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CURRENT MACROECONOMIC DEVELOPMENT CONSTANTS OF TECHNOLOGICALLY LEADING COUNTRIES

KONSTANTE TRENUTNOG MAKROEKONOMSKOG RAZVOJA U TEHNOLOŠKI RAZVIJENIJIM ZEMLJAMA

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Abstract:
The studies on the dynamics of economic growth of most countries make it possible to assert that the development of technologically advanced countries in modern conditions is characterized by a certain constant, which can be considered as "current macro-constant of development." The article indicates their relevance and justifies the statement that "current macro-constants of development" can and should be a landmark of strategic development of all countries aspiring towards equal economic and political relations with the technologically leading countries. The paper identifies the conditions under which the group macro-constant of development appears, evaluates particular values of macro-constants in different countries and presents a number of advantages of long-term growth measure in the absolute values of the change rate of the annual income per capita of the country compared to other indicators

Conclusions are based on the analysis of long-term data of total GDP, GDP per capita and their derivatives in most countries of the world. The analysis of statistical information has been done by using the well-known econometric methods - correlation, regression and cluster analysis. The practical importance of the results is characterized by the opportunity for their long-term use (15 years or more), forecasting and strategic planning of growth rates, both for companies and countries within industrial and economic policies.

Key words:
firm, forecasting, development, economics, constant, clustering.

Apstrakt:
Studije koje se bave proučavanjem dinamike ekonomskog razvoja velikog broja zemalja govore u prilog tvrdnji da razvoj tehnološki najrazvijenijih zemalja u savremenim uslovima karakteriše određena konstanta, koja se može smatrati trenutnom konstantom makroekonomskog razvoja. Ovaj rad ukazuje na njihov značaj i ističe da bi one trebalo da budu orijentir strateškog razvoja bilo koje zemlje koja pretenduje da ima isti ekonomski i politički položaj kao i najrazvijenije tehnološke zemlje.

Ovaj rad prikazuje uslove pod kojim se grupa konstanti makroekonomskog razvoja pojavljuje, procenjuje određene vrednosti konstanti makroekonomskog razvoja u različitim zemljama i ukazuje na prednosti dugoročnog rasta apsolutnih vrednosti stope promene godišnjeg prihoda po glavi stanovnika u odnosu na druge pokazatelje.

Zaključci se izvode na osnovu analize dugoročnih podataka ukupnog bruto nacionalnog dohotka, njegove vrednosti po glavi stanovnika i njegovih derivata u većini zemalja sveta. Analiza statističkih podataka sprovedena je korišćenjem dobro poznatih ekonometrijskih metoda-korelacije, regresije i analize klastera. Praktična vrednost rezultata ukazuje na mogućnost njihove dugoročne upotrebe (15 godina ili više), kao i na mogućnost prognoziranja i strateškog planiranja stope rasta, kako za kompanije tako i za zemlje u okvirima industrijske i ekonomske politike.

Key words:
preduzeće, predviđanja, razvoj, ekonomija, potencijal, konstanta, grupisanje.

INTRODUCTION

The history of coexistence of different countries is characterized by a continuous rivalry. It has moved into the sphere of technological progress over the last haf century. Long-term leadership of a country in the technological race is provided by high long-term growth of its development. The characteristic of this development, in the case of clarifying its stability at significant period of time, can be an important benchmark of development for firms in the competitive rivalry.

The analysis of economic development dynamics of major developed countries suggests that over the next 15 - 20 years their development potential can be characterized by some quantitative indicator. This is an average value of their growth rates, which, in specially identified constraints, is not time dependent.

Our research of dynamics of the largest countries - the world's technological leaders, allows advancing and defending the following statement. After reaching a certain level of development, conventionally, the entrance to the post-industrial period, acceleration of development of large technologically advanced countries is characterized by some constants. They are conveniently called "current macro-constants of development."

According to the available sources, the concept of "macro-constants of development" is currently not used in the theory (Kitov, 2009; Knyaginin & Schedrovitskiy, 2004), or in the practice of industrial policy (Pimenov, 2011; Potapova & Tolkachev, 2006; Rodrik, 2010). Indeed, there is a reliably known inverse characteristic of countries - a high rate of instability of their development. The process of verifying the existence of instability is very simple. It is enough to look at the dynamics of interest growth rates changes of aggregate GDP or GDP per capita of any of the developed countries. For instance, the dynamics of the annual GDP and GDP per capita in Japan between 1961 and 2010 (Figure 1) shows not only the changes at times of percent growth rates change in GDP from year to year, but also a constant declining trend of annual percentage growth.

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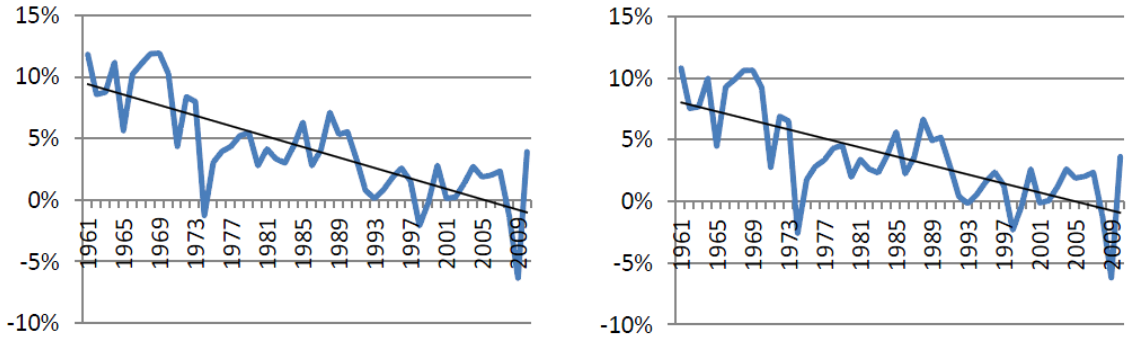

Figure 1. The tendency of interest growth rates change of aggregate GDP (1) and GDP per capita (2) in Japan.

However, it can be stated that conceptually similar studies were conducted by Anglo-American economist Angus Maddison [10]. He showed that there are two different trajectories of development. The first trajectory - A - characterizes countries that grow with a constant low average annual rate, but when considering the growth in large periods of time, the result is high.

The second trajectory – B – indicates that there are countries that are growing, making sometimes serious leaps, but whose average growth rate is not high.

In such a situation, information that the economies of several countries characterized by some measure of development that does not change over a sufficiently long period will be of special interest. That is a characteristic that can be called current macro-constant.

We assume that micro-constant is statistically not changing for a long enough period of time (in 15 -40 years) characteristic of the country's development.

The existence of macro-constants is identified by value of the correlation (determination) coefficient between the tested factor and time. If the correlation coefficient is statistically equal to zero, it can be argued that the value of the test factor (Y) is independent on time (X).

Evaluation of insignificance of determination coefficients is checked by the value of Student's T-criteria. The empirical values of T-statistics were calculated for all considered dependencies and comparison showed that T <Tcrit. So, the null hypothesis was confirmed that the correlation between Y and X is absent.

Usually, economic studies aim to find the dependence of some economic characteristics on time. The problem solved in this case is inverse. It should be shown that at certain stages of global technological development in certain countries, a characteristic can occur which is not time dependent.

In the process of searching for current macro-constants, most common performance indicators in most countries of the world[1] were examined. Changes over time were examined for such macro-characteristics of development as the absolute size of GDP, its growth, the percentage of annual GDP growth, as well as all of these characteristics per capita and per person employed in the country's production. There are nine characteristics in total.

In order to prove the existence of current macro-constants in our chosen group - the major developed countries of the world, three stages of analysis have been implemented.

During the first stage, we clarified which of the nine examined characteristics can claim the status of macro-constants of development and what criteria should be used to select countries whose development is characterized by current macro-constants.

During the second stage, it was shown under what conditions or restrictions current macro-constants arise.

At the third stage, it was shown that current macro-constants, identified on the basis of the previous period, completely, or with a small correction, is stored further.

At the first stage of the analysis, firstly by visual inspection of the development dynamics graphs, all nine macro development characteristics outlined above have been tested. In total, more than 200 countries were tested. As a result, three most interesting candidates were selected. This is the percent of GDP growth - as the most commonly used measure of macro development, the absolute value of GDP per capita and the value of the absolute growth of GDP per capita per year.

One of the few arguments in favor of the constants of macroeconomic development existence can be a persistent increase in the percentage of USA GNP for sufficiently large historical period. So, for almost hundred years from 1890 to 1986, USA GNP growth is well described by a curve with a constant percentage growth per year - 3.2% (Fisher et al, 1995).

However, the statistics show that the leading economies of the world are not capable of maintaining a constant percentage growth rate on a long-term time interval. The modern practice of major developed countries often demonstrates that the interest rates of growth are significantly reduced over time (for example, after a wave of industrialization). This is evidenced in case of Japan, Great Britain, France, and Germany (a typical example is shown in Figure 1).

The second indicator: absolute value of GDP per capita - is closely linked to the value of time and, therefore, cannot claim to be a non-changeable with time constant.

Last contender for the current macro-constants of development role is an absolute increase in GDP per capita**.** The studies have shown that this indicator could claim to be the current macro-constant, but under certain conditions.

The second phase of the analysis determines under what conditions or criteria of selection the current macro-constants of development appear.

For selection of the countries in which macro-constants of development may emerge among all countries in the world (214 countries), three criteria were used.

The first selection criterion limits the minimum size of the country's population. According to our empirical evaluation, this boundary is 3,000,000 people. This number is also close to the minimum population of the leading countries of the world which are included in the annual statistical and analytical reports of the US Bureau of Labor Statistics (BLS). Thus, the mini-

1 Static data taken from the site of the World Bank – http://data.worlbank.org/indicator/...

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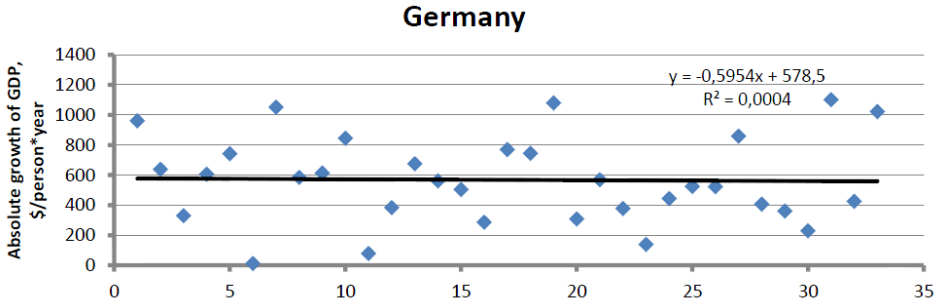

Figure 2. GDP per capita growth in Germany during stable economic development periods (1969 -2011). (Temp.=0,111 < Tcrit.= 2,744; insignificant with 99% probability)

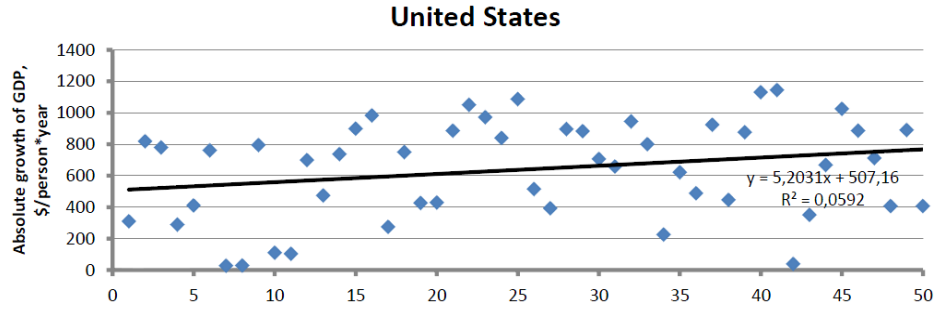

Figure 3. GDP per capita growth in United States during stable economic development periods (1948 -2011). (Temp.=1,739 < Tcrit.= 2,682; insignificant with 99% probability)

mum population for all countries included in the report of the BLS 2011, equals to 3.4 million people (Ireland). Taking a small reserve and rounding down to a million, we get a boundary of at least 3 million people.

The second criterion selects the countries included in the "post-industrial period" of development. Justified in (Asaliev & Yusim, 2012)[2] the lower boundary of the "post-industrial period" beginning for a country is to achieve values of real GDP per capita of 15,000 in constant 2005 US dollars. This boundary is considered necessary, but not sufficient to ensure that the country has entered a "post-industrial period" of development.

The third criterion selects the countries included in the "post-industrial period" of development for a long period of time - not less than 15 years ago.

Upon applying the above-given criteria to all countries of the world, 13 countries were left for further consideration: Australia, Belgium, Canada, France, Germany, Greece, Italy, Japan, South Korea, the Netherlands, Spain, the UK and the USA.

In order to isolate a period of stability (normal) development from the entire set of data, economic crises and stagnations, as well as three years with the highest rate of economic growth were excluded.

A typical graph of the linear approximation of the absolute growth of GDP per capita with time in a stable economic growth is shown in Fig. 2. The figure shows the dependence, or rather the lack of dependence of the absolute growth in GDP per capita with time counter (consecutive years of stable economic development). This proved to be statistically insignificant by t-test value R^2.

Information and base trend of the USA development for the longest period of post-industrial development among all countries of the world is shown in figure 3.

Visually, theoretical regression line in Figure 3 shows an increase in the growth rate of GDP per capita. However, strictly statistical conclusion on the increase of GDP growth rate over time is not confirmed. This also confirmed to be statistically insignificant by t-test value R^2. Similar results were obtained for all 13 countries.

Almost zero value of the coefficient of determination R^2 allows us to conclude that for the countries that meet the three above defined criteria of selection, the absolute increase in per capita GDP in normal economic situation does not depend on time. That is, as a result of the second stage of the analysis, it can be stated that in the post-industrial period, only in large countries and in ordinary conditions constants of macroeconomic development are manifested.

The authors highlight the existence of macro-constants, that arise, firstly, in major advanced countries of the world, and secondly, during the crises. The three-year period with a maximum development speed is excluded from the array of information.

However, it should be mentioned that in most cases macro-constants appear during the crisis period and most productive years, almost without exception.

The task of the third stage of the dynamics of the developed countries analysis is to show, that macroconstants, identified in

2 In article it was shown that in all countries, the level of well-being which is higher than 16 - 20 thousand dollars (PPP) per capita (in dollars, 2005), the ratio of the GDP obtained by the exchange rate and purchasing power parity, is less 1. Moreover, the difference in the values of GDP is relatively small, about 20%. And in all countries, the level of welfare is lower than specified, the ratio of the two values of GDP significantly greater than 1, and they differ from each other ten times stronger. Analysis of the causes of the manifestation of these trends leads to the conclusion that they are caused by the transition countries with a GDP higher than 16 - 20 thousand dollars per capita in the new technological order, in other words, in the post-industrial period of development.

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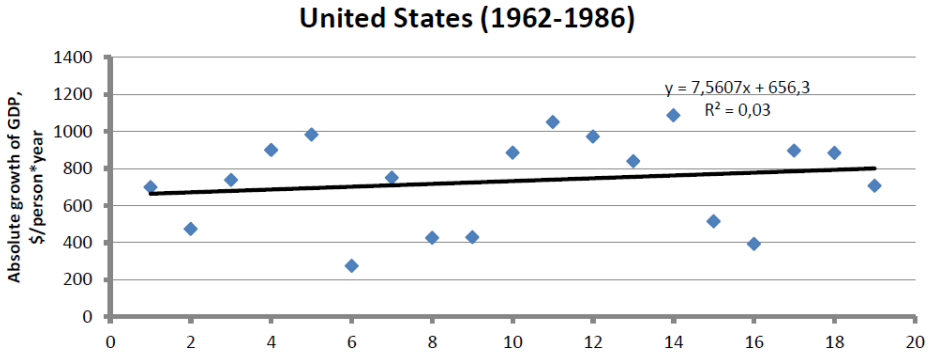

Figure 4. The GDP per capita growth in the US for 25 years in a period of stability economic development (initial). (Temp.=0,725 < Tcrit.= 2,898; insignificant with 99% probability)

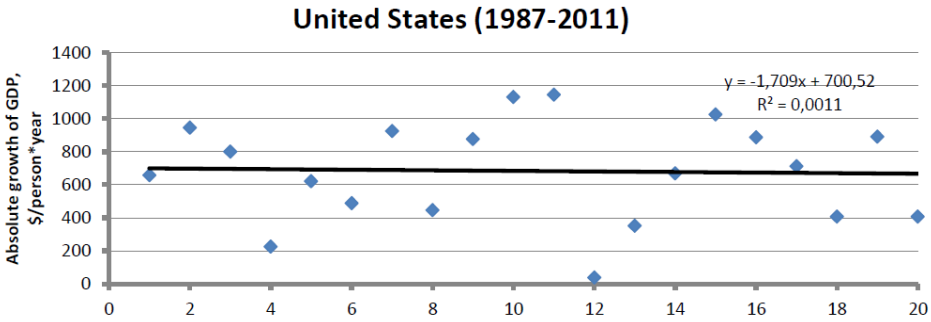

Figure 5. The GDP per capita growth in the US for 25 years in a period of stability economic development (follow). (Temp.=0,14 < Tcrit.= 2,878; insignificant with 99% probability)

the previous years in initial form or with a small correction are stored in the following. This task is solved by a comparison of the USA macroconstants identified for two consecutive periods of 25 years (see figure 4, 5).

The development rate of the country, formed in 1962-1986, which amounts to 732 USD / person per year (see figure 4), seems to be a good forecast of the development rate for the next 25 years. The forecasts for such a long period are sufficiently accurate.

The actual average growth rate in the subsequent period amounting to 683 USD / person per year (see figure 5) differs from the growth rate in the previous period (732 USD / person per year) by 6.7%.

It also means that under normal conditions of post-industrial development, a constant that characterizes the long-term development potential of the major developed countries arises.

The Table 1 shows the values of current macro-constants of developed countries, measured in three time periods - for the entire period of post-industrial development, for the first 20 years upon achieving a period of post-industrial development and for the last 20 years following the period of post-industrial development.

In the accepted interpretation of the concept of "current macro-constants of development" we can say that this indicator quantifies the strategically important characteristic of the country's economy. In other words, when having a high value of current macro-constant, the given country is able to efficiently develop during a long period in any market fluctuations. Moreover, with the low value of current macro-constant, the country cannot ensure high growth rates even under favorable circumstances.

Country	Current macro-constants, 2005, US $ per cap.		
	All post-industrial period	First 20 years of post-industrial period	Last available 20 years of post-industrial period
United States	639.8	505.4	683.7
Japan	555.6	611.0	531.3
Germany	568.4	588.7	561.7
France	412.5	406.7	400.8
United Kingdom	601.0	523.4	696.3
Italy	435.6	499.2	422.7
Korea	837.4	837.4	837.4
Spain	468.4	477.2	461.0
Canada	549.3	515.6	591.5
Australia	514.7	477.9	560.3
Netherlands	592.8	571.7	615.3
Belgium	500.6	516.7	500.0
Greece	462.5	462.5	462.5
Russia	*616.6*		

Table 1. Current macro-constants of major developed countries.

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In addition, due to the fact that the lion's share of the country's GDP is created by firms, management of the companies in terms of hard, and most importantly, dynamic competition, both at domestic and global market, gets in the form of current macro-constants a clear development guideline. If the development pace of the company is lower than the current macro-constant, i.e., below the national average, the firm will lose the competitive battle. If it is higher, the firm assures its prosperity and stability in the market.

That is an objective benchmark that firms could use for strategic assessment of its competitiveness and can serve as a long-term constant of macroeconomic development of major technologically advanced countries of the world.

Modern Russia is formally not on the list of highly advanced technological countries according to the above accepted criteria. Yet, taking into account the interests of the Russian reader, Table 1 shows the estimated value of the average GDP growth of Russia in the available statistics, from 2000 to 2013[3], not including the crisis period.

Current macro-constant of a country is a kind of an average indicator of its business development. Therefore, if a company wants to remain successful and competitive, it is important to follow the pace of development that is not lower than average. In addition, the identified values of current macro-constants can and should be an essential reference point for the industrial policy of technological development, or aspiring to this status of any country, regardless of its size.

For example, the real status of the world's countries such as Lithuania, Latvia, Poland, Serbia will be precisely determined by the over time speed of macro development in the country's economy.

Within the framework of this approach, we tested a hypothesis that the cluster or a group of similar countries will have its own macro-constant.

The assessment of the hypothesis of independent current macro-constant's origin within the group of countries was made using the methods of cluster analysis. In test mode, the clustering was performed on the same set of 13 advanced countries, as highlighted above.

We tested the hypothesis that under certain combination of values of the mean absolute increase in GDP per capita and the number of years of post-industrial period (separate clustering was also considered with a factor of population), groups of countries whose current macro-constants are close to each other can be distinguished.

In order to test this hypothesis, we used the standard hierarchical methods[4]:

1. Single linkage- also known as the "method of the nearest neighbor".
2. Complete linkage- also known as the "method of a distant neighbour."
3. Pair-group method using arithmetic averages.
4. Pair-group method using the centroid average.
   - Unweighted.
   - Weighted (median).
5. Ward's method.

The evaluation of homogeneity of the analyzed sample and their division into clusters was done using the Euclidean[5] metric.

In all cases, the criterion for division into clusters is the rule «3σ». That means that the cluster separation occurs within three standard deviations from the number of all distances between the objects. If the distance between the objects does not exceed three standard deviations, they are considered to belong to the same cluster.

However, none of the clustering methods was initially thought to have given satisfactory results. The countries linked consecutively to each other in the dendrogram, and the rule of «3σ» combined them into one group and one "omitted point" - South Korea. The example of dendrogram or icicle diagram is shown in Figure 6.

Vertical axis of Figure 6 shows the distance between the objects. Connecting lines in the first step shows the objects that are closest to one another ("the letters П"). In subsequent steps, the same lines attach the next nearest objects to those already connected. This occurs as long as the last object of observation is attached to one figurative cluster.

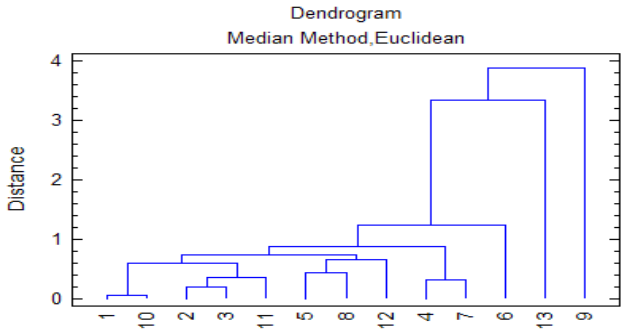

Figure 6. Clustering with population consideration (3σ = 3,7)

The abscissa presents the number of countries participating in the process of clustering: 1) Australia; 2) Belgium; 3) Canada; 4) France; 5) Germany; 6) Greece; 7) Italy; 8) Japan; 9) the Republic of Korea (South Korea); 10) the Netherlands; 11) Spain; 12) the United Kingdom; 13) the United States of America.

The fact that the countries are not divided into groups most likely points to their real uniformity. The total value of intra-group macro-constant is 540 USD.

CONCLUSION

The studies conducted allow drawing several general conclusions. Firstly, we can say that the developmental milestones of technologically most advanced and largest countries in the world, at least at the stage of (contingently called) post-industrial development, are characterized by a specific constant of development: the growth rate of GDP per capita (USD /person per year). Secondly, there is only one group of major advanced countries whose development under ordinary conditions is characterized by intra-group macro constant. Thirdly, the group constant of countries' development - the world's technological leaders can and should become a benchmark for strategic development of both countries and companies within the current period.

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3 Data for 2012 and 2013 were obtained by recalculating the values of GDP per capita dollars 2011 in dollars 2005.

4 The above methods are available, for example, the statistical package Statdraphics.

5 Euclidean distance between p and q is the length of the segment . In Cartesian coordinates, if p = (p1, p2, ..., pn) and q = (q1, q2, ..., qn) two points in Euclidean space, the segment length of p q is equal:

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