Adaptively Targeted Models of Economic Forecasting by Supply Chain Management

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Abstract- Forecasting is an under estimated field of research in supply chain management. Uncertainties inherent in customer demands make it difficult for supply chains to achieve just-in-time inventory replenishment, resulting in loosing sales opportunities or keeping excessive chain-wide inventories. In this paper, we propose two adaptive inventory-control models for a supply chain consisting of one supplier and multiple retailers. Development of an approach that provides the opportunity to construct models for the formation of multidimensional options that describe the forecast image of regions and municipalities. Agreeing with the thesis "the future grows out of the past," the patterns of the past cannot be fully transferred to the future. They should be adjusted in accordance with the existing ideas about the future. To accomplish this opportunity, it is proposed to provide the model of each process with an adaptive mechanism and express the idea of the future with the help of target settings, at which the adaptive change of models is aimed. There has been theoretically substantiated the methodology for constructing adaptively targeted models. Results showed that from cutting costs to keeping consumers happy, forecasting is a vital component of supply chain management, helping companies fill orders on time, avoid unnecessary inventory expenses and plan for price fluctuations.

Keywords; *supply chain management, forecasting, adaptively targeted model, socio-economic development*

1. Introduction

In supply-chain management, the effort of minimizing total costs in terms of reduction in chain-wide inventory has been increasingly addressed and attempted in industry. Russia's transition to a market economy in the nineties, having created a market chaos, but not having canceled the need for forecast calculations, made fundamental changes in the understanding of the role of forecast in the economy, which, as market relations developed, was refined and gradually expanded the boundaries of practical application. First of all, the forecast horizon began to change significantly. At first, it did not exceed one year, and everyone agreed that this is the largest possible horizon of scientifically based economic preemptions in the current market situation.

Then, when the process of the emergence of natural development tendencies began, the forecasting horizon was increased to three years. During this period, changes that occurred in the apparatus used for practical calculations became especially noticeable. The lack of time series of the required sizes for obtaining statistically reliable modeling results led to a situation where the use of statistical forecasting methods was either completely excluded or limited. Basically, intuitive and expert methods were used during this period [1-5], and in some cases, attempts were made to use adaptive methods that did not require statistical reliability, but which, nevertheless, due to their adaptive mechanism, provided plausible short-term forecasts on many indicators.

The period of extra short time series has ended [6]. Those limitations on the forecasting apparatus, which were mentioned above, actually lost their meaning, and it became possible to use any models of this apparatus in practical calculations without exception [7, 8], the recommendations of which must be considered by forecast developers in their models.

In our opinion, the models in the apparatus of modern forecasting, with the help of which it would be possible within the framework of this law, to justify forecast estimates of the socio-economic development of regions, unfortunately, do not exist yet and, therefore, it is necessary to focus mainly on their development. And for this, at least, new ideas and even new principles are required, on which, in all probability, this development will be based. Certainly, the search for new ideas and new principles does not provide that only absolutely new results are obtained, but it will obviously not be possible to focus only on the existing stock of knowledge in this case [9].

1.1 Basic requirements for a modern forecasting apparatus

First of all, it should be noted that in contrast to the past economy, when it was possible to carry out a quantitative comparison of forecast estimates with planned values, supply chain management and based on the results of comparison, to make sufficiently reasonable decisions, such a possibility is completely excluded in the framework of strategic planning. In short, strategic planning should be understood as planning, mainly carried out at a qualitative level, in the framework of which there is no digital material, but if it is still present, then, as a rule, in a generalized integrated form. In other words, the results of strategic planning cannot be directly used to construct predictive models. But with their help, one can determine the main guidelines of the forecast options, from which the forecast image is formed.

With the help of these guidelines, strategic plans should be reflected in forecast calculations. In principle, concepts for the future are most often built on the dissatisfaction with the past. Notably, the nature of this dissatisfaction is very diverse. Not in all cases it is possible to get its clear outlines and, therefore, to predict the concept outlined for implementation in the strategic plan. But, in any case, whether we want it or not, the future grows out of the past. In this process, the patterns of the past are transformed into the patterns of the future, which, quite possibly, have not yet been determined and are only being formed. This transformation is not a one-time act, but is, understandably, a transitional process. A natural question arises, what should be the model of the transition process, what patterns should this model reflect, is it possible to conduct a comparative analysis of the patterns that it reflects with the patterns of the past period. These are, perhaps, the main questions that one would like to receive an answer to. There are other issues as well that will be discussed below.

The above remark that the future grows out of the past is decisive for us in the sense that if the dynamics and patterns of the past were described by some model, then the model of the future should be formed from the model of the past, considering those patterns that are reflected in the model of the past. At the same time, it is necessary to take those plans into account that are reflected in the strategic plan. In a sense, the model describing the transition process in such a situation should become a compromise between the patterns of the past period and concepts, which logically should be reflected in the strategic plan. Whereas, this reflection, mainly, should be quantitative, for example, in the form of target settings, with the help of which new tendencies should be formed in the forecast glidepath. Using which methods and on the basis of which principles forecasting glidepaths are to be targeted, will be discussed below. Note that earlier the forecasting problems in such a formulation were not solved, and therefore one is unlikely to be able to find a suitable model in the arsenal of the forecasting apparatus, in any case, we do not know such a model. Consequently, there is a need to develop a model with similar capabilities. Theoretical validity in the model should be combined with the application capabilities that ensure its application in practical calculations of forecast glidepaths, the formation of which is provided for by the law on strategic planning.

1.2 Key Ideas of Adaptively Targeted Forecasting

To simplify the situation, at the formal level, the task reduces to the need to construct a model that can change its characteristics at the right moment of time, in particular, for example, change the orientation of the forecast glidepath or generate higher growth rates and possibly a number of other characteristics. In fact, it should be another model that demonstrates high consistency with the target settings of the strategic plan and possesses other characteristics. At the same time, it must not be forgotten, as it was mentioned above, that the future grows from the past, and, consequently, the model that characterizes the dynamics of the future, according to this logic, should be obtained from the model that characterizes the dynamics of the past. This is a conclusion with obvious consequences.

1.3 Supply Chain forecasting

Supply chain management and forecasting are divided into three fields including, supplier, demand and project prediction.

Supply forecasting looks at data about your suppliers – whether they provide completed products or parts that are assembled further down the supply chain – and uses it to project how much product they will have available and when. This helps determine the amount that can be ordered and delivered in a specific timeframe. The data important to supply forecasting isn’t limited to production or delivery capacity; factors such as economics, technology and even weather all play a role [10, 11].

Demand forecasting analyzes how much product your customers are likely to want during a specific week, month or quarter. This data allows organizations to keep a suitable volume in stock – enough to fill customer orders, but not so much that time, money and effort are wasted managing excess or obsolete inventory. Demand forecasting or planning is largely about predicting customer behavior, but it goes beyond simply anticipating wants and needs. Consumer confidence, cultural trends, and seasonality are important considerations.

Price forecasting examines data related to supply and demand to project how each factor will affect prices. Other dynamics play a role. A bad hurricane season along the Gulf Coast can cause fuel prices to spike, raising transportation costs throughout the supply chain. That expense may be passed along to customers in the form of higher-priced products. Additionally, shifting cultural trends could make a fashion accessory suddenly popular, allowing for a price hike. Or, rising unemployment could make that same accessory seem frivolous, forcing a price cut. Effective price forecasting helps businesses predict when necessary price increases or decreases may affect customer demand.

1.3 The adaptively targeted model

In the justification of the necessity of using models with built-in adaptive mechanism in forecast calculations, the question of the analytical form of the model, which should be endowed with this adaptive mechanism, was not addressed. However, this question plays an important role in the construction of the final version of the forecast model. In this approach, the simplest model of adaptive first-order autoregression is used. Naturally, the question arises of the appropriateness of using the simplest model in a new approach, focused on solving a very complex problem related to the calculation of forecast glidepaths of interacting economic processes. With the massive use of the forecast model, it is natural to lay into the basics of its construction a universal property of economic processes, the essence of which is that the current values substantially depend on previous values. As it is known, this dependence is conveniently realizable using a first-order autoregressive model [4]. The procedure for constructing such a model is quite simple, which is an important point for the case when it becomes necessary to carry out forecast calculations in the digital environment of the modern economy.

It should also be noted that for a model with a fairly simple structure, the targeting procedure based on the adaptive mechanism, as well as the principle of the formation of target settings that provide the necessary changes in the dynamics of the forecasted process, become transparent. But the most important requirement that these models satisfy is that on their basis it is possible to form a matrix version of the model that ensures the structural balance of multidimensional forecast calculations. After describing the main ideas in accordance with which the model should be constructed, we proceed immediately to the formal description of this model, designed to forecast multidimensional processes.

Given the multidimensionality, for the *i*-th value y_i of the system of forecasted processes, the corresponding autoregressive model is written as follows:

$$y_{it} = b_{i0} + b_{i1} y_{it-1} + \varepsilon_{it}, \quad i = \overline{1, n}, \qquad (1)$$

where b_{i0}, b_{i1} are estimated coefficients, ε_{it} are identically distributed random variables with zero mathematical expectation and constant dispersion.

Remembering that in order to forecast multidimensional processes, the final model must be matrix, we will carry out a targeted modification of the autoregressive model (1). To do this, we will represent a lagging variable with the following sum:

$$y_{it-1} = y_{it-2} + (y_{it-1} - y_{it-2}), \quad i = \overline{1, n}\,. \qquad (2)$$

The lagging variable represented in this form allows us to consider instead of the autoregressive model (1) a regressive model

$$y_{it} = b_{i0} + b_{i1} y_{it-2} + b_{i2}(y_{it-1} - y_{it-2}) + \varepsilon_{it}, \quad i = \overline{1, n} \quad (3)$$

which reflects the impact of the lagging variable and the impact of changes having occurred in the past.

The particularity of this model is that it takes two effects into account. The first effect is the result of the influence of its own dynamics on the modeled value, regardless of other values. The second effect arises as a result of ongoing changes in the own dynamics. It is natural to assume that changes in the dynamics of the modeled value occur under the influence of other values of the forecasted system. In principle, this question can be investigated in detail using the correlation matrix. The possibility of practical use of the results of such a study can be considered separately. But to construct a matrix adaptively targeted model, these results are not needed.

The mentioned features of these effects make it possible to divide the construction of an adaptive matrix model into two consecutive stages. The first stage involves the endowment of each regression equation with an adaptive mechanism. The implementation of this stage does not depend on the second stage, but is focused on achieving high interpolation accuracy, which is necessary for the successful implementation of the second stage.

Since the compact record of the adaptive model is obtained in the vector-matrix form, we begin the corresponding description of the adaptive model of the *i*-th value by introducing the following notations

$$\boldsymbol{x}_{it} = (1,\ y_{it-2},\ y_{it-1} - y_{it-2}), \quad \boldsymbol{b}_{it} = (b_{it}^{(0)},\ b_{it}^{(1)},\ b_{it}^{(2)})', \quad \boldsymbol{C}_{it} = \left(\boldsymbol{X}_i^{'} \boldsymbol{X}_i\right),$$

with which you can write an adaptive model in the form

$$\hat{y}_{it} = \boldsymbol{x}_{it} \widehat{\boldsymbol{b}}_{it-1}(\alpha) \qquad (4)$$

$$\widehat{\boldsymbol{b}}_{it}(\alpha) = \widehat{\boldsymbol{b}}_{it-1}(\alpha) + \frac{\boldsymbol{C}_{it-1}^{-1} x_{it}^{'}}{x_{it} \boldsymbol{C}_{it-1}^{-1} x_{it}^{'} + \alpha} [\check{y}_{it} - \hat{y}_{it}], \qquad (5)$$

where $\check{y}_{it}$ is the target value specified in the scale of the forecasted value.

The parameter α in this model is traditionally called the adaptive targeting parameter. The role of this parameter in the adaptive targeting model differs from the role that this parameter played in the adaptive model. If it is used in the adaptive model to regulate the degree of adaptation of the model to newly arriving data, then in the adaptively targeted model it determines the proportion of old tendencies carried on to the future.

In addition, by changing its value, you can get various options for describing the future. Due to this possibility, the adaptively targeted matrix model turns into an apparatus of not only multidimensional, but also multivariate calculations. In addition, when implementing this approach, all variants of forecast calculations receive a fairly clear explanation, which should be recognized as a very positive property of this procedure. One option differs from the other in the share of the regularities from the past transferred to the future.

Considering the construction of a combined forecasting model, we write in detail the system of adaptive regression equations with a special representation of the last member of the model:

$$y_{it} = b_{it-1}^{(0)}(\alpha) + b_{it-1}^{(1)}(\alpha) y_{it-2} + \frac{1}{n-1} b_{it-1}^{(2)}(\alpha) \sum_{j \neq i} p_{ij} y_{tj}, \quad i,j = \overline{1,n}, \tag{6}$$

where p_{ij} is the indirect growth rate of the lagging variable y_ (it-1), determined using the expression:

$$p_{ij} = \frac{y_{it-1} - y_{it-2}}{y_{tj}}. \tag{7}$$

For convenience, we write system (6) in matrix form. To do this, we introduce the following notations:

$$\hat{\boldsymbol{y}}_{t-2}(\alpha) = \begin{pmatrix} b_{1t-1}^{(0)}(\alpha) + b_{1t-1}^{(1)}(\alpha) y_{1t-2} \\ b_{2t-1}^{(0)}(\alpha) + b_{2t-1}^{(1)}(\alpha) y_{2t-2} \\ b_{3t-1}^{(0)}(\alpha) + b_{3t-1}^{(1)}(\alpha) y_{3t-2} \\ \vdots \\ b_{nt-1}^{(0)}(\alpha) + b_{nt-1}^{(1)}(\alpha) y_{nt-2} \end{pmatrix} \tag{8}$$

$$\boldsymbol{P}_t(\alpha) = \begin{pmatrix} 0 & b_{1t-1}^{(2)}(\alpha) p_{12} & b_{1t-1}^{(2)}(\alpha) p_{13} & \cdots & b_{1t-1}^{(2)}(\alpha) p_{1n} \\ b_{2t-1}^{(2)}(\alpha) p_{21} & 0 & b_{2t-1}^{(2)}(\alpha) p_{23} & \cdots & b_{2t-1}^{(2)}(\alpha) p_{2n} \\ b_{3t-1}^{(2)}(\alpha) p_{31} & b_{3t-1}^{(2)}(\alpha) p_{32} & 0 & \cdots & b_{3t-1}^{(2)}(\alpha) p_{3n} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ b_{nt-1}^{(2)}(\alpha) p_{n1} & b_{nt-1}^{(2)}(\alpha) p_{n2} & b_{nt-1}^{(2)}(\alpha) p_{n3} & \cdots & 0 \end{pmatrix} \tag{9}$$

Using the notations introduced, the system of equations (6) can be written as:

$$\boldsymbol{y}_t = \hat{\boldsymbol{y}}_{t-2}(\alpha) + \boldsymbol{P}_t(\alpha) \boldsymbol{y}_t. \tag{10}$$

The resulting system is significantly different from the system that implements the usual matrix predictor.

Firstly, the matrix here has an index *t*, which indicates that targeting was carried out at time *t*. As a result of targeting, all of its elements, as it is not difficult to understand from (9), were determined by the coefficients, which were converted using the adaptive mechanism in accordance with the specified target values.

Secondly, the coefficients of the system depend on the adaptive targeting parameter, with the help of which the transfer of tendencies of past periods into the future is regulated. It is possible, for example, to largely transfer the tendencies of the past period into the future, or not to give preference to them. In fact, this is the parameter that allows forming future options depending on the past.

In the final version, the adaptively targeted matrix model, with the help of which multidimensional forecast calculations are carried out, is written as follows:

$$\boldsymbol{y}_t = (\boldsymbol{I} - \boldsymbol{P}_t(\alpha))^{-1} \hat{\boldsymbol{y}}_{t-2}(\alpha). \tag{11}$$

We received a vector analogue of the autoregressive model. Substituting into this model $\hat{\boldsymbol{y}}_{t-1}(\alpha)$, we get a forecast estimate $\hat{\boldsymbol{y}}_{t+1}(\alpha)$.

2. Results of the Calculating Experiment

Despite rapid advances in SCM and logistics, inefficiencies still persist and are re-flected in related costs [4]. In developing nations the actual amountsare lower, but proportional share is higher [5]. One of thelogistically unfriendly country groups are oil producers. The high cost for operations offer prosperity for the service providers. In 2006,AP Moller-Maersk raked in US$ 46.8 billion in revenue. We will carry out calculations on real data characterizing the demographic situation in Voronezh.

Table 1. The dynamics of demographic indicators of Voronezh

Year	Population, thousand people	Natural increase ,%	Migration growth, %	Life expectancy, years	Infant mortality per 1000 live births	Total morbidity per 1000 population
2011	970,4	-3,6	12	69	9	1490,3
2012	979,5	-2,7	14,4	69	8,4	1426,4
2013	991,3	-1,9	14,3	70,8	9,8	1415,2
2014	1003,6	-1,8	12,7	70,9	10,4	1393,7
2015	1014,6	-1,7	10,6	70,8	6,9	1486,4
2016	1023,6	-1,45	8,9	71,4	5,8	1484,5
2017	1032,4	-1,34	8	72,6	5,79	1588,7

For each value, according to the table using the least-squares method, we construct the regression equations:

$$y_{1t} = 89{,}351 + 0{,}918 y_{1t-2} + 1{,}206(y_{1t-1} - y_{1t-2})$$
$$y_{2t} = -0{,}964 + 0{,}314 y_{2t-2} + 0{,}144(y_{2t-1} - y_{2t-2})$$
$$y_{3t} = 3{,}033 + 0{,}678 y_{3t-2} + 1{,}309(y_{3t-1} - y_{3t-2})$$
$$y_{4t} = 33{,}565 + 0{,}536 y_{4t-2} + 0{,}341(y_{4t-1} - y_{4t-2})$$
$$y_{5t} = 6{,}043 + 0{,}250 y_{5t-2} + 0{,}832(y_{5t-1} - y_{5t-2})$$
$$y_{6t} = -444{,}709 + 1{,}331 y_{6t-2} + 1{,}080(y_{6t-1} - y_{6t-2})$$

To calculate target values, we use the following technique. First, according to recent observations, we determine the growth rate:

$h_1 = 1{,}010$; $h_2 = 0{,}918$; $h_3 = 0{,}887$; $h_4 = 0{,}990$; $h_5 = 0{,}998$; $h_6 = 1{,}066$.

Using these growth rates, we calculate the target values in the form of the product of recent observations and the corresponding growth rates:

$\check{y}_{1t}$=1042,72;$\check{y}_{2t}$=-1,23;$\check{y}_{3t}$=7,10;$\check{y}_{4t}$=71,87;$\check{y}_{5t}$=5,78;$\check{y}_{6t}$=1692,90.

Having defined the optimal targeting parameter values for each model:

α_1= 0,7; α_2= 0,3; α_3= 0,3; α_4= 0,2; α_5=0,3;α_6=0,3,

we will implement adaptive targeting of each model using the adaptive mechanism that was provided (the inverse matrix of the least-squares was stored). As a result, we get a system of adaptively targeted models:

$$y_{1t} = 59{,}801 + 0{,}951 y_{1t-2} + 0{,}981(y_{1t-1} - y_{1t-2})$$
$$y_{2t} = -0{,}659 + 0{,}459 y_{2t-2} + 0{,}316(y_{2t-1} - y_{2t-2})$$
$$y_{3t} = 1{,}035 + 0{,}829 y_{3t-2} + 1{,}323(y_{3t-1} - y_{3t-2})$$
$$y_{4t} = 42{,}767 + 0{,}405 y_{4t-2} + 0{,}192(y_{4t-1} - y_{4t-2})$$
$$y_{5t} = 2{,}214 + 0{,}664 y_{5t-2} + 0{,}887(y_{5t-1} - y_{5t-2})$$
$$y_{6t} = -909{,}628 + 1{,}655 y_{6t-2} + 1{,}355(y_{6t-1} - y_{6t-2})$$

which, after calculating the matrix of indirect growth rates, we transform into the matrix model:

$$\begin{pmatrix} y_{1t+1} \\ y_{2t+1} \\ y_{3t+1} \\ y_{4t+1} \\ y_{5t+1} \\ y_{6t+1} \end{pmatrix} = \begin{pmatrix} 59{,}801 + & 0{,}951y_{1t-1} \\ -0{,}659 + & 0{,}459y_{2t-1} \\ 1{,}035 + & 0{,}829y_{3t-1} \\ 42{,}767 + & 0{,}405y_{4t-1} \\ 2{,}214 + & 0{,}664y_{5t-1} \\ -909{,}628 + & 1{,}655y_{6t-1} \end{pmatrix} +$$

$$+ \begin{pmatrix} 0 & -1{,}4034 & 0{,}2431 & 0{,}0240 & 0{,}2987 & 0{,}0010 \\ 6{,}6E-06 & 0 & 0{,}0010 & 9{,}7E-05 & 0{,}0012 & 4{,}1E-06 \\ -0{,}0002 & 0{,}1936 & 0 & -0{,}0033 & 0{,}0412 & 0{,}0001 \\ 4{,}4E-05 & -0{,}0374 & 0{,}0065 & 0 & 0{,}0080 & 2{,}7E-0{,}5 \\ -1{,}7E-06 & 0{,}0014 & 0{,}0002 & -2{,}5E-05 & 0 & -1{,}0E-06 \\ 0{,}0271 & -22{,}962 & 3{,}9781 & 0{,}3930 & 4{,}8866 & 0 \end{pmatrix} \begin{pmatrix} y_{1t+1} \\ y_{2t+1} \\ y_{3t+1} \\ y_{4t+1} \\ y_{5t+1} \\ y_{6t+1} \end{pmatrix},$$

with the help of which the calculation of balanced forecast estimates is carried out.

Pre-calculated are the values of autoregressive components of each model, from which the right part of the matrix model is formed $\hat{\boldsymbol{y}}_{t-1}(\alpha)$, and the inverse matrix is calculated $(\boldsymbol{I}-\boldsymbol{P}_t(\alpha))^{-1}$.

As a result, everything is ready for us to obtain forecast estimations according to the formula (11).

We write the results of these calculations in numerical form:

$$\begin{pmatrix} y_{1t+1} \\ y_{2t+1} \\ y_{3t+1} \\ y_{4t+1} \\ y_{5t+1} \\ y_{6t+1} \end{pmatrix} = \begin{pmatrix} 0{,}9999 & -1{,}3788 & 0{,}2458 & 0{,}0234 & 0{,}2918 & 0{,}0010 \\ 6{,}5E-06 & 1{,}0001 & 0{,}0010 & 9{,}5E-05 & 0{,}0012 & 3{,}9E-06 \\ -00002 & 0{,}1972 & 0{,}9996 & -0{,}0034 & -0{,}0417 & -0{,}0001 \\ 4{,}3E-0{,}5 & -0{,}0368 & 0{,}0065 & 0{,}9999 & 0{,}0078 & 2{,}6E-05 \\ -1{,}7E-06 & 0{,}0014 & -0{,}0002 & -2{,}4E-05 & 1{,}0000 & 1{,}0E-06 \\ 0{,}0260 & -22{,}2254 & 3{,}9614 & 0{,}3779 & 4{,}7043 & 0{,}9994 \end{pmatrix} \text{x}$$

$$\text{x} \begin{pmatrix} 1033{,}11 \\ -1{,}3249 \\ 8{,}4097 \\ 71{,}6893 \\ 6{,}0644 \\ 1547.65 \end{pmatrix} = \begin{pmatrix} 1041{,}928 \\ -1{,}290 \\ 7{,}196 \\ 71{,}924 \\ 6{,}055 \\ 1691{,}967 \end{pmatrix}.$$

Assuming that over a certain period of time, the matrix of indirect growth rates remains unchanged, the matrix model turns into a model of a multidimensional autoregressive process.

Below (in table 2) are the results obtained using a multidimensional autoregressive calculation scheme.

Table 2. Forecast estimates of demographic indicators of Voronezh

Indicators	Year				
	2018	2019	2020	2021	2022
Population, thousand people	1041,928	1050,546	1058,953	1067,141	1075,101
Natural increase,%	-1,290	-1,255	-1,221	-1,188	-1,155
Migration growth,%	7,196	5,967	4,724	3,466	2,196
Life expectancy, years	71,924	72,154	72,378	72,597	72,810
Infant mortality per 1000 live births	6,055	6,047	6,038	6,030	6,022
Total morbidity per 1000 population	1691,967	1830,882	1964,343	2092,301	2214,715

The calculations based on real data allow us to conclude that it is possible to use the developed model for solving practical problems of multidimensional forecasting.

3. Conclusion

A particularity of modern economic forecasting is that it is preceded by supply chain management, which sets the main guidelines for the development of regions and municipalities [5, 9]. Therefore, of course, these strategic intentions must be taken into consideration in forecasts. It must be recognized that there is no effective apparatus for solving forecasting problems of this type and, therefore, its creation is required. The article here presents the results of research on the creation of such an apparatus, as well as illustrates the calculating capabilities of the model on real data of full scale.

Noteworthy is the originality of the idea, which was the basis for the development of the apparatus for forecasting the socio-economic development of the regions. To describe this idea, the new term "adaptive targeting" was introduced, by which the authors understand the adaptive reconfiguration of the model, reflecting the tendencies of the past period, into the model that takes the intentions of strategic plans into account.

It is also important to note that the matrix model provides obtaining such forecast options that have system balance. As a result, it is possible to obtain dynamically coordinated glidepaths of socio-economic indicators by supply chain strategy, which reflect strategic intentions for the development of the region.

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