Volume IV/ Issue 2(8)/ Summer 2009

THE EVOLUTION OF REAL GDP PER CAPITA IN DEVELOPED COUNTRIES

Ivan O. **KITOV**
Russian Academy of Sciences, Moscow, **Russia**
ikitov@mail.ru

Abstract:
The growth rate of real GDP per capita is represented as a sum of two components – a monotonically decreasing economic trend and fluctuations related to the change in some specific age population. The economic trend is modeled by an inverse function of real GDP per capita with a constant numerator. Statistical analysis data from 19 selected OECD countries for the period between 1950 and 2007 shows a very weak linear trend in the annual increment of GDP per capita for the largest economies: the USA, Japan, France, and Italy. The UK, Australia, and Canada show a larger positive linear trend in annual increments. The fluctuations around relevant mean increments are characterized by practically normal distribution (with Levy tails). Developing countries demonstrate annual GDP per capita increments far below those for the studied developed economies. This indicates an underperformance in spite of large relative growth rates.

Keywords: economic development, economic trend, business cycle, GDP per capita

JEL Classification: E32, O11, O57

1. Introduction

Real economic growth, as expressed by Gross Domestic Product, has been studied quantitatively since Simon Kuznets' works on accounting of national income and aggregate factor inputs in the 1950s. Hodrick and Prescott (1980) introduced a concept of two-component economic growth – an economic trend and a deviation or business cycle component. The trend component is responsible for the long-term growth and defines economic efficiency. In the long run, the deviation component of economic growth has to have a zero mean value. In 2004, Kydland and Prescott received the "Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel" for the study of "the driving forces behind business cycle", what demonstrates the importance of the best understanding of the economic growth processes and the explanation of the two-component behaviour.

Kydland and Prescott (1982), along with many other researchers, have proposed and studied exogenous shocks as the force driving fluctuations of real growth. Their research during the last 25 years has revealed numerous features of principal variables involved in the description of the economic growth. There are many problems left in the theory of economic growth. The study of Galor (2005) describes the evolution of income per capita since an epoch of Malthusian stagnation and discusses the process, which induced the transition to the current sustained economic growth in developed countries. It looks for a unifying theory accommodating various period of growth and based on solid micro foundations. This paper validates our model (2006) describing the evolution of economic trend in developed countries during the most recent period since 1950. We do not use any sophisticated technique of signal extraction, as proposed by Pedregal (2005), who explored two linear trend models with a nonlinear forecast function. In our framework, the long-term forecast is not limited in time since it is based on a constant annual increment of real GDP per capita. Obviously, our model does not allow an exponential growth path, unlike that presumed in the trend extracting procedures developed by Pollock (2007), and the business cycle has no upper limit to its frequency. We also test the trend forecast using actual time series.

Musso and Westermann (2005) analyzed the long-term evolution of real GDP and supply-side factors in view of potential interest from policymakers. There is a vivid discussion of the influence of modern information and communication technologies on productivity. The model we have developed denies any direct impact of such supply-side factors and roots the long-term economic growth in the rigid and hierarchical structure of income distribution [Kitov, (2008)]. This also means that externalities, including international ones, play no defining role in real economic growth contrary to the hybrid model propose by Klenow and Rodriguez-Clare (2005). We agree with Acemoglu and co-authors (2005), who stress the importance of economic institutions for real economic growth, and

Jones (2005) elaborating on the input of intellectual achievements. There should be basic economic institutions, which "determine the incentives of and the constraints on economic actors, and shape economic outcomes" and a developed framework for testing and implementation of modern ideas - technical, economic, social, etc. However, when established, the institutions are notable to provide any additional input to real economic growth.

In line with Jones and Manuelli (2005), we see the cause for the difference in per capita GDP between developed and developing countries in knowledge, or human capital, and its production and dissemination. The countries that have weaker systems of property rights, or higher wasteful taxation and spending policies, will tend to grow more slowly due to a strong bias of the distribution and evolution of personal incomes [Kitov, (2005)].

In this paper, only the evolution of annual increment of real GDP per capita in developed countries is modeled and no special econometric (statistical) techniques are used to validate the concept. The paper includes numerous figures, since the study is a purely empirical one and the best way to present quantitative results related to time series is to visualize them in form of time history. However, our model of real economic growth has been also tested for cointegration [Kitov, I., Kitov, O., Dolinskaya, S., (2007)]. A wide range of specific econometric tools developed for the investigation of real economic growth is presented by Durlauf and co-authors (2005).

Kitov (2006) proposed a model with the growth of real GDP dependent only on the change in a specific age cohort in the population and the attained level of real GDP per capita. According to this model, real GDP per capita has a constant growth increment and the observed fluctuations can be explained by the population component change. In developed countries, real GDP per capita has to grow linearly over time, if no large change in relevant specific age population is observed. Relative growth rate of real GDP per capita has to be an inverse function of the attained level of real GDP per capita with a potentially constant numerator for developed economies. This paper is devoted to validation of the model using GDP per capita and population data for some selected developed countries. Our principal purpose is to demonstrate the possibility to decompose GDP per capita growth into the two components.

2. The model and data

According to [Kitov, (2006)], there are two principal sources of the per capita GDP growth in the USA – the change in 9-year old population and the economic trend related to the measured GDP per capita level. The trend has the simplest form – no change in absolute growth (annual increment) values and is expressed by the following equation:

$$dG/dt = A \quad (1)$$

where G is the absolute value of real GDP per capita, A is a constant. The solution of this equation is as follows:

$$G(t) = At + B \quad (2)$$

where $B=G(t_0)$, t_0 is the starting time of the studied period. Hence, evolution of real GDP per capita is represented by a straight line if the second factor of growth has no cumulative effect. As discussed below, only some developed countries are characterized by a significant influence of the second factor.

Then, relative growth rate can be expressed by the following equation:

$$dG/dtG = A/G(t) \quad (3)$$

Equation (3) indicates that the relative growth rate of per capita GDP is inversely proportional to the attained level of real GDP per capita, i.e. the observed growth rate should asymptotically decay to zero with increasing GDP per capita. On the other hand, the lower is the level the higher the growth rate. This inference might be a potential explanation for the concept of economic convergence. Relative growth rate must be higher in less developed countries, but the observed absolute gap in GDP per capita can not be overcome in future [Kitov, (2005)] unless some non-economic forces will disturb current status quo.

When considering real GDP per capita, one has to bear in mind the importance of a correction to be applied to the per capita GDP values related to the difference between the total population and population of 16 years of age and above, as discussed in [Kitov, (2006)]. Only this economically active population should be considered when per capita values are calculated. By definition, Gross Domestic Income, which is equivalent to GDP, consists of the personal incomes obtained by the population of 15 years of age and over and corporate income, the corporations owned by the same population category. Thus, one can treat the published (original) readings of GDP per capita as biased and to be corrected for (multiplied by) the corresponding population ratio, i.e. the ratio of the total population and the population above 14 years of age.

Figure 1 shows the population ratio as obtained from the OECD population data (2006). When absent the missed readings are substitute with those for the closest year from above. Between 1955 and 2003, the ratio is characterized by an overall decrease with a slight increase demonstrated by some countries in the 1960s and 1970s. Currently, all the countries have the ratio below 1.3. In the 1950s, the ratio was above 1.3 for all the countries except Austria and Belgium. The last country met the decrease is Ireland - the drop started in 1980. Italy has had the lowermost ratio since 1970.

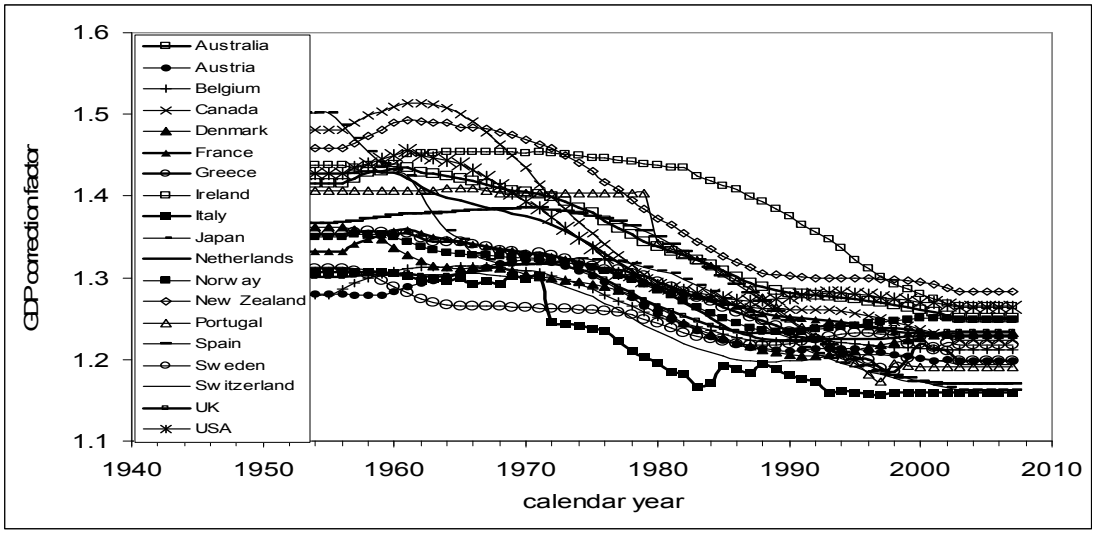

Figure 1. Evolution of a ratio of the total population and the population above 15 years of age for the selected OECD countries (2006).

High values of the ratio mean a relatively underestimated real GDP per capita and vice versa. A general feature of the curves is that after a small increase observed for some countries in the 1960s and 1970s the ratio decreases into the range between 1.3 and 1.15 in 2000. Thus the earlier GDP per capita values are relatively underestimated and the later readings are relatively overestimated. The longest period of a high ratio is observed in Ireland. Italy has a consistently low ratio. In the USA, the ratio drops from 1.45 in 1960 to 1.27 in 2003.

The decreasing ratio implies that the GDP per capita readings during the period between 1950 and 1970 are underestimated compared to those during the last 35 years. The larger is the total drop in the ratio during the entire period of the observation, the larger is the overall correction. In the study, the original and the corrected per capita GDP values are used and compared.

A cross-country comparison implies that GDP per capita is measured in the same currency units. There are two principal possibilities to reduce national readings of GDP per capita to some common scale: to use currency exchange rates or purchase power parities. In the study, we use the latter approach and data provided by the Conference Boars and Groningen Growth and Development Center (2008). For developed countries, two estimates of GDP per capita level are available: measured in 2007 US dollars, for which "EKS" purchasing power parities have been used and that expressed in 1990 US dollars, with the conversion at "Geary-Khamis" PPPs. These PPPs are obtained from the Organization for Economic Co-operation and Development (2005). Being an improvement on the previous dataset, the "EKS" PPPs are considered as more accurate and reliable. Amplitude of the

change induced by the transition from "Geary-Khamis" PPPs to those of "EKS" is evaluated for the counties under investigation. This change potentially characterizes uncertainty in the GDP per capita readings obtained with the PPP approach.

Only nineteen from thirty OECD member countries are analyzed. The selected countries meet some general criteria: 1) large economy size denominated in dollars; 2) continuous observations during the period between 1950 and 2007; 3) high level of real GDP per capita. According to the size criterion, small economies like Iceland and Luxembourg were excluded. When applied, the second criterion rejects Germany from the consideration. The third criterion has excluded such countries as Turkey, Poland and other new EU members. Finland and Korea have been excluded from the analysis with no reason at all.

Figure 2 illustrates the variations induced by corrections made for the "EKS" PPPs compared to those of "Geary-Khamis". The original values of the mean increment of GDP per capita ("EKS" and "Geary-Khamis") for every country are normalized to the corresponding values for the USA. The normalized values are consistently higher for the "EKS" PPPs, i.e. the GDP per capita values converted at "Geary-Khamis" PPPs were underestimated for all the countries. The difference varies with country and reaches 5% to 7% for Austria, Norway and Ireland. For the largest developed economies, the mean increments of GDP per capita expressed in 2007 dollars converge to that for the USA. We use the GDP per capita readings expressed in 2007 US dollars are used in the study. The only exception is the statistical description of the observed fluctuations.

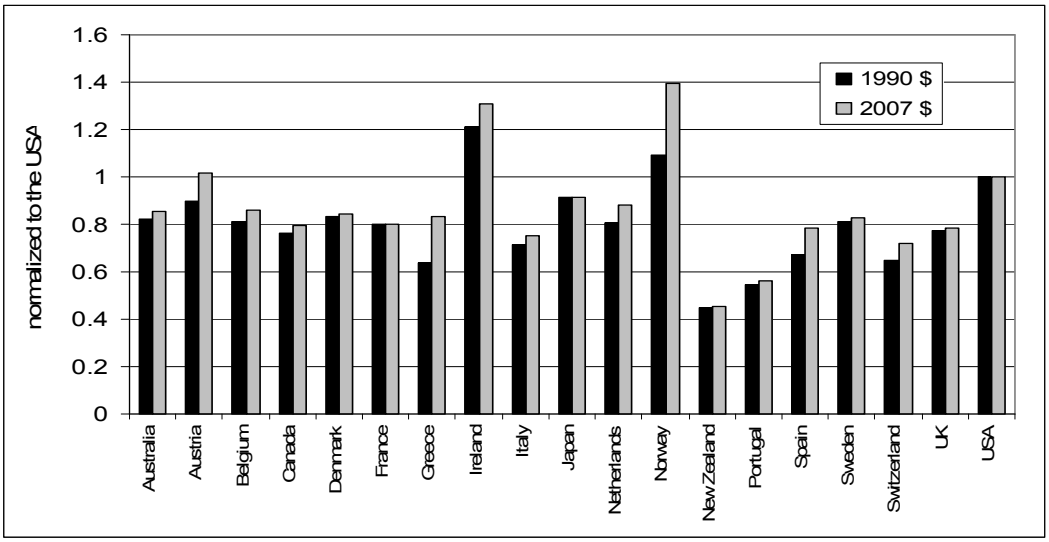

Figure 2. Comparison of two real GDP per capita data sets denominated in 1990 and 2002 dollars (2008), for which "Geary-Khamis" and "EKS" purchasing power parities have been used respectively.
Original values of the mean GDP per capita increment are normalized to the corresponding value for the USA. The normalized values are consistently higher for the "EKS" PPPs (except Canada), i.e. the GDP values converted at "Geary-Khamis" PPPs were underestimated for all the countries. The difference varies with country, however, and is larger than that between the original and corrected for the population values presented in Figure 3.

Figure 3 displays the averaged values of the annual GDP per capita increments denominated in 2007 US dollars for the period between 1950 and 2007. The original and corrected for the population ratio values for the nineteen countries are normalized to corresponding values for the USA. As before, this procedure allows a homogeneous comparison of the mean values. The corrected normalized values can be lower or higher than those for the original set. The sign of the change depends on the overall behavior of the population ratio during the entire period compared to that for the USA. Ireland, Austria and Norway are excellent examples of the originally underestimated GDP per capita values. Canada, Italy and Spain demonstrate an opposite behavior.

It is worth noting that the correction for population is of lower magnitude than that induced by the transition from the "Geary-Khamis" PPP to "EKS" one. The population correction is important,

however, because it reduces potential uncertainty in the decomposition of the GDP per capita growth into two components. The purchase power parity approach to the estimation of national GDP also needs some further improvements. Magnitude of the difference between the GDP per capita values converted at "Geary-Khamis" and "EKS" PPP sets is too high to believe that all the problems with the homogeneous and accurate cross-country comparison are resolved.

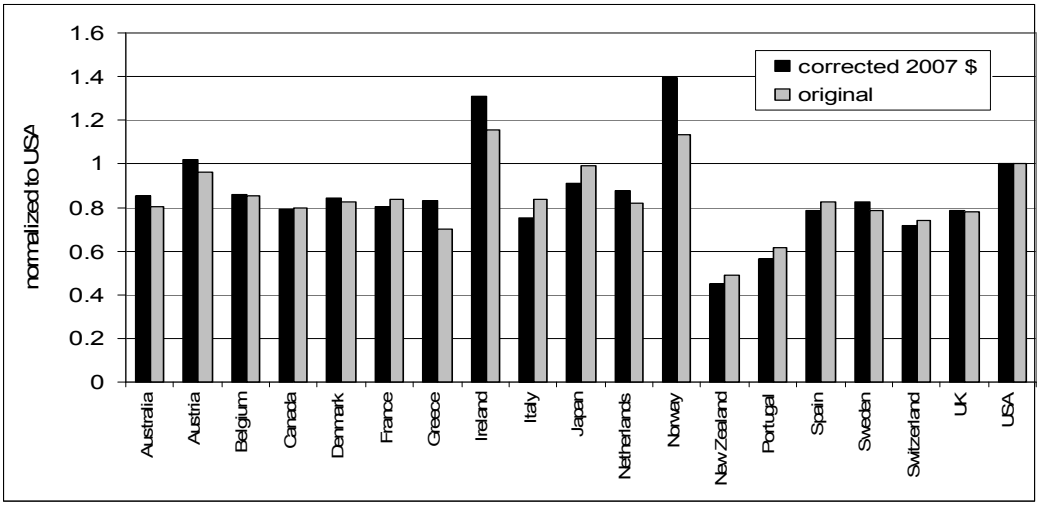

Figure 3. Comparison of the original and corrected for population mean values of GDP per capita increment expressed in 2002 dollars converted at "EKS" PPPs [2]

The values are normalized to the corresponding value for the USA for a homogeneous representation. There are countries with overestimated (where the corrected value is below the corresponding original value) and underestimated (opposite) values relative to the USA.

3. The trend in real GDP per capita

The nineteenth selected countries are presented in alphabetic order. Figure 4 shows the evolution of the annual increment of real GDP per capita for Australia as a function real GDP per capita for the original and corrected GDP readings. This is a natural visualization of Eq. (1). The population corrected values are connected by a solid line in order to highlight the evolution in time. Open circles represent the original measurements. In addition, three straight lines are drawn in the Figure. Bold line corresponds to the averaged increment of the population corrected GDP per capita for the entire period between 1950 and 2007. As a constant, this line is parallel to the x-axis. Second and third (solid) lines represent two linear regressions corresponding to the original and corrected data. Relationships for the regressions are also shown in the Figure; the lower one is always associated with the original GDP readings.

The model introduced in Section 2 implies that the mean value line has to coincide with the linear regression line, when the population induced component has a zero mean value. The observed fluctuations of the annual increment of GDP per capita are either predetermined or random ones, depending on the characteristics of the defining population changes. In terms of statistics, one could expect a normal distribution of the population changes. The number of processes affecting birth rate, mortality rate, and migration processes is very large and, according to the central limit theorem, leads to an approximately normal distribution of the deviations. However, random fluctuations of population do not presume the unpredictability of real economic growth. For example, the number of nine-year-olds in the USA, which are proved to be the driving force of the growth [Kitov, I., Kitov, O., Dolinskaya, S., (2007)], can be counted with any desirable accuracy. Statistical features of the increment are discussed later in Conclusion.

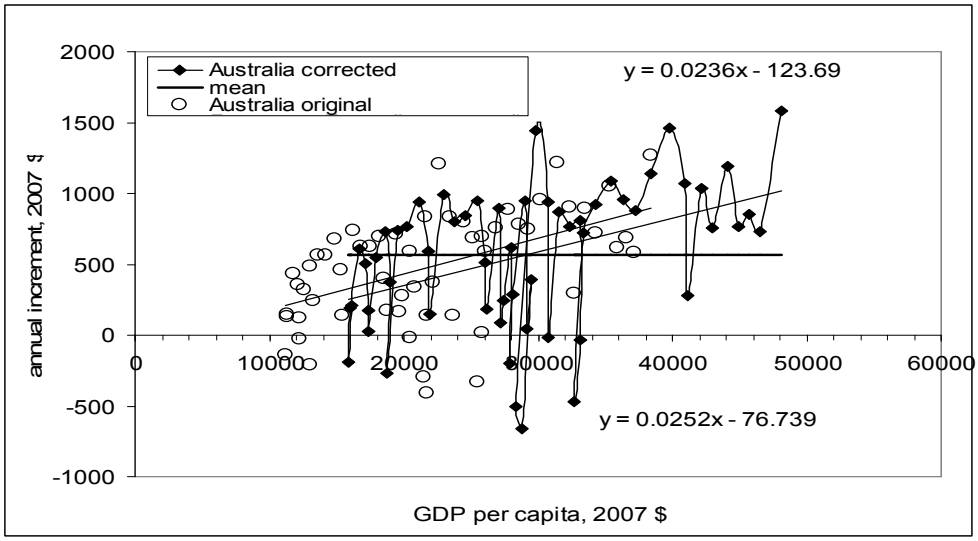

Figure 4. Increment of real GDP per capita (2007 $) vs. real GDP per capita in Australia for the period between 1950 and 2007

Two sets are presented - the original (open circles) and corrected for population (filled diamonds). Consequent values of the latter set are connected by a solid line for illustration of the evolution in time. Bold line represents the mean value of $565 for the population corrected data set. Two solid lines show linear regressions lines. The corresponding linear relationships are displayed, the lower relationship being associated with the original data set. The linear regression lines differ from that for the mean value.

Australia demonstrates a divergence between the regression lines and the mean value line. A positive linear trend (~0.01) has to indicate a more intensive growth of the specific age population in recent years compared to that in the 1950s and 1960s. This effect is observed also for other English-speaking countries under investigation. The average increment is $478 (2007 $). The largest deviation from the mean is -$1218. The linear trend coefficient is lower for the corrected data set than that for the original set. This is a common feature for almost all studied countries. Table 1 lists the mean values and regression coefficients for all country sets: the original and population corrected ones, converted at the "EKS" and "Geary-Khamis" PPPs.

Alphabetically, the following country is Austria. The average increment value for Austria is $570. This value is well above that for Australia. A prominent feature is an almost horizontal regression line for the population corrected data set with the slope of 0.006. Effectively, the mean line and the regression lines coincide, as predicted by (1). For the original set, the slope is slightly larger (0.009). Therefore, one can conclude that relevant specific age population has changed only marginally during the last 57 years (between 1951 and 2007). The largest fluctuation amplitude relative to the mean value was -$740 in 1993. In relative terms, such a deviation from the mean value is almost 4%.

The average increment in Belgium is $480 and the regressions are characterized by a positive linear trend that is higher for the original readings. The largest deviation from the mean value was -$790 in 1975. As in other countries, the negative deviations are usually sharp and deep somehow compensating longer periods of a weaker positive growth. The last twenty years have been relatively successful for Belgium. One can expect a compensating decrease, as was observed between $22.000 and $25.000.

Table 1. Mean values of GDP per capita increment for the original and population corrected readings in 1990 $ (converted at Geary-Khamis PPPs) and 2007 $ ("EKS" PPPs). Coefficients of linear regression (trend) are given for the original and corrected GDP per capita values denominated in 2007 $.

	original, 2007 $	corrected, 2007 $	trend original, $2007	trend corrected, $2007	original, 1990 $	corrected, 1990 $
Australia	478	565	0.025	0.024	317	374
Austria	570	675	0.009	0.006	347	410
Belgium	480	571	0.012	0.010	312	371
Canada	470	526	0.014	0.011	311	348
Denmark	473	560	0.012	0.014	322	381
France	443	531	0.0006	-0.003	305	365
Greece	469	553	0.022	0.018	248	292
Ireland	698	867	0.054	0.052	445	553
Italy	444	500	-0.003	-0.006	289	326
Japan	535	606	0.0001	-0.005	368	417
Netherlands	502	583	0.011	0.010	316	367
Norway	754	924	0.019	0.020	408	500
New Zealand	264	300	0.028	0.031	181	205
Portugal	323	373	0.008	0.004	216	249
Spain	457	522	0.014	0.007	269	307
Sweden	464	549	0.021	0.022	313	371
Switzerland	426	477	-0.010	-0.015	265	297
UK	431	520	0.026	0.026	292	353
USA	557	663	0.017	0.017	383	457

Canada is similar to Australia and is characterized by similar mean increment ($470), but lower trend coefficients (slopes). An important feature of the fluctuations in the Canadian economy is their amplitude reaching -$1391 from the average value – the highest among the studied economies. The two deep drops at $26000 and $31000 compensate a relatively successful history during the rest of the period.

Denmark and France (Figure 5) are similar in terms of weak linear trend, positive for Denmark and negative for France. Corresponding mean increments are also close - $473 and $443, respectively. If to neglect the slight slope observed in France, one can conclude that the observed fluctuations are characterized be a zero mean. Because of a limited time period of the observation, the trend values can be affected by side or truncation effects. The shape of fluctuations differs among the countries but longer periods of observations are necessary for suppressing the side effects.

The Greek economy had some hard years in its history but the last ten years were very successful. The economy is characterized by a relatively the mean increment of $469. The overall performance is expressed in an elevated linear trend. This country can not be used as an example of a developed economy maximizing its performance over years. A more prominent example of an excellent recovery gives Ireland with corresponding results displayed in Figure 6. A slow start was quickly compensated and the last twenty years of an extremely fast growth resulted in the leading position in the world economy with the mean increment $698. There are some doubts, however, that future will be so successful. Such a long and quick growth always ends up in a depression. This was observed in Japan and is related to the long-term decrease in the number of the specific age population [Kitov, I., (2006)]. Ireland has managed to increase birth rate for a very long period and has an age structure similar to that observed in Japan 20 years ago. The population distribution is currently peaked near 20 years with the defining age of 18 years. The years to come will demonstrate only decrease in the defining age population.

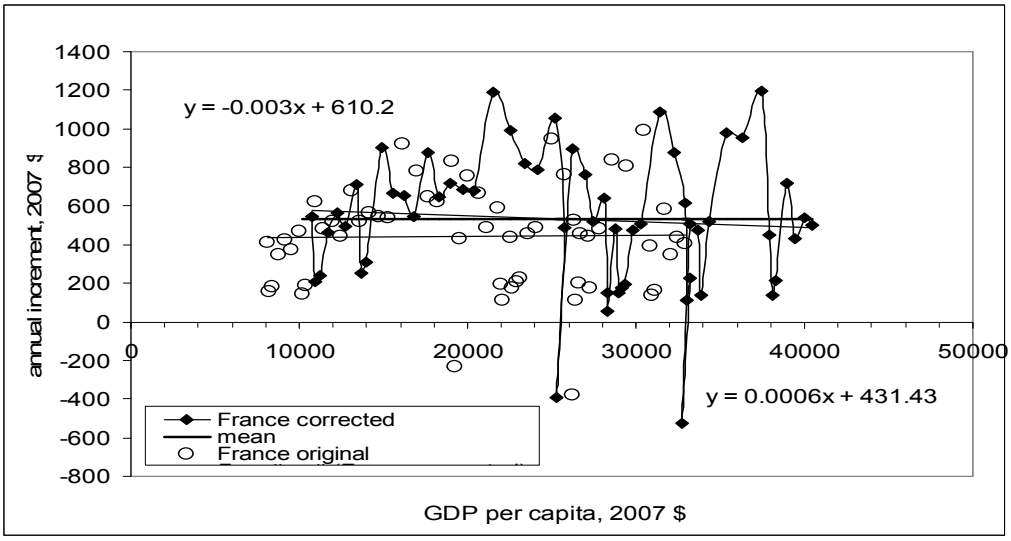

Figure 5. Same as in Figure 4 for France

The mean value is $443. The linear regression line for the original GDP values is practically parallel to the mean value line. The line for the corrected data set is characterized by a negative trend coefficient (-0.003).

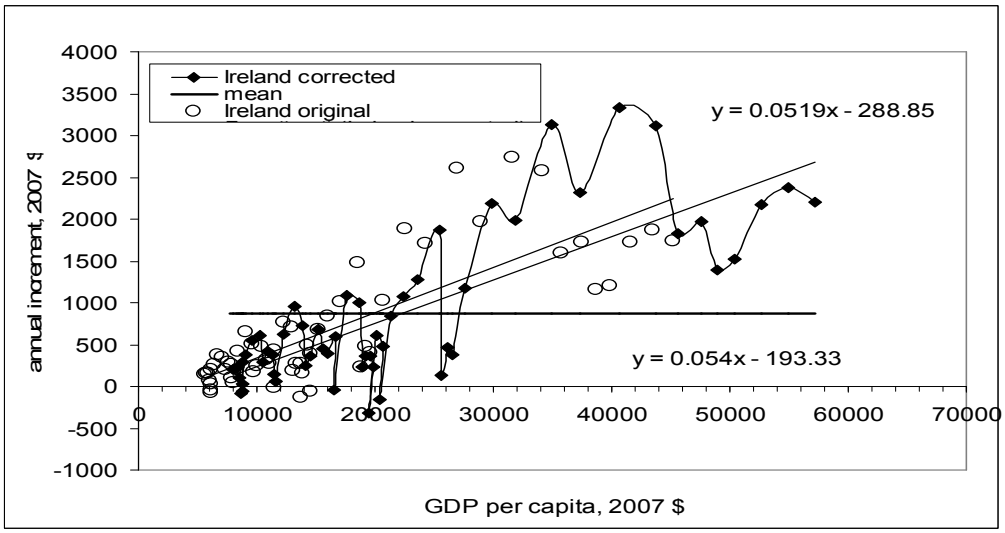

Figure 6. Same as in Figure 4 for Ireland

The mean value is $698. The growth of the real GDP per capita is outstanding during the last twenty years. There is a slight downward tendency during the last four years, however.

The next three countries are Italy, Japan, and Netherlands. Results for them are represented in Figures 7 through 9 and are similar to those for France – a weak positive or negative linear trend and the mean increment between $444 for Italy and $535 for Japan. These are also good examples of a zero linear trend in the history of GDP per capita increment.

Norway and New Zealand are very similar the pair Ireland/Greece. From the point of view of the current study they do not provide any additional insight into the GDP increment behaviour. Portugal is between Greece and New Zealand. Spain and Sweden are similar to other large European economies with a weak linear trend of the per capita GDP increment and the mean value around $450. Switzerland (Figure 10) had a decreasing increment which can be potentially explained by a permanent decrease in the young population portion.

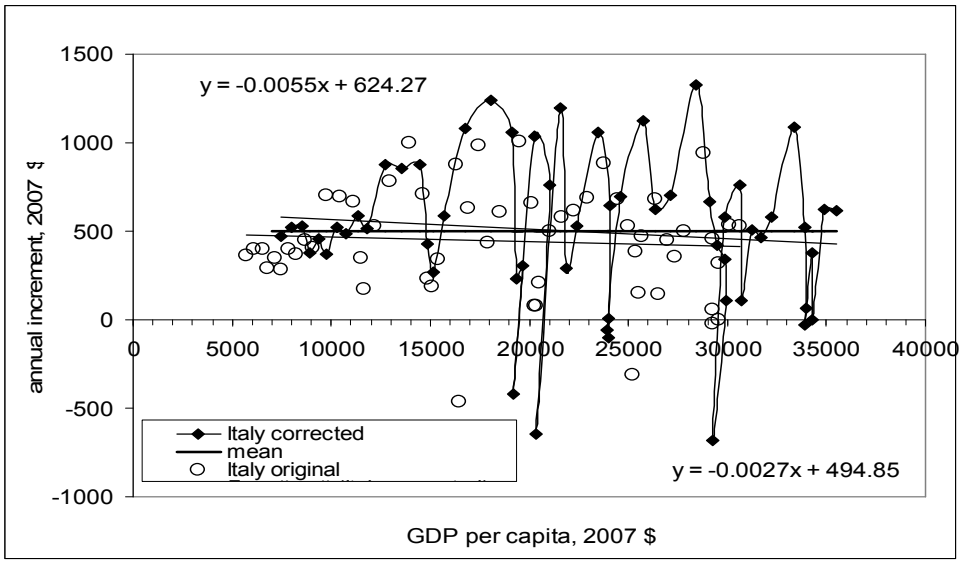

Figure 7. Same as in Figure 4 for Italy

Both the corrected and original GDP values produce a negative trend, the former being of a larger absolute value. Nevertheless, the lines are very close to those for the mean values.

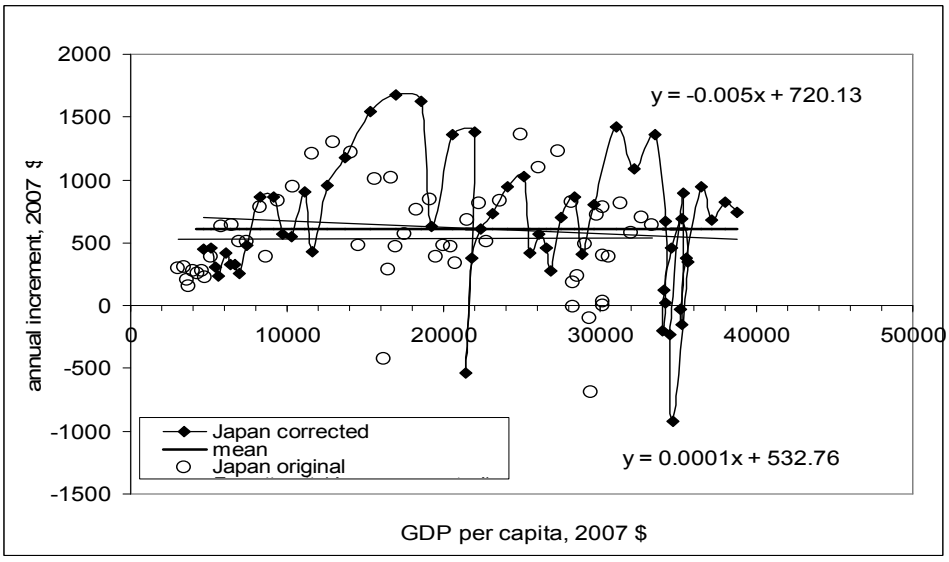

Figure 8. Same as in Figure 4 for Japan. The original linear regression line is parallel to x-axis. The corrected line is characterized by a negative trend. There were two periods of very quick growth between $12000 and $20000 and between $28000 and $33000. Both ended in periods of a low (sometimes - negative) growth rates. Same effect might be expected for Ireland.

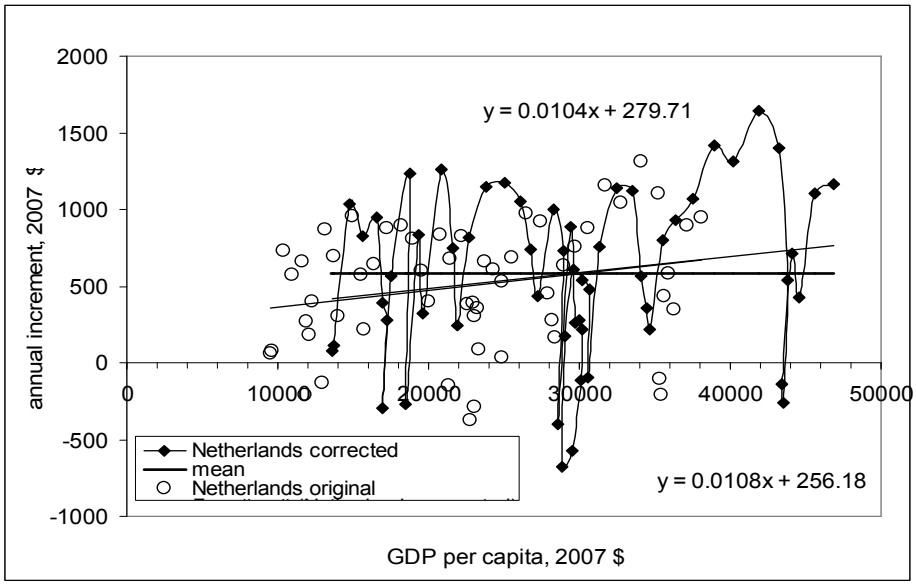

Figure 9 - Same as in Figure 4 for Netherlands. The mean value is $502.

The UK and USA differ only in the mean increment value: $431 and $557, respectively. Positive linear trend is relatively high for the both countries. The US trend is well explained by the change in the nine-year-old population [10]. When corrected for the integral nine-year-olds change between 1950 and 2007, the US mean value is only $462, i.e. in the tight group of the largest economies. The UK statistical agencies do not provide accurate population estimates for the entire period, but from the mean value one can assume that there was no significant increase in the number of nine-year-olds.

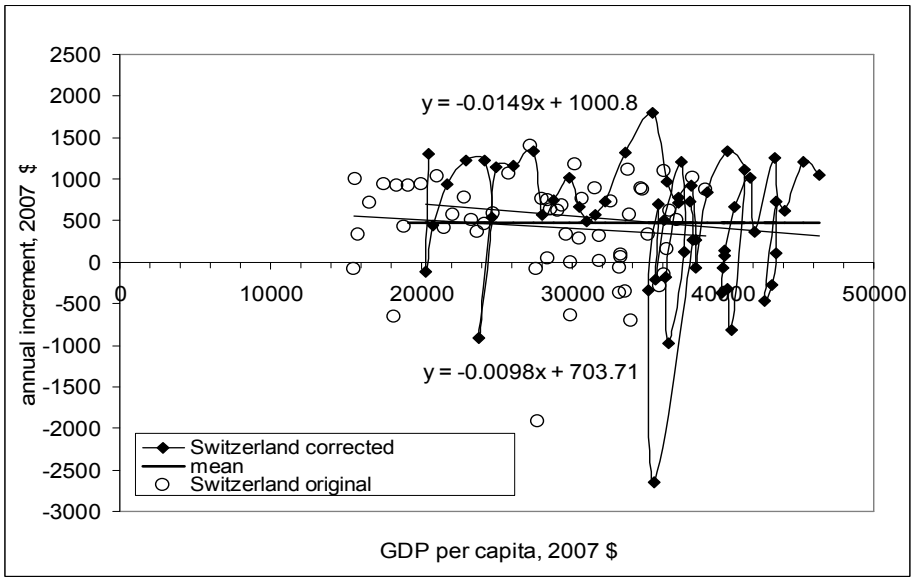

Figure 10. Same as in Figure 4 for Switzerland
The mean value is $426. The country shows a consistent negative trend in the GDP per capita annual increment.

4. Conclusion

The nineteen countries show various types of behaviour of GDP per capita during the period between 1950 and 2007. There are countries with a slightly negative trend of GDP per capita increment: France, Italy, Switzerland, and Japan. Despite the common negative trend the countries have quite different mean increments. Austria is characterized by an almost zero trend and has a large

mean value. One can count it in the club.

A majority of European countries including Belgium, Denmark, Greece, Netherlands, Portugal, Spain, and Sweden are characterized by a slightly positive trend. The mean increment value varies, however, from of $323 for Portugal to $502 in Netherlands. Greece and Portugal showed a weak growth in the beginning of the period, but have recovered to a normal pace. There are two outstanding European countries – Ireland and Norway. Their mean increment is very high, but the countries have a strong downward tendency during the last three to five years. One can expect them to follow the path of Japan – from a strong growth to a long period of stagnation. At the same time, the countries are small. Their influence on the world economy is negligible. Thus, we also deny the countries to influence our analysis of economic trend.

The studied English-speaking countries are characterized by a large positive trend, but should be separated into two groups. The first consists of only one member – New Zealand. The principal characteristic is a very poor performance during the entire period. The second includes Australia, Canada, the UK, and the USA. The mean increment for them is between $431 and $557.

The mean increment in the USA corrected for the total nine-year-olds change between 1950 and 2007 equal to 0.82 is only $557*0.82=$462. The mean value obtained with the correction is by about $100 lower than that without the correction. The accurate population estimates available for the USA allowed explanation for not only the trend, but also the largest fluctuations. Smaller deviations from the mean value are compatible with the characteristic noise of the population estimates and are not so well correlated. For France, this factor is 0.97. The author failed to find reliable data for the other countries under study.

We do not consider the countries with known political and economic problems in the past – Greece, Portugal, New Zealand. Overall, they demonstrated consistent underperformance. Switzerland surprisingly joins the club of weak growth, but the reason might be of a different nature – the decreasing population of the defining age.

The above analysis has revealed that the largest developed economies are characterized by very close values of the mean GDP per capita increment for the period between 1950 and 2007. The mean value defines the long-term economic trend. Thus, the countries are characterized by the same trend level not depending on the attained level of GDP per capita.

A different but important question is: What are statistical properties of the residual growth – fluctuations? In order to answer the question, frequency distributions in $200 (2007 $) wide bins were constructed for each of the original and population corrected data set. The obtained distributions are then approximated by normal distributions with (trail-and-error) parameters fit mainly the segment near corresponding centres.

Figure 11 shows the frequency distribution for the original GDP per capita readings as obtained using “EKS” PPPs. Amplitude of the fluctuations is measured from corresponding mean value for each of the nineteen countries. The distribution is very close to a normal one with the mean value and standard deviation of $0 (the mean value is subtracted) and $400, respectively. The approximating normal distribution is shown by open circles. Both tails of the real distribution are above the predicted values of the normal distribution. This effect is often observed in natural sciences and is associated with inaccurate measurements, limited amount of readings, and sometimes with action of some real factors. One can also suggest that the Levy distribution with heavy tails could better presents the observed tails.

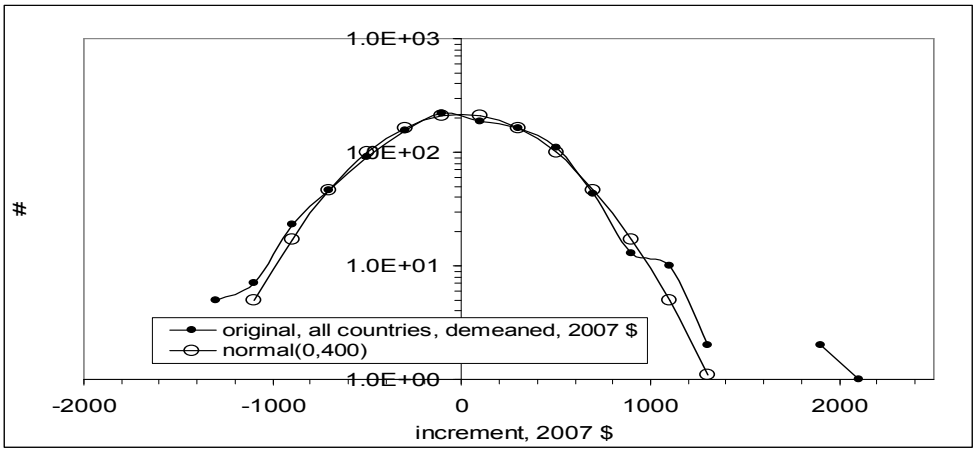

Figure 11. Frequency distribution of the GDP increments for the complete (19 countries) original data set. The GDP values are obtained at "EKS" PPPs. The mean values are extracted from corresponding increments resulting in a zero central value of the distribution. Normal distribution with a zero mean value and standard deviation of $400 is presented by open circles. The normal distribution is very close to the actual one, at least in the central zone.

Figure 12 displays the same curves for the population corrected GDP per capita. Due to relatively narrower bins ($200 original not equal to $200 corrected for the population ratio) the actual distribution is characterized by higher deviations from a normal distribution. At the same time, the central part of the actual distribution is still very close to the normal one.

From the above results, a successful large economy might be characterized by GDP increment randomly fluctuating around some constant level. It is very probable that the fluctuations are normally distributed. This hypothesis is supported by the above observations and the Jarque-Bera test. After removing five largest (in absolute sense) readings, i.e. the outliers likely belonging to some Levy distribution, from each side of the distribution in Figure 11, one can obtain skew ness of -0.095 and kurtosis 3.08. Hence, JB=1.86 for the set of 1073 readings instead of 1083 original readings. Critical JB value at 5% confidence level for two degrees of freedom is 5.99. The obtained JB < 5.99 and one cannot reject the null hypothesis that the data are from a normal distribution. The full set of 1083 readings is characterized by skew ness of 0.035 and kurtosis of 3.48, with JB=11. Obviously, the heavy tails affect the normality test.

There are numerous possibilities to improve convergence of the results if to obtain accurate population data and to enhance the PPP conversion procedure. The mean increment value ~$450 for all countries is a good starting point for calibrating the PPP methodology and evaluation of long term economic performance for developed countries.

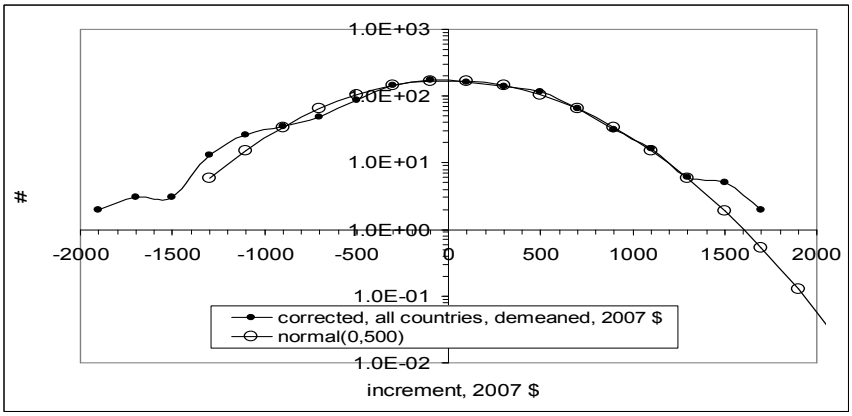

Figure 12. Same as in Figure 11 for the population corrected data set. Larger deviations from the normal distribution are observed

Developing counties also can be evaluated according to their compliance to the principal characteristic for developed countries. One may often hear about a "fast" growth of some developing countries like China and India. There is not criterion, however, to compare their growth rate to that expected in the USA, for example, at the same level of economic development. Using the mean increment, one can easily estimate the pace for any developing country compared to that observed in the developed world. For China, India and the (former) USSR, the increment evolution compared to that for France is represented in Figure 13. One can see that the countries demonstrate increments far below the French mean value (1990 dollars are used as the only available for all the studied countries). Having an intention to catch up a developed economy, any developing country has to analyze its time history of the GDP per capita increment [Kitov, I., (2005)]. No deficiency has to be allowed on the way to prosperity because any gap is created forever judging from the history of such successful developed countries as the USA, France and others.

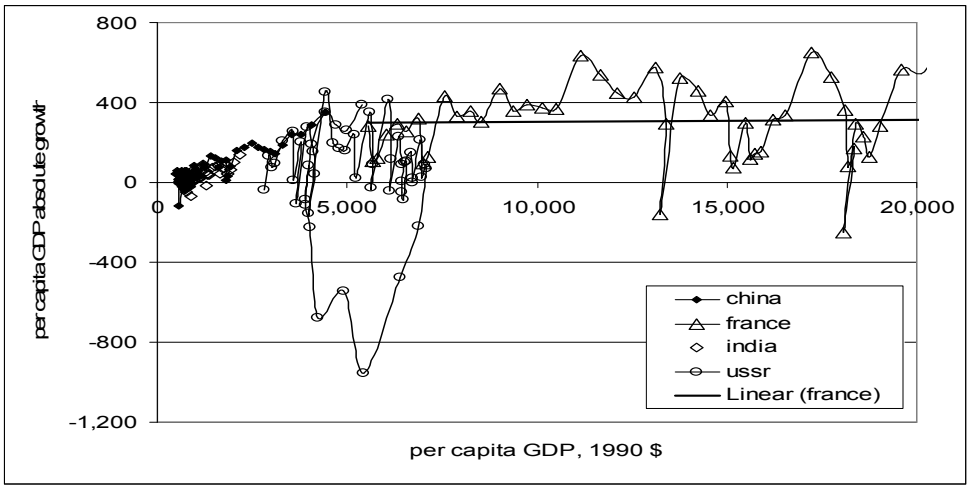

Figure 13. GDP per capita increment for China, India and the (former) USSR for the period between 1950 and 2007 compared to that for France.

GDP is expressed in 1990 $, the only available estimates for the non-OECD countries. India is far below the mean increment for France, but China has just reached the pace of leading developed countries. For the period of existence (between 1950 and 1990 in the study), the USSR was only about a quarter as effective as France.

5. References

[1] Acemoglu, D., Johnson, S., Robinson, J., (2005), *Institutions as the fundamental cause of long-run growth*, in: *Handbook of Economic Growth*, Eds. Aghion, P., Durlauf, S., Elsevier, North-Holland.

[2] The Conference Board and Groningen Growth and Development Centre, (2008), *Total Economy Database*, retrieved November 2008, http://www.conference-board.org/economics/database.cfm

[3] Durlauf, S., Johnson, P., Temple, J., (2005), *Growth econometrics*, in: *Handbook of Economic Growth*, Eds. Aghion, P., Durlauf, S., Elsevier, North-Holland.

[4] Galor, O., (2005), *From Stagnation to Growth: Unified Growth Theory*, in: *Handbook of Economic Growth*, Eds. Aghion, P., Durlauf, S., Elsevier, North-Holland.

[5] Hodrick, R., Prescott, E., (1980), *Postwar U.S. business cycles: an empirical investigation*, Discussion Paper, Northwestern University.

[6] Jones, C., (2005), *Growth and ideas*, in: *Handbook of Economic Growth*, Eds. Aghion, P., Durlauf, S., Elsevier, North-Holland.

[7] Jones, L., Manuelli, R., (2005), *Neoclassical models of endogenous growth: the effects of fiscal policy, innovation and fluctuations*, in: *Handbook of Economic Growth*, Eds. Aghion, P., Durlauf,S., Elsevier, North-Holland.

[8] Kydland, F., Prescott, E., (1982), *Time to Build and Aggregate Fluctuations*, in: *Econometrica*, *Econometric Society*, Vol. 50(6), pages 1345-70, November.

[9] Kitov, I., (2005), *Modelling the transition from a socialist to capitalist economic system*, MPRA Paper 2740, University Library of Munich, Germany, http://ideas.repec.org/p/pra/mprapa/2740.html

[10] Kitov, I., (2006), *GDP growth rate and population*, Working Papers 42, ECINEQ, Society for the Study of Economic Inequality, http://ideas.repec.org/p/inq/inqwps/ecineq2006-42.html

[11] Kitov, I., (2006), *The Japanese economy*, MPRA Paper 2737, University Library of Munich, Germany, http://ideas.repec.org/p/pra/mprapa/2737.html

[12] Kitov, I., (2008), *Modeling the evolution of age-dependent Gini coefficient for personal incomes in the U.S. between 1967 and 2005*, MPRA Paper 10107, University Library of Munich, Germany, http://mpra.ub.uni-muenchen.de/10107/

[13] Kitov, I., Kitov, O., Dolinskaya, S., (2007), *Modelling real GDP per capita in the USA: cointegration test*, MPRA Paper 2739, University Library of Munich, Germany, http://ideas.repec.org/p/pra/mprapa/2739.html

[14] Klenow, P., Rodriguez-Clare, A., (2005), *Externalities and growth,* in: *Handbook of Economic Growth*, Eds. Aghion, P., Durlauf, S., Elsevier, North-Holland.

[15] Musso, A., Westermann, T., (2005), *Assessing potential output growth in the Euro area*, European Central Bank, Occasional Paper Series, No 22.

[16] Organization for Economic Co-operation and Development, (2005). *Purchasing Power Parities 2002*, Paris, January 2005, http://www.oecd.org/department/html

[17] Organization for Economic Co-operation and Development, (2006), *Corporate Data Environment, Labor Market Statistics*, DATA, User Queries, January 8, 2006, http://www1.oecd.org/scripts/cde/

[18] Pedregal, D., (2005). *Trend models for the prediction of economic cycles*, in: *Review on Economic Cycles*, International Association of Economic Cycles, Vol. 3(1), December

[19] Pollock, D., (2007). *Investigation economic trends and cycles*, University of Leicester, Working Paper No. 07/17, November 2007.