Distressed Assets in a Normative Dynamic Model of Kazakhstan Economy

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Abstract. The paper presents a normative mathematical model of Kazakhstan economy with distressed assets in the banking sector. The model contains a lot of unspecified parameters which are not defined directly by the data of economic statistics. A method of identification of the model parameters is a type of global optimization problem. Parallel calculations are used for estimation of model parameters by statistical data of the Kazakhstan economy 2000–2017.

Introduction and Related Work

Kazakhstan has one of the world’s largest oil and natural gas productions per capita. This was a new trend arises over the last two decades for the most part due to the old discovery of the oil and natural gas fields in the Caspian Sea and the new sizeable foreign investments. So they did not notice the crisis of 2008. But the second wave of the crisis has affected the banking sector of Kazakhstan. It was associated with the decline in the world demand for energy resources. This world crisis 2007–2010 remains quite vulnerable due to long-standing asset quality problems. The distressed assets of the second-tier banks of the Republic of Kazakhstan arose in the result of the crisis. They negatively affect the economy.

The paper is linked to two strands of literature. At first, it relates to papers connecting influences of distressed assets on an economic system. At second, it relates to studies of this influences by mathematical models for policymakers.

Shleifer and Vishny [8] study the determinants of liquidation values of assets. This value is not big enough when the distress is industry- or economy-wide. Such illiquidity (the difference between price and value) makes assets cheap in bad times and gives rise in corporate leverage. So, the immediate auction is not the best way to allocate assets of distressed firms. It has important implications for capital structure. Beltratti and Stulz [1] present that performance of banks before the crisis is not the same as during it. Macroeconomic imbalances were related to bank performance during the crisis. Mannasoo and Mayes [4] give attention on banks of Eastern Europe.

The model of Kazakhstan economy [6] takes into account the specific character of economic branches and the peculiarities of the competition between the domestic production and imported
analogs at the domestic market. This model is based on the input-output balance of Kazakhstan economy.

The work [2] presents a description of the banking system considering distressed assets. Here we used this description in a model of the closed economy. We give the inclusion of distressed assets of the banking system and shadow turnover into a mathematical model of Kazakhstan economy with one production sector. This allows us to investigate their influence on the economy and to explore the proposed ways of solving the problem of distressed assets by the model.

To understand how to manage efficiently of distressed assets we will construct a simulation normative mathematical model of economy of the Republic of Kazakhstan of type [5]. We used this methodology for modeling behavior of all economic agents including banking system with distressed assets. The dynamic model of Kazakhstan’s economy has six economic agents: Households (L), Bank system (B), Production sector (P), Trading intermediary (T), Government (G), and the External world (O). For identification of the model parameters, an indirect method and parallel calculations on a supercomputer are used.

The dynamics of material and financial indicators are expressed through changes in the reserves of natural resources, and other factors of production (labor, capital) and money [5]. External parameters (norms) and model variables (macroeconomic indicators) have a clear economic meaning. The model takes into account the features of Kazakhstan’s economy in terms of taxation and foreign economic relations.

Application of a normative economic model was limited by the complexity of parameter estimation due to a lot of unknown parameters. Indirect estimation of unknown economic model parameters based on a comparison of calculated macroeconomic indexes with statistical data. As criteria of the affinity of time series, the Theil index of inequality [9] is used. High-performance computing can give the opportunity to solve the problem of parameter identification for a fairly fast time.

Model Description

Production Sector P

The model of Kazakhstan economy has one production sector P. In the model, the sector name serves as the upper or lower indices of the corresponding variables. The production sector uses labor and capital. Production sector delivers the product on the domestic market and on the external market. It is considered that the prices are formed in each product market and the prices are changing in inverse proportion to change of stocks of corresponding products.

Households H offer labor and consume final production. Trading intermediary T redistributes material and financial flows. Bank system B emits money resources, gives out credits to the production sector. Government G accumulates taxes from the production sector and households. In the model, all taxes in economy of Kazakhstan are combined into seven ones: the corporate income tax $n_1$, the value-added tax $n_2$, excises $n_3$, the uniform social tax $n_4$, the customs duties on export $n_5$ and households (the customs duties on import $n_6$, the surtax $n_7$) and adjusts charges of the budget.

For an accounting of the shadow turnover in the model, we assume that the production sector divides the product on formal and shadow one and they cannot tax the shadow product. For the shadow economy taxes that should be paid are not. As a result, the production sector has two kinds of money — “white” and “black.” They can wash “black” money, and the Government can
expose penal sanctions (a kind of “taxation” of the shadow economy) on the stock of dirty money. All money of the consumer is considered “white,” and the consumer divides the income by norms of consumption of formal and shadow products of the production sector $P$.

For simplicity, we will use standard designations hereafter. Macroeconomic indexes and parameters of the model are supplied by the top and bottom indexes, and the top indexes are used to point agents, and bottom to point the goods as in [7]. So that we can use the same letter as a top or a bottom index or it can stay at a normal place, but all they designate the different things. In the given work, the parameters and the intensive macroeconomic indexes will be designated by small letters, but the extensive macroeconomic indexes and the called indexes are designated by capital letters. It is considered that distribution of stock of each good is made by norm: a value $a_i^{nm}$ is a share of a stock of the good $i$ going from economic agent $n$ to economic agent $m$ ($a_i^{nm} = a_i^n$). It is considered that distribution of money is made also under some norm: $b_i^{nm}$ is a share of money stock going from agent $m$ to agent $n$ for a product $i$ ($b_i^{nm} = b_i^n$). Capital intensities are also set by some norms: $c_i^m$ is agent $m$ norm of expenses on a product $i$ for the creation of one unit of capital product. Constants set the parameters of the production functions of sectors. For example, Cobb-Douglas production function of used production factors (stocks $Q$ of labor $L$ and capital $K$) describes the output $Y_P(t)$ of product $P$ produced by the economic agent $P$ (production sector $P$).

$$Y_P = (a_L^P Q_L^P)^{\delta_L^P} (a_K^P Q_K^P)^{\delta_K^P},$$

(1)

where $\delta_L^P + \delta_K^P = 1$. Hereinafter, we consider all macroeconomic indexes $Y_P(t), Q_L^P(t), Q_K^P(t)$ as functions of time $t$, therefore this argument is omitted in formulas. As a rule, all parameters are constants, here they are $\delta_L^X, \delta_K^X \in (0, 1)$.

The labor stock $Q_L^P(t)$ in sector $P$ grows with the purchase $b_L^P L W^P(t)$ of official labor $L$ at households $H$ at the official rate of wages $s_L^P(t)$ and with the purchase $b_B^P B(t)$ of shadow labor $B$ at the shadow rate of wages $s_B^P(t)$. It decreases with the use of labor $a_L^P Q_L^P(t)$ in the sector $P$.

$$\frac{dQ_L^P}{dt} = \frac{b_L^P L W^P}{s_L^P} + \frac{b_B^P B}{s_B^P} - a_L^P Q_L^P.$$  

(2)

The capital stock $Q_K^P(t)$ in sector $P$ grows due to investments $b_K^P W^P(t)$. It decreases with the use of capital $a_K^P Q_K^P(t)$ in the sector $P$ and due to wear and tear with depreciation rate $\mu_K^P$.

$$\frac{dQ_K^P}{dt} = b_K^P W^P - (a_K^P + \mu_K^P) Q_K^P.$$  

(3)

The production sector $P$ produces an official product $P$ and a shadow product $V$ using the joint capital, the joint labor. The output $Y_P(t)$ shares in fix proportion $(1 - q_P) : q_P$ on an open (“white”) output $P$ and a shadow (“black”) output $V$, where $q_P$ is a shadow share in the output $Y_P(t)$. They use the shadow product for sale to households. In the model, the investments can be official only. The stock of open product $Q_X^P(t)$ increases due to production and decreases due to shipment to agent $L$ and for investments $I_P(t)$. We assume that the charges on investments from the product coincide with incomes of it. There is a fixed share of the product stock that goes on external market $X_P^{PO}(t)$.

$$\frac{dQ_P^P}{dt} = (1 - q_P) Y_P - (a_P^{PL} + a_P^{PO}) Q_P^P - c_P^P I_P,$$  

(4)
where

\[ I_P = \left( \frac{b_P^c W_P}{p_P^c c_P^p} \right), \quad p_P^c = p_P. \]  

\[ X_P^{PO} = a_P^{PO} Q_P^p. \]  

(5)

We assume that agent \( P \) takes all the credit offered by agent \( B \) (the banking system of the Republic of Kazakhstan). However, the amount of the credit \( C^{BP}(t) \) is limited to the liquidation value of production assets. This value is proportional to the capital stock.

\[ C^{BP} = \sigma^P Q_K^p, \quad \sigma^P > 0. \]  

(6)

The debts \( Z_P^P(t) \) of the agent \( P \) to bank system \( B \) grow due to the delivery of new credits \( C^{BP}(t) \) and charges of a current interest rate \( r(t) \) on available debts, and decreases due to repayment flow \( H^{PB}(t) \).

\[ \frac{dZ_P}{dt} = C^{BP} + r Z_P^P - H^{PB}, \quad H^{PB} = b^{PB}_H W_P. \]  

(7)

The stock of open (“white”) money \( W_P(t) \) of the economic agent \( P \) grows when the agent \( P \) takes bank credits, sales the goods on the external market, sales the goods on domestic markets, takes transfers from regional consolidated budget \( T_{PG}^P(t) \) and receipts of the “washed” money from a shadow turnover \( b_{PB}^B B^P(t) \). It decreases due to wages payments to households \( L \), due to fees on credits and transfers of taxes to the consolidated budget,

\[ \frac{dW_P}{dt} = w_P^{PO} p_P^P + C^{BP} + p_L^P a_P^{PL} Q_P^p - (b_{PL}^P + b_{PB}^B W_P) - T_{PG}^P + b_{PB}^B B^P, \]  

(8)

where \( w(t) \) is Tenge/USD exchange rate, \( T_{PG}^P(t) \) is transfer payments to the consolidated budget (it equals to the sum of taxes). Deductions of agent \( P \) to the consolidated budget \( T_{PG}^P(t) \) develop from the corporate income tax \( T_{1PG}^P(t) \), the added value tax \( T_{2PG}^P(t) \), the excises \( T_{3PG}^P(t) \), the uniform social tax \( T_{4PG}^P(t) \), to customs duties on export \( T_{5PG}^P(t) \).

\[ T_{PG} = \sum_{i=1}^{5} T_{iPG}, \]  

(9)

where

\[ T_{5PG} = n_5 w_P^O X_P^{PO}, \]  

(10)

\[ T_{4PG} = n_4 b_{PL}^P W_P, \]  

(11)

\[ T_{3PG} = n_3 [w_P^O X_P^{PO} + p_L^P a_P^{PL} Q_P^P], \]  

(12)

\[ T_{2PG} = n_2 \{ w_P^O X_P^{PO} + p_L^P a_P^{PL} Q_P^P - b_{PB}^P W_P - \sum_{i=3}^{5} T_{iPG} \}, \]  

(13)

\[ T_{1PG} = n_1 \{ w_P^O X_P^{PO} + p_L^P a_P^{PL} Q_P^P - (b_{PB}^P + b_{PL}^P) W_P - \sum_{i=2}^{5} T_{iPG} \}. \]  

(14)
The shadow share $q_P$ in the total output defines a gain of stocks both opened $Q^P_P(t)$ and shadow $Q^L_V(t)$ products. The stock of shadow product $V$ in the production sector $P$ decreases due to deliveries to households and allied sectors,

$$\frac{dQ^P_V}{dt} = q_P Y_P - a^{PL}_V Q^P_B. \quad (15)$$

The stock of shadow money grows by the sale of a shadow product as a final product to households $L$. A part $b^{PL}_B$ of shadow money stock has time to wash, a part $b^{PG}_B$ gets as penal sanctions in a profitable part of the regional government consolidated budget, and a part $b^{XP}_B$ goes to the households as shadow incomes.

$$\frac{dB^P}{dt} = (p_v^{L} a^{XL}_V) Q^P_V - (b^{PL}_B + b^P_B + b^{PG}_B) B^P. \quad (16)$$

**Trading Intermediary $T$**

The economic agent “Trading Intermediary” or agent $T$ in the model plays the role of a net mediator who does not receive income and therefore has no liability for taxes. The description of this agent is introduced to describe the regional product markets, which determine the domestic prices for all products.

Change of the stock $Q^L_P(t)$ for the final product $P$ of production sector of the Republic of Kazakhstan, intended to the agent $L$, $Q^L_P(t)$, determines the change in the consumer price index $p^L_P(t)$ on product $P$.

$$\frac{dQ^L_P}{dt} = a^{PL}_P Q^P_P - \frac{b^{PL}_P W^L}{p^L_P}, \quad \frac{dp^L_P}{dt} = \alpha^{a^L}_P \left( \frac{b^{PL}_P W^L}{p^L_P} - a^{PL}_P Q^P_P \right). \quad (17)$$

Change of the stock $Q^L_V(t)$ for the final shadow product $V$ of production sector of the Republic of Kazakhstan, intended to the agent $L$, $Q^L_V(t)$, determines the change in the consumer price index $p^L_V(t)$ on shadow product $V$.

$$\frac{dQ^L_V}{dt} = a^{PL}_V Q^P_P - \frac{b^{PL}_V W^L}{p^L_V}, \quad \frac{dp^L_V}{dt} = \alpha^{a^L}_V \left( \frac{b^{PL}_V W^L}{p^L_V} - a^{PL}_V Q^P_V \right). \quad (18)$$

The intermediary $T$ in the model does not receive the income and does not pay the taxes. So that all the money of agent $T$ is clean.

$$\frac{dW^T}{dt} = (b^{LP}_P + b^{LP}_V) W^L - p^L_P a^{PL}_P Q^P_P - p^L_V a^{PL}_V Q^P_V. \quad (19)$$

**Households $L$**

Unemployed persons of the economically active population of Kazakhstan in the model are divided into unemployed persons of the formal economy and unemployed persons of the shadow economy. Unemployment increases if the supply of labor exceeds the demand for it and decreases otherwise.
Supply of labor of the agent \( L \) to the open part of economy (formal economy) \( Q_{LP} \) and supply of labor to the shadow economy \( Q_{BP} \) are

\[
\frac{dQ_{LP}}{dt} = a_{LP} Q_{LP} - \frac{b_{LP} W_{LP}}{s_{LP}}, \quad \frac{dQ_{BP}}{dt} = a_{BP} Q_{BP} - \frac{b_{BP} B_{BP}}{s_{BP}}.
\]  

(20)

It is considered that increase of the open and shadow wages can occur both a shortage of the labor, and due to an increase in consumer prices on the production of the sector. The open wage in \( P \) is determined by the equation

\[
\frac{d\psi_{LP}}{dt} = \left[ \alpha_{LP} \left( \frac{b_{LP} W_{LP}}{s_{LP}} - a_{LP} Q_{LP} \right) + \frac{\beta_{LP} \psi_{LP}}{p_{LP}} \left( \frac{b_{LP} W_{LP}}{p_{LP}} - a_{LP} Q_{LP} \right) \right] +.
\]

(21)

The shadow wage in \( P \) is determined by the equation

\[
\frac{d\psi_{BP}}{dt} = \left[ \alpha_{BP} \left( \frac{b_{BP} W_{BP}}{s_{BP}} - a_{BP} Q_{BP} \right) + \frac{\beta_{BP} \psi_{BP}}{p_{BP}} \left( \frac{b_{BP} W_{BP}}{p_{BP}} - a_{LP} Q_{LP} \right) \right] +.
\]

(22)

Hereinafter, the following notation is used: \( X_+ = X \), if \( X > 0 \) and \( X_+ = 0 \), if \( X \leq 0 \). We will assume that all household money is clean, regardless of the source of income.

\[
\frac{dW_L}{dt} = d^{BL} + b^{PL}_{LP} W_{LP} + b^{PL}_{BP} B_{BP} - \left( b^{LP}_{LP} + b^{LP}_{L} + b^{LO}_{L} \right) W_{LP} - T_{LG} + T^{GL}.
\]

(23)

Tax deductions to the consolidated budget \( T^{LG}(t) \) of the agent \( L \) are made up of deductions for customs payments for imports \( T^{LG}_6(t) \) and deductions for income tax \( T^{LG}_7(t) \) from the open part of income.

\[
T^{LG} = T^{LG}_6 + T^{LG}_7, \quad T^{LG}_6 = n_6 b^{LO}_{L} W_{LP}, \quad T^{LG}_7 = n_7 \left( d^{BL} + b^{PL}_{LP} W_{LP} \right).
\]

(24)

**Government**

The money stock on the accounts of the consolidated budget of the Government \( G \) grows from tax revenues and decreases with transfers to production sector \( P \) and households \( L \). In the model, all taxes remain on the accounts of the consolidated budget.

\[
\frac{dW_G}{dt} = b^{PG}_{P} B_{P} + T^{PG} + T^{LG} - \left( b^{PG}_{P} + b^{GL}_{L} \right) W_{G}.
\]

(25)

The current deficit (and if it is \( < 0 \) — the surplus) of the consolidated budget of the Government of the Republic of Kazakhstan \( F^G(t) \) is determined by the right-hand side of (25) with the opposite sign.

\[
F^G = -b^{PG}_{P} B_{P} - T^{PG} - T^{LG} + \left( b^{PG}_{P} + b^{GL}_{L} \right) W_{G}.
\]

(26)

**Bank System**

The model assumes that producers use credit, and the maximum possible amount of debt is proportional to the capital stock. We assume that at any moment of time \( t \) bank assets are composed of gold and foreign exchange reserves \( R(t) \), from standard (non-distressed) debts \( N(t) \)
and distressed (overdue and doubtful) producers’ debts $P(t)$, so that $Z^P(t) = N(t) + P(t)$. The bank liabilities are composed of deposits of owners of firms and banks $D(t)$. Assets and liabilities obey the main financial balance

$$\omega R + N + P = D,$$

where $\omega$ is a given US dollar to national currency (Kazakhstan Tenge) exchange rate. We assume that the gold and foreign exchange reserves $R(t)$ are changing due to the balance of payments

$$\frac{dR}{dt} = \omega pE - (1 - n_6) b^{LO}_M W^L,$$

where $p(t)$ is a price index on export $E(t)$ price index, $W^L(t) = \text{stock of money from households}$, $b^{LO}_M = \text{a household expenditure rate on imported goods and services}$, $n_6 = \text{a rate of customs payments for imports}$.

Non-distressed assets of the bank system are equal to the standard debt $N(t)$ of producers, on which the interest $r(t)$ is calculated

$$\frac{dN}{dt} = C^{BP} + qN - hW^P - X,$$

where $C^{BP}(t) = \text{a volume of newly issued loans}$, $W^P(t) = \text{a stock of money from producers}$, $h = \text{a norm of expenditure of producers’ money for the repayment of the standard debt}$, $X(t) = \text{the flow of assets passing into the problem debt}$. The problematic assets of second-tier banks are equal to the problem debts of producers $P(t)$, on which interest can be calculated $s(t) \leq q(t)$, it can be paid off by the producers under the norm $z$, so that, $h + z = b^{PB}_H$ and $s(t) P(t) + q(t) N(t) = r(t) Z^P$. Besides, the problem assets of the banking system may be reduced by transferring part of them $Z(t)$ to the Fund for Distressed Assets, serviced by the Government.

$$\frac{dP}{dt} = X + sP - zW^P - Z.$$

Bank profit $B(t)$ is determined by the difference between interest income and transfers of distressed assets

$$B = [qN - X] + [sP - (1 - \lambda)Z],$$

where $0 < \lambda < 1 - \text{share of the problematic assets of the banking system by the government Fund for Distressed Assets}$. Deposits of owners of production firms and banks $D(t)$ are

$$\frac{dD}{dt} = (1 - \eta)(A + B) + \rho D,$$

where $\rho(t) = \text{the interest rate on deposits}$, $A(t) = \text{a profit of manufacturing firms}$, and $0 < \eta < 1 - \text{the propensity of business owners to consume}$.

We assume that the reserve of the banking system $R(t)$ provides deposits $D(t)$ at a statutory rate $\xi$, so that

$$\omega R \geq \xi D.$$

So the bank system seeks to issue a maximum credit that equations $\text{(27) and (33) allow.}$

$$N + P = \omega R(1 - \xi)/\xi.$$
Thus, the credit offer $C^{BP}(t)$, by virtue of the equations (28)–(30), (34), is determined by the next relation.

$$C^{BP} = \frac{(1 - \xi)}{\xi} \left( \omega p E - (1 - n_6) b_M^{LO} W_L \right) + Z + (h + z) W_P - q N - s P. \quad (35)$$

The negativity of the value $C^{BP}(t)$ in (35) means the collapse of the banking system. It can be shown that the optimal interest rates $q(t), s(t)$ for normal $N(t)$ and bad debts $P(t)$ are determined by the equality

$$r = q = s = \rho + \left( X + (1 - \lambda) Z \right) / \left( N + P \right). \quad (36)$$

The optimal interest rate on deposits is determined at the maximum credit, when the restriction (33) is fulfilled as equality. Then from (31), (32), (28), (36) we have

$$\rho = \frac{\left( \omega p E - (1 - n_6) b_M^{LO} W_L \right) / \xi - (1 - \eta) A}{D + (1 - \eta)(N + P)}. \quad (37)$$

Research Methods

The new economic model was constructed taking into account the distressed assets. We used criteria of closeness for time series of macroeconomic indexes for indirect estimation of unknown parameters of the economic model by comparison of calculated macroeconomic indexes with their statistical analogs. The simulation model of the economy with identified parameters enables to receive quantitative estimations for trajectories of the macroeconomic indexes of the economy studied, in particular, the dynamics of distressed assets.

A macroeconomic model usually contains a lot of unspecified parameters. Some variables of the macroeconomic model have initial values that are sometimes unknown and should be considered as parameters as well. In most cases, mentioned parameters couldn’t be defined from economic statistics. Moreover, even if all necessary statistics are available the quality of the data isn’t always right. That’s why only confidence intervals for the unknown parameters can be computed from the data. For estimation of the unknown parameters, time-series for some macro-indexes (calculated by the model) and statistical time-series for these macro-indexes should be compared by means of some measure of similarity. The unknown parameters can be determined implicitly as those parameters, which provide a minimum value of the used measure of similarity. Parallel processing on a cluster of workstations or a supercomputer enables to perform an exhaustive search of the parameters within their confidence intervals (determined either from economic sense or the available statistical data) and estimate their values for reasonable time. To use parallel processing, the macroeconomic model should be divided into blocks so that the parameter estimation of any block can be done independently of the other blocks. In this case, not only real statistical data but also data calculated from some block can be used as values for external variables of the other blocks.

Estimated values of the parameters give new knowledge about the macroeconomic system under investigation, and this knowledge can force a researcher to modify the model. Thus macroeconomic model parameter estimation based on parallel processing becomes a powerful tool for mathematical modeling of economic systems.

It was mentioned that calculated and statistical time-series for some macro-indexes should be compared on the basis of some measure of similarity. As used here, two time-series are considered...
to be similar if they are close as functions of time (in other words, if there is a strong, possibly nonlinear dependence between two time-series). Convolution of the Theil’s index was used as a characteristic of closeness between two time-series.

The problem of indirect identification of the economic model is a special case of the global optimization problem and is formulated as follows.

The external parameters are given on a hypercube of dimension $N$ (this is the number of unknown parameters):

$$\vec{a}^- \leq \vec{a} \leq \vec{a}^+.$$ 

Some of the macroeconomic indicators have statistical analogues (time series):

$$X_i^{\text{stat}}(t), \quad t = t_0, \ldots, t_n, \quad i = 1, \ldots, M.$$ 

The Theil inequality index $T(X, Y)$ measures discrepancy of time series $X_t$ and $Y_t = X^{\text{stat}}_t(t)$. The closer it is to zero, the closer the compared series are to each other. For the convenience of calculations, instead of the Theil index, we will use an affinity index,

$$U(X, Y) = 1 - T(X, Y),$$

$$U(X, Y) = 1 - \frac{\sum_{t=t_0}^{T} (X_t - Y_t)^2}{\sqrt{\sum_{t=t_0}^{T} X_t^2 + \sum_{t=t_0}^{T} Y_t^2}}.$$  \hspace{1cm} (38)

For certainty choice of an optimal point, it is possible to use some convolution of affinity indexes for time series of the macroeconomic indexes. For example, if the adjustment of estimated by model and statistical data for all macroeconomic indexes with number $M$ has about equal importance; it is possible to maximize the compound value of all indexes. If $\vec{a}$ is a vector of the search parameters and $\vec{a}^-, \vec{a}^+$ are their boundaries than the next convolution of affinity indexes should be maximized.

$$S = \prod_{i=1}^{M} (U_i) \rightarrow \max_{\vec{a}^- \leq \vec{a} \leq \vec{a}^+}.$$ 

It is necessary to touch only those variants of values of parameters, at which affinity indexes are above some fix positive values. It is necessary to use the directed search, to reduce the number of independent parameters due to additional assumptions and to use the decomposition of the model on rather independent blocks, identification of parameters in which can be made independently, using fixed parameters of other blocks.

Calculations on supercomputers of Joint Super Computer Centre of Russian Academy of Sciences were made.

Numerical experiments with the model were spent to find the efficient variant qualitatively truly reflecting processes, occurring in the economy of the Kazakhstan Republic. Numerical experiments have shown the working efficiency of the full model and its separate parts. It means that the model can be used in the further work. External parameters of this variant can be taken for a basis for more exact identification of parameters of the model in the future, and to use the variant as the base of numerical qualitative scenario calculations with the model.
Analysis and Discussion

The technology of model external parameter estimation offered in work is based on the use of high-speed parallel calculations on multiprocessing systems, reduction of a number of independent parameters due to the assumption of regional economy equilibrium in the initial moment of calculation and a grouping of parameters by their economic sense.

Numerical experiments with the identified model of the regional economy have shown that the dynamics of macroeconomic indexes of Kazakh economy essentially depends on the policy spent by the Government.

Estimated values of the parameters give new knowledge about the macroeconomic system under investigation. This knowledge forces a researcher to modify the model. Thus, macroeconomic model parameter estimation based on parallel processing becomes a powerful tool for mathematical modeling of economic systems.

Forecast stability of an economic model can be studied by the identification sets method [3]. The method is a visual approach to identifying model parameters based on the construction and visualization of a multi-dimensional graph of the identification error function, as well as of sets of quasioptimal parameters. Analysis of identification sets allows us to investigate the stability of solving identification and forecasting problems. It is shown that quasioptimal options of identification ensuring a relatively high accuracy of data series approximation produce very different forecasts of economic behavior under different structural scenarios.

Conclusion

The new technology for estimation of external parameters of the model was used. This gives the opportunity to find the parameters by use of high-speed parallel calculations on a supercomputer. At construction of the model with distressed assets in the banking system and in process of its parameter evaluation, we solve problems of the analysis and structuring of initial statistical data in conformity with model structure. The identified model is used to predict future dynamics of macroeconomic indexes on the data of the Republic of Kazakhstan. The research results may be useful in economic decision-making at the country level. The constructed model can be used for other emerging countries.

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