**Paper prepared for the 18th International Input-Output Conference**
**Sydney, Australia, 20 – 25 June, 2010**

# Russian and Regional Input-Output Tables

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**This paper is posted on the following website: http://www.isa.org.usyd.edu.au/io_2010/**

**Abstract**

The degree of importance of the regional IO tables in the territorial analysis of the Russian economy is determined by the vast territory, the diversity of natural and climatic conditions, as well as by the socio-economic situation and the number of the regions in the Russian Federation (83 subjects). However, the researchers have to compile their own evaluative regional tables due to the non-availability of regional IO tables prepared by the Federal State Statistics Service. In such schemes the developers usually employ the matrix of the coefficient of direct expenses (a technological matrix) obtained from the symmetric input-output table for Russia, thus, they extrapolate the average expenses on the production of the goods and services in Russia to a region in question. As is known, such practices exist in some other countries as well. The author has appraised the feasibility of such an approach and has proposed the methods of adjusting the technological matrix of the national economy in regard to a region. The research has been carried out on the basis of comparative analysis of the Russian symmetric input-output table and of the regional symmetric IO tables for the Republic of Bashkortostan, developed under the author's guidance not on the basis of the Russian technological matrix, but on the basis of a simultaneous study of the expenses' structure and observing the principles of the System of National Accounts and The United Nations Handbook of Input-Output Table Compilation and Analysis (1999)) . Although the differences between technological coefficients in the national economy and the region are significant, still, certain trends can be discerned in these differences. The latter allows to elaborate definite rules for adjusting the technological matrix of the national economy in regard to a region.

Keywords: regional input-output tables, technological coefficients.

## 1. Introduction

The article gives the analysis of the possibility of creation of regional «Input-Output» tables on the basis of the input-output coefficients of Russian tables. The research is based on the comparative analysis of the Russian symmetric "Input-Output" table and the corresponding regional table, composed on the basis of a one-time survey of the production cost structure on production of commodities and services.

Regional planning and forecasting of development of the Russian economy belong to the category of urgent and heavily discussed issues nowadays. Both the scientific papers and the measures, being taken by the executive authorities in the appropriate field give evidence of this fact. Discussion of the instruments for elaboration of the plans and forecasts of regional development and the territorial component of the Russian economy development plan – IO tables, takes place in significantly smaller scales. Unfortunately, compilation of IO tables in Russia is insufficiently profound: 1) before 2003 in Russia the aggregated IO tables were compiled for the profiles of 22 industries, since 2004 the aggregated tables (15 industries) of resources and their use have been being developed; 2) production cost structure, required for compilation of IO tables, being carried out across the whole country, has not been renewed since 1995 in Russia; 3) IO tables for the regions of Russia based on the one-time survey of the production cost structure of commodities and services have not been created since the planned economy. Meantime, an urgent need for compilation of regional tables in connection with the need for elaboration of the strategy for territorial development of Russia has become imminent. The outlined revival of the practice of compilation and use of regional IO tables is, in all likelihood, a result of such need. In particular, a one-time survey of the production cost structure in Russia is expected in 2011.

## 2. Two approaches to construct regional Input-Output tables

Absence of regional IO tables, compiled by the regional offices of Rosstat (Federal State Statistics Service of Russia), makes the researchers resort to compilation of regional assessment tables (for example, [1]). In such compilations the developers, as a rule, use the matrix of coefficients of direct input (technological matrix), derived from the symmetric "Input-Output" table of Russia, thus spreading the average Russian production cost structure to the region under study. By all means, the Russian technological matrix gets corrected with a view to the regional peculiarities of production, and an IO table compiled under such technique represents a valuable instrument for analysis and forecasting. As far as such approach can be met in all, though inconsiderable in number, developments of regional IO tables, quite useful will be a comparative analysis of IO tables for the Russian Federation and the regional IO tables, compiled in accordance with the principles and standards of the System of National Accounts and The United

Nations Handbook of Input-Output Table Compilation and Analysis (1999), adapted with regard to the region. Such developments were carried out by us for the Republic of Bahskortostan (RB) over the year 1995 for the profiles of 227 types of products, and for the year 2002 – for the profiles of 25 types of products. IO tables over 1995 for the Republic of Bahskortostan were compiled on the basis of a one-time survey of production cost structure of the Republic, served for development of calculation tables over 2002 for the region, and are used today as base tables. It seems appropriate to quote the results of the comparative analysis of IO tables of Russia and RB, findings of which can be used where necessary for correction of the technological matrix of Russia with regard to a certain region.

The basic elements of borrowing from the Russian IO tables in the process of compilation of regional tables are direct input coefficients, or, in other words, technological coefficients. Therefore, comparative analysis is generally aimed at this object.

Certainly, the most accurate coefficients are coefficients of direct input, calculated over the year when the study of the production cost structure was made. From this point, the IO tables of 1995, despite the time limitation, represent a greater value, than the tables of 2002, and can give a more objective picture of correlation between the Russian and the regional tables. Moreover, unless otherwise specifically stipulated, comparative analysis shall be carried out for the technological coefficients of 1995.

**3. The comparative analysis of the Russian national and regional tables**

We shall begin with the fact, that the difference between approximately one quarter of the total amount of the Russian and the regional coefficients in the aggregated table is twofold. Among them there are the so-called important coefficients: input per unit of products of oil and gas industry to the power generation, petrochemistry, of the power generation to the oil and gas sector, of the machinery and equipment to the oil and gas sector and other. A significant difference can be observed even in such heavily aggregated indicators, as the share of intermediate consumption in the outputs. We shall note, that significant differences were observed in coal industry, which has almost ceased its output in the republic, in ferrous and nonferrous metals industry, the import dependent industries of the region.

Further, the analysis has shown, that the difference between the Russian and the regional coefficients is substantially formed by the internal structure of the aggregated industries. In the power generation, for instance, the Russian consumption of oil and gas products is 102 rubles lower per 1,000 rubles of electric energy than in the region. It can be explained by the fact, that the region contains mainly heat power plants (for comparison – the overall Russian specific volume of the electric energy, produced by the heat power plants, is 68%, and in the republic – 97%). Heat power plants in the region operate on natural gas and oil-products. Accordingly, the

average Russian input per unit of coal in the power generation is 86 rubles lower, than in the region.

Noteworthy are the differences between the diagonal elements of the technological coefficients matrix (Table 1).

The largest differences in the diagonal elements fall at «non-relevant» industries, i.e. either at the sectors of specialization, or on the contrary – at the underdeveloped industries of the region. The internal consumption of the oil and gas specialization sector (including oil refining industry) in the region is 110 rubles per 1,000 rubles of products higher (in relative terms – 77% higher). The latter can be explained by the presence in the region of both – extraction of crude petroleum and oil refining, as a result of which the intermediate consumption of oil in the region is higher, than on the average in Russia. The share of export of oil resources in Russia – 32,6%, in the region – 18,3%. Due to the same reason the direct input coefficient of oil industry products to the chemical and petrochemical industries in the region is high as well. And on the contrary, surpassing of the Russian coefficients over the regional ones is typical of «non-core» industries: ferrous and nonferrous metals industry, light industry. The intraindustry consumption of ferrous metals industry per 1,000 rubles of products in Russia is 225 rubles higher than in the region. This difference reflects an incomplete processing chain of ferrous metals industry in the region – without mining of ferrous metal ores. A similar situation can be observed in the light industry, operating on imported raw materials: the intraindustry turnover in Russia per 1,000 rubles of products is 43% higher than in the region. A significant difference in the intraindustry input per unit in the coal industry is also a result of practically full shut-down of coal production in the republic – i.e. the result of «non-core» character of the industry. And the smaller, but positive values of the difference in the diagonal elements in the chemical, petrochemical and food industries rather indicate a necessity for intensification of raw materials processing in these industries. A small regional value of diagonal element «Services in financial intermediation, insurance, government administration and non-governmental organizations» comes as a result of only centralized accounting of some government administration services, such as defence, and absence of accounting in the regional outputs of the financial and insurance services sector.

Thus, during the correction of the diagonal elements of the technological matrix the level of the industry's development in the region shall be taken into account. It represents a specifically great importance due to the large, in comparison with the other coefficients, values of diagonal elements.

The comparative analysis has been carried out by us for the input per unit of power generation, oil products (of the oil and gas industry), freight and trade, i.e. of goods and services, being consumed by all industries.

The following results of the analysis of the input per unit of electric and heat energy were revealed. First of all, the regional and the Russian direct input coefficients of that industry differ substantially. In various industries the difference is in the range from one ruble to 117 rubles per 1,000 rubles of products. Secondly, the regional coefficients of direct input are higher than in other industries. To our opinion, that can be explained by two reasons. The first is a considerably harsh climate of the region, the second – a more profound economic depression in the region by 1995. The latter implies large inputs of electric and heat energy to idle facilities and, as a consequence, high values of input per unit to production. The large spread of the difference between the Russian and the regional input per unit to industries is rather a result of different profoundness of the recession of industries, than technological peculiarities alone. It shall be noted, that there is data on the input per unit of electric and heat energy in the regional statistics, and consequently there is a real opportunity for correction of the Russian coefficients of direct input in relation to the region.

The direct input coefficients of the oil and gas industry products in the region is also higher than on the average in Russia. These coefficients reflect the consumption of oil products by the industries. Their high value can be a result of a high specific volume of freight transportation, carried out by domestic transport enterprises. This indicator is not quoted in the statistics.

The input per unit to transportation in the oil and gas industry of the region is 117 rubles per 1,000 rubles of products lower than on the average in Russia, what is quite natural, if we take into consideration the domestic production of oil, which decreases the input to expensive pipeline transportation. And on the contrary, transportation costs are high in the import dependent industries: ferrous and nonferrous metals industry, coal industry.

Trade indicators in the light industry are high. The differences in other industries are insignificant.

The above mentioned analysis belongs to the rows of the technological matrix. Of not minor interest is a comparative analysis of columns, i.e. input in industries. Input per unit significantly differs in the electric energy production: the coefficients of the republic for all industries below (except for the oil and gas and trade). According to the expectations, the largest differences can be observed in the production cost structure of the above mentioned non-relevant industries. Table 2 shows the relative difference [( Russian coefficients – regional coefficients)*100% / Russian coefficients] in the input per unit of industrial products to the oil and gas and coal industries. The oil and gas industry is a sector of specialization, and coal production in the republic has been almost completely ceased.

Not so significant, but pretty obvious difference in the Russian and the production cost structure can be observed in nearly all industries. The greatest similarity can be mentioned in such industries, as the construction materials producing industry, food industry. The important coefficients of input to the production of construction products differ from 3% to 22%; to the production of the food industry – from 12% to 39%. The above mentioned industries are developed in all regions to a greater or lesser degree, the spread of input per unit of the regions is not the highest. The latter, probably, can be explained not only by such a significant difference in the Russian and the regional production cost structure of these industries.

The regional input per unit in the agriculture is higher for such sectors, as oil refining products, chemistry and petrochemistry, repair services, lower – for trade, what on the whole reflects a more progressive pattern of input in the region, and that can be estimated as a technological difference.

The performed analysis fully belongs to the so-called important coefficients, determined by the degree of their influence on the output variable input-output models, in particular, to the gross outputs. The important coefficients compose one quarter of the total amount of technological coefficients and cover 96% of the total volume of interindustry flows. As a rule, those are the coefficients of input of the electric energy, oil refining, chemical industry, machinery and equipment, i.e. those industries, that form a significant share of intermediate consumption in the region. It was revealed, that in the first instance to the important coefficients belong the diagonal elements of the industries with large gross outputs and that these coefficients are higher than the others in their absolute value.

A specific problem is correction of the matrix of the direct input coefficients for the purposes of forecasting. The fact is that the difference in the Russian and the regional coefficients of direct input transform with the course of time. The reasons for changing of the correlation between the regional and the Russian coefficients are various. One of them is the difference in the dynamics of branches prices. The coefficients correlation is also influenced by the level of development of industries, changes in the direction of end use of an industry products, changes in the profoundness of raw material processing, and needless to say – by the technological changes.

The comparative analysis of the IO technical coefficients of the Republic of Bashkortostan and the Russian Federation over 2002 gives the following picture of changes in the correlation between the Russian and the regional coefficients. Input per unit of the electric energy and oil and gas industries is still higher in the republic. Profound changes in the sector input to transport have taken place in the oil and gas industry – in 2002 the coefficients of the republic became higher than the Russian ones, what undoubtedly came as a result of the growth of share of oil

resources import. As a whole, the share of trade and transport margins started to differ significantly in all industries. As before, a great difference can be seen in the diagonal elements of the non-relevant industries. In the oil and gas industry the gap between the diagonal coefficients became larger due to the accounting of the raw materials supplied by customer and the increase of prices for oil. In the nonferrous metals industry the share of intraindustry input in the Republic of Bashkortostan became even less, i.e. the processing chain became shorter. The specific volume of the intraindustry flows in the republic became greater for such industries, as the wood and wood products industry and the construction materials producing industry. The share of the intraindustry turnover in the light industry is still lower than the Russian level, the gap between the food industry and the average Russian value has increased twice.

The difference in the pattern of input has remained roughly the same in the electric energy, oil and gas, chemical and petrochemical, timber, machinery and equipment industry (with no regard to the intraindustry turnover coefficients, share of transport, trade). The pattern of input for ferrous and nonferrous metals industry – import dependent and underdeveloped industries, turned out to be less stable in relation to the Russian one. Table 3 gives the difference between the input per unit to production of ferrous and nonferrous metals industry on the whole in Russia and in the region over years 1995 and 2002. The most significant changes have taken place in the diagonal elements: the share of intraindustry turnover in ferrous metals industry in the republic has nearly reached the average Russian level, what suggests an intensification of raw materials processing. In the nonferrous metals industry a reverse process has taken place – the share of the intraindustry turnover has become 291 rubles per 1,000 rubles of products less than the Russian one. Significant changes have taken place in the correlation of the regional and the Russian intermediate input per unit in the food industry: the gap in the share of the intraindustry turnover has increased twice (in favour of the Russian Federation); the gap in the specific volume of the agricultural product flows, entering the food industry, has increased three times (in favour of the Republic of Bashkortostan), i.e. the processing of raw materials in the region is insufficiently profound. And the progression of that process continues. In the agriculture the republic began to fall behind in the specific volume of such industrial flows, as the chemical and petrochemical industry, machinery and equipment industry, simultaneously with the growth of the intraindustry turnover as compared with Russia. The difference in the regional and the Russian pattern of input to the following services sectors has been smoothed: health, physical culture and social welfare services, education, culture and art, science and scientific servicing, geology and exploration survey, geodetic and hydrometeorological services.

Accordingly, transformation of differences in the Russian and the regional input coefficients through time is another factor, requiring accounting in the process of correction of

technological coefficients as applied to the region. The latter requires special attention in the process of correction of forecasting coefficients and represents a difficult problem as a whole.

In the most vivid way the results of underestimation of the regional peculiarities of the direct input coefficients are revealed in scenario prediction calculations.

For instance, ambiguous conclusions can be made for scenarios of increase of prices for electric energy and oil and gas industry products when using the regional and the Russian technological matrixes. Table 4 gives the calculations of scenarios of price changes in the industries under one percent increase of prices for electric energy and oil and gas industry products, calculated with the help of the direct input coefficient matrixes of the Republic of Bashkortostan and the Russian Federation (the price scenario prediction technique is given in [2]). As we can see, the difference in some industries are twofold and more (ferrous metals industry, coal industry, trade). In some industries the growth of prices is higher with the use of Russian coefficients, in other – with the use of the republic's coefficients. In any way, depending on the use of that or another technological coefficient matrix one can obtain opposite results.

## 4. Differentiation of technical coefficients on Federal Districts

The analysis of an updated information on distribution of technological coefficients in the Federal Districts was performed on the basis of the data of the Federal State Statistics Service of Russia over 2006. An Use table is available for estimation, containing 10 rows for the following products: natural gas production, production of coal and other types of fuel, production, transfer and distribution of electric energy, production, transfer and distribution of steam and hot water, collection, purification and distribution of water, transport, car rent and equipment leasing and other business activities. Such table was estimated by us for the Russian Federation over 2006. The integrating indicators of the compiled table do not conflict with the official aggregated «Supply and Use table at purchaser's prices over 2006», as well as other national measures. It seems that it has its own independent value. But its basic assignment is spatial and time analysis of technological coefficients.

We shall note, that the results, obtained on the basis of the comparative analysis of technological coefficients of RB and the Russian Federation, prove out on the basis of data for the Russian Federation and the Federal Districts. Significant is the differentiation in the Federal Districts of such aggregated indicators, as shares of intermediate consumption in the output of industries. It specifically pertains to the mining and quarrying: the interregional difference in shares of intermediate consumption in oil extraction is 1.8-fold, in natural gas production – almost twofold, in coal production –1.5-fold. The production cost structure in the mining industries varies depending on the natural environment and climatic conditions. The regional

variation of the specific share in the manufacturing is smaller, but influential enough to allow for the use of some average indicators for all regions.

At the same time, there is a group of sectors, which specific volume of intermediate consumption in the output is not exposed to substantial variation in the districts. Here belong the so-called life-support industries, developed to a considerably equal extent in all regions: the food industry, agriculture, production and distribution of electrical energy, gas, steam and hot water, water, construction, trade and transport branches. The greatest oscillation in the districts' specific volume of intermediate consumption can be observed in the output of transport and is 1.5-fold. The specific volume of intermediate consumption is significantly varied in the oil refining of the districts. This type of economic activity in the districts is distributed unevenly, and accordingly the input per unit to manufacturing of that product is irregular, i.e. depends on the level of specialization. The most significant deviations from the average Russian level fall at the districts with a small specific volume of oil refining in the manufacturing industries.

The previously revealed dependence of the regional coefficients of an sector input on its internal structure also takes place. For instance, a structure of input to power generation significantly varies in the districts. The specific volume of natural gas is higher in the Southern, Privolzhsky and Urals Federal Districts. Accordingly, the specific volume of input to coal is higher in the Siberian and Far Eastern Federal Districts. Input to oil products is higher in the Northwestern Federal District.

The above mentioned belongs to the general characteristics of the production cost structure. The scale of variation of separate direct input coefficients is immeasurably higher. For instance, we can give the direct input coefficients of electric energy. The electrocapacity of oil industry in the districts differs 5 times, natural gas production – dozens of times. Even such equally developed sector as the food industry shows the difference in the electric capacity of 2.5 times, and other, less equally distributed industries, are exposed to great variability of input per unit.

The performed analysis shows, that the factors, determining the difference in the regional and the national technological coefficients, are diverse. Evaluation of the regional technological coefficients on the basis of the national ones requires an individual approach in every single case, and additional information, which is often included to the production cost structure, being obtained on the basis of the one-time-only survey of costs structure. Without such study the evaluation of the regional technological coefficients becomes insufficiently accurate.

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**Table 1.**

**Difference of diagonal elements of Russian and regional technological coefficient matrixes (in rubles per 1000 rubles of products).**

| | |
|---|---|
| Power generation | 21 |
| Oil and gas sector | -110 |
| Coal industry | -195 |
| Other types of fuel | 28 |
| Ferrous metals | 225 |
| Nonferrous metals | 129 |
| Chemical and petrochemical industry | 80 |
| Machinery and equipment | -15 |
| Wood and wood products industry | 43 |
| Construction materials | 27 |
| Light industry | 131 |
| Food industry | 66 |
| Other manufacturing | 41 |
| Construction | 3 |
| Agriculture | 7 |
| Transport and communication | 30 |
| Trade | 25 |
| Other business activities | 1 |
| Utilities | 16 |
| Health, physical culture and social welfare services, education, culture and art | 18 |
| Science and scientific servicing, geology and exploration survey, geodetic and hydrometeorological services | 79 |
| Services in financial intermediation, insurance, government administration and non-governmental organizations | 107 |

**Table 2**

**Relative difference in the production cost structure of oil and gas and coal industries**

| | Oil and gas sector | Coal industry |
|---|---|---|
| Power generation | -81% | -9% |
| Oil and gas sector | -77% | 98% |
| Coal industry | 100% | -284% |
| Other types of fuel | 100% | 100% |
| Ferrous metals | -15% | 100% |
| Nonferrous metals | 49% | 100% |
| Chemical and petrochemical industry | -122% | 99% |
| Machinery and equipment | -112% | -82% |
| Wood and wood products industry | 18% | 60% |
| Construction materials | -43% | 100% |
| Light industry | -8% | 100% |
| Food industry | 97% | -82% |
| Other manufacturing | 98% | 100% |

**Table 3**

**Difference of direct input coefficients of "Input-Output" tables of the Russian Federation and the Republic of Bashkortostan**

| | 1995 | | 2002 | |
|---|---|---|---|---|
| | Ferrous metals | Nonferrous metals | Ferrous metals | Nonferrous metals |
| Power generation | 0,006 | -0,018 | -0,013 | 0,008 |
| Oil and gas sector | -0,02 | 0,008 | -0,071 | 0,004 |
| Coal industry | 0,094 | 0,004 | 0,073 | 0,003 |
| Other types of fuel | 0 | 0 | 0 | 0 |
| Ferrous metals | 0,225 | 0,001 | 0,017 | 0 |
| Nonferrous metals | -0,01 | 0,129 | 0,002 | 0,291 |
| Chemical and petrochemical industry | -0,001 | -0,026 | -0,003 | -0,013 |
| Machinery and equipment | 0,019 | 0,002 | 0,007 | 0,006 |
| Wood and wood products industry | -0,004 | 0,002 | -0,005 | 0,001 |
| Construction materials | 0,003 | 0,001 | 0,002 | 0 |
| Light industry | -0,003 | 0 | -0,003 | 0 |
| Food industry | 0 | 0 | 0 | 0 |
| Other manufacturing | 0,003 | 0,002 | 0,003 | 0,001 |
| Construction | 0,003 | 0,003 | 0,011 | 0,009 |
| Agriculture | 0 | -0,006 | 0 | -0,005 |
| Transport and communication | -0,014 | -0,001 | 0,027 | 0,018 |
| Trade | 0,005 | 0,042 | 0,008 | -0,029 |
| Other business activities | 0,002 | -0,002 | -0,001 | -0,001 |
| Utilities | 0 | 0,001 | 0,003 | 0,004 |

| | | | | |
|---|---|---|---|---|
| Health, physical culture and social welfare services, education, culture and art | 0 | 0 | 0 | 0 |
| Science and scientific servicing, geology and exploration survey, geodetic and hydrometeorological services | 0,001 | 0 | 0,003 | 0,006 |
| Services in financial intermediation, insurance, government administration and non-governmental organizations | 0,002 | 0,001 | 0,011 | 0,004 |

**Table 4**

## Scenarios of price changes in industries under one percent increase of prices for electric energy and oil and gas industries (in percentage terms)

| | Growth of prices for oil and gas products | | Growth of prices for electric energy | |
|---|---|---|---|---|
| | Using the region's technological matrix | Using the average Russian technological matrix | Using the region's technological matrix | Using the average Russian technological matrix |
| Power generation | 0,47 | 0,374 | 1 | 1 |
| Oil and gas sector | 1 | 1 | 0,159 | 0,079 |
| Coal industry | 0,138 | 0,105 | 0,167 | 0,103 |
| Other types of fuel | 0,252 | 0,138 | 0,142 | 0,102 |
| Ferrous metals | 0,132 | 0,15 | 0,097 | 0,125 |
| Nonferrous metals | 0,106 | 0,091 | 0,122 | 0,087 |
| Chemical and petrochemical industry | 0,317 | 0,207 | 0,221 | 0,182 |
| Machinery and equipment | 0,132 | 0,104 | 0,137 | 0,104 |
| Wood and wood products industry | 0,189 | 0,135 | 0,143 | 0,098 |
| Construction materials | 0,185 | 0,177 | 0,145 | 0,123 |
| Light industry | 0,123 | 0,09 | 0,146 | 0,102 |
| Food industry | 0,114 | 0,088 | 0,097 | 0,055 |
| Other manufacturing | 0,106 | 0,103 | 0,107 | 0,106 |
| Construction | 0,112 | 0,102 | 0,079 | 0,065 |
| Agriculture | 0,156 | 0,102 | 0,098 | 0,057 |
| Transport and communication | 0,119 | 0,16 | 0,086 | 0,088 |
| Trade | 0,142 | 0,054 | 0,169 | 0,039 |
| Other business activities | 0,051 | 0,048 | 0,048 | 0,042 |
| Utilities | 0,349 | 0,275 | 0,155 | 0,189 |
| Health, physical culture and social welfare services, education, culture and art | 0,111 | 0,084 | 0,121 | 0,082 |
| Science and scientific servicing, geology and exploration survey, geodetic and hydrometeorological services | 0,181 | 0,114 | 0,168 | 0,097 |
| Services in financial intermediation, insurance, government administration and non-governmental organizations | 0,09 | 0,118 | 0,062 | 0,097 |