

The Estimation of Import Consumption Dynamics in Input-Output Mode

Lyubov' Strizhkova¹

Liudmila Tishina²

Mariya Selivanova³

Abstract

The article is devoted to the issues of Input-Output modelling in two inter-related dimensions connected with estimation of import matrix. The first dimension aims to development of the approaches to estimation of import consumption in sectors of national economy. The second dimension focuses on estimation of volumes of transferred value of intermediate imports to value of national output for internal final consumption and exports.

Objective limitations in national statistics determine the complexity of research in the concerned dimensions. So the requirement in solving these problems is very applicable. It is important for estimation of national economic development prospects, for effective foreign trade policy-making. This appears to be the reason of actuality of the article, which takes under consideration the mentioned aspects.

In the first part of article the task of import real demand of main types of intermediate products forecasting was formulated as a problem and solved. Also the way to include these forecasts in Input-Output model, when we estimate shifts in the structure of direct costs matrix, was introduced. In the second part of article the problem of decomposing the value of final national output on national and foreign GVA and net taxes on products was solved. While working at this problem the classical IO model has undergone transformation.

The article contains a description of possible ways to overcome informational limitations, including the solutions found in the field of model constructions for research purposes. Also the quantitative estimates of the results of this method application for Russian economy are given. They include the description of the specification of real import demand functions for the most important types of intermediate products; the estimates of the economy response to shifts in intermediate imports demand, taking into account intersectoral relations and changes in the share of intermediate imports in total value of national output for final consumption, gross capital formation and exports over the last years.

Key words: import, export, gross value added, Input-Output, modelling, sectors of national economy

¹ Doctor of Economics, Head of Centre, Institute of Macroeconomic Research of RFTA, Moscow, Russia, e-mail: l.strijkova@vavt.ru

² Research scientist, Institute of Macroeconomic Research of RFTA, Moscow, Russia, e-mail: shre@mail.ru

³ Research scientist, Institute of Macroeconomic Research of RFTA, Moscow, Russia, e-mail: legeydo@mail.ru

Introduction

The processes of globalization and integration, which take place all over the world nowadays, make the connections between national economies stronger. In this case the analysis of the processes connected with import consumption seems to be very actual. The process of production of gross value added in the national economy in practice is impossible without import goods of intermediate consumption, which are inherent factors of production process. Taking into account the actuality of this issue, this report is devoted to the problems of modelling of import consumption in Input-Output tables system. The report includes two inter-related analytical blocks: modelling of intermediate import consumption by sectors of national economy and estimation of volumes of transferred value of intermediate imports to value of national output for internal final consumption and exports.

New approaches in modelling of import consumption in these two dimensions will support the development of government decisions in improvement of national economy performance and the development of the effective foreign trade policy.

1. Modelling of import goods consumption by sectors of national economy

Modelling of import consumption in the production process of national economy is closely connected with the problem of estimation of input-output coefficients matrix of import and domestic production structure. So, the necessity of the modelling of shifts in input-output coefficients matrix structure leads to development of import goods of intermediate consumption demand function and the creation of scheme of including these functions in intersectoral modelling. The conducted work included several stages:

The 1-st stage. The selection of the essential statistical base for the development of demand regression functions

The data from the official reported Input-Output tables, especially the information from import matrices may be used as the informational statistical base of the consumption of intermediate import goods by economy. However this method is not appropriate for Russia, because the reported tables were developed all over again after a long interruption. Today we have information only for the period 2011-2015 years. It is not enough for the development of demand regression functions. This problem was solved due to development of expert data base, which was set up on the customs statistics.

This data base includes the volumes and index characteristics of imports by the dimensions of use and by sectors of national economy. Expert data base involves the period 2003-2016 years. The method of estimation is based on the appliance of special transformation keys, which turn the data reported in HS system into the NACE classification taking into account the dimensions of use. These transformation keys in combination with the prepared methodological guidelines

describing the development of import indices, help to estimate indices of physical volume and price indices of imports in different groups. The availability of such data base allows estimating the regression demand functions of different types of import intermediate goods.

The 2-nd stage. The identification of the main consumers of different types of import goods and others factors influencing on import consumption

On the second stage we indentified the main consumers of intermediate import goods and also studied the influence of the price factor. The selection of the main consumers was based on the prepared data from import matrices. The structure of use was analyzed for each type of goods and the correlation ratios between the dynamics of real import consumption and the dynamics of output of industry-consumer were estimated. On this stage we estimated the ratio of price competitive ability for each type of import intermediate goods, in particular the ratio of the domestic prices changes to the changes of import goods prices:

$$I_{KONi} = \frac{INF}{IP_{IMi} \times Ik}, \quad (1)$$

where

I_{KONi} - index of price competitiveness of imported intermediate goods type i in the domestic market;

IP_{IMi} - index of average contract prices (USD) of imported intermediate goods type i in domestic economy;

INF - average annual consumer price index for goods and services;

Ik - average annual index of the exchange rate on the Russian market (RUB/USD).

It should be pointed out that in the Russian economy the dynamics of the dollar exchange rate has a significant impact on the prices of imported goods, so this variable was included in the formula (1). Using the assessment of correlation coefficients, the influence of the price factor on the import consumption of intermediate goods by type of activity was also estimated.

The 3-rd stage. Evaluation of the regression demand functions of imported intermediate goods

At the third stage, after identifying the main factors of influence, the regression real import demand functions for the most important types of intermediate products were evaluated. The following specification (2) was taken as a base model:

$$I_{IMint i} = F(I_{Xj}, I_{KONi}), \quad (2)$$

where

$I_{IMint i}$ – index of real demand for imported intermediate goods type i ;

I_{Xj} - volume index of consumer industry output j in domestic economy (j possibly equal i);

I_{KONi} - index of price competitiveness of imported intermediate goods type i in the domestic market.

Regression real demand functions were estimated for all types of imported goods, which had high correlation rates with explanatory variables (competitiveness dynamics and output of consumer sectors).

The 4-th stage. Development of a scheme of connection regression parameters into IO modeling

The developed scheme includes three steps.

The first step of the scheme. Presents the exogenous hypothesis of growth of final use of the type i domestic production ($FUD_i^1 = FUD_i^0 + \Delta FUD_i$). The outputs of domestic production in the new conditions are estimated based on the IO model (3) and their dynamics is calculated (4):

$$X_{N1}^1 = Bd \times FUD^1, \quad (3)$$

$$I_{N1Xj}^1 = \frac{X_{N1j}^1}{X_j^0}, \quad (4)$$

where

X_{N1}^1 - vector of outputs for a given hypothesis of final use growth;

Bd - matrix of full costs coefficients of domestic products;

FUD^1 – vector of final use of domestic production for a given hypothesis;

I_{N1Xj}^1 - output volume index of sector j ;

X_{N1j}^1 - output of sector j for a given hypothesis of final use growth;

X_j^0 – initial output of sector j .

The second step of the scheme. There is an adjustment of row-vector indicators of type i in the matrix of import direct costs coefficients \widetilde{IM}^0 (5). Then the coefficients of direct costs matrix of domestic products the type i is recalculated (6). After matrix of coefficients of full costs of domestic products is recalculated too. The new outputs of domestic production are estimated using new Bo^1 .

$$im_{N1ij}^1 = im_{ij}^0 \cdot \frac{1}{I_{N1Xj}^1} \cdot [el_{ii}(I_{N1Xj}^1 - 1) + 1], \quad (5)$$

$$a_{N10ij}^1 = a_{ij}^0 - im_{N1ij}^1, \quad (6)$$

where

im_{N1ij}^1 - new import intensity of domestic production j for import i under the conditions of sector j output growth;

im_{ij}^0 - initial import intensity of domestic production j for import i ;

el_{ii} - elasticity of demand for imported product i according to the dynamic of demand for domestic products (output of consumer sectors) is determined on a base of real import demand function (results of the 3-rd stage);

a_{N1dij}^1 – new coefficient of domestic production direct costs;

a_{ij}^0 - initial coefficient of direct costs of production j for production i .

The third step of the scheme. The significance of the error in the calculation is checked and it is eliminated if necessary.

The 5-th stage. The approbation of the developed approaches on the reported and expert intersectoral balances of Russian Federation

To approbate the developed model the special calculations for expert system of Input-Output tables for 2016 year were conducted. On the first stage of calculation we accepted the hypothesis of increasing the final use of the domestic goods from the DM sector «Manufacture of transport equipment» by 10% from the general level of final use of this type of goods. Elasticity coefficient estimated with the assistance of the developed functions took a value 2.09. The estimations of the additional requirements in increase of the domestic production of all types and the additional requirements in increase of intermediate imports of all types are presented in table 1.

Table 1 – The results of model approbation calculations based on data for 2016 year in case of 10% growth of DM-goods final consumption

Additional requirement of output	Additional requirement of intermediate import goods
380 RUB bn	101 RUB bn
Rate of economic output growth	Rate of intermediate import goods growth
100.2%	101.2%

The conducted calculations demonstrated that the developed tools allow determining the dynamics of import consumption coefficients when we calculate the additional requirement in output in terms of informational limitations and taking into consideration the adjustment of increase of volumes of domestic production final use.

2. The estimation of volumes of transferred value of intermediate imports to value of national output for internal final consumption and exports (methodological aspects and quantitative examples)

Studying the process of import consumption in Russian economy, the authors also made an efforts to estimate the level of participation of domestic and foreign producers in the production of final value of domestic goods (for consumption, accumulation and exports). Such estimations

are very important for the analysis of reproduction, influence of different factors, including the price effects and also for making actual decisions in the economic policy.

To conduct the research in the sphere of cross-country comparisons, we need the estimations of the exports structure as the sum of transferred domestic and foreign value added. This allows estimating the level of participation of the country in generation of global GDP. Decomposition of value of final domestic production of each type i on value added, which was produced by foreign producers and by groups of domestic producers, is possible to realize with the help of Input-Output method, using Input-Output tables. This method of estimation with the use of full costs coefficient import matrix and full costs coefficient domestic matrix in general may be described with the following formulas (7) – (12):

1. Formula of final use vector:

$$FU = FUD + IM_{FU} = GDPd + IM_{int} + IM_{FU}, \quad (7)$$

where

FU - final use vector;

FUD - vector of domestic final use products;

IM_{FU} - vector of import final use products;

IM_{int} - vector of intermediate import;

$GDPd$ - vector of domestic value added in the value of domestic final products (final product in basic prices).

2. Formula of domestic final use products:

$$FUD = FUD_{DFU} + EXd, \quad (8)$$

where

FUD_{DFU} - vector of domestic products directed to domestic final use at basic prices;

EXd - vector of domestic products directed to export at basic prices.

3. Formula of matrix of import full costs coefficients:

$$I\tilde{M}_{FC} = I\tilde{M} \cdot Bd = I\tilde{M} \cdot (E - A + I\tilde{M})^{-1}, \quad (9)$$

where

$I\tilde{M}_{FC}$ - matrix of import full costs coefficients;

$I\tilde{M}$ - matrix of import direct costs coefficients;

Bd - matrix of full costs coefficients of domestic products;

A - matrix of direct costs coefficients.

4. The calculation of volume of used intermediate imports, the value of which is transferred: a) in value of final domestic products (10), b) in value of final domestic products for

domestic consumption and gross capital formation (11) and c) in value of domestic products directed to export (12):

$$\text{a) } IM_{int} = I\tilde{M}_{FC} \cdot FUD, \quad (10)$$

$$\text{b) } IM_{intDFU} = I\tilde{M}_{FC} \cdot FUD_{DFU}, \quad (11)$$

$$\text{c) } IM_{intEX} = I\tilde{M}_{FC} \cdot EXd, \quad (12)$$

Note that the transition in formulas (10) - (12) to the representation of the vectors FUD , FUD_{DFU} and EXd in the matrix form (diagonal matrices) allows expanding the analysis of import consumption. In turn it is open to characterize in detail the composition and the volume of imports, the cost of which is included in each element of these vectors.

The analysis of informational system of Input-Output tables for 2013-2015 years reported by Federal State Statistic Service and experimental system of Input-Output tables for 2016 year allowed to make the following conclusions with the help of the described method.

1. One of the consequences of the reformation of the structure of world prices under the influence of energy prices decrease became the depreciation of the ruble and appreciation of imports for Russian consumers. When the general expenditure on import increase almost for 19% to the level of 2013, its physical volume fall almost by one third. In addition the real demand on intermediate import was characterized by considerably lower level of decrease in comparison with consumer and investment import. This lead to the growth of its part in imports value by 1.6-1.7% (till more than 47%). Several Russian industries technologically depended of foreign suppliers, had to purchase considerably more expensive import goods to maintain the production processes.

2. In general the part of imports in total value of final domestic production (the estimation in basic prices) grew relatively the level of 2013 year not very strong – by 0.2% (to 9.8%). The appreciation of imports was compensated with the decrease of its physical volumes in situation of slight economic dynamics and low output deflators. The analysis of import full costs coefficients in current prices of analyzed years showed that almost a half (28) from 58 studied consolidated coefficients were characterized with the increase, and the rest had fallen.

3. In value of Russian exports the part of imports value, included in the estimation, was characterized with more concrete growth dynamics – 9.9% (2013 year), 10.6% (2015 year) and 10.8% (2016 year). The shifts in the exports structure influenced on this indicator dramatically. The production of the main Russian exported is relatively less depended on imports, and the influence of the decrease of energy prices made this interconnection even less. This and the rise of physical volumes of exports of other goods, including the goods with a very high dependence on imports, determined the increase of part of imported gross value added in Russian exports value.

4. The analysis of the matrix of full import costs coefficients (58×58) allowed to rank the types of Russian industries by the level of aggregate coefficients of the total import intensity of their products. Several groups of industries were identified:

- a) group with low ability to initiate demand for intermediate imports;
- b) with middle ability;
- c) with upper-middle ability;
- d) with high ability;
- e) with extra-high ability.

Table 2 shows the distribution of the total number of reviewed industries by these groups. Numerical criteria of group allocation are given in %. The criteria demonstrate the share of imports in the value of a unit of final domestic products (in other words full valuation of foreign GVA in the cost of domestic products).

Table 2 - Distribution of industries by the level of aggregate coefficients of full import intensity in 2013-2016

Type of industry	Quantity of reviewed industries	Distribution of industries by the level of aggregate coefficients of full import intensity			
		a) low 10 and low	b) middle 10-15	c) upper-middle 15-20	d+e) high and extra-high more 20
Raw materials	8	6	2	-	-
Manufacturing	23	1	4	8	10
Energy, water supply	2	2	-	-	-
Services	25	14	10	-	1
Economy, total	58	23	16	8	11

5. Almost a half (Table 2) of the total number of manufacturing industries are included in the “d+e” group. This includes various branches of the machine-building, chemical complex, as well as the textile-sewing and shoe industries.

The development of exports with a decrease in the share of raw materials components will be accompanied by an increase in its import intensity. However, if it is possible to increase the export of services (primarily infrastructure and high technology) significantly, these effects can be slightly leveled. Service industries, except air transport, belong to groups a) and b).

Conclusion

The use of IO tools for the study of import consumption and structural features of the economy opens important additional opportunities in the area of increasing the efficiency of public management decision making. Forecasting the full costs coefficients is a very important problem to solve. It allows modelling the shifts in structure of the production process and expands the possibilities of Input-Output tools appliance.

References

1. International Merchandise Trade Statistics: Compiler Guide, First Revised Edition / United Nations. — New-York, 2015. — 364 p.
2. Strizhkova, L. A Three-block Input-Output Model in Scenario Forecasting and Administrative Policy Providing (Practice, Problems, Hypothesis) / L.A. Strizhkova // The 20th International Input-Output Conference and the 2nd Edition of the International School of Input-Output Analysis, Bratislava, Slovakia, June 24-29, 2012, <https://www.iioa.org/conferences/20th/papers.html>.
3. Strizhkova, L.A. On the structure of the value of the final domestic products based on the IO method O / L.A. Strizhkova // Economist. – 2013. – №6. – P.61-71.
4. Strizhkova, L.A. Imported Goods' Demand Functions by the Main Areas of Use / L.I. Tishina, L.A. Strizhkova, M.V. Selivanova // Advances in Economics, Business and Management Research. – 2019. – Volume 47. – P. 713-716.
5. Tishina, L.I. Russian's foreign trade relations researches as an integrated part of an IO analysis / L.I. Tishina, S.N. Slobodianik // The 20th International Input-Output Conference and the 2nd Edition of the International School of Input-Output Analysis, Bratislava, Slovakia, June 24-29, 2012, <https://www.iioa.org/conferences/20th/papers.html>.