurskie	Wielkopolskie	Zachodniopomorskie	Poland
Dolnoslaskie	1,000																
Kujawsko – pomor.	0,769	1,000															
Lubelskie	0,852	0,786	1,000														
Lubuskie	0,874	0,712	0,854	1,000													
Lodzkie	0,706	0,838	0,782	0,721	1,000												
Malopolskie	0,592	0,606	0,789	0,743	0,734	1,000											
Mazowieckie	0,810	0,796	0,831	0,730	0,675	0,454	1,000										
Opolskie	0,953	0,785	0,863	0,919	0,689	0,606	0,826	1,000									
Podkarpackie	0,589	0,681	0,710	0,649	0,814	0,916	0,429	0,550	1,000								
Podlaskie	0,888	0,835	0,755	0,708	0,799	0,472	0,802	0,815	0,606	1,000							
Pomorskie	0,870	0,559	0,792	0,873	0,589	0,546	0,818	0,873	0,446	0,710	1,000						
Slaskie	0,862	0,862	0,829	0,888	0,806	0,777	0,691	0,872	0,797	0,812	0,691	1,000					
Swietokrzyskie	0,701	0,726	0,904	0,816	0,764	0,908	0,681	0,743	0,817	0,596	0,660	0,814	1,000				
Warminsko – mazur.	0,828	0,617	0,766	0,858	0,690	0,796	0,600	0,790	0,775	0,706	0,817	0,823	0,764	1,000			
Wielkopolskie	0,925	0,742	0,919	0,872	0,678	0,676	0,881	0,915	0,604	0,794	0,917	0,796	0,794	0,845	1,000		
Zachodniopomorskie	0,949	0,680	0,743	0,808	0,549	0,425	0,745	0,899	0,437	0,849	0,809	0,803	0,570	0,737	0,838	1,000	
Poland	0,932	0,849	0,949	0,921	0,844	0,787	0,847	0,924	0,765	0,859	0,849	0,926	0,878	0,869	0,940	0,833	1,000

Table A2 Industry – Correlation coefficients

	Dolnoslaskie	Kujawsko - pomorskie	Lubelskie	Lubuskie	Lodzkie	Malopolskie	Mazowieckie	Opolskie	Podkarpackie	Podlaskie	Pomorskie	Slaskie	Swietokrzyskie	Warminsko - mazurskie	Wielkopolskie	Zachodniopomorskie	Poland
Dolnoslaskie	1,000																
Kujawsko – pomor.	0,314	1,000															
Lubelskie	0,439	0,134	1,000														
Lubuskie	0,547	0,395	0,532	1,000													
Lodzkie	0,088	0,221	-0,094	0,222	1,000												
Malopolskie	0,469	0,568	0,396	0,539	0,124	1,000											
Mazowieckie	0,341	0,297	0,232	0,329	-0,066	0,410	1,000										
Opolskie	0,428	0,539	0,397	0,617	0,084	0,546	0,399	1,000									
Podkarpackie	0,520	0,486	0,461	0,482	0,149	0,403	0,442	0,487	1,000								
Podlaskie	0,092	0,246	0,170	0,534	0,297	0,383	0,146	0,253	0,236	1,000							
Pomorskie	0,291	0,226	0,267	0,423	0,206	0,306	0,180	0,253	0,274	0,256	1,000						
Slaskie	0,529	0,604	0,293	0,639	0,225	0,624	0,515	0,485	0,581	0,389	0,410	1,000					
Swietokrzyskie	0,307	0,316	0,183	0,349	0,188	0,351	0,390	0,391	0,334	0,279	0,211	0,444	1,000				
Warminsko – mazur.	0,274	0,388	0,082	0,484	0,298	0,332	0,293	0,358	0,215	0,336	0,263	0,487	0,310	1,000			
Wielkopolskie	0,302	0,396	0,267	0,535	0,203	0,296	0,147	0,370	0,495	0,306	0,103	0,481	0,233	0,418	1,000		
Zachodniopomorskie	0,372	0,303	0,145	0,190	-0,043	0,041	0,131	0,268	0,289	-0,042	0,057	0,172	0,003	0,058	0,240	1,000	
Poland	0,656	0,646	0,461	0,749	0,261	0,704	0,639	0,658	0,706	0,402	0,479	0,886	0,518	0,530	0,591	0,316	1,000