# ЭКОНОМЕТРИЧЕСКАЯ МОДЕЛЬ МЕНГЕСА ДЛЯ СТРАН БРИКС

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**АННОТАЦИЯ**

В статье проведен анализ субмодели Менгеса для экономик стран БРИКС. Данный подход обусловлен интересом изучения производственной части экономики для прогнозирования объема производства. Целесообразно сделать анализ промышленной производительности и валовой операционной прибыли стран БРИКС. Особое внимание стоит уделить проверке адекватности моделей, и их способности предсказывать будущие значения показателей развития экономика. Для каждой из стран БРИКС проведена специальная оценка коэффициентов уравнения с помощью виг и стандартные статистические тесты для оценки корреляции, гетероскедастичности и нормальности остатков.

В работе показано, что модель работает только для России. Причиной этому может быть сходство российской и германской экономики. Другой причиной возможно является то, что данный включают период как перед, так и после финансового кризиса 2008 года. Для таких стран, как Индия и Южная Африка, модель адекватна, но тесты показывают, что линейная модель не лучший способ анализа данных для этих стран. Зависимость между переменными все-таки есть, но, скорее всего, зависимость между переменными не является линейным.

**Ключевые слова**: модель Менгеса для экономик стран БРИКС, эконометрическое моделирование и прогнозирование

# ECONOMETRICS G. MANGE'S MODEL FOR THE BRICS COUNTRIES

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**ABSTRACT**

The article analyzes the Mange's sub models for the economies of the BRICS countries. This approach is due to the interest to study the production side of the economy to predict the output. It is advisable to make the analysis of industrial productivity and gross operating surplus of the BRICS countries. Particular attention should be paid to reviewing the adequacy of the models and their ability to predict future values of economic development. For each of the BRICS countries held a special assessment of coefficients of the equation using the Whig and standard statistical tests to assess the correlation, heteroscedasticity and normality of residuals.

It is shown that the model works only for Russia. The reason for this may be the similarity of the Russian and the German economy. Another reason perhaps is that this period include both before and after the 2008 financial crisis. For countries such as India and South Africa, the model is adequate, but tests show that the linear model is not the best way to analyze the data for these countries. The relationship between the variables is still there, but, most likely, the relationship between the variables is not linear.

**Keywords: Mange's Model for the Economies of the BRICS Countries, Econometric Modeling and Forecasting**

## Introduction.

The global economy has experienced unprecedented paradigm shifts in the last decade. Coupled with the recent crises in developed regions, it may be timely for emerging economies to fill the vacuum of growth left vacant by developed countries in order to drive world economic development. Despite decades of civil unrest, political and economic turmoil overshadowing some of these countries, there are strong indications that economic development is fast growing in these regions. Although still unable to free themselves from the shackles of corruption and poverty, the success of these economies currently rests on their ability to attract foreign direct investments from developed and developing countries

Ever since the investment bank Goldman Sachs coined the acronym BRICs and launched it in the global debate in the early 2000s, there has been much talk about the rise of new powers in the international political economy. Brazil, Russia, India, China and, later on, South Africa have thus become the symbols of a global shift, from an old global economic system led by the so-called West (the US and, to a lesser degree, European countries) to a new development trajectory, in which traditionally "under-developed" countries have come to play a leading a role. The immediate aftermath of the 2008 financial crisis further reinvigorated such a thesis, as the emerging powers continued to grow their economies at a speed unparalleled by any advanced economy, seemingly unaffected by the fall of Wall Street that plunged both the US and Europe into a prolonged economic recession. Since BRICS countries appear to shift global economy, it might be interesting to examine their economics.

Macroeconometric modelling aims at explaining the empirical behaviour of an actual economic system. This paper studies a select set of macroeconomic determinants and their respective impacts on patented innovation in a select group of some emerging economies known as BRICS (Brazil, Russia, India, China, and South Africa). The future economic capabilities of the BRICS countries largely depend on their capacity for economic growth and industrial production.

G. Menges developed macroeconomic model for Western Germany in 1975[1]. The model tries to predict economic output with the help of various economics variables. The model appeared to be accurate for Germany. That is why it is interesting to examine G. Menges submodel of industrial production for BRICS countries – Brazil, Russia, India, China, South Africa.

$$\{Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t ,$$
$$\text{where } Q - \text{profits}, R - \text{industrial productivity}, \varepsilon_t - \text{disturbance term}$$

**The goal of this work:** is to analyze G. Menges submodel for BRICS countries and to check adequacy of the models for the countries mentioned above.

**The main objectives of this work** is to**:**

- understanding of the importance of BRICS countries;

[1] Joachim Frohn. Mit Beitr., G. Menges Makroökonometrische Modelle für die Bundesrepublik Deutschland. - Göttingen : Vandenhoeck & Ruprecht, 1978. – 78-91

- construction a model that expresses the output patterns;
- estimation of parameters;
- testing hypotheses about the patterns and relationships change and economic indicators.

In this paper we examine the economic characteristics and major determinants of economic development for each individual BRICS country, with a focus on parameters relevant to industrial production and national accounts.

Special emphasis is put on the adequacy of the models, and their ability to predict economics flow. After summarizing the results, some implications for BRICS policies are discussed. The Annex provides an extensive list of data for the individual BRICs, allowing for cross-country comparisons at a glance.

# 1. Theoretical part

## 1.1 Menges model

Günter Menges[2] was a professor at the University of the Saarland , at the Faculty of Statistics and Econometrics atthe Ruprecht-Karls-University and social statistics in Heidelberg and the Institute for Employment Research of the Federal Employment Service .

In his book "Macroeconometric models for the Federal Republic of Germany"[3] (1978) he analyzed macroeconomic indicators. G. Menges developed the following model of the West German economy:

$$\begin{cases} Y_t = a_0 + a_1 * Y_{t-1} + a_2 * I_t + \mu_t \\ I_t = b_0 + b_1 * Y_t + b_2 * Q_t + \vartheta_t \\ C_t = c_0 + c_1 * Y_t + c_2 * C_{t-1} + c_3 * P_t + \varphi_t \\ Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t \end{cases}$$

where Y = national income, I = net capital formation, C = personal, consumption, Q = profits, P = cost of living index, and R = industrial productivity.

A practical reason for focusing on submodels is that the modellers may have good reasons to study some parts of the economy more carefully than other parts. For a central bank that targets inflation, there is a strong case for getting the model of the inflationary process right. For forecasting of volume of production, it is advisable to pay attention to industrial productivity or gross operating surplus.

$$\{Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t \,,$$
$$\text{where } Q - \text{profits}, R - \text{industrial productivity}$$

We find that in order to answer such questions - and to probe the the model for BRICS countries - a detailed modelling, drawing on information specific to the economy.

## 1.2 Introduction to BRICS countries

BRICS is the acronym for an association of five major emerging national economies: Brazil, Russia, India, China, and South Africa. The grouping was originally known as "BRIC" before the inclusion of South Africa in 2011. As of 2014, the five BRICS countries

[2] Günter Menges (Ökonom) [Электронный ресурс]. – Режим доступа: http://de.wikipedia.org/wiki/G%C3%BCnter_Menges_(%C3%96konom). – Заглавие с экрана. – (Дата обращения: 11.11.2014).

[3] Joachim Frohn. Mit Beitr., G. Menges Makroökonometrische Modelle für die Bundesrepublik Deutschland. - Göttingen : Vandenhoeck & Ruprecht, 1978. – 78-91

represent almost 3 billion people which is 40% of the world population, with a combined nominal GDP of US$16.039 trillion (20% world GDP) and an estimated US$4 trillion in combined foreign reserves. As of 2014, the BRICS nations represented 18 percent of the world economy.

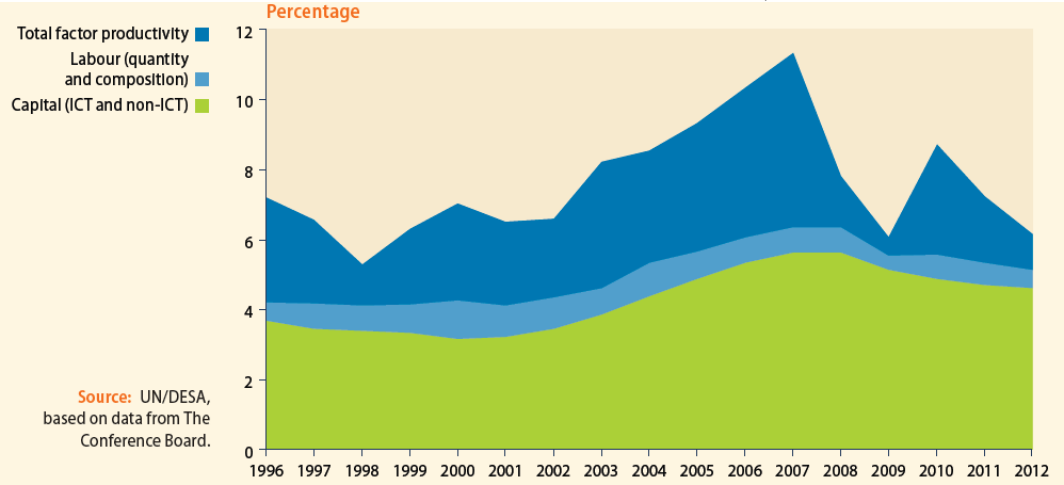
The BRICS show many similarities in their interactions with the EU, but significant differences as well. The major reason behind the latter is that they are following different models of economic development. In brief, Brazil is a domestically oriented service economy; Russian economic development is heavily dependent on energy and raw material resources; the Indian economy is essentially service-led, supported by exports; and China's economic development is driven by manufacturing exports and investment, South African manufacturing and agricultural economy. Nevertheless, looking at the more recent policies of the BRICS and their development plans for the future, a certain 'convergence' of strategies across all of them can be observed. The different characteristics of the models of economic development in the individual BRICS lead to different challenges and opportunities for EU competitiveness and respective policy implications.

The rapid rate at which the emerging economies of Brazil, Russia, India, China and South Africa have in recent years been closing the gap with the developed world has been breath-taking. The popular BRICS acronym referring to these rising powers has in the last decade come to signify the major shifts underway in global economic and political relations.

Yet, the reality appears much more complex than the "global power shift" discourse would have us believe. First of all, the BRICS countries have little in common in political terms. As many analysts have argued, the "alliance" can be better described as a marriage of convenience rather than a real partnership for change. The only uniting factor is the scale of their economies in terms of gross domestic product (GDP) and their sustained growth rates in the past two decades. As resource-rich economies, they have adopted a development paradigm based on intensive extraction of natural resources (e.g. fossil and bio-fuels, minerals, etc.), which drive most of their exports, and cheap labor, especially in China and India. They have pursued GDP growth with little or no investment in human development, thereby allowing the gap between the haves and have-nots to widen.

A standard growth decomposition exercise for the BRICS for the period 1996-2012 can reveal some interesting features about the growth deceleration in these countries. By a production function approach, GDP growth can be decomposed into the contributions from three sources: growth in labour inputs, accumulation in capital, and increase in total factor productivity (TFP)—a catch-all category that measures the overall efficiency of the economy in transforming labour and capital into output.

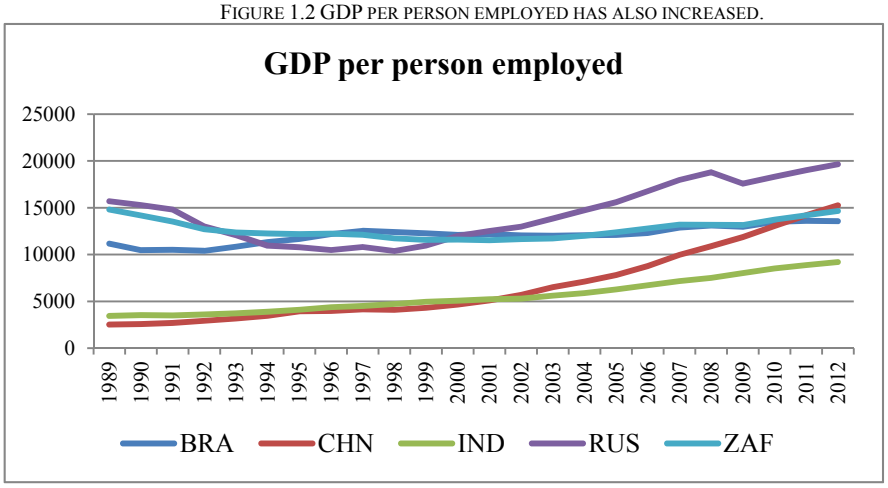
FIGURE 1.1. GROWTH DECOMPOSITION FOR THE BRICS, 1996-2012




SOURCE: UN/ DESA. WORLD ECONOMIC SITUATION AND PROSPECTS 2014, UNITED NATIONS NEW YORK, 2014

Estimates of potential output and output gaps (the gap between actual GDP growth and potential growth) in the BRICS suggest: First, prior to the crisis, from 2005-2008, actual GDP grew faster than potential output, resulting in a significant positive output gap at the onset of the crisis. The rising output gap was associated with a marked increase in inflation in all of these economies, except Brazil. The output gap was probably largest in the Russian Federation and South Africa. Second, potential GDP growth seems to have declined in the aftermath of the crisis in all five economies, with the decline most pronounced in China and India.

FIGURE 1.2 GDP PER PERSON EMPLOYED HAS ALSO INCREASED.




SOURCE: UNITED NATIONS STATISTICS DIVISION - DATA.UN.ORG .

In many large developing countries, including the BRICS (Brazil, the Russian Federation, India, China and South Africa), economic growth has weakened considerably over the past two years and is now well below the pre-crisis level. While the BRICS countries were relatively unscathed by the 2008 financial collapse and its immediate aftermath, their GDP growth rates have begun to slow down and, in some cases, they have fallen dramatically since 2011. For 2013, weighted gross domestic product (GDP) growth in the BRICS is at 5.6 per cent, down from an annual average of about 8 per cent during the period 2000-2008. An important question is how much of the recent slowdown in these emerging economies is cyclical and temporary, and how much is structural and longer-term.

All in all, BRICS are not among the most prosperous countries according to per capita income. However, through their strong economic dynamics as well as territorial and demographic dimensions BRICS are influencing global economic development to a great extent. Reflecting their increasing relevance, BRICS have started to constitute a strategic alliance with institutionalized meetings on ministerial and presidential level. Although a primary objective is to gain influence in institutions of global governance, their strategy is based on multilateral soft balancing.

This paper provides an application of G. Menges submodel for BRICS countries describing the production function (which determines potential output), focusing on economic indicators, such as gross operating surplus and volume of industrial productivity.

## 2. Test of models.

### 2.1 Construction of the model.

Econometric models for the economy of a single country, such as the former econometric model of the Bundesbank for the German economy, can only be applied to the analysis of economic developments in that particular country. It is interesting to analyze the accordance of Menges model of Germany for Brazil, Russia, India, China, South Africa.

In Menges model, the economy is separated into four broad sectors: national income, net capital formation, personal consumption, and profits. Analysis of profits seems to be crucial for

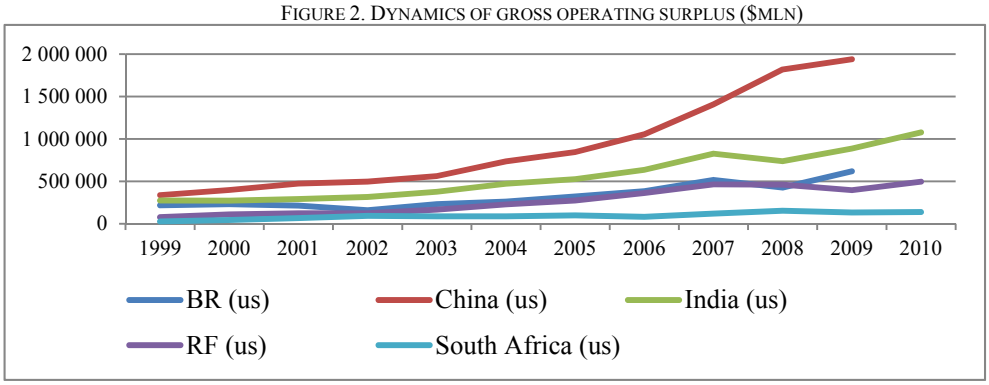
economics, as under profits of the economy the author implies gross operating surplus depending on the productivity.

$$\{Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t ,$$
$$E(\varepsilon_t) = 0, \qquad \sigma(\varepsilon_t) = const$$
$$\text{where } Q - \text{gross operating surplus}, R - \text{industrial productivition}$$

For every country of BRICS special estimation model is built in which gross operating surplus depends on lag variable of gross operating surplus and volume of industrial production.

Operating surplus is an accounting concept used in national accounts statistics. It may be used in macro-economics as a proxy for total pre-tax profit income, although entrepreneurial income may provide a better measure of business profits. Operating surplus is a component of value added and GDP. Operating surplus therefore does not necessarily refer to all gross profit income realized in an economy. Profits are also realized from all kinds of property transactions which do not involve new production, such as capital gains, and net profits are often also received from foreign countries or paid to foreign countries.

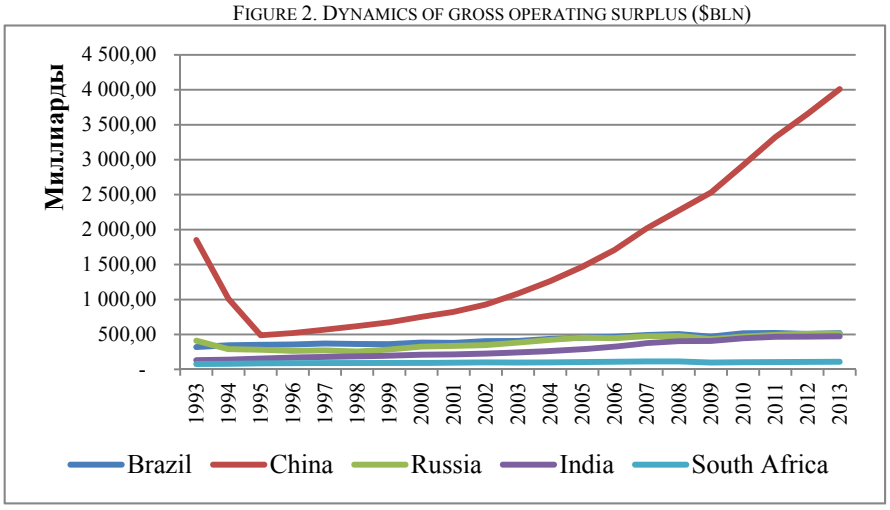
FIGURE 2. DYNAMICS OF GROSS OPERATING SURPLUS ($MLN)




SOURCE: UNITED NATIONS STATISTICS DIVISION - DATA.UN.ORG .

It is evident from the graph that GSP has increased since 1999 for all countries of BRICS. Gross operating variable is dependent variable. Previous year gross operating variable is independent variable. Data was taken from the National Accounts Section of the United Nations Statistics Division Another independent variable volume of industrial production. It is an economic indicator that measures changes in output for the industrial sector of the economy. The industrial sector includes manufacturing, mining, and utilities. Data is in constant US$, seasonally adjusted. The base year is 2005. Industrial Production, constant US$, seas. adj. Data was downloaded from World Bank Cross Country Data.

FIGURE 2. DYNAMICS OF GROSS OPERATING SURPLUS ($BLN)




SOURCE: UNITED NATIONS STATISTICS DIVISION - DATA.UN.ORG .

So, the model include one dependent variable – gross operating surplus (GSP) and two independent variable – GSP of previous year and industrial production (IP).

The modeling strategy is the general to specific approach, using ordinary least squares to estimate equilibrium correction models. Restrictions based on economic theory are applied when statistical support is found. It is also emphasized that the final estimated equations should pass standard statistical tests for serial correlation, heteroscedasticity and normality in the residuals. Parameter stability is tested through recursive estimation[4].

## 2.2 Brazil

Brazil has one of the world's largest economies, with well-developed agricultural, mining, manufacturing, and service sectors. Vast disparities remain, however, in the country's distribution of land and wealth. Roughly one fifth of the workforce is involved in agriculture. The major commercial crops are coffee (Brazil is the world's largest producer and exporter), citrus fruit (especially juice oranges, of which Brazil also is the world's largest producer), soybeans, wheat, rice, corn, sugarcane, cocoa, cotton, tobacco, and bananas. Cattle, pigs, and sheep are the most numerous livestock, and Brazil is a major beef and poultry exporter. Timber is also important, although much is illegally harvested.

Brazil has vast mineral wealth, including iron ore (it is the world's largest producer), tin, quartz, chrome ore, manganese, industrial diamonds, gem stones, gold, nickel, bauxite, uranium, and platinum. Offshore petroleum and natural gas deposits discovered in the early 21st cent. could also make the nation a significant oil and gas producer, but development has been slow and below expectations. There is extensive food processing, and the leading manufacturing industries produce textiles, shoes, chemicals, steel, aircraft, motor vehicles and parts, and machinery. Most of Brazil's electricity comes from water power, and it possesses extensive untapped hydroelectric potential, particularly in the Amazon basin. In addition to coffee, Brazil's exports include transportation equipment, iron ore. Machinery, electrical and transportation equipment, chemical products, oil, and electronics are major imports.

**Period for observed indicators for Brazil: 1996 – 2008,** as the last reporting period for gross operating surplus was 2009 and that figure is needed for confidence interval.

$$\begin{cases} Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t \\ E(\varepsilon_t) = 0, \qquad \sigma(\varepsilon_t) = \text{const} \end{cases}$$

**1. Data collection:** Data was collected on 11.11.2014 for the period 1996 – 2008.

**2. Correlation**

In statistics, dependence is any statistical relationship between two random variables or two sets of data.

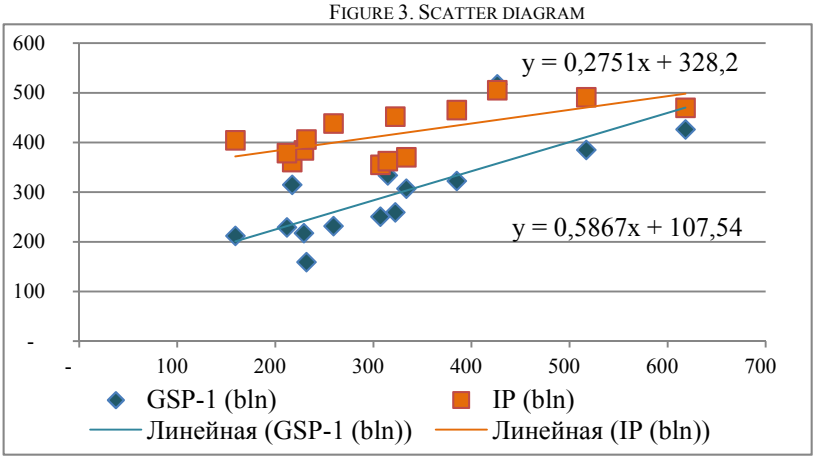
| | GSP (bln.) | GSP-1 (bln.) | IP (bln.) |
|---|---|---|---|
| GSP (bln.) | 1 | | |
| GSP-1 (bln.) | 0,78 | 1 | |
| IP (bln.) | 0,67 | 0,59 | 1 |

Correlation between variables is high, so it can be suggested that model would be reliable.

**3. Scatter diagram**

[4] Трегуб И.В., Математические модели динамики экономических систем монография.- М.: Финакадемия. 2009, 50-57с.

FIGURE 3. SCATTER DIAGRAM




It can be understood that scattering of variables implies linear trend.

**4. Estimated form of the model**

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95%* | *Нижние 95,0%* | *Верхние 95,0%* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -78,81 | 29,10 | -2,71 | 0,01 | -139,73 | -17,90 | -139,73 | -17,90 |
| GSP - 1 | 0,69 | 0,11 | 6,49 | 0,00 | 0,47 | 0,92 | 0,47 | 0,92 |
| IP | 1,11 | 0,36 | 3,09 | 0,01 | 0,36 | 1,87 | 0,36 | 1,87 |

After regression analysis is performed, we can built estimation form of the model.

$$\begin{cases} Q_t = -163{,}82 + 0{,}59 * Q_{t-1} + 0{,}71 * R_t + \varepsilon_t \\ (147{,}46) \quad (0{,}23) \quad (0{,}42) \quad (62{,}49) \\ [-1{,}11] \quad [2{,}55] \quad [1{,}71] \\ R^2 = 0{,}67 \\ F = 10{,}10 \quad F_{crit} = 4{,}10 \\ t_{crit} = 2{,}23 \\ GQ = 0{,}29 \quad \frac{1}{GQ} = 3{,}42 \quad F_{crit\,GQ} = 4{,}28 \\ DW = 1{,}95 \end{cases}$$

This linear model implies that for Indian economy gross operating surplus depends on 0,59 billion$ of lag-variable gross operating surplus and 0,71 billion $ of volume of industrial production minus 163,82. So, we can see the positive slope of the curve. This relation is explained by the economy of Brazil: Brazil is mostly based on natural sources and gross operating surplus is based in production. So gross operating surplus from the budget is affected positively by increase in last year operating surplus and productivity. Increased productivity in one sector of economy for instance leads to larger income of the sector and then leads to increased operating surplus. Increase in productivity by 1 leads to increase of 0,71 billions $ of gross operating surplus.

**5. Analysis of coefficients and test results.**

In statistics, the coefficient of determination, denoted $R^2$ is a number that indicates how well data fit a statistical model – sometimes simply a line or curve. It provides a measure of how well observed outcomes are replicated by the model, as the proportion of total variation of outcomes explained by the model

**$R^2$=0,67.** It is higher than 0,5 and it means that 67% of variables in independent variable is described by variance of dependent variable by linear model.

An F-test is any statistical test in which the test statistic has an F-distribution under the null hypothesis. It is most often used when comparing statistical models that have been fitted to a data set, in order to identify the model that best fits the population from which the data were sampled.

In linear model for Brazil $\mathbf{F = 10,10}$ **and** $\mathbf{F_{crit} = 4,10}$, besides $F > F_{crit}$. It means that coefficient of determination is not random. Quality of specification is high.

A t-test is any statistical hypothesis test in which the test statistic follows a Student's t distribution if the null hypothesis is supported. It can be used to determine if two sets of data are significantly different from each other, and is most commonly applied when the test statistic would follow a normal distribution if the value of a scaling term in the test statistic were known.

$\mathbf{T_{crit} = 2,23}$ **,** $\mathbf{T_{a0}}$**=-1,11,** $\mathbf{T_{a1}}$**=2,55,** $\mathbf{T_{a2}}$**=1,7**

The rule is that $|T|>T_{crit,}$ which means that coefficients $a_0$ and $a_2$ are not significant. If to analyze the model further, industrial prediction variable should be excluded.

In statistics, the Gauss–Markov theorem, states that in a linear regression model in which the errors have expectation zero and are uncorrelated and have equal variances, the best linear unbiased estimator (BLUE) of the coefficients is given by the ordinary least squares (OLS) estimator.

To apply the Gauss-Markov theorem the data must be assumed to have the following properties:

- E[e(i)] = 0 (lack of structural errors, needed to avoid bias)
- V[e(i)] = c (equal variance, one form of homoscedasticity)
- cov[e(i),e(j)] = 0 (non-correlation of errors)

So, the next step is to check conditions of Gauss-Markov theory.

1)The first is mathematical expectation of residuals should be equal to zero. $\mathbf{E}(\boldsymbol{\varepsilon_t}) = \mathbf{0}$ This condition is confirmed.

2)We need to check homoscedasticity using **Goldfeld Quant theorem**.

The Goldfeld-Quandt (GQ) test in econometrics begins by assuming that a defining point exists and can be used to differentiate the variance of the error term. Sample observations are divided into two groups, and evidence of heteroskedasticity is based on a comparison of the residual sum of squares (RSS) using the F-statistic. In the context of multiple regression (or univariate regression), the hypothesis to be tested is that the variances of the errors of the regression model are not constant, but instead are monotonically related to a pre-identified explanatory variable.

**Results of GQ test:**

| | |
|---|---|
| GQ= | 0,29 |
| 1/GQ= | 3,42 |
| Fcrit= | 4,28 |

If $\begin{cases} GQ < Fcrit \\ \frac{1}{GQ} < Fcrit \end{cases}$ is fulfilled, then second GW condition is confirmed. In linear model for Brazil this equation can be performed, second GW condition is confirmed and one can use ordinary least square technic in order to estimate parameters of the model.

3)After that, it is necessary to check autocorrelation of the residuals of the model with the help of Durbin–Watson statistic.

In statistics, the Durbin–Watson statistic is a test statistic used to detect the presence of autocorrelation (a relationship between values separated from each other by a given time lag) in the residuals (prediction errors) from a regression analysis. It should be noted that the distribution of this test statistic does not depend on the estimated regression coefficients and the variance of the errors.

**Results of DW test:**

| 0 | dl | du | 2 | 4-du | 4-dl | 4 |
|---|---|---|---|---|---|---|
| | 0,81221 | 1,57935 | | 2,42065 | 3,18779 | |
| | | | **DW = 1,95** | | | |

So, DW test shows that there is no autocorrelation between residuals. Third GM condition is confirmed. It is possible to use OLS or estimation of coefficients of the model.

**6. Confidence interval**

To check adequacy of the model, it is desirable to build confidence interval and to compare real value with the predicted by linear model.

$$Q_t = -163{,}82 + 0{,}59 * Q_{t-1} + 0{,}71 * R_t + \varepsilon_t$$

Frequently the observed interval contains the parameter is determined by the confidence level or confidence coefficient. Whereas two-sided confidence limits form a confidence interval, their one-sided counterparts are referred to as lower or upper confidence bounds.

**Results:**

Q predicted for 2009 = 423,85

| Low confidence interval | Q real for 2009 | Upper confidence interval |
|---|---|---|
| 478,92 | 618,16 | 757,40 |

This means that the predicted figure (423,85) is not included into the confidence interval. So, the model is not reliable. May be it is connected with crisis of 2008 and improvement of the economy in 2009.

## 2.3 Russia

Russia today has a diversified economy, but its most important sector is the sale of raw materials and primary commodities such as oil, timber, and gold. Russia is well-endowed with natural resources and raw materials. Russia ranks among the world's leading producers of petroleum and gas, copper, manganese, bauxite, graphite, uranium, titanium, gold, silver, and platinum. The former Soviet Union was a leading international producer of manufactured items such as chemicals, weapons, and military and aerospace equipment. Much of the industrial base of these manufacturing sectors was located within the Russian Republic itself.

The World Bank says there are substantial risks to the medium-term outlook for Russia's 2014-2016 growth. As the Russian economy needed to internalize several rounds of sanctions, countersanctions and measures to stabilize the economy, this environment of higher risk lowered domestic demand. A more balanced and diversified portfolio of national assets, including natural resources, capital, and economic institutions, will help overcome structural constraints to growth. Institutional weaknesses are now the main stumbling block on the road to greater economic efficiency and a higher growth potential.

**Period for observed indicators for Russia: 1999 – 2012.** This period is taken due to crisis in 1988 so that the data is not mixed.

$$\begin{cases} Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t \\ E(\varepsilon_t) = 0,\ \sigma(\varepsilon_t) = const \end{cases}$$

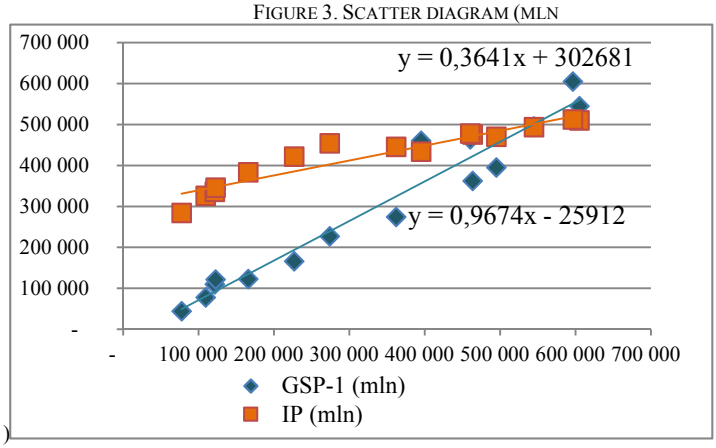
**2. Correlation**

| | GSP (mln.) | GSP – 1 (mln.) | IP (mln.) |
|---|---|---|---|
| GSP (mln.) | 1 | | |
| GSP – 1 (mln.) | 0,97 | 1 | |
| IP (mln.) | 0,95 | 0,90 | 1 |

Correlation between variables is high, so it can be suggested that econometrics model would be reliable.

**3. Scatter diagram**

FIGURE 3. SCATTER DIAGRAM (MLN




It can be understood that scattering of variables implies linear trend.

**3. Estimated form of the model**

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95%* | *Нижние 95,0%* | *Верхние 95,0%* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -255 857,10 | 103 026,05 | -2,48 | 0,03 | -482 615,91 | -29 098,28 | -482 615,91 | -29 098,28 |
| GSP - 1 | 0,67 | 0,13 | 5,14 | 0,00 | 0,38 | 0,96 | 0,38 | 0,96 |
| IP | 0,93 | 0,32 | 2,90 | 0,01 | 0,22 | 1,63 | 0,22 | 1,63 |

After regression analysis is done, estimation form of the model can be built.

$$\begin{cases} Q_t = -255\,857{,}1 + 0{,}67 * Q_{t-1} + 0{,}93 * R_t + \varepsilon_t \\ (103\,026{,}05) \quad (0{,}13) \quad (0{,}32) \quad (36\,620{,}01) \\ [-2{,}48] \quad [5{,}14] \quad [2{,}90] \\ R^2 = 0{,}97 \\ F = 153{,}33 \quad F_{crit} = 3{,}98 \\ t_{crit} = 2{,}20 \\ GQ = 0{,}21 \quad \frac{1}{GQ} = 7{,}52 \quad F_{crit\,GQ} = 9{,}28 \\ DW = 2{,}08 \end{cases}$$

This linear model implies that gross operating surplus depends on 0,67 mln of lag-variable gross operating surplus and 0,93 mln of volume of industrial production minus 255 857,1. Russian economy is natural-based, meaning that natural sector takes most part of gross operating income.

It is known that Oil & Gas sector takes almost 60-70 % of the economy and of the budget income. That is the reason why increased productivity influence operating surplus so much. If we increase productivity by 1, then gross operating surplus will increase by 0, 91 billions of dollars,

**4. Analysis of coefficients and test results.**

**$R^2$=0,97** Coefficient of determination is very high. It is higher than 0,5 and it means that 97% of variables in independent variable is described by variance of depended variable by linear model.

In linear model for Russia $\mathbf{F = 153,33}$ **and** $\mathbf{F_{crit} = 3,98}$, besides $F > F_{crit}$. It means that coefficient of determination is not random. Quality of specification is high.

$\mathbf{T_{crit} = 2,20}$ , $T_{a0}$=-2,48, $T_{a1}$=5,14, $T_{a2}$=2,90

The rule is that $|T|>T_{crit}$, which means all coefficients are significant. So, we can estimate model further.

So, the next step is to check conditions of Gauss-Markov theory.

1) The first is mathematical expectation of residuals should be equal to zero. $\mathbf{E}(\boldsymbol{\varepsilon_t}) = \mathbf{0}$. This condition is confirmed.

2)We need to check homoscedasticity using Goldfield Quant theory.

**Results of GQ test:**

| | |
|---|---|
| GQ= | 0,13 |
| 1/GQ= | 7,52 |
| Fcrit= | 9,28 |

If $\begin{cases} GQ < Fcrit \\ \frac{1}{GQ} < Fcrit \end{cases}$ is fulfilled, then second GW condition is confirmed. In linear model for Russia heteroscedsticity is found, second GW condition is not confirmed.

3)After that, it is necessary to check autocorrelation of the residuals of the model with the help of Durbin–Watson statistic

**Results of DW test:**

| 0 | dl | du | 2 | 4-du | 4-dl | 4 |
|---|---|---|---|---|---|---|
| | 0,86124 | 1,56212 | | 2,43788 | 3,13876 | |
| | | | **DW = 2,08** | | | |

So, DW test shows that there is no autocorrelation between residials. Third GM condition is confirmed. It is possible to use OLS or estimation of coeficientsof the model.

**6. Confidence interval**

To check adequacy of the model, it is desirable to build confidence interval and to compare real value with the predicted by linear model.

$$Q_t = -255\,857{,}1 + 0{,}67 * Q_{t-1} + 0{,}93 * R_t + \varepsilon_t$$

**Results:**

Q predicted for 2013 = 623 538,70

| Low confidence interval | Q real for 2013 | Upper confidence interval |
|---|---|---|

| | | |
|---|---|---|
| 515 811,86 | 596 411,95 | 677 012,05 |

So, the model is reliable and it can be used for predictions. The reason for that might be the similarity of economic systems of Russia and Germany.

## 2.4 India.

The overall GDP growth from 2013 to 2014 was at 4.9%, according to the Central Statistics Office. This implies that the Indian economy is performing well, as the rate is slightly above the 4.5% GDP growth recorded from 2012 to 2013.

The production clusters include Chennai, for IT and auto parts, Tirupur, known for its knitted garments; Ludhiana, for mass production of knitwear; Surat and Mumbai, for precious gems and jewelry products; Kolkata, Agra and Chennai, for leather and leather products; and Maharashtra, for Paithani sari (cloth woven by hand and made of very fine silk).

**Period for observed indicators for India: 2000 – 2010,** as the last reporting period for gross operating surplus was 2010 and that figure is needed for confidence interval.

$$\begin{cases} Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t \\ E(\varepsilon_t) = 0,\ \sigma(\varepsilon_t) = const \end{cases}$$

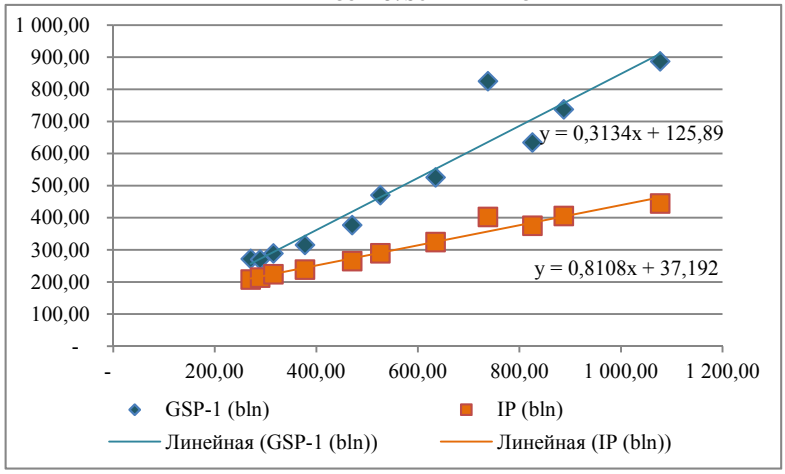
**2. Correlation**

| | GSP (bln.) | GSP – 1 (bln.) | IP (bln.) |
|---|---|---|---|
| GSP (bln.) | 1 | | |
| GSP – 1(bln.) | 0,96 | 1 | |
| IP (bln.) | 0,98 | 0,99 | 1 |

Correlation between variables is high, so it can be suggested that econometrics model would be reliable.

**3. Scatter diagram**

FIGURE 3. SCATTER DIAGRAM




It can be understood that scattering of variables implies linear trend.

**4. Estimated form of the model**

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95%* | *Нижние 95,0%* | *Верхние 95,0%* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -668,39 | 142,06 | -4,71 | 0,00 | -995,98 | -340,81 | -995,98 | -340,81 |
| GSP - 1 | -1,00 | 0,44 | -2,28 | 0,05 | -2,01 | 0,01 | -2,01 | 0,01 |
| IP | 5,70 | 1,16 | 4,91 | 0,00 | 3,02 | 8,38 | 3,02 | 8,38 |

After regression analysis if performed, initial estimation of the model can be presented.

$$\begin{cases} Q_t = -668{,}39 - 1{,}00 * Q_{t-1} + 5{,}70 * R_t + \varepsilon_t \\ (142{,}06) \quad (0{,}44) \quad (1{,}16) \quad (44{,}46) \\ [-4{,}71] \quad [-2{,}28] \quad [4{,}91] \\ R^2 = 0{,}98 \\ F = 182{,}08 \quad F_{crit} = 4{,}46 \\ t_{crit} = 2{,}31 \\ GQ = 0{,}01 \quad \frac{1}{GQ} = 113{,}88 \quad F_{crit\,GQ} = 19{,}00 \\ DW = 1{,}36 \end{cases}$$

This linear model implies that for Indian economy gross operating surplus depends on minus1mln of lag-variable gross operating surplus and 5,7 mln of volume of industrial production minus 668,39. So, we can see the negative slope of the curve. The difference from the previous models is that the relation between last year gross operating model and current year gross operating model of negative. The reason for that while nominal growth maintains India in a positive, manufacturing productivity is lagging, with a decline of 0.2% (2013's number was a 1.1% growth). Today, India continues to manufacture various goods. Engineering-inclined products, such as metal parts, castings and forgings, and pumps and compressors, top its manufacturing production and constitute 19% of total annual exports. This is followed by jewellery (15%), chemical products (13%), agricultural products such as root crops and rice (9%), and textiles (9%).

Increase in productivity by 1 leads to increase of 5,70 billion dollars of gross operating surplus.

**5. Analysis of coefficients and test results.**

**$R^2$=0,98** Coefficient of determination is very high. It is higher than 0,5 and it means that 98% of variables in independent variable is described by variance of debendend variable by linear model.

In linear model for Brazil $\mathbf{F = 182,08}$ **and** $\mathbf{F_{crit} = 4,46}$, besides $F > F_{crit}$. It means that coefficient of determination is not random. Quality of specification is high.

$\mathbf{T_{crit} = 2,31}$ **,** $\mathbf{T_{a0}}$**=-4,71,** $\mathbf{T_{a1}}$**=-2,28,** $\mathbf{T_{a2}}$**=4,91**

The rule is that $|T|>T_{crit.}$ Judging by this criteria, coefficients $a_0$, $a_2$ are significant, whereas coefficient $a_1$ is not significant. In case to evaluate this linear model further, it might be necessary to exclude this variable – gross operating surplus from previous period.

Anyway, we can estimate the model further. So, the next step is to check conditions of **Gauss-Markov theorem**.

1)The first is mathematical expectation of residuals should be equal to zero. $\mathbf{E}(\boldsymbol{\varepsilon_t}) = \mathbf{0}$ This condition is confirmed.

2)We need to check homoscedasticity using Goldfield Quant theorem.

**Results of GQ test:**

| | |
|---|---|
| GQ= | 0,01 |
| 1/GQ= | 113,88 |
| Fcrit= | 19,00 |

If $\begin{cases} GQ < Fcrit \\ \frac{1}{GQ} < Fcrit \end{cases}$ is fulfilled, then second GW condition is confirmed. In linear model for India heteroscedsticity is found, second GW condition is not confirmed.

3)After that, it is necessary to check autocorrelation of the residials of the model with the help of Durbin–Watson statistic.

**Results of DW test:**

| 0 | dl | du | 2 | 4-du | 4-dl | 4 |
|---|---|---|---|---|---|---|
| | 0,69715 | 1,64134 | | 2,35866 | 3,30285 | |
| | | **1,36** | | | | |

So, DW test shows that DW statistics is situated in interval, where in can not be determined whether there is autocorrelation between residuals or not. So, third GM condition is not confirmed. It is impossible to use OLS or estimation of coefficients of the model.

**6. Confidence interval**

To check adequacy of the model, it is desirable to build confidence interval and to compare real value with the predicted by linear model.

$$Q_t = -668{,}39 - 1{,}00 * Q_{t-1} + 5{,}70 * R_t + \varepsilon_t$$

**Results:**

Q predicted for 2010 = 982,88

| Low confidence interval | Q real for 2010 | Upper confidence interval |
|---|---|---|
| 974,45 | 1 076,98 | 1 179,50 |

This means that the real figure is included into the confidence interval. So, the model is reliable.

However, tests show that this linear model is not the best way to analyze data. Even though $Q_{real}$ is included in confidence interval and coefficients $a_0$, $a_2$ are significant, Gauss Markov theory can not be used to estimate coefficients, since second and third conditions are not confirmed.

Since the model is reliable, it may imply that the dependence between variables is not linear. May be that linear model is not the best way to estimate the data and logarifm model is more preferable.

The reason for falling into confidence interval may the recovery of the economy of India after financial crisis.

## 2.5 China

China is the world's most populous country, with a continuous culture stretching back nearly 4,000 years. Many of the elements that make up the foundation of the modern world originated in China, including paper, gunpowder, credit banking, the compass and paper money.

Nowadays China is one of the world's top exporters and is attracting record amounts of foreign investment. In turn, it is investing billions of dollars abroad. The collapse in international export markets that accompanied the global financial crisis of 2009 initially hit China hard, but its economy was among the first in the world to rebound, quickly returning to growth.

**Period for observed indicators for China: 1995 – 2008,** as the last reporting period for gross operating surplus was 2009 and that figure is needed for confidence interval.

$$\begin{cases} Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t \\ E(\varepsilon_t) = 0,\ \sigma(\varepsilon_t) = \text{const} \end{cases}$$

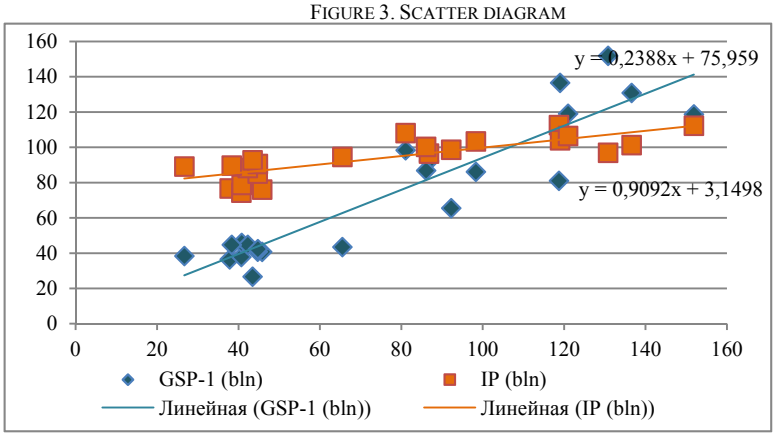
**2. Correlation**

| | GSP bln | GSP bln - 1 | IP(bln.) |
|---|---|---|---|
| GSP bln) | 1 | | |
| GSP bln - 1 | 0,99 | 1 | |
| IP(bln.) | 0,99 | 0,98 | 1 |

Correlation between variables is high, so it can be suggested that econometrics model would be reliable.

**3. Scatter diagram**

FIGURE 3. SCATTER DIAGRAM




It can be understood that scattering of variables implies linear trend.

**4. Estimated form of the model**

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95%* | *Нижние 95,0%* | *Верхние 95,0%* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -75,89 | 40,02 | -1,90 | 0,08 | -163,97 | 12,19 | -163,97 | 12,19 |
| Переменная X 1 | 1,20 | 0,23 | 5,24 | 0,00 | 0,70 | 1,70 | 0,70 | 1,70 |
| Переменная X 2 | 0,08 | 0,14 | 0,56 | 0,58 | -0,23 | 0,39 | -0,23 | 0,39 |

After regression analysis is performed, one can estimate the model.

$$\begin{cases} Q_t = -75{,}89 + 1{,}20 * Q_{t-1} + 0{,}08 * R_t + \varepsilon_t \\ (40{,}02) \quad (0{,}23) \quad (0{,}14) \quad (47{,}42) \\ [-1{,}90] \quad [5{,}24] \quad [0{,}56] \\ R^2 = 0{,}99 \\ F = 648{,}07 \quad F_{crit} = 3{,}98 \\ t_{crit} = 2{,}20 \\ GQ = 0{,}05 \quad \frac{1}{GQ} = 18{,}70 \quad F_{crit\,GQ} = 6{,}39 \\ DW = 2{,}01 \end{cases}$$

This linear model implies that for Chinese economy gross operating surplus depends on 1,2 mln of lag-variable gross operating surplus and 0,08 mln of volume of industrial production minus 75,89. So, we can see the positive slope of the curve. The economic structure is shown more balanced after the census. The new figures show China's economy with a total GDP of $17.6 trillion in 2014, just ahead of the U.S. with a GDP of $17.4 trillion. But a competitive change was

already noticeable with the significant exports decline China experienced during the 2009 recession. In preceding economic downturns, such as in 2001, China's export position was mostly unaffected. At that time, China was in or near the lowest cost position on the global labor-intensive finished goods manufacturing cost curve, forcing other regions to make the necessary factory shutdowns. This has now changed and represents a significant development for materials suppliers to China. That is the reason why the relation between figures is positive.

Increase in productivity by 1 increases gross operating surplus by 0,08 billion dollars.

**5. Analysis of coefficients and test results.**

**$R^2$=0,99** Coefficient of determination is very high. It is higher than 0,5 and it means that 99% of variables in independent variable is described by variance of dependent variable by linear model.

In linear model for China $\mathbf{F = 648,07}$ **and** $\mathbf{F_{crit} = 3,98}$, besides $F > F_{crit}$. It means that coefficient of determination is not random. Quality of specification is high.

$\mathbf{T_{crit} = 2,20}$ , **$T_{a0}$=-1,90, $T_{a1}$=5,24, $T_{a2}$=0,56**

The rule is that $|T|>T_{crit.}$ Judging by this criteria, coefficient $a_1$ I s significant, whereas coefficients $a_0$, $a_2$ are not significant. In case to evaluate this linear model further, it might be necessary to exclude this variable - industrial production. Anyway, we can estimate the model further.

So, the next step is to check conditions of **Gauss-Markov theory**.

1)The first is mathematical expectation of residuals should be equal to zero. $\mathbf{E}(\boldsymbol{\varepsilon_t}) = \mathbf{0}$ This condition is confirmed.

2)We need to check homoscedasticity using Goldfield Quant theory.

**Results of GQ test:**

| | |
|---|---|
| GQ= | 0,05 |
| 1/GQ= | 18,70 |
| Fcrit= | 6,39 |

If $\begin{cases} GQ < Fcrit \\ \frac{1}{GQ} < Fcrit \end{cases}$ is fulfilled, then second GW condition is confirmed. In linear model for China heteroscedsticity is found, second GW condition is not confirmed.

3)After that, it is necessary to check autocorrelation of the residials of the model with the help of Durbin–Watson statistic

**Results of DW test:**

| 0 | dl | du | 2 | 4-du | 4-dl | 4 |
|---|---|---|---|---|---|---|
| | 0,86124 | 1,56212 | | 2,43788 | 3,13876 | |
| | | | **DW = 2,010** | | | |

So, DW test shows that DW statistics is situated in interval with no autocorrelation. Third GM condition is confirmed. We can use Ordinary least square techniq.

**6. Confidence interval**

To check adequacy of the model, it is desirable to build confidence interval and to compare real value with the predicted by linear model.

$$Q_t = -668,39 - 1,00 * Q_{t-1} + 5,70 * R_t + \varepsilon_t$$

**Results:**

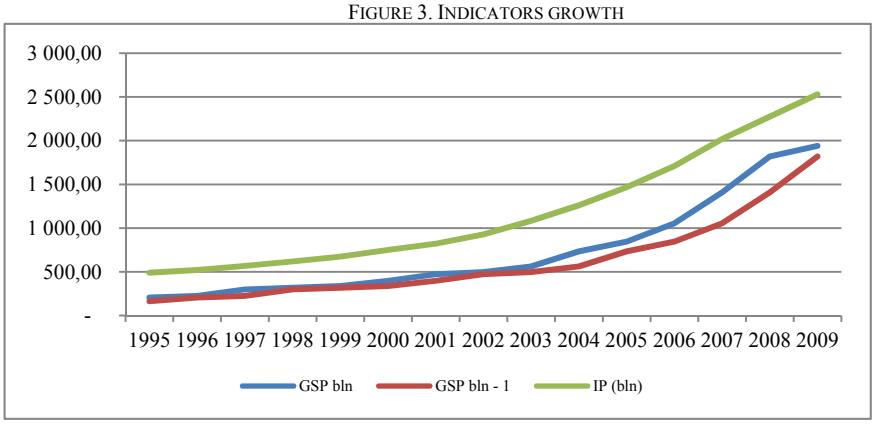
Q predicted for 2009 = 2 309,61

| Low confidence interval | Q real for 2009 | Upper confidence interval |
|---|---|---|
| 1 834,94 | 1 940,18 | 2 045,42 |

This means that the real figure is not included into the confidence interval. So, the model is not reliable.

Moreover, tests also show that this linear model is not the best way to analyze data. Second Gauss Markov theory is not confirmed and third coefficient is not significant. So, G. Menges submodel is not suitable for China. The reason for that may be the huge differences between economies of Germany in 20th century and the one of China in 21st century.

FIGURE 3. INDICATORS GROWTH




SOURCE: UNITED NATIONS STATISTICS DIVISION - DATA.UN.ORG .

Judging by the dynamics of volume of production and gross operating surplus from 1992 to 2009, economics is developing in a rapid way with average geometric growth of 18% in GSP and 13% increase in volume of industrial production in $bln.

## 2.6 South Africa.

The economy of South Africa is the second largest in Africa, behind Nigeria, it accounts for 24% of its gross domestic product in terms of purchasing power parity, and is ranked as an upper-middle income economy by the World Bank; this makes the country one of only four countries in Africa in this category (the others being Botswana, Gabon and Mauritius).

South Africa has a comparative advantage in the production of agriculture, mining and manufacturing products relating to these sectors. South Africa has shifted from a primary and secondary economy in the mid-twentieth century to an economy driven primarily by the tertiary sector in the present day which accounts for an estimated 65% of GDP or $230 billion in nominal GDP terms.

**Period for observed indicators for South Africa: 1991 – 2011,** as the last reporting period for gross operating surplus was 2012 and that figure is needed for confidence interval.

$$\begin{cases} Q_t = d_0 + d_1 * Q_{t-1} + d_2 * R_t + \varepsilon_t \\ E(\varepsilon_t) = 0, \quad \sigma(\varepsilon_t) = const \end{cases}$$

**2. Correlation**

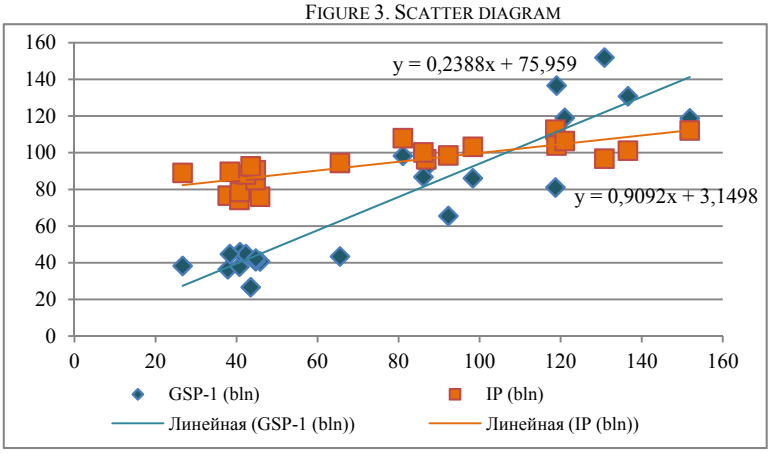
| | GSP(bln.) | GSP - 1(bln.) | IP(bln.) |
|---|---|---|---|
| GSP (bln.) | 1 | | |

| | | | |
|---|---|---|---|
| GSP - 1(bln.) | 0,92 | 1 | |
| IP(bln.) | 0,81 | 0,71 | 1 |

Correlation between variables is high, so it can be suggested that econometrics model would be reliable.

**2. Scatter diagram**

FIGURE 3. SCATTER DIAGRAM




Linear trend of the model is visible from the graph.

**3. Estimated form of the model**

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95%* | *Нижние 95,0%* | *Верхние 95,0%* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -78,81 | 29,10 | -2,71 | 0,01 | -139,73 | -17,90 | -139,73 | -17,90 |
| GSP - 1 | 0,69 | 0,11 | 6,49 | 0,00 | 0,47 | 0,92 | 0,47 | 0,92 |
| IP | 1,11 | 0,36 | 3,09 | 0,01 | 0,36 | 1,87 | 0,36 | 1,87 |

After regression analysis is performed, estimated form can be constructed.

$$\begin{cases} Q_t = -78{,}81 + 0{,}69 * Q_{t-1} + 1{,}11 * R_t + \varepsilon_t \\ (\ 29{,}10\ ) \quad (0{,}11) \quad (\ 0{,}36\ ) \quad (\ 13{,}28) \\ [-2{,}71] \quad [\ 6{,}49] \quad [3{,}09\ ] \\ R^2 = 0{,}90 \\ F = 81{,}37 \quad F_{crit} = 3{,}52 \\ t_{crit} = 2{,}09 \\ GQ = 0{,}02 \quad \frac{1}{GQ} = 40{,}16 \quad F_{crit\,GQ} = 6{,}39 \\ DW = 1{,}01 \end{cases}$$

This linear model implies that for South African economy gross operating surplus depends on 0,69 billions of lag-variable gross operating surplus and 1,11 billions of volume of industrial production minus 78,81. So, we can see the positive slope of the curve.

The country's economy is reasonably diversified with key economic sectors including mining, agriculture and fisheries, vehicle manufacturing and assembly, food processing, clothing and textiles, telecommunication, energy, financial and business services, real estate, tourism, transportation, and wholesale and retail trade. That is why increased production in this model leads to increase in gross operating surplus. Increase of productivity by 1 leads to increase of 1,11 billions of dollars of gross operating surplus.

**5. Analysis of coefficients and test results.**

**$R^2$=0,90**

Coefficient of determination is very high. It is higher than 0,5 and it means that 90% of variables in independent variable is described by variance of depended variable by linear model.

In linear model for South Africa $\mathbf{F = 81,37}$ **and** $\mathbf{F_{crit} = 3,52}$, besides $F > F_{crit}$. It means that coefficient of determination is not random. Quality of specification is high.

$\mathbf{T_{crit} = 2,09}$ **,** $\mathbf{T_{a0}}$**=-2,71,** $\mathbf{T_{a1}}$**=6,49,** $\mathbf{T_{a2}}$**=3,09.**

The rule is that $|T|>T_{crit.}$ Judging by this criteria, coefficients $a_1$, $a_0$, $a_2$ are significant. We can estimate the model further.

So, the next step is to check conditions of **Gauss-Markov theorem**.

1)The first is mathematical expectation of residuals should be equal to zero. $\mathbf{E(\varepsilon_t) = 0}$ This condition is confirmed.

2)We need to check homoscedasticity using Goldfield Quant theory.

**Results of GQ test:**

| | |
|---|---|
| GQ= | 0,02 |
| 1/GQ= | 40,16 |
| Fcrit= | 6,39 |

If $\begin{cases} GQ < Fcrit \\ \frac{1}{GQ} < Fcrit \end{cases}$ is fulfilled, then second GW condition is confirmed, which is not true for our South African model. In linear model for South Africa heteroscedsticity is found, second GW condition is not confirmed.

3)After that, it is necessary to check autocorrelation of the residials of the model with the help of Durbin–Watson statistic.

**Results of DW test:**

| 0 | dl | du | 2 | 4-du | 4-dl | 4 |
|---|---|---|---|---|---|---|
| | 1,12461 | 1,53849 | | 2,46151 | 2,87539 | |
| | **DW = 1,01** | | | | | |

So, DW test shows that DW statistics is situated in interval from 0 to dl with positive autocorrelation. Third GM condition is not confirmed. We not use Ordinary least square techniq. If we have positive autocorrelation $\mathbf{cov(\varepsilon_t, \varepsilon_{t-1}) = 0}$ and we can not use OLS.

**6. Confidence interval**

To check adequacy of the model, it is necessary to build confidence interval and to compare real value with the predicted by linear model.

$$Q_t = -78,81 + 0,69 * Q_{t-1} + 1,11 * R_t + \varepsilon_t$$

**Results:** Q predicted for 2012 = 122,19

| Low confidence interval | Q real for 2012 | Upper confidence interval |
|---|---|---|
| 93,17 | 120,97 | 148,78 |

This means that the real figure is included into the confidence interval. So, the model is reliable.

However, tests show that this linear model is not the best way to analyze data. Even though $Q_{real}$ is included in confidence interval and coefficients $a_0$, $a_2$ are significant, Gauss Markov theory can not be used to estimate coefficients, since second and third conditions are not confirmed.

Since the model is reliable, it may imply that the dependence between variables is not linear. May be that linear model is not the best way to estimate the data and logarifm model is more preferable.

## 3. Complex analysis of application of G. Menges model for BRICS countries.

The economic development models of BRICS countries is significantly different from that of developed countries and regions like the United States, Europe and Japan and Germany. The economic growth in the five BRICS countries was established on the basis of low-cost labour, abundant mineral resources, and few technological innovations. Taking China as an example, it depends highly on investments for economic growth as opposed to consumption which has no contributing value.

The economic structures of BRIC countries are inadequate. Russia mainly depends on the energy, military and heavy industries, but the service and financial sectors are underdeveloped. China is at the low end of the industry-chain structure, whilst South Africa, Brazil and India do not have a comprehensive industrial system and external dependence is prominent.

China and India mainly rely on an abundant and low-cost labour force, and are engaged in the processing and exporting of low value-added labour-intensive products and the outsourcing of services. They can easily be influenced by the international market, especially the decline in demand in developed markets and market protection policies. Russia, Brazil and South Africa mainly develop mineral products for export. Furthermore, export revenue is vulnerable to international demand and price fluctuations.

On the other hand, G. Menges model was first applied and tested for West Germany analyzing relations between productivity and gross operating surplus. Germany is relatively poor in raw materials. Only lignite and potash salt are available in economically significant quantities. Power plants burning lignite are one of the main sources of electricity in Germany. Oil, natural gas and other resources are, for the most part, imported from other countries. Germany imports about two thirds of its energy. The service sector contributes around 70% of the total GDP, industry 29.1%, and agriculture 0.9%. Most of the country's products are in engineering, especially in automobiles, machinery, metals, and chemical goods. Germany is the leading producer of wind turbines and solar power technology in the world.

Testing model for BRICS countries shows that Menges model is reliable only for Russia. Economic reason for this may be found in dependence on heavy industries and raw materials. Another reason may be that the period for Russian model was taken from 1998 to 2012 that is taking into account not only world financial crisis but also recovery period. While for the data of other countries last available period was only 2010.

## Conclusion

All in all, model works only for Russia. The predicted Q for 2013 figure is included into the confidence interval. So, the model is reliable. The reason for that may be behind similarities of Russian and Germany economies. Another reason is that the period taken into account contains data before as well as after financial crisis of 2008.

For such countries as India and South Africa, Q predicted is included in the confidence interval, yet the models need some adjustments. Tests show that this linear model is not the best way to analyze data. Even though $Q_{real}$ is included in confidence interval, some coefficients are not significant, Gauss Markov theory can not be used to estimate coefficients, since second and third conditions are not confirmed.

Since the models are reliable, it may imply that the dependence between variables is not linear. May be that linear model is not the best way to estimate the data and logarifm model is more preferable.

For such countries as China and Brazil, the model for them does not work. This means that the real figure is not included into the confidence interval. So, the model is not reliable.

Moreover, for China for example, tests also show that this linear model is not the best way to analyze data. Second Gauss Markov theory is not confirmed and third coefficient is not significant. So, G. Menges sub model is not suitable for China. The reason for that may be the huge differences between economies of Germany in 20th century and the one of China in 21st century. Judging by the dynamics of volume of production and gross operating surplus from 1992 to 2009, economics is developing in a rapid way with average geometric growth of 18% in GSP and 13% increase in volume of industrial production in $bln.

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# The Annex

Brazil

| *Регрессионная статистика* | | Дисперсионный анализ | | | | |
|---|---|---|---|---|---|---|
| Множественный R | | *df* | *SS* | *MS* | *F* | *Значимость F* |
| R-квадрат | Регрессия | 2,00 | 28 721,70 | 14 360,85 | 81,37 | 0,00 |
| Нормированный R-квадрат | Остаток | 19,00 | 3 353,16 | 176,48 | | |
| Стандартная ошибка | Итого | 21,00 | 32 074,86 | | | |
| Наблюдения | 22,00 | | | | | |

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95 %* | *Нижние 95,0 %* | *Верхние 95,0 %* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -78,81 | 29,10 | -2,71 | 0,01 | -139,73 | -17,90 | -139,73 | -17,90 |
| GSP - 1 | 0,69 | 0,11 | 6,49 | 0,00 | 0,47 | 0,92 | 0,47 | 0,92 |
| IP | 1,11 | 0,36 | 3,09 | 0,01 | 0,36 | 1,87 | 0,36 | 1,87 |

| *Наблюдение* | *Предсказанное GSP* | *Остатки* |
|---|---|---|
| 1,00 | 31,86 | 5,98 |
| 2,00 | 30,21 | 10,48 |
| 3,00 | 34,11 | 11,69 |
| 4,00 | 40,59 | 0,21 |
| 5,00 | 44,31 | 0,40 |
| 6,00 | 50,50 | -8,21 |
| 7,00 | 51,43 | -6,69 |
| 8,00 | 52,11 | -13,78 |
| 9,00 | 47,01 | -20,32 |
| 10,00 | 42,93 | 0,54 |

| *Наблюдение* | *Предсказанное GSP* | *Остатки* |
|---|---|---|
| 11,00 | 56,63 | 8,88 |
| 12,00 | 76,48 | 15,78 |
| 13,00 | 92,58 | -5,77 |
| 14,00 | 93,02 | -6,92 |
| 15 | 95,94 03 | 2,37 898 6 |

China

| *Регрессионная статистика* | | Дисперсионный анализ | | | 3,98 |
|---|---|---|---|---|---|
| | *df* | *SS* | *MS* | *F* | *Значимость F* |
| Регрессия | 2,00 | 2 963 552,50 | 1 481 776,25 | 648,07 | 0,00 |
| Остаток | 11,00 | 25 150,80 | 2 286,44 | | |
| Итого | 13,00 | 2 988 703,31 | | | |
| Наблюдения | 14,00 | | | | |

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95 %* | *Нижние 95,0 %* | *Верхние 95,0 %* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -75,89 | 40,02 | -1,90 | 0,08 | -163,97 | 12,19 | -163,97 | 12,19 |
| Переменная X 1 | 1,20 | 0,23 | 5,24 | 0,00 | 0,70 | 1,70 | 0,70 | 1,70 |
| Переменная X 2 | 0,08 | 0,14 | 0,56 | 0,58 | -0,23 | 0,39 | -0,23 | 0,39 |

| *Наблюдение* | *Предсказанное Y* | *Остатки* |
|---|---|---|
| 1,00 | 158,30 | 46,57 |
| 2,00 | 211,58 | 11,48 |
| 3,00 | 237,23 | 62,40 |
| 4,00 | 333,16 | -16,40 |
| 5,00 | 358,12 | -21,02 |
| 6,00 | 388,71 | 9,62 |
| 7,00 | 467,97 | 4,58 |
| 8,00 | 565,48 | -69,58 |
| 9,00 | 605,93 | -43,10 |

| *Наблюдение* | *Предсказанное Y* | *Остатки* |
|---|---|---|
| 10,00 | 700,53 | 34,22 |
| 11,00 | 923,38 | -78,09 |
| 12,00 | 1 075,31 | -20,48 |
| 13,00 | 1 351,46 | 56,65 |
| 14,00 | 1 795,98 | 23,14 |

India

| *Регрессионная статистика* | Дисперсионный анализ | | | | |
|---|---|---|---|---|---|

Russia

| *Регрессионная статистика* | Дисперсионный анализ | | | | |
|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Множественный R | 0,99 | | *df* | *SS* | *MS* | *F* | *Значимость F* |
| R-квадрат | 0,98 | Регрессия | 2,00 | 71986825 | 35993413,08 | 182,00 | 0,00 |
| Нормированный R-квадрат | 0,97 | Остаток | 8,00 | 1581395 | 1976,74 | | |
| Стандартная ошибка | 44,46 | Итого | 10,00 | 73568220 | | | |
| Наблюдения | 11,00 | | | | | | |

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95 %* | *Верхние 95 %* | *Нижние 95,0 %* | *Верхние 95,0 %* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -668,39 | 142,06 | -4,71 | 0,00 | -995,98 | -340,81 | -995,98 | -340,81 |
| GSP - 1 | -1,00 | 0,44 | -2,28 | 0,05 | -2,01 | 0,01 | -2,01 | 0,01 |
| IP | 5,70 | 1,16 | 4,91 | 0,00 | 3,02 | 8,38 | 3,02 | 8,38 |

| *Наблюдение* | *Предсказанное GSP* | *Остатки* |
|---|---|---|
| 1,00 | 247,32 | 23,26 |
| 2,00 | 281,35 | 7,84 |
| 3,00 | 322,91 | -7,42 |
| 4,00 | 380,70 | -2,96 |
| 5,00 | 467,19 | 3,48 |
| 6,00 | 513,46 | 12,63 |
| 7,00 | 658,59 | -23,75 |
| 8,00 | 840,50 | -14,90 |
| 9,00 | 807,38 | -69,34 |
| 10,00 | 910,27 | -22,95 |
| 11,00 | 982,88 | 94,10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Множественный R | 0,98 | | *df* | *SS* | *MS* | *F* | *Значимость F* |
| R-квадрат | 0,97 | Регрессия | 2,00 | 411235177116,79 | 205617588558,39 | 153,33 | 0,00 |
| Нормированный R-квадрат | 0,96 | Остаток | 11,00 | 14751275809,76 | 1341025073,61 | | |
| Стандартная ошибка | 36620,01 | Итого | 13,00 | 425986452926,55 | | | |
| Наблюдения | 14,00 | | | | | | |

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95 %* | *Нижние 95,0 %* | *Верхние 95,0 %* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -255857,10 | 103026,05 | -2,48 | 0,03 | -482615,91 | -29098,28 | -482615,91 | -29098,28 |
| GSP - 1 | 0,67 | 0,13 | 5,14 | 0,00 | 0,38 | 0,96 | 0,38 | 0,96 |
| IP | 0,93 | 0,32 | 2,90 | 0,01 | 0,22 | 1,63 | 0,22 | 1,63 |

| *Наблюдение* | *Предсказанное GSP* | *Остатки* |
|---|---|---|
| 1,00 | 36414,82 | 41207,33 |
| 2,00 | 97791,79 | 11786,41 |
| 3,00 | 127927,73 | -6403,42 |
| 4,00 | 145587,37 | -23030,88 |
| 5,00 | 180926,45 | -14967,32 |
| 6,00 | 245433,11 | -18567,55 |
| 7,00 | 316184,24 | -42153,96 |
| 8,00 | 339859,02 | 22213,14 |
| 9,00 | 426812,49 | 36849,77 |
| 10,00 | 496926,57 | -36496,25 |
| 11,00 | 453725,11 | -58585,50 |
| 12,00 | 443694,10 | 51330,25 |
| 13,00 | 532365,91 | 12534,74 |
| 14,00 | 580848,99 | 24283,24 |

South Africa

| *Регрессионная статистика* | | Дисперсионный анализ | | | | | |
|---|---|---|---|---|---|---|---|
| Множественный R | 0,95 | | *df* | *SS* | *MS* | *F* | *Значимость F* |
| R-квадрат | 0,90 | Регрессия | 2,00 | 28 721,70 | 14 360,85 | 81,37 | 0,00 |
| Нормированный R-квадрат | 0,88 | Остаток | 19,00 | 3 353,16 | 176,48 | | |
| Стандартная ошибка | 13,28 | Итого | 21,00 | 32 074,86 | | | |
| Наблюдения | 22,00 | | | | | | |

| | *Коэффициенты* | *Стандартная ошибка* | *t-статистика* | *P-Значение* | *Нижние 95%* | *Верхние 95%* | *Нижние 95,0%* | *Верхние 95,0%* |
|---|---|---|---|---|---|---|---|---|
| Y-пересечение | -78,81 | 29,10 | -2,71 | 0,01 | -139,73 | -17,90 | -139,73 | -17,90 |
| GSP - 1 | 0,69 | 0,11 | 6,49 | 0,00 | 0,47 | 0,92 | 0,47 | 0,92 |
| IP | 1,11 | 0,36 | 3,09 | 0,01 | 0,36 | 1,87 | 0,36 | 1,87 |

| *Наблюдение* | *Предсказанное GSP* | *Остатки* |
|---|---|---|
| 1,00 | 31,86 | 5,98 |
| 2,00 | 30,21 | 10,48 |
| 3,00 | 34,11 | 11,69 |
| 4,00 | 40,59 | 0,21 |
| 5,00 | 44,31 | 0,40 |
| 6,00 | 50,50 | -8,21 |
| 7,00 | 51,43 | -6,69 |
| 8,00 | 52,11 | -13,78 |
| 9,00 | 47,01 | -20,32 |
| 10,00 | 42,93 | 0,54 |
| 11,00 | 56,63 | 8,88 |
| 12,00 | 76,48 | 15,78 |
| 13,00 | 92,58 | -5,77 |
| 14,00 | 93,02 | -6,92 |
| 15,00 | 95,94 | 2,38 |
| 16,00 | 109,67 | -28,63 |

| *Наблюдение* | *Предсказанное GSP* | *Остатки* |
|---|---|---|
| 17,00 | 102,82 | 15,89 |
| 18,00 | 128,42 | 23,45 |
| 19,00 | 134,26 | -3,47 |
| 20,00 | 124,58 | 12,01 |
| 21,00 | 131,67 | -12,68 |
| 22,00 | 122,19 | -1,22 |