Regional Input-Output Model with Endogenous Households' Income and Demand

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Abstract

Territorial planning and projection of national economics development are actual and actively discussed problems. Owing to this, elaboration of interconnected projection of regional production volume, income and consumption are of great importance. One of the instruments for analysis and projection parameters of region's economics system and income/demand indices of households is a closed Input-Output model with endogenized income and demand of households. The feature of the approach, which results of application described in the given paper is that simultaneously with extraction of households' indices in 2 and 3 quadrants of symmetric Input-Output (IO) table, in the model developed by the authors the intermediate input matrix was transformed to separate intermediate input of the households from input of other institutional sectors. Necessity of such approach is caused by fact that the population of Russia has high share of consumption of products made into households in total private consumption. Application of this methodological approach in Russia comes against absence of regional IO tables. Due to this, authors simultaneously had to solve the task of developing some methods for constructing regional IO tables, compilation of regional IO tables (the authors are developers of regional Input-Output tables for the Republic of Bashkortostan (RB) for 1995 and 2002, whose results are published (Sajapova, 2008)), extending it by endogenizing of households' income and demand and applicated usage of projection model. The offered technique at regional level is realized for the Republic of Bashkortostan.

Keywords: regional IO tables, territory planning, forecasting and simulation.

1. World and Russian experience of constructing regional Input-Output tables

It is well known that regional IO tables are constructed in many countries. For example, authors know some models of regional tables in Canada. Regional tables were produced for 10 provinces and 2 regions of the country for 1974, 1979, 1984 and 1990. In 1997 it was decided to produce regional tables yearly. In 1997 Statistics Finland launched a project on making multiregional system of IO tables for 1995. The conception used in the country was taken by Statistics Finland of Denmark and Canada. In recent years Statistics New Zealand has been looking into the possibility of constructing IO tables for the country's regions by studying the experience of Canada and Finland. At the regional level the Input-Output method in China is used for analysis of interregional connections of provinces, autonomous regions and municipalities, which constructed their own regional tables for 1987, 1992 and 1997. It is possible to continue the enumeration of examples, but let's return to Russia's experience in construction regional IO tables.

Since 80-s no regional IO tables have been worked out by official organs of statistics in Russia. Absence of regional IO tables in Russia, worked out by territorial organs of Federal State Statistics Service, makes the researchers resort to generating regionalized IO tables. In such schemes developers, as a rule, use direct coefficient matrix, gained from national Russian IO table, thereby they spread average Russian structure of production of goods and services inputs on the studied region. It is obvious that Russian technical coefficient matrix is corrected by taking into account regional production peculiarities and regional IO table worked out by the same method is still a very precious prognostic-analytical instrument.

At the same time Russia had the opportunity of constructing survey-based regional IO tables, according to the principles and standards, outlined in the System of national accounts of 1993 and in European System of Accounts 1995 - ESA 1995 and "Handbook of Input-Output Table Compilation and Analysis" (United Nations Organization, 1999), as in 1995 one-time-only survey was carried out. Such developing was made up by the authors for Republic of Bashkortostan (RB) for 1995 on 227 types

of products and for the year 2002 on 25 types of products[1]. Inter-branch balance of production and distribution of goods and services (symmetric IO table) for the year 1995 in Republic of Bashkortostan (RB), constructed on the one-time-only survey of republican production cost structure, is basic. It served regional annual IO table compilation for 2002.

2. Methodological peculiarities of constructing regional tables in Russia

Despite vigorous activity of countries in making regional IO tables authors didn't come across any methodology basis for their generation, like "Handbook of Input-Output Table Compilation and Analysis" (United Nations Organization, 1999). That is why in the process of regional IO table developing 2 interconnected problems were being solved - adapting of IO table constructing method in the conception of SNA to the regional conditions and indirect valuation of the missing regional statistic information. All-Russia methods of annual IO tables formation was adapted to the peculiarities of regional statistics.

As specialists believe, regional IO tables contain a sufficient number of the so called estimated figures. They include, e.g. interregional trade flows, which cannot be taken into account in full force and effect. Despite the impossibility of full accounts of separate regional indices, interindustrial research specialists point out the necessity and possibility of constructing regional IO tables. This is exemplified in the experience of constructing regional IO tables during planned economy.

In the process of IO table compilation some problems of informational and methodological nature, arising in estimating of some macroeconomic indices, were solved. A number of indices which are not estimated by territorial organs of Federal State Statistics Service were calculated including trade and transport margins and net taxes on products. Important macro-structural parameters of RB's economy were verified, such as regional trade-flows according to industries. Difficulties of their

[1] The IO tables for the year 1995 and 2002 is compiled under the leadership of Sayapova , A.R. Some results are published, for example, in articles: Sayapova, A.R. (2004), Tablitsy "zatraty-vypusk" v analize i prognozirovanii structurnyh parametrov economiki regiona (Input-Output Tables in forecasting structural parameters of a regional economy), Problemy prognozirovania, 6; Nigmatulin, R.I., Sayapova, A.R. and L.D. Mazitova (2006), Tablitsy "zatraty-vypusk" Respubliki Bashkortostan (IO tables for the Republic of Bashkortostan), EKO, 3; Sayapova A.R. (2008) Regionalnie I rossiskie tablitsy "zatraty-vypusk". (Regional and Russian Input-Output tables)//Problemy prognozirovania, 6.

estimation are connected not only with the open nature of the region's economy, but also with the absence of total survey of establishments which have the fullest information about delivery and receipt of production. This fact results in underestimation of foreign trade activity and interregional flows. Calculation of import and export indices is of especial difficulty due to the following reasons: some part of factories are registered in other regions; it is quite difficult to estimate deliveries by pipeline transport, where it's nearly impossible to set aside export (import) from republic and transit trade; no information about shuttler traders and self-employed entrepreneur exists. Due to this, for the purpose of full reflection of export/import volumes it was decided to combine sources from different departments – RB's Department of statistics, Customs of Bashkortostan, RB's Ministry of foreign economic relations.

In the process of investigation, problems of several classifiers agreement of goods and services were solved: classification of goods of foreign economic activity in two-digit and four-digit codes, All-Russia industry of the national economy classifier, classification IO table codes in 25 different industries. Methodological peculiarities of some indices calculation at the region level were recognized, some evaluation methods of regional indices for "pure" industries (commodities) were proposed.

Taking into account the declared theme of the article we will dwell upon methodical features of calculating the third quadrant of the symmetric IO table for region. The system of regional accounts in Russia is at an initial stage of development today, which is caused by presence of methodical and technical difficulties in estimation of some macroeconomic indicators of the region. In order to overcome these difficulties at calculating the third quadrant the national technique of Federal State Statistics Service has been adapted to the features of information base and the statistics at regional level.

In IO table values of gross value added in different industries are found similarly to the production account – as difference between total output of industries and their intermediate consumption and for calculation of the third quadrant it is necessary to calculate elements of gross value added on industries, namely:

compensation of employees, which includes gross wages and salaries and social contributions (real and imputed),

gross operating surplus,

gross mixed income,

other net taxes on production.

According to the technique of Federal State Statistics Service, at compiling the third quadrant, control results of gross value added elements became indicators of generation of income account and its calculation tables, notably on economy branches they are directly transferred from the generation of income account, while on sub-branches the additional calculation, basic part of which is made by distribution on industrial branches, is carried out. However, generation of income accounts on regions of the Russian Federation till 2001 were not made, in this connection, at calculation of gross value added elements for regional IO table for 1995 both procedures of the third IO table quadrant calculation and generation of income account are used. These techniques are used in formation of control results on economy as a whole, as well as in calculation of elements of the added cost on industrial branches.

At wages calculation in IO table the primary aim is transition from the indicators relating to wages according to the statistical reporting, to the indicators corresponding to System of national accounts (SNA). The difficulty of the problem is that the wages in the reporting consists of a set of components entering into this or that part of payment fund.

Estimation of other taxes on production which are taxes on applied manufacture factors and include tax on property of the enterprises, payments for environmental contamination and other taxes and payments, requires complex calculations. Difficulty to calculate these taxes lies in the fact that a lot of federal, regional and local taxes, gathering and payments referring here have various nature of distribution on industries and demand calculation of tax base of industries almost for each tax.

The initial stage of taxes calculation became the formation of these taxes, gathering and payments lists, as it is not uniform for all regions of the Russian

Federation. This demanded studying of their charge methods, calculation of tax bases etc. Proceeding from this list, control results on separate taxes and payments on the basis of tax service reporting about receipt and debts change under separate articles, and also on the basis of the report on execution of RB's budget are calculated. At distribution of other taxes on production tax bases in different branches under separate taxes are calculated. This demanded attraction of the additional data on volumes and structure of a fixed capital, ecological payments and other information.

The use of Federal Tax Service information concerning payments of large and medium-sized enterprises in different branches for specification of branch volumes of taxes on some integrated branches that has allowed to specify volumes of other taxes on production in branches of fuel and energy, chemico-petrochemical and agroindustrial complexes became one of the offered approaches.

3. Extraction of indicators of households in II and III quadrants

Quite a developed way of endogenization of households demand used in domestic research is a differentiated balance of income and consumption of population. When considering various consumption propensities of different population groups it is possible to count the changes of macroeconomic parameters caused by changes of amount of different population groups' income as a result of income change of different population groups and its redistribution between profitable groups.

For calculation of differentiated balance of population income and expense indicators, and also its inclusion in the IO model, it was necessary to work out the scheme of transition between indicators of Balance of Money Income and Expenditure of the Population (BMIEP), Household Budget Survey (HBS) and IO table. In SNA the disposable income, which is not calculated by regional organs of statistics, is accepted as basis of consumption and population savings. However, there is a possibility to estimate it with the use of available information in BMIEP and HBS. Calculation is conducted with the help of all these forms. Firstly, owing to the fact that in the disposable income on SNA, besides monetary income, natural income is also included (it still makes a considerable share in aggregate income of households in Russia), secondly, as data calculation for differentiated structure of population income and

expense is available only in HBS, and there exist divergencies between these forms in calculation algorithms of monetary income and expense.

For the calculation of differentiated balance, estimation of population income differentiation has great value. From annual numbers of population distribution according to their income a decile structure of population's monetary income assuming technique of lognormal distribution of the population according to their income was received. Distribution is based on the modal income of a sample and per capita money income of a general totality from BMIEP. Unlike official statistics in which the dispersion of income in a sample practically coincides with a general totality dispersion, which is fabulous, at the use of the given technique, differentiation of income is essentially higher than in official publications. Under such scheme indicators of structure of distribution for 1995, 1997-2007 are calculated. Proceeding from the structure of money income distribution for 2002, there were distributed volumes of expendable income, expendable resources and other indicators in different profitable groups, participating in calculations at transition from primary incomes to the disposable income.

Distribution of indicators, including expendable resources, final consumption of production from personal subsidiary plot (PSP) and others according to decile groups was carried out on estimated from HBS regressional correlations. Also on the basis of HBS correlation of per capita consumption in profitable groups depending on their income in 25 different industries of IO table was estimated. These equations were used to estimate final demand of general totality's decile groups, and also, with some updating, became the basis for the model of the differentiated balance of income and expenditure of the population to find final demand of households in the modified IO model.

4. Extraction of households in I quadrant

For more exact reflexion of productive activity of population (entrepreneurial work and production for self-consumption) and accounting of sectorial discrepancies of cost structure in IO table the sector of households was extracted. In turn, this sector was subdivided into enterprise sector and sector of a subsistence economy with the purpose

of separation of money income from productive activity and income in kind (money income gained from production includes entrepreneurial income and real estate sales revenue in BMIEP).

The given IO model has the following form:

$$A^{\bullet R} X^{R} + A^{\bullet M} X^{M} + A^{\bullet N} X^{N} + Y = X$$

where $X^{R} + X^{M} + X^{N} = X$ - is the sum vectors of gross outputs in 3 sectors: M – entrepreneurial subsector of households and N – subsector of households' natural economy, R – other organizations and $A^{\bullet R}, A^{\bullet M}, A^{\bullet N}$ – direct coefficient matrices of these sectors.

5. Results of projectional and analytical calculations

The constructed extended IO model with inclusion of the differentiated balance in it is an iterative model. It allows to receive totals of the disposable income and consumption, and also the basic components of the monetary income in projectional period.

The differentiation of income was carried out by the method specified above not only for base 2002 for construction of differentiated balance of population's income and consumption for this year, but also for the whole 1995-2007 period, for studying the dynamics of population stratification according to their income and drawing up retroprognoses. Differentiation indicators alone, received in such a way, represent a separate interest as they characterize changes in living standards of different population levels in the given region.

Funds coefficient, determined from the calculated distribution of the population in general totality according to money income for 1995, 1997-2007 (Appendix Fig. 1, p.14) had the average value of about 21,4. Its greatest annual gain was observed in 2004 – from 21.6 up to 28.8 in 2003. In the next 2005-2007, the coefficient grew in slower rates, reaching 32.5 in 2007. It is remarkable that the coefficient of funds fell in 2000 to 14.4 while in 1998 it was 16.7. That is even during that time and in the first years after

financial crisis of 1998 stratification level of the population according to their income was lower than at the subsequent growth of economy.

The Gini index changes more smoothly as it considers income distribution of all decile groups, not only extremegroups. Basic characteristics of Gini coefficient dynamics for 1997-2007 are the following indicators: the minimum level – 0.44 was observed in 1997 (for comparison: in 1995 it was 0.386), then, almost stably rising, it reached a maximum level in 2007 – 0.50.

The graphic shows distinguishing stabilization and growth retardation of differentiation coefficients since 2005, in particular, Gini coefficient since this year, annually added less than or equal to 0.05. It is remarkable that in 2004 active realization of various social programs started, and in 2006 realization of national projects began, which, certainly, affected low-profit population clusters of Russia and had positive effect on their living standard.

For the period under review it is impossible to explain growth of differentiation of money income of the population only by shifts in the structure of income, namely growth of relative density of entrepreneurial income, other income, at simultaneous decrease in shares of wages and social transfers, though they, certainly, have considerable effect. It is obvious that there were also changes in the distribution of income components. If we consider changes in income distribution for the period of 2003-2004 it is visible that in the structure of monetary income in 2004 there are no considerable shifts in comparison with 2003, while income stratification degree strongly increases. At the same time, the analysis shows that the differentiation is growing and it is accompanied essentially by higher increase rates of entrepreneurial income and other income in comparison to other components. It once again confirms that the basic share of entrepreneurial, and also various not observable types of income, including latent wages, is gained by highly remunerative groups, resulting in stratification growth of the population according to their income.

Adequacy checking of the differentiated balance model of money income and expense was conducted on the account data of 2003-2004 by means of retroprognozing. Usage of income elements of the accounting BMIEP for 2003 in models of

differentiated balance of income and consumption, and also use of accounting indicators of income distribution leads to the consumption indicators close to actual ones. In particular, it can be tracked on dynamics of total volume of households' final consumption indicators: actual base rate of growth in 2003 and in 2004 were 113.3 % and 130.0 % accordingly from level of 2002, and modeled – 110.5 % and 125.4 %. The model underestimates the gain of expenses on real estate purchase in 2003, possibly, it is connected with the fact that in 2002 there was a considerable reduction of the given expense article in comparison to 2001 even in nominal expression. It is possible to tell that the calculated dependency of demand for the real estate in 2002 underestimated medium-term propensity to consumption, and in 2003 growth of expenses on habitation purchase was unusually high because of lack of demand in the previous period. Also it can be caused by weaker connection of demand for the real estate and the revenue, it is obvious that demand is defined by long-term dynamics of income. From other factors, which probably affected demand for the real estate, it is possible to note the decrease of nominal and real total book profit of the enterprises and organizations in RB for 2002 in comparison with 2001 which in 2003 nominally was almost equal to level of 2001. Possibly it essentially affected demand of those population categories whose income is formed by economy profit. The specified says that demand of separate households categories can depend on the type of income received by them. At the same time, the volume of expenses estimated on the basis of model on real estate purchase in 2004 (201.1 % from level of 2002) slightly differs from the fact sheet (198.6 %). Thus, the model of the differentiated balance as a whole reflects dependence between income and expense of population quite well.

Simple substitution of outputs of 2003 in expanded IO model at acceptance of last parities of gross value added elements and articles of population income leads to good estimations of wages and social transfers volumes (Appendix Table 1, p.14), however such elements as entrepreneurial income and other income appear thus strongly underestimated. One of the reasons is that the share of businessmen considerably increases in output in 2003 from 4.7 % to 5.8 %, which is caused by growth of entrepreneurial activity of the population and other factors of institutional character. At the same time, in 2004 the share of entrepreneurs again decreases to 5.0 %. Indicators of wages fund and social transfers for 2004 are also well estimated by the

model. Higher deviation of social transfers in 2004 is most likely connected with institutional factors which led to rupture between the paid social deductions and the received social transfers of the region. In particular, since 2004 unified social tax inpayments have risen a bit at the expense of inclusion of income of foreign persons and persons without citizenship in taxable base.

Extended IO model with the differentiated balance of the population income and expense as well allows to calculate full gain of a final demand or GDP of a region (Gross Regional Product - GRP) as a result of exogenous changes of population income, for example, at increase of social transfers from the federal budget. Primary growth of income causes consumption growth and after this production and primary income of economy, hence, aggregative gain of population income will surpass their primary change. So, the initial increase in the money income at 1 % will lead to a final gain of the money income on 2.2 % (Appendix Table 2, p.15). In this case, the final gain of the population income more than twice exceeds its primary increase. If we originally increase income by size for more than than 1 percent, the gain will be less than 2.2 times. That is with the rise of primary increase, relation of the general gain of income to primary gain will fall. In particular, at initial increase of monetary income at 10 %, full gain will make already 17.2 %. It is connected with decrease in average propensity to consumption with the population.

Individual income decrease render reverse multiplicative effect leading to more considerable income decrease, and also to lower levels of GRP and output. The shown model is capable to estimate both total changes of economic indicators, and changes occurring to their structure. This is especially important in crisis conditions when carrying out an active intervention of the state in economy is necessary at quite limited resources.

Here it is necessary to notice that at the given calculation influence of the State expenditure on inflationary processes is not taken into account as in the given closed model prices of the goods and services are not considered. This fact slightly reduces its prognosing abilities.

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APPENDICES

Fig.1 Differentiation of money income dynamics of RB's population

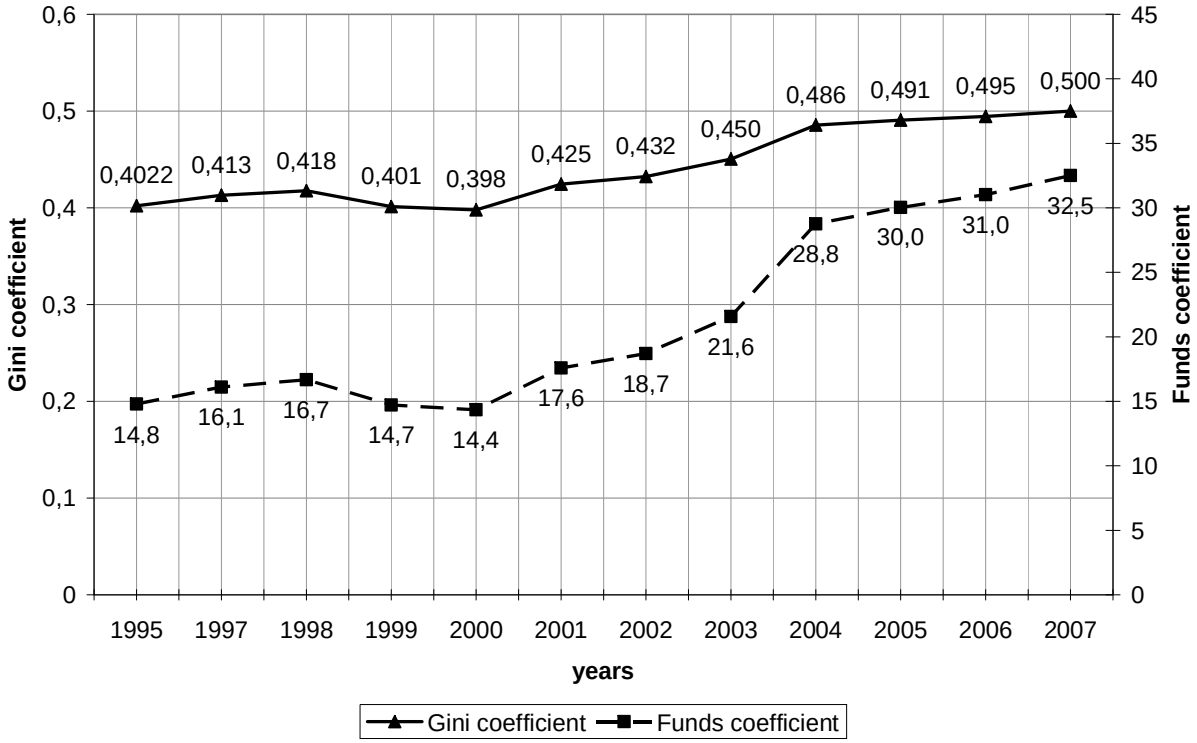

Table 1. Fact and estimate indicator for the investigated period

	fact	estimate
Real growth of wages in 2003 (in % by 2002)	106,2	106,8
Real growth of social transfers in 2003 (in % by 2002)	105,0	106,9
Real growth of wages in 2004 (in % by 2002)	112,4	113,5
Real growth of social transfers in 2004 (in % by 2002)	108,4	113,8

Table 2. Aggregative gain of indicators as a result of primary gain of the money income

Primary gain of the population's money income (in % to the initial money income)	Total gain of population's money income (in % to the initial money income)
1	2,2
3	6,5
10	17,2
15	28,4