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Regional differentiation of technological coefficients in Russia

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Abstract

The paper focuses on concept that countries with large territories and diverse natural and climatic conditions need constructing regional IOTs. At that, regional tables should be compiled basing on data of one-time-only survey of production cost structure but not on averaged country technological coefficients.

This question is especially urgent in condition of forthcoming one-time-only survey in Russia in 2011 and subsequent constructing of IOTs. However, none of the 83 subjects of the Federation is going to have IOT constructed, and the author points out that it is crucial mistake for the spatial analysis and planning.

In fact, analysis of regional difference of technological coefficients requires availability of regional tables. However, regional IOTs haven't been constructed in Russia for 25 years yet. Luckily, separate kinds of unit costs (electric energy, refined petroleum products, gas, transportation services) are measured in every region of Russia. The author has carried out interregional comparative analysis of their required input per one unit of industry output. Certainly, technological coefficients and unit costs aren't the same. However, there are quite

many products produced mainly by single industry, and in this case regional variation of unit costs reflects regional differentiation of technological coefficients.

Regional variation of unit costs has been studied at different aggregation levels of industries and regions. Factors of regional differentiation of unit costs are studied as well. Comparative analysis of regional and average Russian technological coefficients was carried out in previous research (the 18th IOT conference, A. Sayapova).

The sufficiently detailed study has revealed high level of regional differentiation of unit costs. That proves necessity of constructing regional tables with the use of one-time-only survey data.

Introduction.

Compilation of regional IOTs is highly topical issue in Russia now considering that one-time-only survey of production costs structure has been planned for this year (2011). The need of constructing regional IOTs using the forthcoming survey data is obvious, and the article addresses two particular points of this issue. The first one is analytical and predictive potential of regional tables, whereas the second one concerns the method of constructing. The second comes up due to the fact that regional tables can be constructed basing on non-survey method (using averaged country technological coefficients), or else they can be constructed basing on data of one-time-only survey of regional production cost structure. Mere explanation of what we mean by these terms seems enough to see that constructing regional IOTs in Russia is a must. However, the current situation in the sphere of tables constructing forces us to keep belaboring the obvious.

Regional IOTs forecasting potential

As to the first point, regional IO tables were constructed even in the times of planned economy, though Soviet regional economic complexes were far from being considered holistic economic subsystems (they were regulated mainly through central planning network). Nowadays, each region – subject of Federation – is an economic subsystem with strong interconnectedness of main elements. Besides, regional authorities have much more powers. And IO table is "the economic profile" of such a subsystem. As a statistical model of regional economy, regional IOTs provide information on many issues not covered by current regional statistics. Not going into details, some remarks. Regional IO tables are the best to show import-export flows, as well as carriage inwards-outwards. Evaluation of interregional counter flows of goods is the most complicated but still the most yielding element in compiling IOTs. The representation quality is provided with the use of wide range of data sources, as well as with the method of constructing IOTs per se. The balancing detects unaccounted outgoing and incoming production flows of region. IOTs provide us with technological coefficients which meet two goals. Firstly, they allow evaluating production cost structure and secondly, offer an opportunity for Input-Output model based forecasting.

It's no overstatement to say that there can hardly be an aspect of regional forecasting for which the IOT model is inapplicable. The ways of applying regional IOTs for planning and forecasting include balancing of autonomous plans and forecasts; designating of priority industries (in terms of different criteria) and designing of clusters development programs; measuring of multiplicative effect of realization of investment projects and their impact on the regional economy; analysis of multiplicative effects caused by changes of output, demand, tax rates, prices, etc; update, analysis and optimization of interregional trade flows; distribution of

redistributions; elaboration of interconnected forecast of the following regional indexes: industries total output, income and consumption of households; forming of basic breadboard model of long-term and medium-term plans and forecasts; co-ordination projects of Russian Federation and regions, etc.

Russian researches of technological coefficients changes in time and place

The second point to explain why IO tables are necessary to be constructed is as follows. As it has already been mentioned, the main effect of constructing regional IOTs but a sticking point for IOT based forecasting is technological coefficients. They are obtained only through table constructing and actually mirror goods and services production cost structure. The few non-survey regional tables, which have been constructed recently, are based on averaged Russian cost structure. Actually, it goes without saying that a regional cost structure differs from the averaged ones. Interregional differences of technological coefficients are quite expectable in Russia. However, regional IO tables haven't been constructed in Russia since 1987, so regional balances have to be constructed basing on Russian averaged technological coefficients. Although in 1995, the survey of production cost structure was carried out in every region, regional IOTs were not constructed still. Furthermore, after the forthcoming survey of production cost structure will have been carried out, official statistic services are not going to have IOTs constructed.

For IOT model based forecasting, valid technological coefficients are needed. In fact, the latter limits the use of IOT model in planning and forecasting. Therefore, technological coefficients serve as the central element of IOT model application. Besides, coefficients are changing in time and place. Still there are very few researches on this topic in Russia. Only one Russian scientific research was conducted on coefficients of direct input in 1990-2007 (N.V. Suvorov, [6-7]). Such negative effect on scientific activity was due to almost 20 years of breakup in constructing IOTs in Russia. That narrowed down the data base for forecasting researches. Though, on the other hand, W. Leontief believed that an important role in technological coefficients forecasting must belong to technical and engineering staff [1, p. 209].

Regional differentiation of technological coefficients was explored only in few researches and they all were conducted in the Soviet times. Regional IO tables were being constructed then, but the information around regional IOTs was kept secret. Scientists working with IOTs had usually access to 2-3 IOT: their original regional tables, tables for the USSR and tables for the Russian Republic. For example, such research of 1972 is reported in a paper [8, стр. 28]: "Comparative analysis of technological matrixes has defined that republic and Union coefficients either coincide or difference is small. However, this difference is significant for industries of specialization." To be fair, we should note that our comparative analysis of coefficients of direct input of the USSR and the Russian Republic in 1972 also marked moderate differences. The collected book «The National Economy of the USSR of 1973» and "the National Economy of the Russian Soviet Republic of 1974» presented separate coefficients of direct input some of them can be counted with the use of the IOTs presented thereby. The list of coefficients is scarce: there are given direct input coefficients for a number of products (production of basic chemicals, electric and heat power generation, coal extraction). There can be estimated coefficients of direct input for production process of electric and heat power, production of basic chemicals, manufacture of pulp and paper. The biggest difference was counted in intra-industry consumption of electric and heat energy – 2,5-fold. Separate coefficients have 50-70%-difference; average index is 10-20%. Thus, due to these particular indexes we can make a conclusion that planned economy norms and stable prices were promotive of geographically flat cost structure. At that we should not forget that the vast majority of production was situated in the Russian Republic, and some productions were fully kept within the territory of Russia.

Besides, comparative analysis of coefficients of direct input was held for the year 1995 based on the RF IOT and Bashkortostan IOT. The latter was worked out under the guidance of the current paper author [4]. Brief outcomes of comparative analysis are the following. About a quarter of all Russian and regional coefficients in aggregated table differ more than twofold. These include so called important coefficients: unit costs of oil-and-gas industry products for electric power industry, petro chemistry, and unit costs of electric power industry for oil-and-gas industry, and unit costs of machinery-producing industry for oil-and-gas industry, etc. Furthermore, substantial differences have been revealed even in such highly aggregated indices as intermediate consumption share in output. Difference in intra-industry consumption coefficients may go twofold, though they are somewhat not subject to prices fluctuation. The biggest differences of unit costs are in Bashkortostan's industries of specialization.

Technological coefficients in natural measurement

W. Leontief compared the ideal column of technological coefficients to a recipe. [1, p..205]: "A brief description of a method to define the functioning of a given industry, and particularly its connection with other economic sectors, can be called a "recipe" where there are mentioned amounts of all current costs, such as raw materials, intermediate goods, various kinds of labor, etc., as well as the fixed capital – buildings, vehicles, all kinds of stocks needed for production process". As such a "recipe", net technologies can be described only with natural indexes. Cost measurement of technologies, as well as aggregated one, produces immediate effect on cost structure. Firstly, cost structure (technological coefficients) depends greatly on price ratio Secondly, coefficients of direct input depend on data which are components both of outputs aggregation, and current input aggregations. "Individual costs coefficients for raw materials, fuel, electric energy in various sub-industries of an aggregative industry may differ substantially. That's why significant structural changes of production at sub-industry level may influence aggregated indexes of unit costs even in case norms for fuel and raw materials consumption are stable at sub-industry level". [7, p.38] In the grand scheme of things, analysis and forecasting of technological coefficients changes must consider all factors: technological, structural, pricing, etc. Anyway, net metering of technological changes is possible only "ceteris paribus".

Regional differentiation of technological coefficients is determined by a large number of factors. Besides the abovementioned technological, structural and pricing, we can't but take into consideration natural and climatic conditions, interregional differences in pricing, concentration level of industry, differences in external and internal corporate prices, etc. It is hardly possible to take account of regional manifestations of all those factors and to adapt average Russian coefficients to a separate region. It seems much more effective and valid to construct regional IO tables directly, right on the data obtained through one-time-only survey.

. We shall begin conducting the analysis of current situation with regional differentiation of technological coefficients with studying unit costs in natural measurement. Such information is not in excess supply, but after revising about 30 regional annual statistical data books, we have managed to compile Table 1, which deals with unit costs of electric energy for separate kinds of products. Even in case we regard technological coefficients as only the abovementioned "recipe" in natural measurement and with other factors eliminated, the regional differentiation is still quite impressive. For example, electric intensity of oil extraction in Bashkortostan republic is almost twice bigger that average Russian indexes and the same is about indexes of refined petroleum products. Average Russian and Komi republic differ the same way in indexes of electric intensity of coal mining. Karelia and Komi differ the same way in electric intensity of manufacture of pulp. Electric intensity differs greatly even in manufacture of bakery products.

The Table 2 shows differences in equivalent fuel consumption per unit of electricity (kg/kWh) and per heat energy (kg/Gcal) across Federal districts. Those differences are quite moderate, whereas the indexes of subjects of Federation have greater range. For example, unit costs of equivalent fuel for electric power generation in Kaluga region is 2 times higher than the averaged Russian index. And conversely, Belgorod region accounts for only 76% of the averaged

Russian index. The similar results are obtained for unit costs of equivalent fuel per heat power generation.

Analysis of regional differentiation of cost structure in current conditions

As mentioned above, to conduct analysis of regional differentiation of technological coefficients, we lack information in the form of regional IO tables. Some information may be got from governmental statistical form "1-predpriyatiye" ("1-factory"), available in all subjects of Federation. We should point out right off that we are far from equating technological coefficients with unit costs, which we have from «1-factory». Firstly, technological coefficients are calculated for «pure industries» (more rarely they are calculated for industries). And the mentioned information sources give costs of separate kinds of goods for industries which can be used to calculate their required input per one unit of industry output Secondly, outputs provided in «1-factory» are noncomplete. Thirdly, there exists regional dispersion of product sets related to same-named activities. Fourthly, different regions have different proportion of products to industries. And, fifthly, «1-factory» presents data on large and medium-scale factories. However, if we use «1-factory» data to evaluate unit costs, it seems to picture a certain representation of regional differentiation of technological coefficients. Looking back at the second point, we refer to our comparative analysis of "complete" output counted to the end using Rosstat (Russian Statistics Service) method and basing on "1-factory" data and "incomplete" output that was presented in "1-factory" for 45 aggregated sectors for 2006. The biggest difference has been found in sea transport manufacturing and repairs (22%). The difference in all other sectors was far less (rarely exceeding 5%). That's why it is possible to use "1-factory" to analyse unit costs obtained through dividing costs by noncomplete outputs taken from the information source. To check the forth point, we have also conducted comparative analysis of total output of industries and products throughout Federal districts. For that purpose, we have used available information on volumes of shipped goods of industries and products (Russian Statistics Service website, central statistical database). It was found out that the difference is not so big in Federal districts and it exceeds 10% only in some rare cases. The exception is only for Central Federal district. There, the difference is especially big between products and industries of mining and quarring . Subsequently, that information must be taken into consideration when analyzing regional differentiation of unit costs. Furthermore, let's point out that we need information on unit costs, given in «1-factory» not as standard of costs, but we use it to analyse regional differentiation. In our opinion, unit costs, counted with the use of “1-factory”, still can be used for the latter purpose even despite all reservations mentioned above.

Concerning the first and the forth points, we can mention the following. The “1-factory” provides us with costs of separate kinds of goods: electric power, natural gas, refined petroleum products and some others. That fits “pure industries” (products). The output ratio of industries and products was discussed above. It bears mentioning that difference in output of industries and products, increase in proportion to classification of kinds of activities. For example, in Russian economy «pure industry»-industry shipment of goods ratio according is the following: D – 0,96, DA– 0.91, DB– 0,85, DG – 2,68, DH – 1,96, DJ – 0,98, subdivision DJ –off-the-shelf metal goods production – 0,87, DL-0,97, subdivision DL – office equipment – 0,68 (sections are marked according to the RCEA (Russian Classifier of Economic Activities / Obscherossiyskiy Klassifikator Vidov Ekonomicheskoy Deyatelnosty, OKVED, 2001). Concordantly, in the first instance, the industries have been chosen where industries and products outputs have close levels. It should be kept in mind that structural factors that determine regional differentiation of unit costs may be oppositely directed. On the one hand, aggregated kinds of activities can have differences hidden. But on the other hand, the differences may be increased due to different product structures. For example, electric power consumption by power industry itself shows that the more detailed the division of activities is, the bigger the difference is between unit costs in the Russian averaged index and the Central Federal District index.. Difference of unit costs in disaggregated activities may be caused by the following. The factory activity is defined by what the biggest output is. The predominance may be not so considerable, i.e., besides basic product, the factory may produce considerable amounts of secondary products. The more detailed classification is, the more possible such case is, because such niche specialization can hardly exist. Then, because of the output structure, unit costs of factories that were classified narrowly will differ much. Correspondingly, if a sector is defined as a collation of factories having one kind of activity, the sectors will then differ in unit costs in the same way by regions. When sectors are aggregated, some leveling of output structures occurs, so dispersion of unit costs in regions may be smaller. Though, as it has already been mentioned, the process has different trends, it is regional specialization that provokes differences in regional output structure for aggregated industries as well.

Composition of input and output aggregates is surely a very important factor in estimating technological coefficients. When forecasting, the composition is implicitly or explicitly supposed to be unchangeable. So, all other factors held equal, technological coefficient for base period can be applied to forecast period. The same refers to regional technological coefficients. Even if differences in regional technological coefficients are explained only by structural factors, we don't have any ground to assume that in a forecast period these structural differences disappear. Therefore, average technological coefficients for Russian economy can't be applied for all the regions. It is assumed that composition of aggregates for estimating regional technological coefficients will remain stable for the forecast period. Interregional differences of technological coefficients caused by structural reasons won't change either. That's why it is very important to trace regional differentiations of technological coefficients for base period.

Differentiation of unit costs across regions and production units may be leveled down through adjusting the list of activities included into IOTs. If we manage to achieve product homogeneity in each industry, the structural factor may produce smaller effect on technological coefficients. However, no classification can reduce to nothing regional differentiation of unit costs. Differentiation exists even between two separate production entities on common territory. The task of regional IOTs is exactly to keep track of that differentiation to the full extent.

Thus, analysis of regional unit costs differentiation on basis of governmental statistical form "1-factory" assumes certain errors. However, the IOT model itself suggests quite considerate assumptions. These are, for example, ITA (industry-technology assumption) and CTA (commodity-technology assumption) of transition ways from Supply and Use tables to Symmetrical tables. ITA-method assumes that an industry has one and the same processing technology for both main and secondary products, and CTA-method assumes that processing technology of any product is the same in all industries. Both assumptions allow certain errors. Our assumptions are supposed to be not so big if compared with those errors. Nevertheless, when choosing industries for further analysis of unit costs, maximum effort was made to eliminate errors caused by various assumptions. For example, when applying ITA-method, all products of electric power generation industry use the same amount of gas per unit of output. Electric power is generated in a number of industries, not only in electric power generation industry. Gas consumption per unit of electric power is defined as weighted average sum of unit costs, beared by all industries which consume gas and produce electric power. Weights are measured by the share of industry in electric power generation. In this case, the main factor is gas consumption in electric power industry. I.e., in this case, technological coefficient of gas consumption for generating electric power is similar to unit costs given in "1-factory". Unit costs of gas for Section E (Electricity, gas, steam and water supply) differ 50 times across Federal Districts, almost 40 times in kinds of activity 40.10.11 (RCEA 2001) - electric power generation at thermal power plants. Required input of electric power per one unite of electric power generation output (electric intensity) in Federal districts (code 40.10.1, RCEA 2001) differ 3.8-times, electric power generation at thermal power plants – 6 times, and electric power generation at hydroelectric power plants – hundreds of times.

Taking as a framework ITA assumptions for transition from init costs to technological coefficients, we can use the example with electric power generation industry (which accounts for the biggest share in main production – electric power) as a model for analyzing mining and quarrying industries (oil and gas extraction, coal and ironstone extraction, etc.). Judging by the output ratio of "pure industries" and industries, valuation of regional differentiation of unit costs may be conducted for almost all of Sector D.

Table 3 shows electric intensity of separate industries per Federal districts and requires no particular comments.

There has been carried out the analysis of unit costs of gas, refined petroleum products, and transportation services. The abovementioned unit costs prove the same figures of regional differentiation. At that, unit costs differentiation at subjects of the Federation is higher than that at Federal districts.

There has been examined another angle of analysis of regional differentiation of costs coefficients basing on our original Use tables for Federal districts according to 1-factory for 2006 [5]. Tables dimension 10x45. 10 table rows show costs of 9 product kinds given in "1-factory" and other costs. Table columns show 45 industries aggregated on the basis of IOTs' 110-industries classifier of 1995. Differentiation per Federal districts is essential even if we look at such aggregative indexes as intermediate consumption shares in industries' outputs. It especially concerns mining and quarrying: interregional difference of intermediate consumption shares of oil extraction industry is 1,8-fold, gas extraction – about twofold, coal mining

–1,5-fold. There is no point mentioning coefficients of direct input. For example, electric intensity of oil extraction per Federal districts differ 5 times, gas extraction – tens of times.

Even if it is granted that regional differentiations of unit costs are caused by structural factors mainly, they must be taken into consideration because, firstly, they are too big to be forgotten and, secondly, structural factor is still a factor of regional differentiation of technological coefficients. Besides, it is very stable and it may be even more stable that dynamics of technological changes. That is why technological coefficients must be measured for each region separately.

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Table 1

UNIT COSTS OF ELECTRIC ENERGY FOR PRODUCTION OF CERTAIN KINDS OF GOODS AND SERVICES in 2006 (per one ton, kilowatt-hour)

	The Russian Federation	Bashkortostan Republic	Karelia Republic	Komi Republic
Extraction of crude petroleum	107,9	201,2	x	x
Manufacture of refined petroleum products	46,4	81,1	x	x
Mining of coal and lignite	22,7	x	x	41,2
Manufacture of steel	564,7	1286,1	x	x
Manufacture of synthetic rubber	2531	2844,8	x	x
Manufacture of pulp	x	x	320	800
Manufacture of paper	1093	x	740	900
Manufacture of bakery products	203	x	290	360

Table 2

Regional differentiation of unit costs of equivalent fuel

Federal districts	Proportion of equivalent fuel unit costs for electric power generation to the averaged Russian index	Proportion of equivalent fuel unit costs for heat power generation to the averaged Russian index
Central	93,3%	97,3%
North-West	94,9%	98,1%
South	108,9%	101,6%
Volgian	99,3%	98,5%
Ural	100,2%	100,6%
Siberian	105,3%	103,5%
Far East	115,0%	107,0%

Table 3

Industrial electricity unit costs per federal districts (Russian Federation-Federal District ratio)

Activity	Code	Central	North-West	South	the Volga District	the Urals District	Siberia	Far East

Mining and quarring	C	x	1,13	0,87	1,10	1,15	0,79	0,79
Mining and quarrying of fossil fuels	CA	x	1,64	0,80	0,96	1,03	0,68	1,17
Mining of coal and lignite	10	x	0,61	0,65	1,24	0,31	1,16	0,95
Extraction of crude petroleum and natural gas	11.1	x	2,17	1,13	0,85	0,97	0,97	6,87
Mining of iron ores	13.1	x	1,19		1,70	0,84	1,29	
Manufacture of food products	DA	1,19	1,48	0,79	0,86	0,66	0,68	0,60
Manufacture of wood and of products of wood	DD	0,76	1,06	0,65	0,86	1,30	1,74	0,89
Manufacture of refined petroleum products	23.2	2,50	2,59	0,76	0,81	0,05	0,18	0,07
Manufacture of chemicals and chemical products	DG	1,24	1,61	0,58	0,92	1,67	0,96	0,75
Manufacture of other non-metallic mineral products	DI	1,34	1,39	0,60	0,87	0,76	1,02	0,72
Manufacture of basic metals and fabricated metal products	DJ	1,28	1,42	0,92	1,11	0,94	0,83	0,44
Manufacture of electrical equipment, computer, electronic and optical products	DL	1,00	1,53	0,94	1,01	0,65	0,78	0,76
Manufacture of motor vehicles and other transport equipment	DM	0,75	1,35	1,04	1,21	0,69	0,77	0,40
Electricity, gas, steam and water supply	E	1,07	1,13	0,70	1,03	0,89	1,36	0,73
Electric power generation	40.10.1	1,49	0,55	1,00	0,96	1,10	1,60	0,42
Electric power generation at thermal power plants	40.10.1 1	2,33	0,38	1,09	0,97	1,08	1,56	0,40