doi 10.15826/recon.2015.2.012
UDC 332.1

V. V. Dobrodey [a)]
[a)] Ural Federal University named after the First President of Russia B. N. Yeltsin

DISINTEGRATION AND COORDINATION OF FORECAST PARAMETERS OF SOCIO-ECONOMIC DEVELOPMENT AND THE FUEL AND ENERGY BALANCE OF THE REGION[1]

The scope of strategic planning documents for the constituent entities of the Russian Federation, the procedure for their development and coordination on interregional and federal levels, the requirements for their content and conjunction with other long- and medium-term territorial programs are now approved by statute. The article presents the theoretical and methodological problems of detailing and interrelation of the region's socio-economic development scenarios with the forecast parameters of regional energy consumption based on the fuel and energy balance under conditions of incomplete retrospective information. This situation is typical of the market environment, and some restrictions on access to statistical data are irremovable. This fact reduces the opportunity to apply formal and rigorous evaluation methods and the objectivity level of not only the forecast indicators, but also of the current ones. The coordination of these documents is methodologically and practically relevant due to the relative isolation of their formation process, a different level of detailing of the forecast scenarios, and a lack of the required information. The author uses the energy saving and energy efficiency measurement technique that is based on the structural comparison of performance, current and estimated fuel and energy balances, consistent with the region's socio-economic development forecast. The author is also concerned with the development of this technique for the purpose of a comparative regional energy consumption analysis in retrospective and predictive periods. Since 2007, the author has been involved in practical calculations within the framework of the state order of the Ministry of Energy, Housing and Utilities of the Sverdlovsk Region. The article describes methodological characteristics of the author's approaches to the development of variants of the fuel and energy balance, taking into account maintaining the official scenarios of socio-economic development of the region, the errors and the incompleteness of statistical data, and the regulatory requirements pertaining to the quality of forecasts.

Keywords: regional economy, energy saving, energy efficiency, reliability, stochasticity, trend, dynamics, information, forecast, fuel and energy balance

The relevance and empirical background of the problem

The main purpose of this article is to discuss the development of a methodology for the complex analysis of the regional energy consumption dynamics in the framework of modified models of the fuel and energy balance, the use of which would be quite correct in the context of limited access to information, its non-completeness, the need for coordination with aggregate indicators of the approved socio-economic development forecast and participatory monitoring of these documents in accordance with applicable legislation[2]. The consideration of the general principle — the less accessible and objective the information, the lower the accuracy of the analytical estimates — is extremely relevant in the research of infrastructure subsystems of the regional economy. The International Energy Agency emphasizes the danger of a lack of basic data in the energy information system. Highly important is the reliability of forecasts for regions, the economies of which are characterized by energy criticality — a low share of own fuel and energy sources and a significant amount of their consumption.

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[2] On Strategic Planning in the Russian Federation. Federal Law No. 172-FZ dated June 28, 2014 [Electronic resource] Access through ConsultantPlus Legal Reference System.

It is known that energy saving and energy efficiency programs can offer significant economic benefits for such regions, including, in particular, the Sverdlovsk Region. This is possible due to the reduction of fuel and energy transportation costs, the increase in business profitability, the reduction of environmental emissions, the softening of constraints in the fuel and energy balance, and, consequently, more sustainable provision of the region with energy resources. The solution to problems related to the energy efficiency increase in the regional economy relies on the systematic development of a methodological framework for energy management in a competitive market environment, the evaluation and selection of energy efficiency regulation models, mechanisms and instruments, the formation of a package of adequate programs and activities, the prediction of target indicators and the development of methods for their assessment, and the monitoring of territorial socio-economic development forecasts and strategies. Within the constituent entities of the Russian Federation and in accordance with applicable legislation, local governments have developed programs aimed at improving energy efficiency in the regional economy. For the Sverdlovsk Region, the corresponding program is comprehensive — with particular emphasis given to activities for the development of the housing and utilities sector. The scope of target indicators and activities focused on the use of extrabudgetary funds has also been determined. However, the problems of non-budgetary investments in energy savings are still relevant for the Sverdlovsk Region, as well as for other regions of the Russian Federation [1]. According to the International Energy Agency, the effect of energy saving for the Russian Federation is equivalent to almost 2/3 of natural gas exports [2].

The development of fuel and energy performance and prospective balances is a valid and indispensable instrument in the quantitative analysis of current and future energy consumption parameters. Without analysis and forecast of the fuel and energy balance, it is impossible to justify the energy, environmental and socio-economic forecasts [3]. The fuel and energy balance is used to detail the structure of the consumption of fuel and energy resources, estimate the total *GRP* energy efficiency components, assess the influence of certain types of economic activities and territorial programs on the dynamics of this process, and identify the trends of the target indicators. Taking into account the socio-economic development forecasts in the region[3] and the programs for development of the territorial energy complex (TEC), the fuel and energy balance forecast enables the identification of possible risk situations associated with the supply of energy resources in the region [4]. Coordination of the fuel and energy balance forecasts at interregional and federal levels is necessary to estimate directions of the spatial development of the Russian territorial energy complex [5] and to solve the problems related to its modernization [6].

The information availability level significantly affects the theoretical and methodological principles of the formation of fuel and energy balance models, the indicator calculation method, and, indirectly, the methodological basis for energy consumption regulation. The market has introduced additional restrictions as to the availability and accuracy of information. The inclusion of corporate energy consumption indicators as primary statistical data into publicly available information contravenes current legislation[4].

The legislative acts aimed at the protection of trade secrets and free competition complicate or preclude access to quantitative indicators of corporate programs and to the volumetric indicators of energy resources consumption for individual companies, and sometimes, as a consequence, for certain economic activities and even municipalities as a whole. As a general case, in accordance with the Law On Commercial Secrets, it is impossible to implement the order of the Ministry of Energy of the Russian Federation on the development of the fuel and energy performance balances of the municipality without special additional agreements[5]. For this reason, there are quite numerous information "gaps" at the regional level. The conclusion of confidentiality agreements allows for the creation of a standard aggregate fuel and energy balance; however, the volumetric characteristics of the balance, except for relative dynamics indicators, still belong to confidential indicators. This poses serious limitations on

[3] On Socio-Economic Development Forecasting for the Sverdlovsk Region for 2015–2017. Decree of the Government of the Sverdlovsk Region dated October 28, 2014 No. 928-pp. Yekaterinburg [Electronic resource]. Access through ConsultantPlus Legal Reference System.

[4] On the Official Statistical Accounting and the State Statistics System in the Russian Federation. Federal Law dated November 29, 2007 No. 282-FZ (as amended on July 23, 2013) (article 4, paragraph 5 and article 9, paragraph 1.) [Electronic resource] Access through ConsultantPlus Legal Reference System.

[5] On Commercial Secrets. Federal Law No. 98-FZ as amended by Law No. 35-FZ dated March 12, 2014 [Electronic resource] Access through ConsultantPlus Legal Reference System.

the possibility of public analysis of the fuel and energy balance characteristics, as well as of their comparison between different periods, by energy-intensive product type, and by separate territories.

This "agency-level" principle of using information that is very important from macroeconomic and social points of view is not conducive to the objectivity of the published data, or to the prevention of intentional distortion, among other reasons, due to political factors.

This article does not touch upon the individual indicators or targets of the territorial energy consumption for the subsequent comparison and rating of the constituent entities of the Russian Federation, although the significance of such papers is undoubted [7]. The problem of reliability of the fuel and energy balance is complex and has peculiarities for individual territories. The author considers them specifically in terms of the Sverdlovsk Region. The approaches, described below, are not evaluated as the best or very satisfactory, we do not aim to find the most correct and reliable solution for a non-trivial task — to offer the best method of detailing and coordinating current and estimated parameters of the socio-economic development forecast for the region and the fuel and energy balance of the region out of some number of possible options. In the conclusion, the author relies upon experience in practical calculations, using as an empirical base the fuel and energy balances formed and upgraded by them for 2007–2013, the available statistical information for 2004–2014, and the evolution of methods of forming the fuel and energy balance used by them [8, 9, 10] and other researchers, especially by the staff of the Energy Research Institute of the Russian Academy of Sciences[6] and the Center for Energy Efficiency (CENEF) [11, 12]. It is assumed that discussion of such papers is useful for the gradual reduction of the relevance of information-related and methodological problems.

The implementation of regional programs for energy saving and efficiency increasing essentially involves the management of innovation processes in energy consumption. However, the reflection of innovative components of energy saving within the fuel and energy balance model through the creation of special units is possible only partially. In particular, it is possible to estimate the reduction of greenhouse gas emissions from fuel combustion and emissions to water and soil, but these processes may be a consequence of investments and a low level of innovativeness. However, it is known that significant changes in energy efficiency are possible only through innovation. The innovative aspects of energy saving can be estimated to the fullest extent on the basis of analysis of relevant corporate programs and activities, but this information is not always available.

There is a general trend — to obtain assessment for the retrospective and current period in the form of a quantitative interval, reflecting the inaccuracy of information, in the forecast period — to use expert analytical and econometric methods for evaluating the scenarios, as it is accepted in Russia's energy [13] and socio-economic development forecasts.

Informational aspects of formation of the fuel and energy balance

The situation with information support of the fuel and energy balance for the Sverdlovsk Region, described below, is typical for other regions. In particular, this is confirmed by the author's similar studies as related to the Perm Krai. The calculation of the *GRP* energy consumption and energy intensity in the Sverdlovsk Region even for the reporting year (preceding the current) is of an evaluative nature[7]. This is due to the delay of the publication of statistical materials that are available only in the fourth quarter of the current year (revised data on volumes of consumption of thermal and electric energy) or the next year (information of the territorial agencies of the Federal State Statistics Service on the *GRP* structure). However, evaluation of the dynamics of *GRP* energy intensity and other indicators of energy efficiency of the regional economy, the energy consumption structure and relative characteristics of the fuel and energy performance balance, its three-year forecast in the document monitoring system of the Ministry of Energy, Housing and Utilities shall be generally ready in the third quarter of the current year.

Available information for the reporting year, being of the highest importance for the calculations at the level of the constituent entities of the Russian Federation, includes statutory[8] state statistics

[6] Fuel and Energy Balances. [Electronic resource]. URL: http://www.eriras.ru/data/4/rus (accessed date February 20, 2015).

[7] Wide application in materials of the territorial agency of the Federal State Statistics Service of the Sverdlovsk Region of relative indicators of dynamics of production volumes (in % as related to the previous year) in the absence of volumetric data for the previous period does not allow this information to be used in the calculations of absolute energy intensity indicators.

[8] On Approval of the Official Statistical Methodology for Compiling the Fuel and Energy Balance of the Russian Federation. Federal State Statistics Service. Order dated April 4, 2014, No. 229 [Electronic resource]. Access through ConsultantPlus Legal Reference System.

documents. However, the data contained in the statistical reports do not allow information to be formed on the distribution of fuel and energy resources, differentiated according to the full list of basic types of economic activities and consumption of energy resources by small companies. However, it is possible, with satisfactory balancing, to evaluate the distribution of fuel and thermal power by the type of economic activities, with domestic consumers shown separately.

The structure of electricity consumption by the type of economic activities is just partially reflected in the provided sources of information. And, as a rule, operational data do not coincide with the indicators of electrical balance, which (with a considerable delay) reflects the information on electricity consumption in general for the region and for the main types of economic activities, the supply of electricity from third parties, consumption by domestic consumers, and losses in the grids. However, some types of economic activities here are grouped into a single unit, causing fundamental difficulties in the development of forecasts.

As a consequence, a problem arises pertaining to comparison of the types of economic activities in terms of added value energy intensity. Cooperation with the regional offices of Rosstat and the use of additional analytical documents allow, as experience shows, partial elimination of information gaps. Nevertheless, it is impossible to fully eliminate persistent incompleteness of the data on the consumption structure of fuel and energy resources and the inconsistency of individual documents. Data rounding causes additional errors. In particular, starting from 2004, in Rosstat's database the added value indicators for the Sverdlovsk Region in the "B" type of economic activities — "fishing and fish-farming" — are rounded to zero, and the corresponding *GRP* balances are distorted. Therefore, the calculations require the adjustment of data on the *GRP* structure, added value deflators for certain types of economic activities, and their dynamics.

The time lag of the publication of the *GRP* volume and structure of statistical data is about 2 years. In particular, the Briefing Note On the Production and Use of the *GRP* in the Sverdlovsk Region for 2010–2011 (code 05023) was prepared in 2013, and the estimated *GRP* rates and structure changed compared to the previous data. Thus, the fuel and energy balance forecast is performed with consideration of the retrospective view, for which some parameters of not only the current, but also the reporting year, in terms of the structure of consumption of fuel and energy resources and the *GRP* volume, are of an evaluative nature that may affect the quality of the forecast.

The main idea of the author's approach to the formation of fuel and energy balance forecasts lies in the use of *GRP* detailing, according to Rosstat, by the type of economic activities, analysis of the dynamics of vectors obtained in the period of 2004–2013, the forecast of the added value for each type of economic activities and their energy intensity in future. The specialists of the Institute of Energy Saving, a state-financed entity of the Sverdlovsk Region, have applied this technique since 2007. Currently, a similar approach is used at the Energy Research Institute of the Russian Academy of Sciences, where earlier the development of the fuel and energy balance was based on the results of studies by A. A. Makarov and A. G. Vigdorchik and the "standard" method for energy consumption measurement (the product of the bill of fuel and energy resources for the production of basic products, and integration in the consolidated balance of boiler and furnace fuels). Bringing the fuel and energy balance in line with the OKVED format corresponds with Rosstat's basic data structure, simplifies the procedure for approval of the fuel and energy balance at interregional and federal levels, and their relation with strategic planning documents. As previously noted in the studies of the Institute of Economic Forecasting of the Russian Academy of Sciences, the absence of a system of national accounts at regional level was the main information obstacle for the structural analysis of regional development [14].

To assess indicators of the current year the general economic situation in the region has to be analyzed on the basis of retrospective and operative data on manufacturing volumes of the key products. This allows a substantiation of conclusions about the *GRP* structural dynamics. Analysis for the Sverdlovsk Region for 2007–2013 has shown sustainable *GRP* growth, with the exception of 2009 (Table 1); the *GRP* index in basic prices significantly exceeded the actual volume index (in comparable prices of 2007), which is typical for other regions. It can be assumed that the main factor behind the increased cost is inflation; its overall assessment differs from the official one — this indicator is from

On Approval of the Procedure for Compiling the Fuel and Energy Balances of the Constituent Entities and Municipalities of the Russian Federation. The Ministry of Energy of the Russian Federation. Order dated December 14, 2011, No. 600. [Electronic resource]. Access through ConsultantPlus Legal Reference System.

Table 1

The parameters of the set (core) of economic activities, defining the main component of the region's *GRP* dynamics

Type of economic activities	2007	2008	2009	2010	2011	2012	2013 (Estimate)
Industry (*C* + *D* + *E*) share in *GRP*, basic prices, %	40.13	40.02	35.53	37.80	36.58	33.03	32.29
The added value index in basic prices vs. previous year, %	100.00	112.20	79.35	134.90	119.37	103.82	104.52
Physical volume in 2007 prices, share in *GRP*	40.13	42.5	42.32	45.4	44.9	43.4	43.35
The index of physical volume vs. previous year	100	108.50	88.07	119.55	107.64	103.45	102.98
Wholesale and retail trade, etc. (*G*) share in *GRP*, basic prices, share, %	22.1	19.2	20.0	20.3	19.1	21.56	20.16
The added value index in basic prices vs. previous year, %	100.00	97.45	93.47	128.33	115.96	129.98	99.98
Physical volume in 2007 prices, share in *GRP*, %	22.1	19.6	19.13	17.9	17.9	18.18	18.06
The index of physical volume vs. previous year, %	100	90.9	86.2	104.5	108.4	108.93	102.35
Transport and communication (*I*) basic prices, share in *GRP*, %	9.3	9.4	9.2	9.4	11.1	12.02	12.036
The added value index in basic prices vs. previous year, %	100	114.4	87.4	129.3	145.6	124.85	107.01
Physical volume in 2007 prices, share in *GRP*, %	9.3	9.2	9.06	9.4	11.6	12.97	13.21
The index of physical volume vs. previous year, %	100	102.1	86.9	115.6	134.1	120.02	104.9
Real estate operations, etc. (*K*) share in *GRP*, basic prices, %	7.5	8.1	9.3	9.3	9.5	10.44	10.63
The added value index in basic prices vs. previous year, %	100	121.1	102.2	126.8	126.1	126.52	108.82
Physical volume in 2007 prices, share in *GRP*, %	7.5	7.9	8.59	8.3	7.4	8.26	8.44
The index of physical volume vs. previous year, %	100	107.6	95.8	108.3	96.9	119.12	105.3
Total share in *GRP*, basic prices, %	79.06	76.71	74	76.7	76.2	77.0	75.12
Total share in *GRP* in 2007 prices, %	79.06	79.23	79.1	81.1	81.8	82.8	83.06
The added value index of the core of the chain, basic prices, %	100.00	112.52	89.36	126.82	123.35	114.98	101.31
The added value index of the core in 2007 prices, %	100.00	102.50	88.40	111.40	108.90	107.10	103.37

7.4 % (2012) to 13.8 % (2010). Over the past three years, the share of the production sector in the *GRP* in current prices has decreased from 37.8 % to 33.03 %, and in 2007, it was more than 40.13 %. Both the share of physical volume of added value in the production sector, and its volume indices in basic and comparable prices decreased (from 108.5 % in 2008 to 103.8 % in 2012). Thus, the growth of the physical volume of added value in the production sector was combined with the decline of its share in *GRP*. One of the causes of structural changes is the accelerated growth of indicators for economic activities of the "*I*" type — "transport activity", and the "*K*" type — "operations with real estate, etc.", which indirectly confirms the findings on the accelerated growth of the corresponding prices and tariffs.

Despite significant structural changes of the *GRP*, the share of the "core" of the territorial economy has been stable in recent years — the variability was within 76.7–77 % in current prices and 81.1–82.8 % in comparable prices. Therefore, the orientation in the evaluation of the estimated *GRP* values on the dynamics of the "core" seems to be justified.

The methodology used by the author for disintegration of the *GRP* of the reporting and current year by the type of economic activities and the subsequent forecast, in the practice of calculations for the Sverdlovsk Region, takes into account, in accordance with the stated comments, a number of structural features of the existing information base.

1. The estimated *GRP* of the current year (in one option) is determined in the socio-economic development forecast for the region. For the reporting year, data are available on the total heat and electricity consumption by small enterprises, domestic consumers, and large and medium-sized enterprises (in the reduced structure of types of economic activities).

2. Detailed indicators of fuel consumption by domestic consumers, large and medium-sized enterprises are available.

3. Data are available on the turnover structure by the basic types of economic activities and characteristics of the fuel and energy balance for a retrospective period from 2007, and retrospective indicators of the *GRP* structure from 2004.

4. The unit of retrospective information from 2007 is created on the dynamics of the output volumes of key products, specific and total energy intensity, the dynamics of targets of energy saving and energy efficiency.

The content of the main measurement and analytical units

Under the above conditions, the following stages of payment transactions are carried out for the reporting (previous) and current years (illustration according to data for the Sverdlovsk Region).

1. We evaluate the relationship of *GRP* in basic prices (*GRPcur*) and the total turnover (*TURNover*) for large and medium-sized enterprises for 2004–2013. Analysis of the correlation between the time series of the *GRP* and the turnover in the region, between the added value by type of economic activities (*VALaddcur j*), $j = \overline{1,15}$ and turnover (*TURNover j*) showed that the correlation coefficient in the first case exceeds 0.9. Obviously, a portion of the correlation value is due to the dependence of the indices of total factor — the level of favorability of the economic situation. The regression analysis of statistical dependence $GRPcur = F(TURNover) + \varepsilon$ shows, with a high approximation degree (normalized $R^2 = 0.86$), the relation of indicators: $GRPcur = \text{Const} + K \times TURNover + \varepsilon$, and the confidence interval for the coefficient *K* contains actual and scenario values of *GRP* for the last two years.

A similar correlation coefficient for individual types of economic activities is also very high with the exception of *B* — "fishing and fish-farming", and *J* — "financial activity". The contribution of these economic activities into *GRP* is less than 1 % and unstable, but the errors of these data have practically no effect on the accuracy of *GRP* estimates. The feasibility of the *GRP* estimate and structure based on the statistical relationship of the desired indicators with actual data on the turnover relies on the meaningful interpretation of indicators: there is a functional relationship between gross output and added value at year-end, but in the dynamics this relationship is stochastic. The differences between the turnover and the gross output are financial and structural — the balance of work in process at cost, and non-sold products at average market prices are disregarded and, as a consequence, the relationship between gross output and turnover is also stochastic in the dynamics. Statistical methods, as a generally recognized tool for studying stochastic dependencies, are applicable to analysis of the "turnover → gross output → *GRP*" relation, or directly, "turnover → *GRP*" (Figure 1).

It is reasonable to compare indicators of the confidence interval (GRP_{min}, GRP_{avrg}, GRP_{max}) with the scenario *GRP* level from the socio-economic development forecast. According to data for the Sverdlovsk Region, the time trend for 2013 determines, with high significance, the average interval, close to the official scenario assessment of *GRP*. From the standpoint of scientific accuracy, it is reasonable to check the transfer of the approved forecast estimates against the obtained confidence intervals for the reporting and current year. Experience of calculation shows that the formal *GRP* evaluation is often very optimistic and can be considered as an innovation scenario.

Unfortunately, a high degree of 2007–2013 retrospective approximation allows using the time trend and regression only for *GRP* evaluation in the reporting year of 2013, the last in the period of

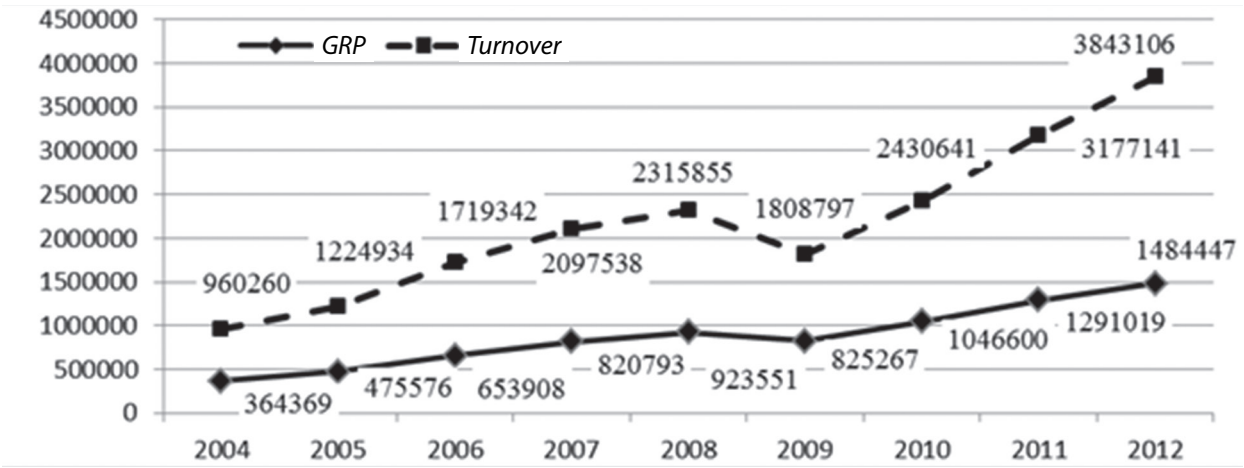

Fig. 1. *GRP in current prices against turnover of the Sverdlovsk Region ratio*

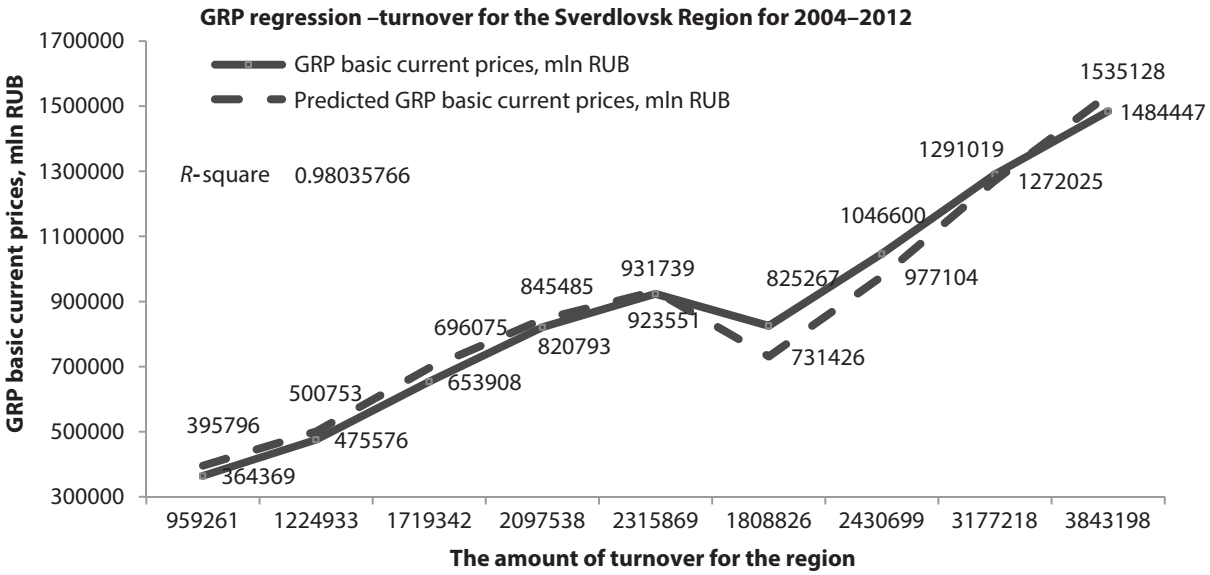

Fig. 2. *Illustration of the regression approximation level of GRP dynamics*

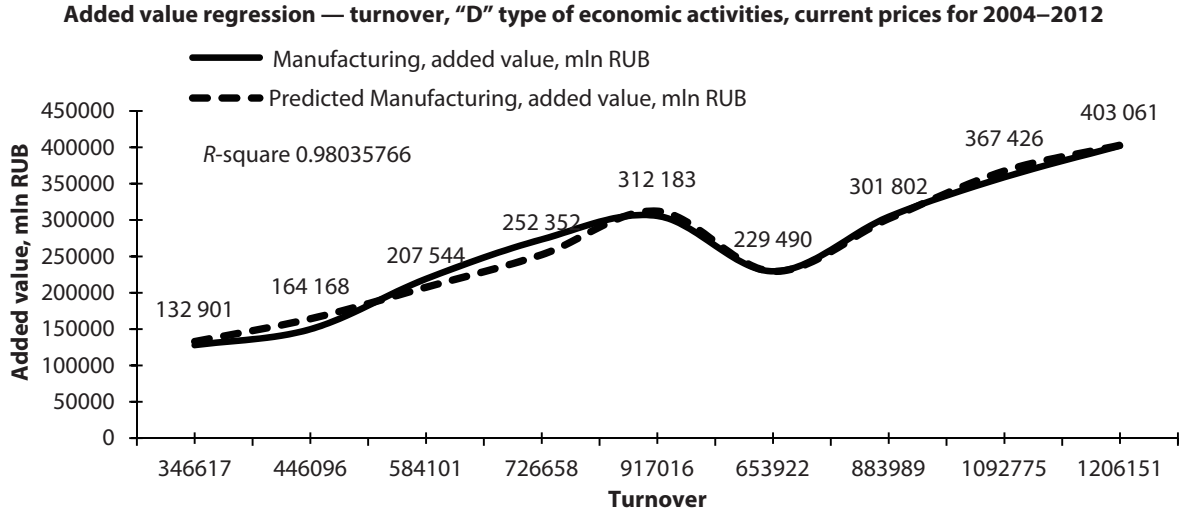

Fig. 3. *Analysis of the dependence of added value of the "D"-type economic activities on turnover*

relatively stable behavior of this indicator. In the short term, the socio-economic development forecast for the Sverdlovsk Region does not suggest significant growth. Even for optimistic variants by certain types of economic activities, the added value dynamics is displayed with curves with a falling growth rate (logarithmic or power trends). Such tools as economic logic and expert evaluation are increasingly used.

2. The purpose of the second unit of the calculations is detailing *GRP* of the reporting year — the evaluation of the added value indicators in basic prices (AddedValuecurr) for basic economic activities. Here, different methods can be used. The simplest one is based on the added value/turnover ratio of the previous vs. reporting year and the subsequent "normalization" of indicators to ensure the *GRP* balance. This approach is valid under the assumption of high inertia of this ratio for recent years of the retrospective, and such estimates are subject to revision. However, this method defines a balanced variation of the *GRP* structure of the region, taking into account the general inflation index from the official forecast. In a more rigorous scheme of the calculations, it is appropriate to apply regression analysis and time trends to evaluate the dependence of the added value on the turnover. Figures 3–4 illustrate the calculation for economic activities of the "*D*" type — "manufacturing", and the "*G*" type — "wholesale and retail trade, repair of motor vehicles, etc.". In particular, the most optimistic for 2013 in terms of the "*D*" type of economic activities was the estimate based on the added value / turnover ratio; a nonlinear time trend showed an intermediate value and the regression was minimal; the range of variation was less than 6 %.

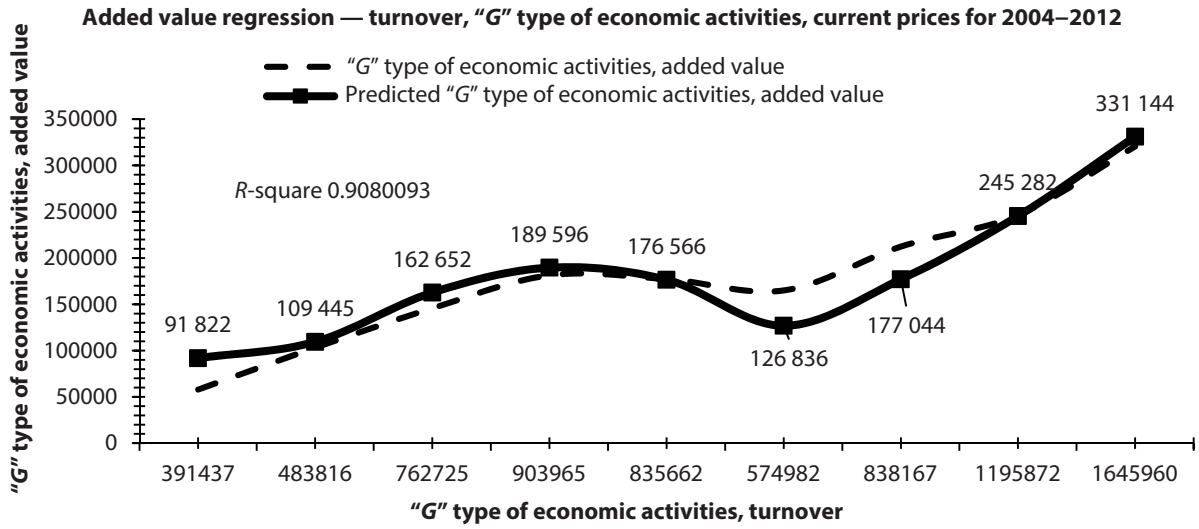

Fig. 4. *Analysis of the dependence of added value of the "G" type of economic activities on turnover*

A similar analysis for the "*G*" type of economic activities (Figure 4) allows a "central interval" to be obtained for the reporting year of 2013, where the mean value corresponds to the regression, the left border corresponds to the added value/turnover ratio, and the right border corresponds to a nonlinear trend.

3. For the transition from basic prices to the comparable prices (of the previous year) and the calculation of chain volume indexes, estimates of added value deflators are required for each type of economic activities. The information available for the analysis is actual deflators for 2007–2012 (Table 2) and operational statistics. The sequence of operations takes into account the scenario values of *GRP* in current basic prices from the official forecast, and the balanced structure of *GRP* is determined at a given index of physical volume of *GRP* for each of the scenarios on the basis of regression analysis and subsequent "normalization". To adjust the estimates, operational data are used in comparable prices: the index of the industrial production, the index of gross output of the agricultural sector, the scope of work, performed by the "*F*" type of economic activities — "construction", the index of freight turnover of transport and passenger turnover ("*I*" type of economic activities), the turnover of retail and wholesale trade (the fragment of the "*G*" type of economic activities).

As a result, variants of the *GRP* balanced structure in basic and comparable prices, chain and integral deflators are determined (Table 2). However, formation of the method, clearly providing the most reliable interval of the structural forecast, is impossible due to incomplete information. Orientation on official indicators of the socio-economic development forecast for the region is also not entirely

Table 2

***GRP* of the Sverdlovsk Region for 2004–2012 and the estimate for 2013**

Year of the period	*GRP* basic current prices, mln RUB	Physical volume index of the chain from 2004	*GRP* in comparable prices of 2004	Deflator to 2004	*GRP* in comparable prices of 2007	Physical volume index of the chain the prices of 2007	Deflator to 2007
2004	364,368.8	1.0000	364,368.8	1.0000	614,507.3	1.0000	0.5929
2005	475,575.5	1.0950	398,983.8	1.1920	672,885.5	1.0950	0.7068
2006	653,908.3	1.1150	444,867.0	1.4699	750,267.4	1.1150	0.8716
2007	820,792.5	1.0940	486,684.5	1.6865	820,792.5	1.0940	1.0000
2008	923,550.8	1.0250	498,851.6	1.8514	841,312.3	1.0250	1.0978
2009	825,267.4	0.8840	440,984.8	1.8714	743,720.1	0.8840	1.1096
2010	1,046,600.1	1.1140	491,257.1	2.1305	828,504.2	1.1140	1.2632
2011	1,291,019.1	1.0890	534,978.9	2.4132	902,241.0	1.0890	1.4309
2012	1,484,447.4	1.0710	572,962.5	2.5908	966,300.2	1.0710	1.5362
2013	1,587,000.0	1.0299	590,120.8	2.6893	995,237.7	1.0299	1.5946

satisfactory — the operational monitoring of this document is delayed, and the current scenarios may differ significantly from the observed dynamics.

However, statistical analysis methods can provide consistency, balance, and relative reliability of the estimates. The practice of calculations for the Sverdlovsk Region shows that the obtained estimates reflected the retrospective trends well overall.

Evaluation of *GRP* structure allows, in comparison with the previous and basic years, the calculation of the dynamics of energy consumption, saving and efficiency. Simultaneously, we adjust chain and integrated (to 2007) deflators in the retrospective period from 2004[9].

In the analysis, we used conventional methods for calculating the *GRP* parameters. To describe the basic procedures we use the following notation. Let t be the index of the year (in the calculations $t \in \overline{2004;\ 2013}$), *bas* — index of the first (base) year; $GRP_{t\ cur}$ — *GRP* in current basic prices; $GRP_{bas\ cur}$ — the same for the base year; similar indicators in comparable prices — $GRP_{t\ comp}$ and $GRP_{bass\ comp}$. For the base year by definition there is an equality $GRP_{bas\ comp} = GRP_{bas\ cur}$. In Rosstat's data, the first (2004) year is taken as the base, and the chain (in the previous year's prices) indices of the physical volume of *GRP* $\alpha_{t\ comp}$ are shown. For $t = bas$ we have $\alpha_{bas\ comp} = 1$ (or 100 %); consequently, $GRP_{t\ comp}$, the physical volume of *GRP* in year t in comparable prices of the first ($bas = 2004$) year, will be determined from the relation

$$GRP_{t\ comp} = \prod_{t=bas}^{t} \alpha_{t\ comp} GRP_{bas\ cur}. \quad (1)$$

Or through the sequence of operations

$$GRP_{t\ comp} = GRP_{t-1\ comp}\alpha_{t\ comp};\ \ t = \overline{2005\ ;\ 2013}. \quad (2)$$

We calculate deflator indices of the chain вt chain def from 2004:

$$\beta_{t\ chain\ def} = GRP_{t\ cur} / GRP_{t-1\ cur} / \alpha_{t\ comp};\ \ t = \overline{2005;2013} \quad (3)$$

and deflator indices of the integral вt intbass def to 2004:

$$\beta_{t\ \mathrm{int}\ bass\ def} = GRP_{t\ cur} / GRP_{t\ comp};\ \ t = \overline{2005;2013} \quad (4)$$

or through chain indices:

$$\beta_{t\ \mathrm{int}\ bass\ def} = \prod_{t=bass}^{t} \beta_{t\ chain\ def};\ \ t = \overline{2005;\ 2013}. \quad (5)$$

The deflator index of *GRP* vs. the base year by definition $\beta_{bas\ def} = 1$.

In the legislative documents taken for calculation of the energy efficiency and saving, 2007 was taken as the base year, and Table 1 shows the results of the relevant recalculation. The simplest formula for recalculating the integral deflators for the new base year ($bass1 = 2007$) in our case (with already known integral deflators vs. the first year of the period) is:

$$\beta_{t\ \mathrm{int}\ bass1\ def} = \beta_{t\ \mathrm{int}\ bass\ def} / \beta_{t=bass1\ \mathrm{int}\ bass\ def};\ \ t = \overline{2004;\ 2013}. \quad (6)$$

Similar operations for the retrospective period are carried out for each type of economic activities, including the reporting year with incomplete information. As a result (according to scenarios), structural parameters of *GRP* by the type of economic activities are adjusted, including the dynamics of chain and integral deflators vs. the beginning of the period and the base year (2007). This information is necessary to monitor the accuracy of the added value calculations by the type of economic activities. In particular, the balance sheet ratios should be checked in current basic and constant prices of the base year

$$GRP_{t\ cur} = \sum_j AddedValue_{curr\ j};\ \ GRP_{t\ comp} = \sum_j AddedValue_{comp\ j};\ \ j = \overline{1;15}, \quad (7)$$

where $AddedValue_{t\ cur\ j}$; $AddedValue_{t\ comp\ j}$, $j = \overline{1;\ 15}$ — added value in current, and consequently, in comparable prices for the types of economic activities. The correctness of the deflator calculation is also checked and their accuracy is assessed.

[9] Structural characteristics of *GRP* in the official statistics are given approximately (fractional precision of the types of economic activities in *GRP* is rounded to one significant digit in the fractional part).

$$GRP_{t\,comp} = GRP_{t\,curr}\,\bar{\beta}_{t\,\text{int}\,bass\,def};\ \ t = \overline{2004;2013}, \tag{8}$$

$\bar{\beta}_{t\,\text{int}\,bass\,def}$ — *GRP* chain deflator, calculated as weighted average by the type of economic activities.

$$\bar{\beta}_{t\,\text{int}\,bass\,def} = \sum_{j} \beta_{t\,\text{int}\,bass\,def\,j}\,\delta_{tj};\ \ j = \overline{1;15}, \tag{9}$$

where $\delta_{tj} = AddedValue_{t\,curr\,j} / GRP_{t\,curr}$; $t = \overline{2004;\ 2013}$; $j = \overline{1;\ 15}$ — the share of the type of economic activities in the region's *GRP* (current basic prices).

Scenario values of *GRP* deflator and its volume in comparable prices are known from the official forecast. Therefore, the index of the *GRP* physical volume is also known (Table 3), and the deflator is determined for the base year (2007), and within 2007–2012, all intermediate indicators and chain deflators are adjusted, using consistent optimization of additional decimal digits (described below).

Table 3

Scenario indicators, used in the forecast of the fuel and energy balance for 2014–2017

Indicator	2012	2013 (Estimate)	2014		2015		2016		2017	
			Ver. 1	Ver. 2	Ver. 1	Ver. 2	Ver. 1	Ver. 2	Ver. 1	Ver. 2
GRP, region, basic prices, bln RUB	1,484.5	1,587	1,655.8	1,707	1,780	1,864	1,940	2,070	2,150	2,338
Physical volume index vs. previous year, %	107.10	103	98.99	102.05	102.19	103.60	103.31	105.16	104.16	106.05
Deflator index vs. previous year, %	107.36	103.80	105.40	105.40	105.20	105.40	105.50	105.60	106.40	106.50
GRP in comparable prices vs. previous year, bln RUB	1,382.7	1,528.9	15,716	1,619.5	1,692	1,768	1,838.9	1,960.2	2,020.7	2,195.3
Deflator index vs. 2007, %	153.6	159.5	168.1	168.1	176.8	177.2	186.5	187.1	198.5	199.2
GRP in 2007 prices, bln RUB	966.3	995.24	985.2	1,015.6	1,006.7	1,052.2	1,040	1,106.6	1,083.3	1,173.5
Control, bln RUB	966.3	99,524	985.2	1,015.6	1,006.7	1,052.2	1,040	1,106.6	1,083.3	1,173.5

Analysis of the dynamics of $AddedValue_{t\,curr\,j} / AddedValue_{t\,comp\,j}$ for each type of economic activities, the regression analysis and the operational information are deflators in 2013 for the "*C*", "*D*", "*E*", and "*A*" types of economic activities, allowed for determination of the balanced version of deflators for 2013. At the same time, a parallel balancing of shares of the types of economic activities in *GRP* and the added value volumes does not require complex calculations.

Clarification of Rosstat data for the Sverdlovsk Region to account for errors due to *GRP* structure rounding by the type of economic activities is a necessary initial phase of the calculations.

Due to the rounding of shares of the types of economic activities in *GRP*, the added value amount in current prices does not coincide with the corresponding volumes of *GRP* for the region. The rounding of physical volume indices by the type of economic activities also disrupts the *GRP* balance by the type of economic activities — by shares of the types of economic activities and by the added value volumes. We used the data of Rosstat as the source information for the adjustments, and the adjustment procedures for the current and comparable prices have a similar content for each year of the retrospective. The following formal description of the adjusted data in comparable prices of 2007 assumes that the necessary adjustments have already been implemented in current basic prices.

The keys used: γ_{jt} — physical volume indices of the added value by the type of economic activities $j = 1, 2, \ldots, 15$; $t = \overline{2008;\ 2012}$ — index of the year; λ_{jt} — desired corrective multipliers (their values belong to some neighborhood of identity); $\lambda_{jt} \times \gamma_{jt}$ — the required results of adjustment; d_{jt} — initial volumes of the added value, $d_{jt} = d_{jt-1} \times \gamma_{jt}$, d_{j2007}, for the base year $t = 2007$ — known fixed value in current basic prices.

Criteria in the procedures have the following form:

$$F_t = \sum_{j=1}^{j=15} (\lambda_{jt}\gamma_{jt} - \gamma_{jt})^2 \to \min,\ \ t = \overline{2008,2012}. \tag{10}$$

Optimized parameters — λ_{jt}, $j = 1, 2, \ldots, 15$.

Restrictions — execution of balance conditions (11) for each year of the retrospective (this procedure is not required for the base year):

$$\sum_{j=1}^{j=15} d_{jt} = \sum_{j=1}^{j=15} \lambda_{jt} \gamma_{jt} d_{jt-1} = GRP_{t\,comp}, \quad t = \overline{2008, 2012}. \tag{11}$$

Upon completion of the optimization procedures, the shares of each type of economic activities in the *GRP* in comparable prices for the base year (2007) and all other related parameters are automatically updated. The adjustment of retrospective data is carried out once or if data from Rosstat is updated. The procedures are easily automated using MS Excel, and this method can be used for normalization (balancing) of the structural indicators of *GRP* in evaluating the projected structure of *GRP*. This approach simulates the maximum likelihood methods (the rounding of obtained results does not contradict the data from Rosstat); the interrelated physical volume indices of GDP and deflators were corrected.

The general scheme of the fuel and energy balance forecast is a combination of two fundamental approaches:

— the reflection in the balance of the specificity of the territorial production and energy intensity of the essential types of products (works, services) — the product unit of the fuel and energy balance;

— the reflection of the energy consumption structure by the type of economic activities, which allows the industry specificity of the fuel and energy balance to be taken into account.

The methodology of forecast calculations based solely on the product components is defective — many activities, such as medicine, education, financial services, public administration, science, and culture, etc., are not represented in the statistics in the form of a sufficient list of works, services, or products. Such information is only fragmentary and subject to change.

As a stable index in the dynamics of the "core" of the territorial economy, we consider the totality of economic activities, providing the utmost impact on the dynamics of socio-economic development and the energy consumption structure.

We used an econometric forecast of indicators, including:

— the added value by the type of economic activities (in comparable prices of 2007);

— the energy intensity of each type of economic activities.

We carried out the normalization of statistical estimates of the added value indicators in accordance with the known scenario values of the region's *GRP* and analyzed the ratio of the official scenarios to the estimated confidence intervals. As a result, we determined the shares of each type of economic activities in the region's *GRP*.

Selection of the first indicator for the forecast is appropriate from the standpoint of its expressed resilience in the dynamics, typical of old industrial areas. In addition, its level reflects the interaction of sectoral, intersectoral and spatial factors of the location and development of the economy. We used methods of time series analysis or regression analysis (apart from the "time" factor, we additionally tested other factors, in particular, the share of the type of economic activities in *GRP*), selected the best types of regression equations (usually nonlinear power, logarithmic, autocorrelation dependencies) according to the approximation criterion, not contradicting the expert logic of territorial economic development. For rows with severe bends, a steep increase or decrease of the indicators by the end of the period, we applied expert coefficients of dynamics stabilization, the smoothing methods — exponential with the selection of the attenuation coefficient, the moving average. The author agrees in advance with opponents that the testing of the statistical significance of other factors, affecting the change in the added value, is mandatory. It is suggested to develop the methodology in this direction, particularly the measurement of price changes for the products.

The energy intensity indicators by the type of economic activities in most situations have a severe underlying trend with the break of 2009 as a consequence of the crisis that is local in terms of time. The information for the forecast is a short range — 11 annual observations (2004–2014) for the product unit and structural characteristics of retrospective fuel and energy balances (2007–2013). From the general economic position, this is a very long stage in the development of the Sverdlovsk Region, and some factors have changed or significantly lost their relevance. There are few observations from the standpoint of econometric correctness, although technically enough for a three-year period of the forecast. Formal requirements do not have the generality and, subject to stable dynamics, the forecasting interval may exceed one third of the retrospective, which in our case that occurred for most of the main indicators — the amount of the added value, the share of economic activities in *GRP* and their energy intensity, with few exceptions. However, since 2014, the growth of the added

value for economic activities that determine the general dynamics of *GRP* has been greatly reduced, and replaced by stagnation or decline. This process is reflected in new scenarios of the official socio-economic development forecast and in operational statistical data. This allows a formal approximation of the observed process in the changing trends. The partitioning of annual indicators into quarterly ones, using expert-analytical estimates in our case increases the number of observations and, in fact, is equivalent to smoothing the actual dynamics and the resulting trends.

In addition to assessing the predictive dynamics of the "core", we conducted a forecast of the consumption of fuel and energy resources by domestic consumers (regression with the "time" and "residential area for 1 person" factors), the forecast of losses of gas, electric and heat energy in grids, allocated to the region (regression with the "time" and "the amount of the resource allocation" factors), and some other, less sustainable indicators — heat energy and electricity consumption for own needs, the consumption of fuel and energy resources for non-fuel needs and as raw materials, etc.

We should note the minor variation of scenario indicators in the socio-economic development forecast for the region (about 2 %). The scenario forecast usually assumes that the range of variation with high reliability includes actual future values of the estimated parameters. However, in this situation, it is hardly ensured, judging by the fact that the developers of the approved forecasts have already changed the scenario borders toward a drop in their optimistic features.

The structure of the statistical forms determines the peculiarities of the formation of specific long-term balances of fuel and energy resources — fuel, heat and electricity consumption by type of economic activities is estimated without taking into account the consumption and losses in the grids, which are subject to separate analysis. With the known scenario indices of the physical volume of *GRP* $\alpha_{t\,comp}$, $t \in \overline{2013;\,2017}$, the normalization is carried out in respect of the resulting predictive performance of the added value by type of economic activities for each year of the period (the above procedure for the correction) to achieve the balance:

$$GRP_{t\,comp} = \sum_{j=\overline{1,15}} AddedValue_{t\,comp\,j};\ \ t = \overline{2013;2017}. \tag{12}$$

Forecast estimates of the energy intensity of the added value — fuel, heat, and electricity intensity by type of economic activities, the volumes of consumption of fuel and energy resources by domestic consumers, the loss of gas, heat and electricity in the grids — allow an estimation of the total consumption of fuel, heat and electricity for each year of the perspective, to calculate the specific indicators of *GRP* energy intensity and its total energy consumption (in tons of reference fuel per thousand rubles) for each scenario. The comparison of forecast dynamics of the energy intensity of *GRP* with the target values of the relevant indicators allows an evaluation of the achievability of planned indicators for 2020. In particular, the assessment of total energy savings for any year t of the forecast period $\Delta EnergyCost_t$ and the impact of structural changes in the *GRP* $\delta EnergyCost_t$ is performed according to the formulas:

$$\begin{aligned} \Delta EnergyCost_t &= \sum_{j=\overline{1,15}} AddedValue_{t\,comp\,j} + \sum_{j=\overline{1,15}} (EnergCost_{2007\,j} - EnergCost_{tj}); \\ \delta EnergyCost_t &= \sum_{j=\overline{1,15}} (\delta_{tj} - \delta_{2007\,j}) EnergCost_{2007\,j};\ \ t = \overline{2013;2017}. \end{aligned} \tag{13}$$

The estimates showed that the obtained confidence intervals of the energy consumption indicators significantly exceed their observed retrospective variation. Thus, the "optimistic" official assessment of the reliability of scenario indicators of *GRP* and its structure can be interpreted as the allocation of the central range. However, the conditional probability of the transfer of the formal assessments to fixed intervals of the scenario variations depends on the level of subjectivity of socio-economic development forecasts.

In the standard concept of the fuel and energy balance at the level of constituent and municipal entities of the Russian Federation, in contrast to the schemes of the International Energy Agency, Eurostat and the UN, the energy consumption in the production, agricultural, transportation and housing sectors is interpreted by the type of products, activities, processes, and services. In the fuel and energy balance model, applied by the author of this article, to account for the territorial specialization of production, we allocated the unit of main kinds of products that allows a reflection of the physical energy efficiency indicators [15], independent of price distortions of *GRP* and added value. However,

informational problems associated with fuel and energy balance reporting and forecasting, as noted above, complicate the detailing of the distribution of energy resources. In particular, in statistical forms, the information on the consumption of fuel and energy resources in the production of non-ferrous and rare metals remains closed, but such data are available on the Internet. However, the data reliability is questionable — the figures are distorted for the advertising purposes of publications.

The use of more advanced methods of econometric analysis is possible for aggregated patterns of the fuel and energy balance, but we may thus lose opportunities to detail the energy efficiency indicators and structural characteristics of the balance. As a result, the practical significance of the research would be considerably reduced; the targeting of conclusions and recommendations would disappear. On the other hand, the aggregate fuel and energy balances as a support add-in are very useful for analysis of spatial aspects of the development of the fuel and energy complex of the country and regions, and the energy policy formation [16].

The incompleteness and inaccuracy of the retrospective and current information determine only some of the factors that increase uncertainty and reduce the reliability of the fuel and energy balance. However, the information problems pose fundamental difficulties in the design and development of the forecasting methods, providing their necessary reliability — low quality of the forecasts becomes particularly noticeable in the periods of crisis phenomena with increasing information uncertainty. The unfounded optimism in the official forecasts at the regional level has led to the fact that the territorial problems associated with the economic development and corresponding decline in the volume of industrial production was not adequately reflected in the strategic planning documents. We should note the urgency of solving the information-related problems at the legislative level, in particular, the development of data forms that meet the approved types and composition of the fuel and energy balance at regional and municipal levels, the coordination of calendar dates for the formation, and publication of the required statistical materials.

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Information about the author

Dobrodey Vladimir Vavilovich (Yekaterinburg, Russia) — PhD in Economics, Associate Professor, the Ural Federal University named after the first President of Russia B. N.Yeltsin, Higher School of Economics and Management (19, Mira St., 620002 Yekaterinburg, Russia; e-mail: dobrodeyvv@mail.ru).