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# Using of aggregate indexes in the process of oil export modeling on an example of the Republic of Tatarstan before the 2009 crisis

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## Abstract

The degree of relevance of this research is defined by the need of expansion and strengthening of the foreign economic regional relations as an instrument of increase of the economic status of the modern region (Republic of Tatarstan) through the interregional and foreign trade linkages. In respect of the foreign trade of the region there is a set of approaches for the decision of these tasks. Thus basic data which could be used for the analysis of current cooperation linkages on a separate period of time for the purpose of seeking the ways of increasing their efficiency due to its contents are limited mainly by the volumes of the purchases/sales which could be expressed in any of the trade, logistic or cost units. The index method chosen for the modeling of foreign economic relations allows us to define the general index of efficiency of trade i.e. the index number with the changed and constant (fixed) weights, an index of structural changes, to calculate the absolute variation of the 2009 to 2007 result and to show which part of this increment (decrease) is received from the changes of the size of basic cost, from the productivity of trade with the certain countries or from the changes of structure of basic cost during the processes of trade.

So, application of the aggregated indexes even on the limited massive of basic data allows to carry out the factorial analysis of the most essential parts of the analysed phenomenon. Therefore, the index analysis due to principal limitations of statistical data in the modern Russia conditions concerned with the famous social and economic reasons could be very productive instrument in the analysis of the chosen objects of research.

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## 1. Introduction

As we noted above for the creation of any model is especially important the choice of the most adequate formalized tools (mathematical apparatus) according to statistical information at the time of research. Accordingly it could be offered an algorithm of the solution of this task in a conditions when in the analysed group of the exported (imported) goods from the territory of the certain region (on the example Republic of Tatarstan) by the separate commodities the suppliers are constrained by the strict liabilities which aren't concerned with the other commodities trade of analysed group.

## 2. Choice of the mathematical model

As it is known the efficiency of creation of social - economic models is mainly determined by the character of basic data and adequate to them procedures of the formalized processing. Even the superficial review of applied methods testifies the considerable opportunities of the correlation and regression analysis taking a noticeable place among other methods of the analysis and modeling. However its application shows to basic data on a studied problem serious requirements which in some cases can't be fully realized (deficiency of information of the necessary sort and its available contents, existence of available information in various scales, etc.). At the same time in economic statistics are successfully applied the methods which have been initially focused for aprioristic deficiency of the information to which without noticeable reservations it is possible to carry so-called index method focused on calculations of relative statistics, which characterize the phenomena in time, in space and on the relation with the general plan see Boiko and Karmanov, 1999. Also known feature of an index method is its orientation for the minimum statistical information, however divided for two strict periods – basic and reporting. Indexes can be divided on individual and the general which in turn can be constructed as the averages from individual and as aggregate. Especially the aggregate indexes as formalization tools probably, can be somehow adapted for the solution of the problem above. Here could be interested not only separate aggregate indexes, but also such set of indexes and their relationship as indexes of the constant weights, the fixed weights and an index of structural changes.

In the classical statement of an index task of this kind at substantial level it is necessary and enough to have in the basic and reporting periods some abstract "productivities" ( $y_0, y_1$  – for the basic and reporting periods) and their initial "opportunities" ( $P_0, P_1$  – also for the basic and reporting periods). Then their products with the corresponding indexes ( $y \cdot P$ ) can be interpreted as some "results" which we will show on the following example (see table 2) where as an initial statistical information could be used the levels of dynamic ranks (table 1) offered to the subsequent consideration.

Table 1. The volume of supply of RT oil export (mln. US dollars)

№, i	Country	2007year j=1	2008 year j=2	2009 year j=3
1	Hungary	3207.00	1238.02	625.50
2	Germany	1390.90	373.93	613.40
3	Netherlands	1251.90	905.90	785.80
4	Ukraine	5128.21	200.00	1121.40
5	Turkey	1635.25	3219.00	3080.10
6	UK	40.80	99.78	200.10
7	Poland	2177.90	3367.00	2835.40

8	Belarus	1361.70	1900.00	1464.70
9	Czech Republic	170.20	2115.37	665.20
10	Italy	938.60	3052.50	3567.20
11	France	399.00	407.28	480.40

On the basis of contents of table 1, displaying dynamic ranks with the levels of studied parameter given in the table (the amount of realization of oil from RT, mln. of US dollars), having assumed as a basis 2007 as a basic year, it is possible to create the modified statistical data both for basic and for reporting periods if we will use the following rules.

### 3. Adaptation of initial information for the method of index modelling

The monetary volume of sales of the previous year taken as a basic (in mln. US dollars) as a basic parameter for the next index analysis will be estimated as an "opportunity" whereas its "productivity" could be estimated in relation to the next year as the relation of monetary volume from oil sale of the next year (2008) to considered year (2007). Then, if to accept a matrix given in table 1 in the form of a data file in an interval scale  $C = \{C_{ij}\}$ , where  $i=1, N = 11; j = 1, m = 3$  (2007, 2008, 2009), "productivity" for the basic period of  $y_{0i}$  could be estimated as the relation of export sales of the following (2008) to previous (2007) year:

$$y_{0i} = \frac{C_{i,j+1}}{C_{ij}} \tag{1}$$

By the same rule for "productivity" of  $y_{1i}$  for the reporting period there will be equally fair the ratio similar to expression (1):

$$y_{1i} = \frac{C_{i,j+2}}{C_{i,j+1}} \tag{2}$$

The calculated on expressions (1) and (2)  $y_{0i}$  and  $y_{1i}$  values are given in tab. 2 in the P0 and P1 columns. It is quite obvious that dimensions of counted parameters in expressions (1) and (2) needs some specification. Formally they are obliged to be dimensionless coefficients (mln. US dollars/mln. US dollars). At the same time, according to the contents as "productivity" it has to comprise information in so-called "the removed look". As (1) and (2) reflect the attitudes of the previous cost indexes towards the subsequent in time their denominators reflect the so-called initial cost (IC of mln. US dollars), whereas numerators reflect the new created cost (NCC of mln. US dollars). Then dimension of "productivity" in both expressions could be expressed as [to NCC mln. US dollars/ IC of mln. US dollars]. If as the basic "opportunity" logically accept the statistical set of oil sales of the table 1 for 2007 as  $P_{0i}$  – statistical set of C2007, so as the reporting "opportunity" it is possible to consider  $P_{1i}$  - set of C2008 from the table 1. Then taking into account (1), (2) and given above results the table 2 will be the following.

Table 2. Table for the analysis on the scheme “productivity” X “opportunity”= “result”

№, i	Countries	Productivity		Opportunity	
		$y_0$	$Y_1$	$P_0$	$P_1$
1	Hungary	0.386	0.502	3207.00	1238.02
2	Germany	0.269	1.640	1390.90	373.93
3	Netherlands	0.724	0.867	1251.90	905.90

4	Ukraine	0.039	5.607	5128.21	200.00
5	Turkey	1.970	0.957	1635.25	3219.00
6	UK	2.446	2.005	40.80	99.78
7	Poland	1.546	0.842	2177.90	3367.00
8	Belarus	1.439	0.771	1361.70	1900.00
9	Czech Republic	12.429	0.314	170.20	2115.37
10	Italy	3.252	1.169	938.60	3052.50
11	France	1.021	1.180	399.00	407.28

According to the accepted expressions (1) and (2) given in table 2 in the names of columns as operands with the corresponding mathematical indexes for carrying out the index analysis have the following dimensions: "y" are measured in units [NCC mln. US dollars/ IC of mln. US dollars], "(P)" - in units [IC of mln. US dollars], products of "yP" are measured in (NCC mln. US dollars/ IC of mln. US dollars) · (IC of mln.US dollars) = [by NCC of mln. US dollars]. Therefore, from the available as the statistical data short dynamic ranks of table 1 due to the formulated rule in an adaptation of basic statistical data to the index analysis we accept as the basic period 2007, and as the reporting – 2008, as it is reflected in working table 2. Further, using basic data in the form of  $y_{0i}$ ,  $y_{1i}$ ,  $P_{0i}$  and  $P_{1i}$ , it is easy to find products necessary for calculations look like (yP) and their sums up with the corresponding interlinear symbols:  $\sum P_0 = 17701,46$  IC mln. US dollars;  $\sum P_1 = 16938,78$  IC mln.US dollars;  $\sum y_0P_0 = 16941,31$  NCC mln.US dollars;  $\sum y_1P_1 = 15481,55$  NCC mln. US dollars;  $\sum y_0P_1 = 52487,94$  NCC mln. US dollars. It is clear that the sums of "productivity"  $\sum y_0$  dimension [NCC mln. US dollars/ IC of mln. US dollars] and  $\sum y_1$  dimension [NCC mln. US dollars/ IC of mln.US dollars] don't have physical sense and therefore don't pay off. As the basic period (2007) and reporting (2008) are created by the rules declared here it must be kept in mind that circumstance that "result", for example, look like  $\sum y_1P_1$  will be already belong to the following, 2009 owing to specifics of adaptation of initial information (table 1) to modified initial information (table 2).

#### 4. Modelling on the basis of modified initial information

Chosen for modelling of foreign economic relations famous index method as provided in Gromuko, 1999 allows us to define the general index of productivity of trade - the variable and fixed (constant) structure, an index of structural changes, and also to calculate the absolute changes of result in 2009 in relation to 2007 and to show what part of this gain (decrease) is received from the change of the IC size, efficiency of trade over the certain countries and changes of structure of IC in the process of trade. The step-by-step algorithm of the offered model of trade on the modified basic data (see table 2) will be the following.

1. We define an index of productivity of trade of variable structure as the relation of average efficiency of volumes of trade in 2008 to average efficiency in 2007. On the sums calculated earlier we will receive:

$$I = \frac{\sum y_1P_1}{\sum P_1} : \frac{\sum y_0P_0}{\sum P_0} = \frac{15481,55}{16938,78} : \frac{16941,31}{17701,46} = 0,914 : 0,957 \approx 0,955 = 95,5\%.$$

This means that the average efficiency of interstate cooperation linkages of the Republic of Tatarstan as the region of the Russian Federation with the far abroad and neighbouring countries decreased for the studied period (from 2007 to 2008) in relative expression on

$\Delta y_{c.c.} \% = 95,5\% - 100\% = - 4,5\%$  or, in absolute expression, on  $\Delta y_{c.c.} = y_{1av} - y_{0av} = 0,914 - 0,957 = - 0,043$  (NCC mln. US dollars/ IC of mln. US dollars).

The received results generally mean very insignificant decrease, however is important the identification not only the maintenance of probably revealed relationships of cause and effect of the received preliminary result as consequences but also an assessment the sizes of influence of the possible factors revealed at modelling.

For this purpose (identification of factors of decrease for 4,5% of overall effectiveness of trade that made losses of 0,043 mln. US dollars) it is necessary to find the indexes of productivity of trade of the fixed structure and an index of structural changes.

2. We find an index of trade productivity of the fixed structure eliminating influence of change of initial costs structure (IC, mln. US dollars) for the basic and reporting periods on a dynamics of average efficiency:

$$I = \frac{\sum y_1 P_1}{\sum P_1} : \frac{\sum y_0 P_1}{\sum P_1} = \frac{15491,55}{16938,78} : \frac{52487,94}{16938,78} = 0,914 : 3,099 = 0,2949, \text{ or } 29,5 \%$$

This means that from the change of trade productivity with the certain countries (which could be seen from the table 1) average efficiency for the reporting period decreased in relative expression on  $\Delta y_{f.c.} \% = 29,5\% - 100\% = -70,5\%$  or, in absolute expression, on  $\Delta y_{f.c.} \% = 0,914 - 3,099 = -2,185$  (NCC mln. US dollars/ IC of mln. US dollars).

3. Further we find an index of the structure reflecting the structural changes of basic data according to tab. 1 over all countries on dynamics of average productivity of trade for the considered period:

$$I = \frac{\sum y_0 P_1}{\sum P_1} : \frac{\sum y_0 P_0}{\sum P_0} = \frac{52487,95}{16938,78} : \frac{16941,31}{17701,46} = 3,099 : 0,957 = 3,2377, \text{ or } 323,77\%$$

This means that from the change of initial opportunities structure (commodity volume turnovers over the countries) average productivity of trade increased in relative expression on  $\Delta y_{str.} \% = 323,77\% - 100\% = 223,77\%$  or, in absolute expression, on  $\Delta y_{str.} = 3,099 - 0,957 = +2,1416$  (NCC mln. US dollars/ IC of mln. US dollars). Thus, the general decrease in average efficiency of trade (on  $-0,043$  NCC mln. US dollars/ IC of mln. US dollars; in another words decreased the speed of creation of new cost in relation to the initial cost) which occurred from 2007 to 2008 is caused by action of two factors: decrease in productivity of trade over the certain countries (on  $-2,185$  NCC mln. US dollars/ IC of mln. dollars) and change of structure of IC of the certain countries (on  $+2,141$  NCC mln. US dollars/ IC of mln. US dollars). Then indexes of the fixed structure and structural shifts in the absolute expressions ( $-2,185$  and  $+2,142$ ) are the explaining factors of decrease in average productivity of trade as a whole ( $-0,043$ ), and the balance of ratios can be presented as below:

$$-0,043 = -2,185 + 2,142 \text{ (NCC mln. US dollars/ IC mln. US dollars)} \quad (3)$$

In particular using a ratio (3), it is easy to estimate the weights of the revealed factors influencing throughout the studied period on average productivity of trade in relation to the considered countries. As a result of simple ratios it is possible to conclude that to the share of the productivity of trade with the certain countries (negatively operating factor) it takes 50,5% whereas the factor of structure of the trade (positively operating factor) takes 49,5% (as a result it is about 50 to 50). Thus, the general insignificant decrease in the general efficiency (efficiency) of trade (only on 43 thousand dollars) is caused upon really operating with two mutually counterbalancing each other (in this case) by processes: on the one hand – obvious decrease in efficiency of use of earlier saved up experience and the possible developed traditions of trade with the certain countries, with another – in the Republic of Tatarstan for the studied period and within this model quite convincing counterbalance in the form of creation of such successful structure of interaction (in this model – in the form of oil sales volumes in 2007 and 2008) is shown. As identification of the real reasons (purposefully from state bodies of RT, business owners or it is spontaneous) so successful balance presented in expression (3) in a research objective doesn't enter. At this investigation phase expedient it will be simple to estimate structures of initial opportunities – volumes of commodity turnovers (on our terminology) the basic

and reporting periods (see tab. 3), having used the primary (initial) statistical information provided in tab. 1 (weight in the % reflecting structure of trade by years in tab. 3, are provided through a virgule).

Table 3. The volume of supply of RT oil export (mln. US dollars) (mln. US dollars) / weight, %

№.	Country	2007	2008
1	Hungary	3207.00/18.1	1238.02/ 7.3
2	Germany	1390.90/ 7.8	373.93/ 2.2
3	Netherlands	1251.90/ 7.1	905.90/ 5.3
4	Ukraine	5128.21/29.0	200.00/ 1.2
5	Turkey	1635.25/ 9.2	3219.00/19.0
6	UK	40.80/ 0.0	99.78/ 0.1
7	Poland	2177.90/12.3	3367.00/19.9
8	Belarus	1361.70/ 7.7	1900.00/11.2
9	Czech Republic	170.20/ 1.0	2115.37/12.5
10	Italy	938.60/ 5.3	3052.50/18.0
11	France	399.00/ 2.2	407.28/ 2.4
	Summary weight	99.7%	99.1%

As we could see from the table 3, the structure of oil supply over the far abroad and neighbouring countries in the reporting and basic periods differs very significantly. In the revealed structure of trade practically for 2007 – 2008 period there is no stable supply of oil for any of the countries whereas the overall picture testifies the unstable nature of studied process unless it is possible to carry as "quasicontinuous" trade with known convention such countries as the Netherlands, Poland, Belarus and France. For other countries given in table 3 instability is the main characteristic, however, the same is looked and for 2009 (see table 1). Nevertheless such reorientation in supply of oil that is reflected in structure of trade for RT for the studied period was factually by the result as a compensating factor, despite decrease in trade as a whole: in 2007 – on 17701,46 mln. US dollars, whereas in 2008 – on 16938,78 mln. US dollars.

Therefore, having rather limited set of basic data (see table 1) it is quite possible to carry out the factually two-factorial analysis as a result of which it is possible to find the reasons though insignificant (in this case) but the decrease in average productivity of trade in 2008 (reporting) in relation to 2007 (basic) year. The further using of the accepted index method as a formal tool of modelling the studied problem gives such opportunities as an identification of the reasons, what part of a pure gain (pure loss) in oil foreign trade in 2008 in comparison with 2007 is considered with the level of their results from the positions of the sizes of initial sales volumes (2007 and 2008), with the productivity (efficiency) of trade with the certain countries listed in table 1 and with the trade structure (see table 3).

4. For the solution of these objectives it is necessary to determine firstly in absolute expression the change of total "results" of oil sale as multiply of "productivity" and "opportunities" ( $\Delta$ op.b. ) in reporting 2008 in comparison with basic 2007:  $\Delta = \sum y_1 P_1 - \sum y_0 P_0 = 15481,55 - 16941,31 = - 1459,76$  (NCC mln. US dollars).

So, for this period (2007 - 2008) took place the reduction of total result of oil sale on 1459,76 mln. US dollars or  $\approx 1,46$  NCC bln. US dollars that make considerable volume new, half-received cost for RT. In this connection also as well as in a case with the productivity of oil sale is interested the former question of identification as the maintenance of the reasons of this circumstance and an assessment of their level of influence on total (summary) result. For the identification of that and another factor we will make the following calculations.

5. Estimation of losses (the missed benefit) / acquisitions at the expense of change of sales volumes from 2007 to 2008 as a difference of the sums of initial opportunities with the multiplication of this difference to the

size of average productivity of sales in the basic period (2007):

$$\Delta (\Sigma P) = (\Sigma P_1 - \Sigma P_0) \cdot y_{0av} = (16938,78 - 17701,46) \cdot 0,957 = - 729,93 \text{ (IC mln. US dollars).}$$

6. Estimation of losses/acquisitions at the expense of change of productivity (efficiency) of oil sales with the certain countries:  $\Delta = \Sigma y_1 P_1 - \Sigma y_0 P_1 = 15481,55 - 52487,94 = - 37006,39$  (NCC mln. US dollars).

Here the productivity is taken of different kinds for 2008 and for 2007, but in relation to opportunities of 2008 that is nothing as a difference between the numerator and the denominator of an index of productivity of the fixed structure (weight) in an aggregate look.

7. Assessment of acquisitions/losses at the expense of changes of initial opportunities structure (see table 3):

$$\Delta = \left( \frac{\Sigma y_0 P_1}{\Sigma P_1} - \frac{\Sigma y_0 P_0}{\Sigma P_0} \right) \cdot \Sigma P_1 = 36276,56 \text{ (NCC mln. US dollars).}$$

Further it is necessary to verify the justice of a ratio (balance) of item 4 with the items 5 - 7:

$$- 1459,76 = - 729,93 - 37006,39 + 36276,56 \quad (4)$$

The usefulness of the check of an expression (4) will be expressed better if to draw the conclusions using the continuation of the factorial analysis begun at an analysis stage of the productivity of trade on available basic data.

Thus, the general decrease in results of oil sale in reporting 2008 in comparison with the basic 2007 on – 1459,76 NCC mln. US dollars is caused by three factors as it is revealed according to their contents and level of influence:

1) on – 729,93 IC mln. US dollars decreased the general result from the reduction of the size of initial opportunities (sales volumes in 2007 and 2008);

2) on – 37006,39 NCC mln. US dollars gross collecting decreased from the decrease in productivity (efficiency) of export to the certain countries;

3) on + 36276,56 NCC mln. US dollars the result increased from the change of structure of initial volumes of oil sales in the basic and reporting periods.

Weight indicators of the operating factors listed here (it is revealed three of them) unlike the factors influencing to the productivity of trade (them it was revealed two) will be others. To the share of a factor "reductions from the reduction of the size of initial opportunities" (owing to the operating objective / subjective reasons – hereinafter it isn't investigated) it is 0,99% fall, the factor of "decrease in productivity of sales" falls to the share of 50,0%, to a factor share of "change of structure of initial volumes" it is 49,01% (in total 100%).

The weight of two last factors listed above differ from earlier given scales relating to an assessment of action of factors on the share of productivity of trade with the certain countries (also negatively operating factor) takes 50,5%, and for the factor of trade structure (also positively operating factor) it takes 49,5%. Therefore the factor "the size of initial opportunities" in the here accepted terminology has no noticeable impact.

## 5. Conclusion

So, application of the aggregated indexes even on the limited massive of basic data allows carrying out the factorial analysis of the most essential parts of the analysed phenomenon. Therefore, the index analysis due to principal limitations of statistical data in the modern Russia conditions concerned with the famous social and economic reasons could be very productive instrument in the analysis of the chosen objects of research. It is enough to have only as it was already shown some statistical data, and after that it is possible to use the

scheme: "Efficiency (y)" multiply to "Opportunities (P)" = "Result (yP)".

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