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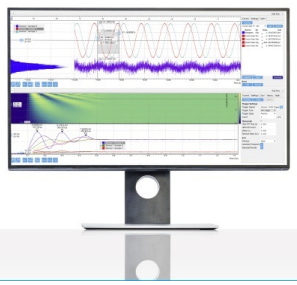
Alexander M. Tarasyev, Julian Vasilev, Victoria F. Turygina, and Alla V. Usova



Development of a Model of the Gross Regional Product of the Kurgan Region

Alexander M. Tarasyev[1, 2, a)] , Julian Vasilev[3, b)], Victoria F. Turygina[2, c)] and Alla V. Usova[2, d)]

[1]*Krasovskii Institute of Mathematics and Mechanics UrB RAS, 620990, S. Kovalevskay Street, 16, Yekaterinburg, Russia.*
[2]*Ural Federal University, 620002, Mira Street, 19, Yekaterinburg, Russia.*
[3]*Varna University of Economics, bul. "Knyaz Boris I-st '77 9002 Varna, Bulgaria*

[a)] Corresponding author: tam@imm.uran.ru
[b)]vasilev@ue-varna.bg
[c)]v.f.volodina@urfu.ru
[d)] studymail.alla@gmail.com

Abstract. Gross Regional Product (GRP) is the main indicator of the effectiveness of any given region. However, it is usually not possible to predict and analyze its change. The article considers the main indicators that potentially affect the GRP of the Kurgan region, assesses the impact of these factors on the GRP, and compares the correlation matrix and pleiade. The results of the study allow us to evaluate the real impact of various factors and determine the vector of actions for the development of the region.

INTRODUCTION

Kurgan region is a subject of the Russian Federation located in the South of the West Siberian plain. The territory of the region is 71,488 square km. The population of the Kurgan region, according to 2019, amounted to 834 718 people [1].

The data for developing a model was received from the statistical collection "The passport of Kurgan region". Experts of the institute of economy of the Ural branch of the Russian Academy of Sciences have allocated the list of the indicators potentially influencing GRP of Kurgan region. The number of indicators was more than 40, the values of indicators correspond to the period from 2007 to 2017.

DATA PROCESSING. DEVELOPMENT OF A MODEL OF THE GROSS REGIONAL PRODUCT OF THE KURGAN REGION

The data for developing a model was received from the statistical collection "The passport of Kurgan region". Experts of the institute of economy of the Ural branch of the Russian Academy of Sciences have allocated the list of the indicators potentially influencing GRP of Kurgan region. The number of indicators was more than 40, the values of indicators correspond to the period from 2007 to 2017. Methods and models shown in the research [1,2].

Using MS Excel, we calculated correlation coefficients for each indicator with GRP (in basic prices) in millions of rubles. Indicators whose correlation value with a GRP lower than 0.3 have a very weak connection strength, in some cases we can say that there is no connection.

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After that, we built the correlation matrix shown in figure 1. This is done in order to investigate indicators on the strength of statistical relationships between them, to identify multicollinearity and to investigate indicators that have similar purposes. All values in the range between -1 and -0.7, as well as between 0.7 and 1 (corresponding to the presence of a strong link) are highlighted in red in figure 1.

	x1	x2	x3	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16	x17	x18	x19	x20	x21	x22	x23	x25	x26	x29	x30	x31	x32	x33	x34	x37	x39	x41
x1	1,00																																
x3	-0,31	0,98	1,00																														
x5	0,01	0,84	0,91	1,00																													
x6	0,70	-0,18	-0,04	0,37	1,00																												
x7	-0,96	0,31	0,16	-0,21	-0,87	1,00																											
x8	0,79	0,02	0,15	0,41	0,67	-0,82	1,00																										
x9	0,57	0,18	0,31	0,57	0,71	-0,70	0,84	1,00																									
x11	-0,72	0,75	0,67	0,47	-0,34	0,61	-0,16	0,01	-0,31	1,00																							
x12	-0,77	0,68	0,60	0,44	-0,26	0,60	-0,32	0,08	-0,72	0,88	1,00																						
x13	0,51	-0,27	-0,24	-0,19	0,06	-0,35	0,44	-0,12	0,99	-0,32	-0,73	1,00																					
x14	-0,99	0,50	0,36	0,07	-0,63	0,92	-0,74	-0,52	-0,57	0,78	0,81	-0,50	1,00																				
x15	0,70	-0,52	-0,42	-0,15	0,59	-0,70	0,47	0,56	0,02	-0,61	-0,41	-0,06	-0,72	1,00																			
x16	0,29	-0,84	-0,85	-0,77	0,02	-0,16	-0,13	-0,28	0,19	-0,59	-0,55	0,24	-0,33	0,14	1,00																		
x17	-0,22	-0,63	-0,71	-0,79	-0,32	0,33	-0,53	-0,58	-0,10	-0,24	-0,17	-0,01	0,17	-0,22	0,87	1,00																	
x18	0,93	-0,22	-0,07	0,20	0,66	-0,91	0,87	0,69	0,56	-0,56	-0,62	0,46	-0,92	0,70	-0,02	-0,50	1,00																
x19	0,92	-0,17	-0,03	0,23	0,63	-0,90	0,87	0,69	0,54	-0,54	-0,60	0,44	-0,91	0,68	-0,06	-0,53	1,00	1,00															
x20	0,98	-0,59	-0,45	-0,14	0,67	-0,92	0,72	0,46	0,62	-0,78	-0,83	0,55	-0,98	0,70	0,41	-0,09	0,88	0,86	1,00														
x21	0,82	-0,06	0,07	0,26	0,46	-0,75	0,81	0,61	0,57	-0,43	-0,54	0,49	-0,82	0,51	-0,04	-0,47	0,89	0,90	0,75	1,00													
x23	0,39	-0,04	0,02	0,14	0,34	-0,38	0,72	0,60	0,41	0,20	-0,01	0,31	-0,34	0,32	-0,11	-0,31	0,46	0,45	0,38	0,42	0,70	1,00											
x24	0,10	0,16	0,19	0,20	0,09	-0,10	0,45	0,44	0,15	0,38	0,24	0,07	-0,07	0,15	-0,24	-0,31	0,21	0,21	0,08	0,23	0,46	0,89											
x26	-0,99	0,51	0,36	0,05	-0,70	0,94	-0,76	-0,56	-0,56	0,75	0,77	-0,48	0,99	-0,69	-0,38	0,12	-0,90	-0,89	-0,98	-0,80	-0,40	-0,37	0,62	1,00									
x29	-0,95	0,54	0,40	0,05	-0,77	0,94	-0,64	-0,54	-0,37	0,80	0,72	-0,30	0,94	-0,76	-0,38	0,10	-0,83	-0,81	-0,94	-0,67	-0,18	-0,22	0,71	0,95	1,00								
x30	-0,72	0,14	0,02	-0,28	-0,70	0,77	-0,65	-0,47	-0,49	0,41	0,49	-0,42	0,65	-0,23	-0,21	0,15	-0,61	-0,60	-0,68	-0,57	-0,38	-0,10	0,57	0,72	0,74	1,00							
x31	-0,99	0,51	0,37	0,08	-0,64	0,92	-0,73	-0,48	-0,62	0,77	0,82	-0,55	0,99	-0,66	-0,37	0,13	-0,89	-0,88	-0,99	-0,80	-0,36	-0,35	0,59	0,99	0,94	0,71	1,00						
x32	-0,92	0,62	0,48	0,16	-0,70	0,87	-0,60	-0,43	-0,47	0,79	0,77	-0,41	0,90	-0,71	-0,38	0,07	-0,81	-0,78	-0,93	-0,62	-0,31	-0,24	0,73	0,92	0,95	0,72	0,91	1,00					
x33	-0,98	0,57	0,43	0,10	-0,71	0,94	-0,67	-0,51	-0,47	0,82	0,78	-0,39	0,98	-0,77	-0,38	0,11	-0,88	-0,86	-0,98	-0,74	-0,25	-0,26	0,70	0,98	0,99	0,69	0,97	0,95	1,00				
x34	-0,79	0,84	0,75	0,57	-0,31	0,63	-0,36	-0,13	-0,47	0,90	0,88	-0,46	0,84	-0,68	-0,63	-0,24	-0,66	-0,63	-0,86	-0,53	-0,18	-0,14	0,59	0,82	0,80	0,40	0,83	0,85	0,85	1,00			
x35	-0,98	0,57	0,43	0,09	-0,74	0,95	-0,69	-0,50	-0,51	0,80	0,79	-0,43	0,97	-0,74	-0,38	0,11	-0,87	-0,85	-0,98	-0,70	-0,29	-0,28	0,74	0,98	0,98	0,73	0,97	0,96	0,99	0,83			
x37	-0,72	-0,09	-0,25	-0,47	-0,59	0,76	-0,78	-0,73	-0,33	0,27	0,29	-0,21	0,66	-0,43	0,17	0,54	-0,74	-0,76	-0,61	-0,70	-0,32	-0,37	0,32	0,67	0,70	0,74	0,68	0,65	0,65	0,33	1,00		
x38	-0,73	-0,14	-0,28	-0,52	-0,63	0,80	-0,75	-0,71	-0,30	0,36	0,35	-0,19	0,71	-0,58	0,36	0,74	-0,86	-0,89	-0,62	-0,72	-0,26	-0,26	0,54	0,66	0,65	0,51	0,66	0,56	0,67	0,32	0,74		
x41	-0,17	0,72	0,74	0,75	0,19	0,02	0,18	0,23	-0,02	0,49	0,39	-0,05	0,24	-0,34	-0,71	-0,62	0,06	0,07	-0,27	0,04	0,36	0,11	0,16	0,21	0,28	0,00	0,26	0,25	0,29	0,56	-0,07	0,99	1,00
x42	0,18	0,55	0,62	0,72	0,38	-0,29	0,43	0,39	0,21	0,21	0,08	0,16	-0,13	-0,12	-0,57	-0,67	0,39	0,39	0,09	0,40	0,48	0,23	0,06	-0,16	-0,04	-0,24	-0,11	-0,07	-0,06	0,25	-0,32	0,96	0,91
x43	0,60	-0,07	0,01	0,09	0,22	-0,50	0,60	0,25	0,73	-0,33	-0,58	0,70	-0,59	0,03	0,09	-0,22	0,67	0,66	0,57	0,65	0,75	0,28	-0,28	-0,60	-0,40	-0,51	-0,59	-0,50	-0,48	-0,45	-0,43	0,43	0,31

FIGURE 1. Correlation matrix of the investigated indicators.

Furthermore, we have constructed a cause-effect diagram to explain the correlations whose values take absurd values (see figure 2).

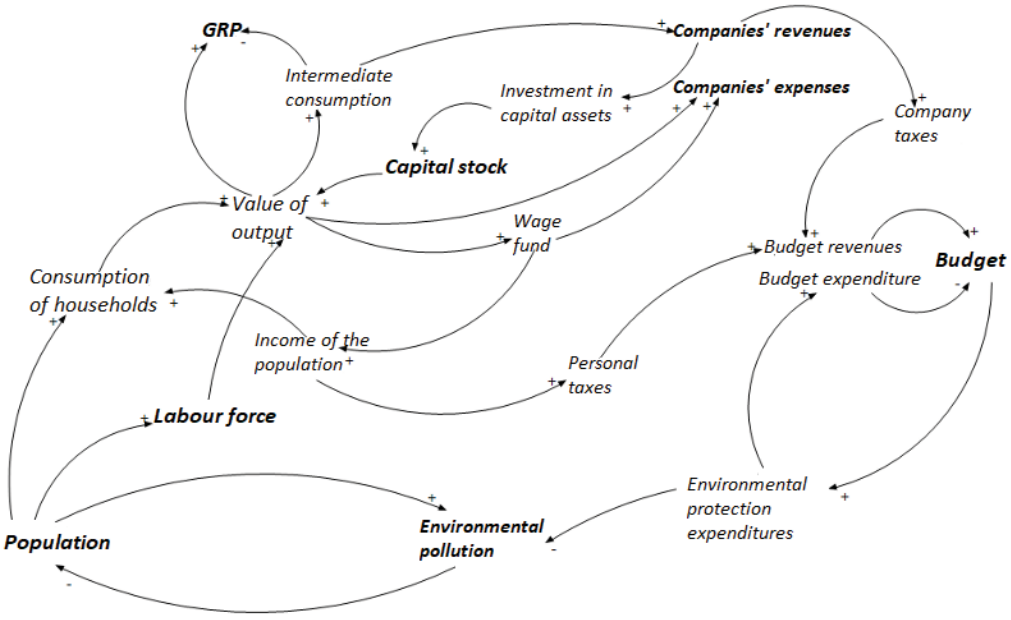

FIGURE 2. Cause-effect diagram of the investigated indicators.

The main elements of the cause-effect diagram are: GRP, fixed assets, organizational income, organizational expenses, budget size, environmental pollution, population and labour force. This diagram reflects the functional dependencies of indicators, which will make it possible to assess the adequacy of correlation coefficients.

From the correlation matrix, we can understand that there are indicators that correlate with many others. The most obvious are x1, x7, x8, x11, x12, x14, x18, x19, x26, x31, x32, x33, x34, x35. This is due to the fact that many indicators have causal links. For example, x8 - labour force and x1 have a causal relationship, if the population is larger, then the labour force is also larger. The solution to this situation can be factor analysis, which combines a large number of indicators in a smaller number of artificially constructed factors. Based on this correlation matrix, a number of indicators can be discarded [3].

Indicator x1 (population) correlates with many other indicators. Some of these indicators have causal links. This is true for indicators x8, x20, x21, x29, x31, x32, x33, x35, if the population is larger, the importance of these indicators becomes also greater. It is advisable to leave these indicators, in the case of further application of factor analysis.

Indicators x2, x3, x4, x5, x6. x7 should be removed from the list, as they reflect the change in the indicator "population", this information is redundant.

Indicators x8 and x11 are duplicated (labour force and labour force participation rate). If the number of population is to be discarded later, then x11 should be retained.

Pairs of indicators x9 - x12, x10 - x13 (x10 and x13 have a correlation of 1) are actually duplicated, it is worth leaving one each (x12 and x13).

Indicators x12 and x13 correlate with each other. In this case we should also leave only x13. Also, it is worth to get rid of indicator x15, this information is redundant. Indicators that are adjusted for inflation are redundant, because all other indicators are not adjusted.

Indicators x16 and x17 describe the same phenomenon, the difference being that x16 is absolute and x17 is relative. In this situation it is worth giving preference to the relative indicator.

Indicators x19 (Gini coefficient) and x18 (Fund coefficient) have a correlation of 1 and correlate almost equally with other indicators. This is explained by the fact that the indicators have similar meaning. x23 and x24 also have similar meanings, differing only in that x23 is absolute and x24 is a relative indicator. For further research, the relative one should be left [4].

Indicators x30, x31, x32 form x29, that is why it is worth leaving either x29 or a formation group. Out of x39, x40, x41, x42, only one should be left.

Indicator x1 has a strong negative correlation with GRP, this correlation contradicts causal relations, therefore, there is a false correlation.

Also, indicators whose correlation values are statistically insignificant should be excluded from the obtained indicators. As the sample size is 11 values, the statistically significant correlation value is 0.602 (according to the table of critical values, at the statistical significance level is 0.05). Therefore, the following will also be excluded: x13, x17, x22, x23, x27, x28, x36, x41, x42, x43.

Table 1 shows the indicators that need to be left at this stage.

TABLE 1. Suitable indicators for the GRP model

Symbol	Correlation coefficient with GRP	Symbol	Correlation coefficient with GRP
x1	-0,99	x25	0,60
x8	-0,80	x26	0,99
x11	0,70	x29	0,94
x12	0,73	x33	0,97
x14	0,99	x34	0,79
x19	-0,92	x35	0,96
x20	-0,98	x37	0,69
x21	-0,84	x38	0,71

For the next phase, we combine the results of the correlation matrix and Table 1. To do this, we will present the results in the form of a graph, a set of nodes (each indicator corresponds to one node) and edges (the relationship between the nodes, each of which is assigned a correlation value). This type of graph is also called a correlation pleiad (picture 3). The blade reflects only those correlations whose value module is in the range from 0.7 to 1.

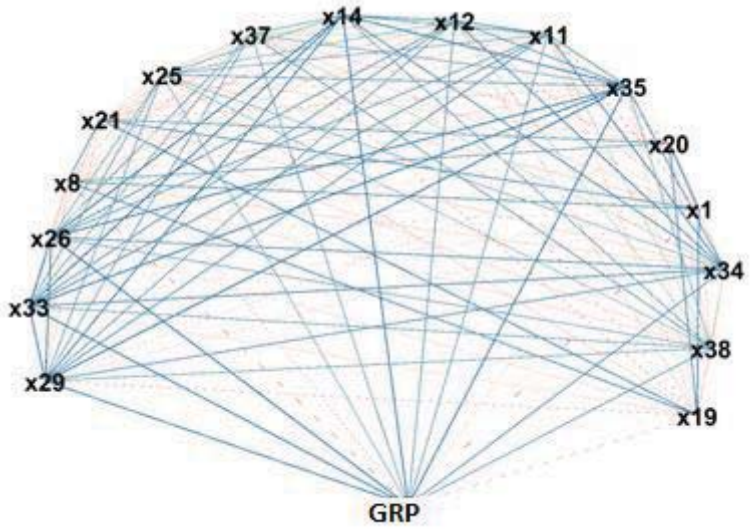

FIGURE 3. Correlation pleiade of indicators influencing GRP with statistically significant correlation value

Based on the correlation pleiad shown in figure 3, we can notice that the parameters affecting GRP also have a strong relation to each other, i.e. they are multicollinear.

CONCLUSION

We conducted a correlation analysis of the indicators. Indicators with weak correlation with GRP and indicators with statistically insignificant correlations were excluded. In addition, all indicators were analyzed for correlation coefficient to identify multicollinearity and explore indicators that have similar uses. We have prepared the basis for further research in this area, as it is impossible to objectively assess and predict such a variable indicator as GRP based on only one method of analysis.

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