Statistical Modeling of Mutual Influence of the EU and Russia Industrial Growth in Conditions of Economic Instability

Elena V. Zarova

Plekhanov Russian University of Economics, Moscow, RUSSIA

zarova.ru@gmail.com

In recent times inter country interaction has largely determined the strengthening of macroeconomic instability, especially if the economic shocks of individual countries coincide with recession in the dependent countries. The investigations of export-import dependence of EU and RF economic growth are widely represented in literature. However, the mediated inter country effect of changes in sectors and branches can manifest itself through different information channels of international economic integration. Among them - financial market signals, market reaction for the conjuncture expectations of producers in real sector and changes in the economic behavior of households. Their inter country influence was not sufficiently explored in theoretical and applied research. For the purpose of statistical modeling and analysis of the EU and RF real sectors interaction, the data base was formed from the sources of Eurostat and Rosstat by the combination of monthly industry production indexes (IPI) and industry price production indexes (IPPI) of different branches. The initial time series consisted of 187 points. All indexes were presented in seasonally adjusted form. The plan of the research included several stages: firstly - decomposition of the time series and extracting their trend, cyclical and random components; secondly - statistical estimation of the time series cointegration on the following levels: for the IPI and IPPI of industry on the whole, as well as manufacturing of the EU countries and Russia, and for interdependence between Russian oil and gas production indexes and European industry indexes. The third point of the research plan was dedicated to the influence of economic shocks on the statistical evaluation of the identified dependencies of the time series. And on the last stage of the study the models of industry growth with the factors of inter country interdependence were developed for the purposes of the scenario forecast. The results of the empirical calculations have shown: close correlation between the speed of industry growth and the length of phases and amplitude of industry business cycles; the difference of the external shocks prolonged effect for the industry growth of the more and less developed countries; significant reciprocal influence of the fluctuations of the gas and oil production in Russia and industry production dynamics of European Union countries. The derived models and statistical evaluations were used for forecasting the inter country impact of the macroeconomic turbulence for the expected economic growth.

Keywords: time-series, inter country economic interdependence, deterministic trend, business cycle, cointegration.

Introduction

Recently inter country interaction has largely determined the strengthening of macroeconomic instability, especially if the economic shocks of individual countries coincide with the recession in the dependent ones. The investigations of export -import dependence of EU and RF economic growth are widely represented in literature [3, 5, 6]. However, the mediated inter country effect of changes in sectors and branches can manifest itself through different information channels of international economic integration. Among them - are financial market signals, market reaction for the conjuncture expectations of the producers in real sector and changes in the economic behavior of the households. Their inter country influence was not sufficiently explored in theoretical and applied statistical research. This article presents the results of a quantitative investigation of inter country economic interdependence, based on statistical modeling of the mutual influence of industry production volumes and industry producer prices dynamics of the European Union and the Russian Federation. The investigation has included two main stages. On the first stage it was necessary to test the hypothesis of the statistical measurable effect of the inter country industry interdependence. For this purpose we have used the method of canonical correlation, allowing taking into account two aggregates: EU countries and Russian regions. On the second stage, based on methods of time series decomposition and cointegration modeling, the interaction of the

individual EU countries real sector development and Russian manufacturing and fuel production dynamics was studied.
For the presented above purposes of statistical modeling and analysis of the EU and RF real sectors interaction, the data base was formed from the sources of Eurostat [1] and Federal State Statistical Service [2] by the combination of monthly industry production indexes (IPI) and industry price production indexes (IPPI) of different branches. The initial time series consisted of 187 points. All indexes were presented in seasonally adjusted form.

Canonical correlation analysis in testing the inter country industrial interaction

The application of canonical correlation phase allowed quantifying the statistical response of short-term dynamics (with a monthly periodicity) of the EU countries manufacturing production to the relevant changes in production volumes of manufacturing and mining (oil and gas production) in Russian regions. At this stage we also estimated the dependence of monthly industry production indexes (IPI) in manufacturing of the EU countries from the changes of producer prices in the mining sector in Russian regions. With high values of canonical correlation (R=0.979) there was obtained the following result: monthly dynamics of industrial production in the manufacturing sector of the EU countries explains 83.7 % of the variation of manufacturing production monthly growth in the federal districts of Russia. And in the opposite direction: monthly dynamics of production in the manufacturing sector of Russia federal districts causes 33.6 % of similar indicators changes in the European Union. These results suggest a rather strong dependence between the variables of two sets. The calculations were performed for 17 European countries and Russian regions, separated by the regions of the European part of Russia and regions of Asian, Siberian and Far Eastern part of this country. The last group is presented by the regions where the main part of the energy production in Russia is located. The results of the mutual influence estimation of manufacturing production dynamics across the groups of countries and regions are presented in Figure 1.

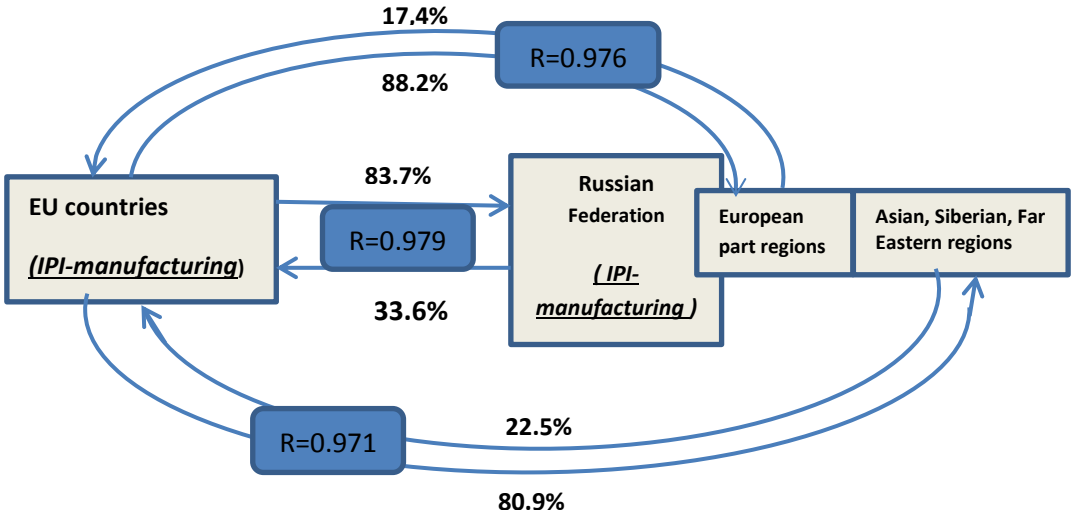

Fig.1 Results of canonical correlation analysis: assessment of production volume dynamics interdependence of the European countries and the Russian Federation (for manufacturing activities).

Figure 2 shows the results of canonical analysis, similar to the previous one, allowing assessing the interdependence of the dynamics of manufacturing activity in the EU and mining production in Russia. Comparison of the results shown in Figures 1 and 2 leads to the conclusion that the response of the Russian industrial production to market signals from the European Union is stronger than the response of the European manufacturers to short-term fluctuations in production in the regions of Russia. The reaction of the monthly fluctuations of the manufacturing volume in the EU to short-term fluctuations in the volume of manufacturing in Russia is weaker than on the corresponding fluctuations in the Russian mining and quarrying production (the bulk of which is oil and gas).

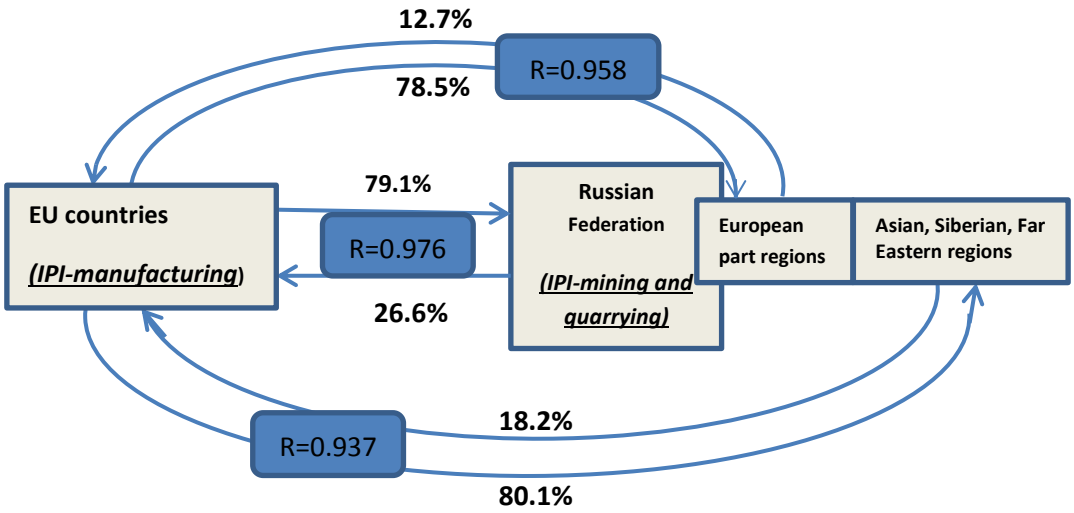

Fig.2 Results of canonical correlation analysis: assessment of production volume dynamics interdependence of the European countries and the Russian Federation (for manufacturing activities of the EU countries and mining and quarrying activities of the Russian Federation).

Even weaker is the response to monthly dynamics of production in the manufacturing sector of the European countries on the dynamics of producer prices in the sector of crude production in the Russian Federation (Fig.3).

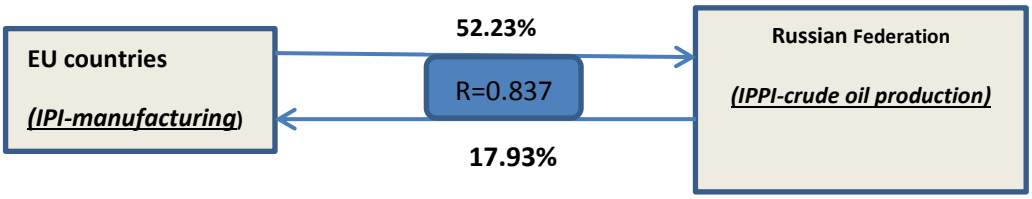

Fig.3 Results of canonical correlation analysis: assessment of the interdependence between monthly industry production indexes (IPI) in manufacturing activity of the European countries and industry price production indexes (IPPI) in Russian crude oil production.

Canonical analysis conducted with the delay lags has revealed certain cyclicity in mutual influence of industrial growth of the European countries and Russia. As shown in Table 1, the most significant effect of the dynamics of industrial production in mining and quarrying sector in RF regions on the industrial production growth in the manufacturing sector of the European countries occurs with a delay of 7 months (explained variance of 36.19%). Reverse (more significant) impact of the manufacturing industry in the European countries on the dynamics of mining and quarrying production in RF regions appears a little faster - with a lag of 6 months (explained variance of 86.37%). The greatest explanatory effect was obtained with the lag equal to 5 months (R=0.988).Thus, it can be concluded on the basis of the initial analysis of the need to deepen its results through decomposition of the original time series.

Table1. Results of canonical correlation analysis with lags of the mutual influence of industry production dynamics in the European countries and in RF regions.

Lag (months)	Explained variance. %		Canonical correlation coefficient (R)
	Industry growth in manufacturing of the European countries by the industry growth in mining and quarrying in RF regions	Industry growth in mining and quarrying in RF regions by industry growth in manufacturing of the European countries	

-1	21.18	80.39	0.969
-2	19.50	73.77	0.949
-3	16.26	78.26	0.969
-4	23.88	76.10	0.964
-5	25.46	81.57	0.988
-6	33.43	86.37	0.986
-7	36.19	76.30	0.972
-8	26.46	81.29	0.964
-9	19.51	76.68	0.942
-10	18.03	80.69	0.976
-11	21.44	80.58	0.961
-12	27.93	81.57	0.972

Decomposition of time series in the study of latent intercountry linkages in industrial production

The stage of time series decomposition included several points: firstly - extracting deterministic trend [4], cyclical and random components of time series; secondly - statistical estimation of the time series cointegration on the following levels: for the IPI and IPPI of industry on the whole, as well as manufacturing of the EU countries and Russia and also for interdependence between Russian crude oil production indexes and European industry indexes.

Table 2 shows the simulation results of the trend and cyclical components of the time series for those cases (European countries), in which the linear trend of the dynamics of the monthly industry production indexes in the manufacturing sector was statistically significant. For a number of European countries quadratic trend was statistically significant (Italy, Greece, Ireland, Spain, Luxembourg) or the most appropriate model was the model of a "break point" linear regression (France, Cyprus). However, for these cases, as for the cases of a linear trend, the model of cyclic component has been developed on the base of residuals series with the use of Fourier harmonic analysis methodology: [*+sin(t+)+cos(t+)*]. This made it possible to determine the parameters of sustainable economic cycles (time period, amplitude) in the dynamics of the manufacturing volume in the EU countries (columns 6&7 of Table 2).$\Delta y = b_o b_1 c_1 k_1 b_2 c_2 k_2$

Table 2. Parameters of the linear trend and assessment of cycles duration in the structure of the industry production indexes time series of the manufacturing sectors of the EU countries.

Country	Starting Point of the Initial Time Series (year,month)	Linear Trend Parameteres ($y=a_0+a_1*t$)		Multiple Correlation Coefficient for Linear Trend (R1)	Duration of Cycle Periods in the Structure of the Time Series (years)		Multiple Correlation Coefficient for Cyclical Component of the Time Series (R2)
		A0	A1		S1	S2	
1	2	3	4	5	6	7	8
EU (17 countries)	1999M01	85.58	0.082	0.765	3.32	8.68	0.843
Germany	1999M01	72.00	0.132	0.905	5.20	7.40	0.711
Finland	1995M01	76.53	0.150	0.711	4.57	7.76	0.579
Norway	1995M01	89.19	0.061	0.673	14.30	5.23	0.732
Austria	1996M01	62.77	0.236	0.941	3.55	28.59	0.649
Lithuania	1998M01	56.97	0.339	0.914	4.76	3.25	0.746
Slovenia	1998M01	81.87	0.126	0.687	5.31	3.61	0.544
Belgium	2000M01	68.26	0.244	0.939	5.01	10.4	0.676
Bulgaria	2000M01	74.08	0.262	0.694	11.02	2.42	0.904
Czech							

Republic	2000M01	67.59	0.283	0.884	4.61	9.41	0.853
Denmark	2000M01	111.84	-0.0291	0.833	1.05	5.7	0.612
Estonia	2000M01	62.01	0.399	0.880	7.87	12.67	0.681
Latvia	2000M01	76.92	0.258	0.813	9.60	4.98	0.908
Hungary	2000M01	70.43	0.259	0.847	4.36	9.18	0.874
Netherland	2000M01	88.86	0.089	0.799	8.92	4.77	0.716
Poland	2000M01	44.31	0.431	0.983	6.02	10.06	0.675
Portugal	2000M01	124.22	-0.172	0.910	5.15	3.36	0.705
Romania	2000M01	71.12	0.284	0.920	----	6.76	0.798
Slovakia	2000M01	38.91	0.532	0.961	4.58	2.59	0.812
United Kingdom	1998M01	110.24	-0.052	0.684	5.29	3.53	0.681

Similar results were obtained for the Russian Federation and its regions. In particular, for the country as a whole trend in the form of second-degree polynomial was extracted in the dynamics of the monthly industry production index in oil and natural gas production: $y=0.955+0.0079*t-0.000027*t^2$ (R=0.964).
On the base of harmonic analysis and simulation two interconnected business cycles with periods of 10.17 and 6.01 years were extracted from the residual time series (R=0.877).
In the structure of the time series of the industry production index in the manufacturing sector a linear trend (y=0.810+0.0038*t) has been allocated with a high degree of reliability (R=0.908). Also, as in the previous cases, two statistically significant cycles were determined with periods 4.3 and 8.6 years (R=0.787). The starting point of both time series - 2000M01.
From the example shown in Figures 4 and 5 , it follows that the basis of mutual reaction of industrial production of the EU and Russia in the short term is neither the interaction of long-term trends (they are unidirectional) nor the interaction of business cycles (Russian medium-term cycles are much weaker in comparison with the amplitude of the European cycles). The hypothesis about the lack of cointegration of trends was confirmed by the Engel-Granger criterion.

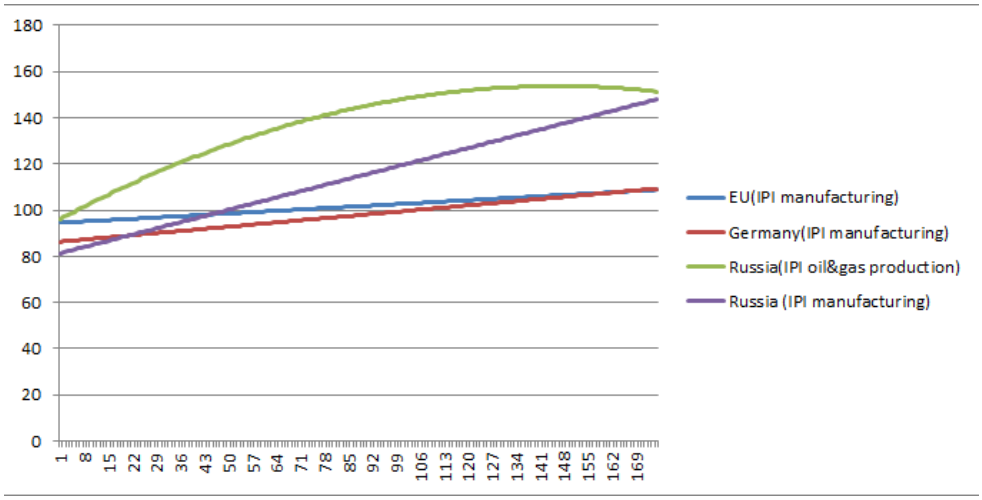

Fig.4 Ratio of trend curves of the monthly industry production indexes (IPI) dynamics in manufacturing of the EU countries and Germany (as example) and Russia (manufacturing and oil and nature gas production).

Conclusion

Using the test for Granger causality in the ranks of residuals leads to the conclusion that a spatial short-term cyclical interaction of industrial production volatility is statistically significant and allows discovering stable quantitative connections that have appeared only after the decomposition of the time series procedures (Fig.6).
The presented results define the directions for further research, such as the need to develop multifactorial models of industrial and economic growth of countries [7] taking into account the spatial - temporal regularities of their cyclic interference in highly volatile economic situation.

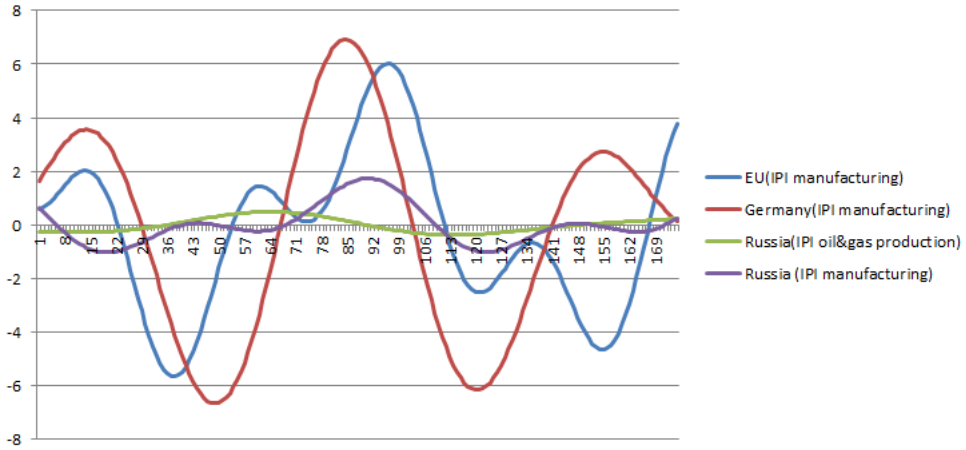

Fig.5 Ratio of cyclic curves of the monthly industry production indexes (IPI) dynamics in manufacturing of the EU countries and Germany (as example) and Russia (manufacturing and oil and nature gas production).

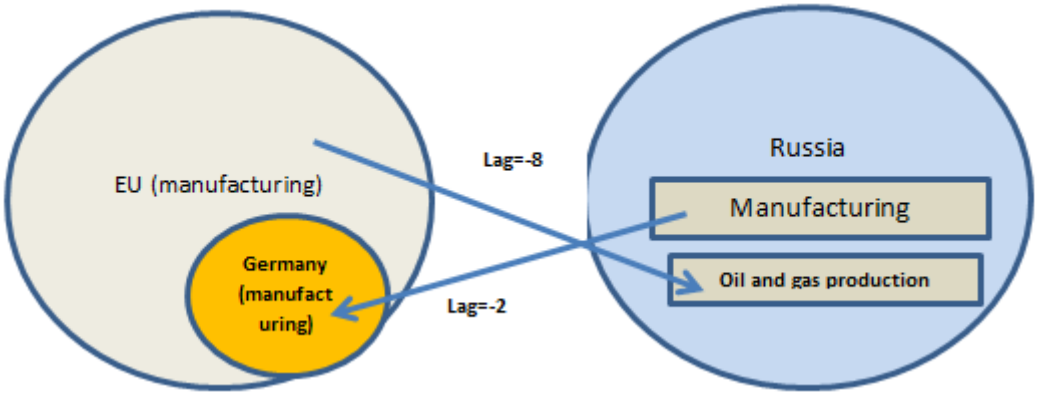

Fig.6 Diagram of the inter country space-time interaction of irregular components of the industrial production indices short-term dynamics (indicating the delayed impact of the lag in months); Germany cited as an example.

References

1. Eurostat.Database.-www.ec.europa.eu
2. Federal State Statistical Service – www.gks.ru
3. Gartzke.E, Li.Q,. (2003). Measure for Measure: Concept Operationalization and the Trade Interdependence – Conflict Debate. Journal of Peace Research., vol.40, no.5.
4. Kirchgassner.G, Wolters.J ,Hassler.U,. (2013). Introduction to Modern Time Series Analysis. Second Edition.Springer.
5. Meyer.B, Luts.C,. (2007). The GINFORS Model. Model Overview and Evaluation.
6. Neal, L. (2007). The Economics of Europe and the European Union. Cambridge University Press.
7. Novales. A, Fernandes. E, Ruiz. J,. (2009) Economic Growth.Theory and Numerical Solution Methods. Springer.