АНАЛИЗ МОДЕЛИ ЭКОНОМИЧЕСКОГО РОСТА КИТАЯ

ANALYZING CHINA'S ECONOMIC GROWTH MODEL

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РЕФЕРАТ

ЭКОНОМИЧЕСКИЙ РОСТ, ФАКТОРЫ ЭКОНОМИЧЕСКОГО РОСТА, СТАДИИ ЭКОНОМИЧЕСКОГО РАЗВИТИЯ КИТАЯ, МОДЕЛЬ ЭКОНОМИЧЕСКОГО РОСТА КИТАЯ

Статья посвящена исследованию экономического роста Китая, а также трансформации его факторов на различных этапах развития страны.

Объектом исследования является современная экономика Китая.

Предметом исследования являются факторы экономического роста Китая.

Цель исследования – выявление особенностей развития Китая и разработка модели его экономического роста.

Научная новизна результатов исследования заключается в выявлении актуальных факторов экономического роста Китая, а также в разработке математической модели, описывающей экономический рост Китая на современном этапе его развития.

Разработанная модель может быть использована для прогнозирования экономического роста Китая.

ABSTRACT

ECONOMIC GROWTH, FACTORS OF ECONOMIC GROWTH, STAGES OF CHINA'S ECONOMIC DEVELOPMENT, MODEL OF CHINA'S ECONOMIC GROWTH

The article is devoted to the study of China's economic growth, as well as the transformation of its factors at various stages of the country's development.

The object of the research is the contemporary economy of China.

The subject of this research is the factors of China's economic growth at the present stage and in the near future.

The purpose of the study is to identify the features of China's development and develop a model of its economic growth.

The scientific novelty of the research results is expressed by the identification of the actual factors of China's economic growth, as well as by the development of a mathematical model describing the economic growth of China at the present stage of its development.

The developed model can be used to predict China's economic growth.

The relevance of the research topic is determined by the increased role of the Chinese economy in the contemporary system of world economic relations, which was due, first of all, to the stable and high rates of economic growth of the country over the past four decades. The specific feature of the implementation of the model of China's social-and-economic development from the last quarter of the past century to the beginning of this century was accelerated economic growth, despite the general slowdown in the development of the world economy, which makes it possible to consider as highly reliable the official forecasts that the country will achieve absolute leadership in the world economy.

Despite a large number of scientific articles and monographs as well as a number of Chinese and Western experts engaged into various aspects of China's economic development, the issues they discuss do not fully explain the specifics of China's

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economic growth.

All this justifies the interest in studying the Chinese economy both in relation to the definition of the role of China in the global economy, and as the unique opportunities to use the Chinese experience in other emerging economies.

FACTORS AFFECTING ECONOMIC GROWTH

Economic growth is one of the most important processes in the economy. Its dynamics are used to judge the economic development, the standard of living, and how effectively limited resources are used. Therefore, it is important to study the factors of economic growth to determine the main vectors of their impact.

Study of factors that increase or hinder economic growth was one of the central principles of theoretical and empirical researchers of growth.

Researchers will distinguish various factors of economic growth for developing and developed countries (Table 1).

The results of the study show that factors such as human capital, physical capital, domestic investment, foreign direct investment, trade openness have a significant positive effect on economic growth. Factors such as inflation and population growth have a significant negative effect on economic growth. At the same time, the growth of the urban population, according to the research results, has a positive effect on economic growth. S. J. Most and H. Van de Berg [11] obtained different results in their studies. Some factors have a positive effect on the economic growth of a number of countries, while they negatively affect the economic growth of others.

We use the information shown in Table 1 to identify factors affecting China's economic growth.

THE STAGES OF DEVELOPMENT OF THE CHINESE ECONOMY

The development of the economic system is primarily characterized by the country's GDP trend, the positive dynamics of which indicates economic growth.

Studying the dynamics of China's GDP allowed us to highlight several stages in its development (Figure 1), each of which is characterized by a different set of factors that influence economic growth.

Thus, China's economy can be divided into pre reform stage (1950–1979) and post reform stage (1979-present). The post reform stage can be divided into five substages because of the different development of each stage: reform preparation stage (1979–1991), opening stage (1991–1999), coordinated development stage (1999–2008), credit economy stage (2008–2019) and new steady state stage (2019-present).

Table 2 shows the factors influencing the economic growth of China at certain stages of its development.

The factors analyzed had a significant impact on the development of the Chinese economy. The greatest influence on the economic growth of China was made by such factors as agricultural and industry production volume, exports, imports, gross capital formation, foreign direct investment, population, monetary sector credit. We will use them to build a model of China's economic development.

BUILDING A MODEL FOR THE DEVELOPMENT OF CHINA'S ECONOMY

Building a model of China's economic growth involves several stages.

1. Estimation of the parameters of the linear regression model by the Ordinary Least Squares method (OLS).

Below is a regression equation in the form of:

$$y=\alpha_0+\alpha_1 \cdot x_1+\alpha_2 \cdot x_2+\alpha_3 \cdot x_3+\alpha_4 \cdot x_4+ \\ +\alpha_5 \cdot x_5+\alpha_6 \cdot x_6+\alpha_7 \cdot x_7+\alpha_8 \cdot x_8 , \quad (1)$$

where y – Gross Domestic Poduct (GDP); x_1 – Agriculture, Forestry, and Fishing; x_2 – Industry; x_3 – Exports; x_4 – Imports; x_5 – Gross Capital Formation; x_6 – Foreign Direct Investment; x_7 – Population; x_8 – Monetary Sector Credit.

Statistical modeling of the relationship by the method of Linear Regression Analysis will be carried out in 3 stages:

1) estimation of the parameters of the linear regression model by the Ordinary Least Squares (OLS) method;

2) checking the adequacy of the regression model (checking the significance of individual estimates of the coefficients of the model using the Student's T-test and evaluating the significance of the regression equation as a whole using Fischer's F-test);

Table 1 – Factors that either increase or hinder economic growth in developing and developed countries

Author(s)	Countries	Methodology	Factors increase economic growth	Factors hindering economic growth
Developing Countries				
Anyanwu	53 African countries (Tunisia, South Africa, Egypt, Republic of Congo, Mauritania, Algeria, Botswana and e.g.), China	Cross-county panel regression Time-series regression	Domestic investment Net official aid Secondary school enrolment Metal price index Government effectiveness Urban population Trade openness	While official development aid Population growth Inflation Credit to private sector Agricultural material price Oil price indices
Bhaskara-Rao and Hassan	Bangladesh	Neoclassical growth framework – ARDL method	Foreign direct investment Money supply Trade openness Implementation of policy reforms	Government expenditure Inflation
Easterly and Levine	Sub-Saharan Africa, Latin America, Caribbean Countries (Cameroon, Tanzania, Zambia, Jamaica, South Africa, Kenya, Liberia, Angola, Mali, Sierra Leone, Haiti, Dominican Republic and e.g.)	Cross-sectional regression	The log of schooling Financial depth Measure of telephones per worker Fiscal surplus	Political assassinations Black market premiums
Knight, Loayza and Villanueva	76 developing countries (Argentina, Bangladesh, Central Africa Republic and e.g.)	Panel regression	Physical capital Human capital Public investment	Weighted tariff rates Openness to trade Population growth
Most and Vann de Berg	11 Sub-Saharan Africa countries – Nigeria, Zambia, Togo, Ivory Coast, Rwanda, Cameroon, Botswana, Niger, Senegal and e.g.	Country-specific time series regression	Foreign aid Domestic savings Foreign direct investment	Foreign aid Domestic savings Foreign direct investment Population growth
Developed Countries				
Asheghian	Japan	Augmented neoclassical growth model-Beach-Mackinnon technique	Total factor productivity Domestic investment	–
Bayraktar	Turkey	Extreme Bounds Analysis	Investment share Human capital	Inflation
Checherita-Westphal and Rother	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain	Conditional convergence equation	Government balance Government debt Private savings Trade openness	Population growth Real interest rates

Source: compiled by the author according to [1–7, 9, 11].

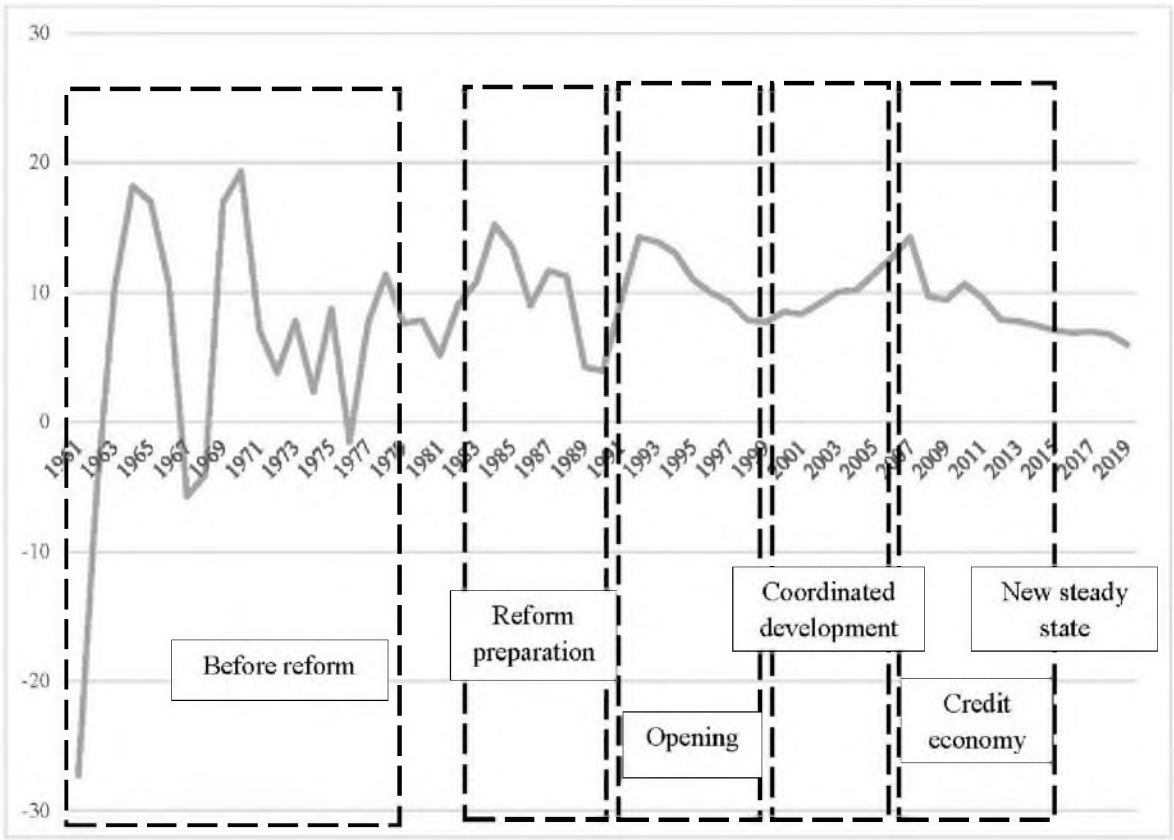

Figure 1 – Chinese Annual GDP Growth: 1961–2019, percentage change

Source: compiled by the author according to World Economic Outlook Database.

3) analysis of the fulfillment of the prerequisites of OLS (Gauss-Markov conditions).

To carry out the research, the GRETL (GNU Regression Econometrics and Time Series Library) software package was used, which is a toolkit for the practical implementation of complex computational procedures for econometric modeling. To obtain estimates of such a regression model, we apply the classical Ordinary Least Squares method (OLS).

We formulate a null hypothesis about the insignificance of the coefficient (α_i = 0 and only due to accidental circumstances it turned out to be equal to the checked value) and an alternative – about the significance ($\alpha_i \neq 0$), and also choose the level of significance (1%– the maximum allowable probability of erroneous acceptance of an alternative hypothesis).

According to the observations, the following model was compiled:

$$y=3.7032\cdot10^{12}-0,2303\cdot x_1+1.8191\cdot x_2+ +0.472\cdot x_3-0.1191\cdot x_4-0.4025\cdot x_5-1.5712\cdot x_6- -2909.97\cdot x_7+0.2852\cdot x_8 . \quad (2)$$

We see that in the estimated model (2), only the coefficients for the variables x_2 (Industry) and x_8 (Monetary Sector Credit) are significant (in this case, the probability of error when accepting the hypothesis about their significance is p-value = = 0,001 %), for the coefficient at x_6 (Foreign Direct Investment), the probability of an error when accepting the hypothesis about its significance

Table 2 – Factors influencing the economic growth of China at certain stages of its development

Stage of development	Development features	Factors influencing the economic growth
Before reform	Totally planned economy, political factor matters most. Only resource matters, other factors are not working	Government spending, net official aid, physical capital, agricultural production volume
Reform preparation	Political factor still plays the most important role. Investment and human capital starts working in light industry area	Population, inflation, human capital, public investment, industry production volume
Opening	Political factor is playing important role, but most of the area is open. Investment, human capital, science and technology are playing very important role	Human capital, cross capital formation, public investment, industry production volume
Coordinated development	Political factor is playing less important role, only for protecting. China joined WTO, mostly working as an open country	Export, import, physical capital, public investment, foreign direct investment, urban population, industry production volume
Credit economy	Political factor is playing an medium role, leading in some areas like construction. There's a need for large investments to increase GDP	Monetary sector credit, trade openness, public, domestic and foreign direct investment
New steady state	Political factor is playing medium role, leading in some areas like High-tech area. GDP slows down	Unemployment, foreign demand, domestic demand, volume of e-commerce and financial services, government spending, net official aid, export, foreign technology, national debt

Source: compiled by the author.

is p-value = 0,005 %. All other parameters are insignificant.

In the considered model, the weakest variables are x_4 (Imports) and x_1 (Agriculture, Forestry, and Fishing) – the probability of an error when accepting the hypothesis about their significance is 79.3 % and 72 %, respectively.

According to the method of selecting explanatory variables a posteriori, it is assumed to exclude variables with minimal modulo values of the T-criterion, in the case under consideration – variables x_1 (Agriculture, Forestry, and Fishing), x_3 (Exports), x_4 (Imports), x_5 (Gross Capital Formation), x_6 (Foreign Direct Investment), x_7 (Population).

2. Assessment of the suitability of the model.

Let's evaluate the suitability of the model (2) using the following indicators: Fisher's F-criterion.

Determination coefficient R^2 (Unadjusted R^2 и Adjusted R^2), the Sum of the squares of the residuals (RSS), Standard error of residuals, information criteria (Akaike information criterion, Schwarz Bayesian criterion, Hannan-Quinn criterion).

In the model under consideration, Fischer's F-criterion F(8, 11) = 17952.91 for p-value < < 0.00001. Since the p-value is less than the selected significance level (p = 1 %), a decision is made to accept an alternative hypothesis, i.e. the adequacy of the model as a whole. Thus, as a result of the analysis of the considered model for adequacy, we can conclude: the model according to the Fisher F-criterion is adequate, but six regression coefficients (for variables x_1, x_3, x_4, x_5, x_6, x_7) are insignificant.

In this case, the model is suitable for making some decisions about the dependence of the

variable y (Gross Domestic Product) on the variables x_2 (Industry) and x_8 (Monetary Sector Credit), but not for making forecasts.

We exclude variables $x_1, x_3, x_4, x_5, x_6, x_7$ from the model (2) and repeat the considered sequence of actions to obtain a linear regression model that establishes the dependence of the variable y (Gross Domestic Product) on variables x_2 (Industry) and x_8 (Monetary Sector Credit).

Thus, we get an adjusted model:

$$y=7.4032\cdot10^{10}+1.4209\cdot x_2+0.2722\cdot x_8 . \quad (3)$$

In this model, the variables x_2 and x_8 are significant and the model as a whole is suitable for practical use for decision-making and forecasting.

Regression analysis of linear functions based on the conventional or one-step Least Squares (OLS) method must satisfy four Gauss-Markov conditions:

1. The mathematical expectation of the random component, $M(u_i)$ in any observation should be zero.

2. The variance of the random component should be constant for all observations. If this condition is not met, then heteroscedasticity occurs, the presence of heteroscedasticity can be determined using the White test, which allows you to check the significance of the regression of the squares of the residuals relative to the complex of model variables and their squares. At the same time, a null hypothesis is formulated about the homoscedasticity of the residuals (the equality of all coefficients of the model to zero).

3. The absence of a systematic relationship between the values of the random component ui in any two observations. Absence of autocorrelation of residues.

Let's check the Gauss-Markov conditions.

1. Zero average value (mathematical expectation) of the residuals.

To verify this statement, select the created variable residuals, the average value of the residuals (mean) is 0.

2. Checking the condition of homoscedasticity of residues.

The results window in this case shows that the value of p-value = 0.1429 greater than the significance level of 0.01 indicates that the null hypothesis should be accepted and the condition of homoscedasticity of the residuals is fulfilled.

3. The absence of a systematic relationship between the values of the random component u_i in any two observations (lack of autocorrelation of residues).

Let's calculate the correlation coefficient between these variables by selecting the variables Residual and Residual1. We get a coefficient of 0.3644, indicating an insignificant correlation (correlation is considered strong if its coefficient is higher than |0.6|.

4. The random component must be distributed independently of the variables x_i and y (the random nature of the residuals).

For verification, a graph of the dependence of the u_i residuals on the theoretical values of the resultant feature y and x is plotted.

Let's construct a paired regression of the Residuals error from the model values of the resultant attribute y_final. As a result, we get a zero coefficient value and a single p-value, as well as the location of the residuals on the graph in the form of a horizontal strip, which indicates the absence of this dependence and the random nature of the residuals.

The dependence of the residuals on the variables x_2 and x_8 can be checked from the model window $y = 7.4032\cdot10^{10}+1.4209\cdot x_2+0.2722\cdot x_8$ by plotting the corresponding graphs. On the obtained graphs, the residuals are also arranged in the form of horizontal bands, which indicates the absence of corresponding dependencies.

From the above, it can be established that all the prerequisites for the use of OLS to determine the parameters of the model in question are fulfilled. The constructed model $y = 7.4032\cdot10^{10}+1.4209\cdot x_2+ +0.2722\cdot x_8$ based on its Fischer F-test is generally adequate, and all regression coefficients are significant (as a result of the Student's T-test). Such a model can be used to make decisions and implement forecasts.

Let's calculate the GDP for five years from 2020 to 2024, using the available data from 2000 to 2019.

The Table 3 in the second column shows numerically projected GDP values from 2020 to 2024.

Comparing the projected GDP value for 2020 of $1.44814 \cdot 10^{13}$ $ according to the proposed model (3) and the real value of $1.47227 \cdot 10^{13}$ $ published by the World Bank at the end of 2020, we see that the deviation is 1.64 %.

Thus, a multifactorial regression model reflecting the dependence of GDP on various economic factors of China's development is proposed. The OLS method has established two factors (Industry, Monetary Sector Credit) that have the greatest importance for GDP. A study was conducted and the adequacy of the proposed model was proved. The GDP value was predicted for 5 years. The comparison with the available World Bank data shows a deviation of 1.64 %.

Table 3 – Numerically projected GDP values from 2020 to 2024

Year	GDP values, $\cdot 10^{13}$ $
2020	1.44814
2021	1.52372
2022	1.59929
2023	1.67487
2024	1.75045

Source: compiled by the author.

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