About the possibility of taking into account the updated data in the Russian block of World Input-Output Tables

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Abstract

In the international databases of the world input-output tables, the Russian block is statistically represented very weakly. Even the developers of the updated version of the WIOT database do not advise using a diagonal Russian block for analyzing the Russian economy. The reason for that is a poor database of national input-output tables for Russia. However, after an interval of almost 20 years, a one-time-only survey of production costs structure was carried out for Russia and an input-output table for the year 2011 was constructed. Unfortunately, the publication of the tables was conducted after the WIOD database was updated, so new Russian data were not included in this version. In addition, the Russian tables are made in the old version of ISIC, which was used for the world tables of input-output for 1995-2011. We have attempted to include the updated data for the Russian block for 2011 into the world input-output tables. For this purpose, based on the supply table and the use table for the domestic products, a block of intermediate consumption of domestic products industry by industry is calculated. Preliminary calculations show that the difference with the previous version of the Russian block and the new one, taking into account the results of the recent survey of the cost structure in the Russian economy, are significant. In some industries, the intermediate demand for domestic products is differs several times from the one from previous version. Differences can be seen not only in intermediate demand, but also in the output of industries. Therefore, when adapting to the new structure of costs, most attention is paid to the input-output coefficients. For balancing, the RAS method and optimization methods are used.

Introduction

Regrettably, in the source [2] included in the overview of the sources and characteristics of the new 2016 release of the WIOD database on page 60 stated: "User warning: Given the paucity and outdated nature of the publicly available Russian statistics, we do not advise users to make an analysis of the Russian economy based on this data. There is still no official Supply and Use table available (a 2011 SUT was announced for November 2015 but has not been released yet),

which means that we have to rely on an outdated table for 1997. We have included Russia in this version of the WIOD only for analyses of international trade with Russia. The trade data is relatively more complete and up to date."

Indeed, until March 2017, the Russian input-output tables in the SNA concept, based on a one-time-only survey of the cost structure, were developed and published only in 1995. Finally, after almost a 20-year break, Russian tables for 2011, based on a one-time-only survey of the cost structure were published. The Federal State Statistics Service of Russia (Rosstat) has developed and published a supply table for goods and services, use table for the goods and services in buyers' prices and basic prices, tables of trade and transport margins and taxes, net of subsidies for products. Also were published: use table of domestic products in basic prices, use table of imported products in CIF prices, symmetric input-output table, symmetric input-output table for domestic products, symmetric input-output table for import [4]. Of these dimensions of rectangular tables (supply and use (SUT), tables of trade-transport and tax margins, use table of domestic and imported goods and services) are 248x178, dimensions of symmetrical tables - 126x126. The methodological basis of the basic input-output tables for 2011 is the updated version of the SNA 2008. The nomenclature of the industries of the base tables is based on the OKVED-2007 (All-Russian Classifier of Economic Activities) harmonized with the Statistical Classification of Economic Activities in the European Economic Community (NACE Rev.1.1). The nomenclature of the products is based on the All-Russian Classifier of Products by types of economic activity of the OC-2007, harmonized with the Statistical Classification of Products by Activity in the European Economic Community (CPA 2002).

Unfortunately, these tables, as already mentioned above, were not published either during the development of the first version of the WIOD database for 1995-2011, (based on the classifier NACE Rev.1), or during the development of the updated version of the tables for 2000-2014 years. Thus, the Russian block of the WIOD database, in fact, is based on the 1995 cost structure. We have attempted to update the Russian block taking into account the data of the Russian basic input-output tables for 2011. For the calculations, the first version of the World Input-Output Table (WIOT) for the years 1995-2011 was selected, since the new Russian tables are made in classifiers, harmonized with the classifiers of this table.

Aggregation of symmetrical input-output tables

Worldwide input-output tables in WIOD are compiled in the form of industry-by-industry tables, each country in which is represented by 35 industries. According to the developers of the tables, a diagonal block (a block of intermediate consumption of Russian domestic goods and services) is questionable for Russia. Therefore, a comparative analysis of this block should be performed with the first quadrant of the symmetric input-output table of domestic products compiled in the form of industry-by-industry table. A set of Russian input-output tables for 2011

allows us to estimate the first quadrant. In order to move to a symmetrical domestic input-output table, method D was applied to calculate technical coefficient matrix A:

$A = M'\hat{q}^{-1}\bar{U}\hat{g}^{-1}$ (1),

where M' - transposed supply matrix,

$\hat{q}$ - diagonal products output matrix,

$\bar{U}$ - use table of domestic products,

$\hat{g}$ - diagonal industries output matrix.

Accordingly, the matrix of the first quadrant of the symmetric domestic input-output table is found as $A\hat{g}$.

The aggregation of a symmetrical domestic input-output table to 35 industries was accomplished in two ways. One way was to first create a symmetrical table of dimension 178x178, which is then aggregated into a 35x35 dimension table. The other way is to aggregate the supply table and use table into 35x35 dimension tables at first, and then calculate a symmetric 35x35 table on their basis. Both options are converted in millions of dollars at the rate shown in the WIOD database. Empirical analysis shows that the difference between the results of the rows and the results of the columns of the Russian block of the world input-output tables (WIOT) for 2011 and the first quadrant of the symmetric domestic input-output table based on Rosstat data is greater for the first method. Therefore, the results of the second method are applied for further calculations and analysis.

The differences between the Russian data in the WIOD for 2011 and the Russian input-output tables mainly relate to the intermediate consumption of Russian domestic products, that is, the diagonal Russian block in the WIOT. For example, the biggest differences in output are observed for textiles and leather production - textiles in WIOT are understated 2 times, and leather production, on the contrary, is overestimated by 2 times. Apparently, the differences are of a classification nature. Given the small size of the industries, such differences, in our opinion, are not a reason for revising the volume of their issues. The next significant difference is observed for the "Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel": in the Russian input-output tables, this figure is lower by 29%, but output of another retail sector “Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods” is higher. Apparently, differences in trade are also of a classification nature. Based on the analysis carried out, and taking into account the fact that the change in all Russian data in WIOT-2011 requires a new assessment of the entire world input-output table, it was decided to change only the diagonal Russian block in this table.

Analysis of the difference between the results of the rows and the results of the columns of the Russian block WIOT-2011 and the first quadrant of the symmetrical domestic input-output table of Rosstat shows that the most significant are the differences between the results of the rows, that is, the difference in the intermediate demand across the sectors. For example, there are industries for which

the intermediate demand for the two is several times higher. Thus, fivefold excess of WIOD data in comparison with Rosstat data is observed for the "Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods" industry, threefold excess - for the "Public Admin and Defense; Compulsory Social Security" industry. And vice versa, according to WIOD, the intermediate demand for inland transport services is two times lower that of Rosstat, "Financial intermediation" is 2.5 times lower, and intermediate demand for "Real Estate Activities" is also two times lower. In general, the result of the first quadrant (intermediate consumption), according to WIOD data is 1.2% lower than intermediate consumption according to Rosstat. The latter suggests that the differences in the industries can largely be the result of the differences in the classifiers of the basic Russian input-output tables for 1995, compiled in OKONKh[1] (applied in WIOD) and the base Russian input-output tables for 2011 year, compiled in OKVED. On the other hand, there is no doubt that there were some structural changes in the Russian economy that occurred during the transition period. Thus, the conclusion arises about the need to revise the Russian diagonal WIOT block taking into account the new data of the Russian input-output tables for 2011.

Balancing methods

Since, as noted above, it is not possible to review the entire global input-output data, the restriction for changes in the Russian diagonal block is the equality of the results of the rows and the results of the columns for every industry to the first version of WIOT 2011 data (WIOT2011) compiled for 1995-2011 years.

The most common method for solving similar problems is the RAS method. Let us briefly consider the method itself and its modifications[1][3][5].

RAS method

We denote the original matrix $X_0 = (x_{ij}^0)$, and the refined matrix we want to obtain is $X = (x_{ij})$. For each column and row, we denote their sums $\sum_i x_{ij} = u_j$ and $\sum_j x_{ij} = v_i$, respectively. The resulting matrix must satisfy the following conditions:

1) $f(X, X_0) = u_j - u_j^0 \to 0$, for all j (2)

2) $f_1(X, X_0) = v_i - v_i^0 \to 0$, for all i (3)

To solve this problem, we use the iterative algorithm $X_{k+1} = NX_k$ in the case of even k and $X_{k+1} = MX_k$ in the case of odd k, where

$$N = \begin{pmatrix} \frac{u_1^0}{\sum_j x_{1j}^k} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \frac{u_n^0}{\sum_j x_{nj}^k} \end{pmatrix} \quad (4) \text{ and } M = \begin{pmatrix} \frac{v_1^0}{\sum_i x_{i1}^k} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \frac{v_n^0}{\sum_i x_{in}^k} \end{pmatrix} \quad (5)$$

This algorithm is convergent, since all elements of the matrix X_0 are nonnegative. All the elements of the matrix X also turn out to be nonnegative.

[1] All-Russian classifier of branches of national economy

Modified RAS method

Also, a modified RAS method was applied, in which restrictions were imposed not only on the sum of rows and columns, but also on individual elements x_{ij}, for example, related to oil production and refining, as well as electricity generation.

Sign preserved RAS

This method allows the use of linear constraints of any kind. We can formulate it for the problem in a generalized form. Let us write the general system of linear constraints in a generalized form:

$Cx = d,$ (6)

where $C = (c_{ij})$, x, d – column vectors.

Then the elements of the matrix x in the iterative algorithm will have the form:

$x_j^k = x_j^{k-1}(r^k)^{sign(x_j^{k-1}c_{ij})},$ (7)

where

$$r^k = \frac{d_i + \sqrt{d_i^2 + 4\sum_{j,x_j^{k-1}c_{ij}>0} x_j^{k-1}c_{ij} \sum_{j,x_j^{k-1}c_{ij}<0} x_j^{k-1}c_{ij}}}{2\sum_{j,x_j^{k-1}c_{ij}>0} x_j^{k-1}c_{ij}} \quad (8)$$

$i = k\ mod(q)$, where q is the total number of equations in the system. In this case, the signs of all elements of the matrix to be approximated must be preserved.

Non-sign preserved RAS

If all of the above-mentioned methods fails to balance our matrix, we can use this method. In it, it is possible to change the sign of the elements of the matrix X during balancing. The algorithm in that case will look like:

$x_j^k = x_j^{k-1}(r^k)^{sign(x_j^{k-1}c_{ij})},$ (9)

where

$$r^k = \frac{sign(\sum_i c_{ij}x_j^{k-1})d_i}{\sum_{j,x_j^{k-1}c_{ij}>0} x_j^{k-1}c_{ij} - \sum_{j,x_j^{k-1}c_{ij}<0} x_j^{k-1}c_{ij}} \quad (10)$$

Selection of criteria and analysis of results

"Balancing", that is, the change of the Russian diagonal WIOT2011 block, while taking into account the new cost structure (according to the base Russian tables of input-output for 2011), with constant results of rows and columns is performed by two methods: conventional RAS and Modified RAS. Before we start analyzing the results of balancing, we need to determine the criteria for choosing the best variant of the desired table. In selecting the criteria, in turn, the purpose of this study is taken into account: obtaining updated input-output coefficients, or technological coefficients of direct costs a_{ij} for the Russian diagonal block WIOT for predictive-analytical calculations. We denote by A^W the initial matrix of direct input-output(IO) coefficients for the diagonal Russian WIOT2011 block, by A^R- the matrix of the direct IO coefficients of domestic production according to the basic Russian input-output tables for 2011, by A^{Wnew}- the matrix of direct IO coefficients for the updated

Russian diagonal WIOT2011 block, taking into account the basic Russian input-output tables for 2011. Table 1 shows the results of a comparative analysis of various variants of technological coefficients. As we can see, the difference in the share of intermediate consumption in the releases by matrices A^W and A^R is significant for a sufficiently large number of industries. The greatest differences are observed for the leather industry, transport services and public administration services - account for 10-17% of the volume of issues. The analysis shows that the difference between individual direct IO coefficients may be greater than the difference in the indicators of the shares of intermediate consumption in the issues. For example, the costs of products of the "Mining and Quarrying" for 1000$ of refined products by A^W are 163$ lower than in A^R; Intra-industry electricity costs for A^W are 300$ lower than in A^R in the calculation of 1000$ of electricity output, and oil product cost coefficients for electricity are higher in A^W than in A^R by 130$. It should be noted in general a significant difference in the structure of the cost of electricity production in matrices A^W and A^R.

The RAS method allows to achieve a change in the Russian diagonal block WIOT taking into account the new Russian input-output tables, while maintaining the previous volumes of intermediate demand and intermediate consumption of domestic goods and services. But what is the price of restrictions on intermediate demand and intermediate consumption of domestic goods? How much is the distortion of the cost structures obtained based on the basic Russian input-output tables for 2011? In our opinion, the results are quite comforting. For example, Table 1 shows the difference between the columns of the electric power industry for the matrices A^R and A^{Wnew}. If the equality condition of the columns results of the electric power industry in the matrices A^W and A^{Wnew} is satisfied, the individual cost coefficients in A^R and A^{Wnew} differ insignificantly. The coefficients of intra-branch electric power consumption have substantially approached the indices of matrix A^R, the coefficients of expenses of the oil products industry on the electric power industry have improved. Despite the fact that the cost coefficients of the output of the extractive industry for oil refining has significantly approached the corresponding indicator A^R, the difference still remains and is 91$ (instead of the previous 163$) for 1000$ of refined products. Attention is also drawn to the cost coefficients for refined products. Although the cost ratio of petroleum products for the production of electricity has improved (from exceeding in A^W by 130$ per 1000$ compared to A^R exceeded 16$), the whole line of petroleum products has improved with varying success. Some coefficients have approached A^R, and others - on the contrary. Moreover, after applying the RAS method, the oil production IO coefficients of the matrix A^{Wnew} became steadily higher than those of the matrix A^R. The same stable processes are observed for the line "inland transport": the data of the matrix A^R steadily exceed the analogous data from the matrix A^{Wnew}. The opposite signs of the lines may be determined by the change in the accounting of oil

products' costs for own motor transport, as a result of which the indicated differences in the rows of the matrices A^R and A^{Wnew} are observed.

The modified RAS method with constraints on individual elements allows obtaining the desired values of the individual coefficients a_{ij}. However, such an "improvement", as a rule, occurs due to the removal of other coefficients of the matrix A^{Wnew} from the analogous coefficients of the matrix A^R. The choice of "improved" coefficients is rather difficult, and the attempt to estimate the "damage" for the remaining coefficients is even less productive. Nevertheless, the application of the method is possible when performing scenario calculations, in which the efficiency of the selected values of the individual coefficients is determined from the output values of the model variables.

It should be noted that the change in the Russian diagonal WIOT block leads to some changes in the results of calculations for other countries. This is especially true for calculations involving the matrix of total expenditure coefficient L. Analysis of the difference between the matrices L (original and updated) shows: 1) all total expenditure coefficients have changed to some extent, which is quite understandable. Although the changes in the IO coefficients have affected only the Russian diagonal block of the world input-output table, but since all the IO coefficients participate in the calculation of each total expenditure coefficient, all the total expenditure coefficients have changed. 2) The greatest changes occurred in the Russian diagonal block of the matrix of total expenditure coefficients, which is understandable and does not require additional interpretations. 3) Changes in the results of the columns, in general, are insignificant. Exceptions are Russian indicators, which is also understandable. 4) If the results of the Russian columns of the matrix of total expenditure coefficients of the world input-output table subtract the results of the columns of the Russian diagonal block, the indicators also appear to be significant. The latter suggests that the share of imports needed for a unit of final demand also changes following the direct cost coefficients.

Calculations to assess the place of Russia in the global value chains (GVC) with the use of the updated matrix L also show changes in results compared to the old version of the matrix L. Since a detailed analysis of such a revaluation can serve as the subject of another article, we give only some results. For example, from one to two percent, the value added of the Russian extractive industry is growing in the final demand for China's construction, in the oil refining of Italy, France, and the Netherlands, which are leading in the distribution of value added to the Russian extractive industry. With the updated IO coefficients, the added value of Russian production, embodied in the final demand of Russian oil refining, is growing substantially. A sizeable redistribution of the value added of the Russian extractive industry is also observed between the final demand of other Russian industries.

Conclusion

Thus, the conducted studies show both the need and the possibility of adjusting the Russian diagonal block of WIOT tables. Necessity arises, firstly, due to a significant difference between the IO coefficients of the Russian WIOT unit and the IO coefficients of the new base Russian input-output tables. Secondly, due to significant changes in the results of scenario forecast calculations using the updated matrix of total expenditure coefficients. The possibility of specifying the Russian diagonal WIOT block is confirmed by the results of calculations based on various methods of adjusting the technological matrix, which make it possible to obtain acceptable results.

Table 1

Industries	The difference in the share of intermediate consumption in issues for matrices A^W and A^R	The difference between the columns of the electric power industry for matrices A^R and A^{Wnew}	The difference between the IO coefficients of oil products for matrices A^R and A^{Wnew}
Agriculture, Hunting, Forestry and Fishing	-0,011	0,000	-0,028
Mining and Quarrying	-0,024	0,017	-0,017
Food, Beverages and Tobacco	-0,010	0,000	-0,006
Textiles and Textile Products	-0,024	0,000	-0,004
Leather, Leather and Footwear	0,163	0,000	-0,006
Wood and Products of Wood and Cork	-0,082	0,000	-0,011
Pulp, Paper, Paper , Printing and Publishing	0,045	0,000	-0,013
Coke, Refined Petroleum and Nuclear Fuel	-0,073	-0,016	-0,078

Chemicals and Chemical Products	-0,019	0,000	-0,057
Rubber and Plastics	0,064	0,000	-0,022
Other Non-Metallic Mineral	-0,065	0,000	-0,016
Basic Metals and Fabricated Metal	-0,010	-0,002	-0,021
Machinery, Nec	0,038	0,002	-0,008
Electrical and Optical Equipment	0,070	0,000	-0,006
Transport Equipment	-0,009	-0,001	-0,004
Manufacturing, Nec; Recycling	-0,035	0,000	-0,006
Electricity, Gas and Water Supply	-0,043	0,020	-0,016
Construction	0,049	0,012	-0,015
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	-0,029	0,000	-0,003
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0,021	0,008	-0,012
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	-0,068	-0,015	-0,007
Hotels and Restaurants	-0,010	0,000	-0,003
Inland Transport	-0,057	0,006	-0,029
Water Transport	0,119	0,000	-0,091
Air Transport	0,165	0,000	-0,128
Other Supporting and Auxiliary Transport Activities;	-0,137	0,001	-0,022

Activities of Travel Agencies			
Post and Telecommunications	0,023	-0,001	-0,001
Financial Intermediation	-0,041	0,010	-0,001
Real Estate Activities	0,097	0,005	-0,002
Renting of M&Eq and Other Business Activities	0,052	0,002	-0,005
Public Admin and Defence; Compulsory Social Security	0,114	-0,002	-0,018
Education	0,054	0,000	-0,004
Health and Social Work	0,086	0,000	-0,009
Other Community, Social and Personal Services	0,048	0,000	-0,011
Private Households with Employed Persons	0,000	0,000	0,000

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