



Munich Personal RePEc Archive

## **From socialism to capitalism: 1989-2007**

Kitov, Ivan

IDG RAS

28 April 2009

Online at <https://mpra.ub.uni-muenchen.de/14914/>

MPRA Paper No. 14914, posted 01 May 2009 04:56 UTC

# FROM SOCIALISM TO CAPITALISM: 1989-2007

Ivan O. Kitov

Institute for the Geospheres' Dynamics, Russian Academy of Sciences  
Leninskii prospect, 38/1, Moscow, Russia  
ikitov@mail.ru

## Abstract

*The transition of former socialist countries to capitalist economic system is modelled for the period between 1989 and 2007. The transition is entirely defined by three empirical parameters and the model describes only the evolution of real GDP per capita since the start of the disintegration of socialism. It is found that the transition has practically finished in many Central and Eastern European countries and their economic evolution is driven by forces associated with capitalist system. In the long run, the future evolution of the former socialist countries has to follow the same path as observed in other developed countries in the past. Even in the case of perfect economic performance, the studied countries will never catch up the most advanced countries. In Russia and some countries of the Former Soviet Union, the transition process has not been completed.*

**Key words:** socialism, capitalism, transition, economic modelling, GDP per capita

**JEL Classification:** O12, P10, P27

## 1. Introduction

Several Central and East European countries joined the European Union in 2004 and some in 2007. These countries had an almost 40 year history of economic development governed by rules of socialist system. The countries of the Former Soviet Union (FSU) had an even longer period of socialism reigning in economic life. From the point of view of economics, it is of theoretical and practical interest to understand qualitatively and quantitatively what happened during these socialist years and during the transformation from socialism to current state. How far are these countries from a pure capitalist state and do they still bear some (economic) elements of socialism?

The socialist system has been disintegrating since 1989. This period is often referred to as the transition from socialism to capitalism and is characterized by some specific features, qualitative and quantitative, different from those observed in pure socialist or pure capitalist social systems. At any moment between the start of the process and its end, current social state is not just a mechanical sum of the socialist and capitalist portions. Economy is an important and inevitable component of modern society. Obviously, the isolation of economic behavior from other social phenomena and processes is not entirely feasible. Nevertheless, some quantitative relationships can show a high level of statistical reliability and, thus, be useful for the description of the sophisticated transition process. Moreover, any reliable relation might serve as a framework for quantitative and qualitative analysis and a solid basis for wider discussions and interpretations.

This paper demonstrates that such measured macroeconomic variable as real GDP per capita can be represented as a straight sum of two independent components: socialist and capitalist ones. In other words, one can predict separately the input of socialist and capitalist sub-systems to the overall GDP per capita. Unlike in phase transition processes observed in physics, for example, ice/water transition at  $0C^{\circ}$ , where the behavior of components is pre-determined by mass and energy conservation laws, the transition from socialism to capitalism permits a degree of freedom for both sub-systems. There must be some interaction and coordination between the processes of the socialist system disintegration and the construction of capitalism. Undoubtedly, pleasant features of capitalism attract people still living under the socialist economic rules of income earning; we consider personal income distribution as one of the most important, but likely not the only, process defining the difference between the economic systems; and force them to "jump off the cliff" into free market. On the other hand, some cumulated social guarantees and benefits provided by the old socialist system often prevail, and some people are very reluctant to drop out of the system of social care. Therefore,

one can expect different types of individual and social behavior. Quantitatively, there is an absolute barrier between the systems in a given country: the number of people who have left the socialist system must not be *less* than the number of people who have entered the capitalist one. Our model obeys this “conservation” law.

The understanding of specific features and relationships created by the (unique in the history of the mankind) process of the socialism/capitalism economic transition is a big challenge to economics as a science. One has to describe the observed processes and to introduce new terms and relationships, when necessary. The principal question is - Whether it is possible to quantitatively predict the evolution of measured macro-variables during the transition process, i.e. to express the evolution in a functional form, or whether the transition is fully stochastic and can be described only in statistical terms?

The main goal of this study is to develop a quantitative model of the transition based on simple assumptions about the economic state during the transition period, and to predict the behavior of real GDP per capita during the last 20 years and in the future. Apparently, the transition period in many former socialist countries (FSC) has been not completed. We use data from major, and likely reliable, statistical agencies and databases, which provide original measurement of population and GDP.

The transition process has attracted attention of many economists and practitioners from the very beginning. In 1992, Brada and King [4] argued that Czechoslovakia, Hungary, and Poland did not demonstrate commonly expected J-curve phenomenon, as induced by the initial decrease in economic performance and following gradual improvement due to the growth of the new system. They explained contemporary economic behavior by exogenous shocks to the balance of trade, to investments and to autonomous consumption. We think that this conclusion was premature and all FSC have demonstrated the J-curve behavior with a varying depth of the downturn.

Bezemer with co-authors [2] simulated the performance of the socialist and capitalist economic system using the difference in creation and destruction of contacts. Their general equilibrium model described the development of the technological gap between two systems and the transition process to capitalism. The authors also discussed how insider privatization and a civil society may impact on transition paths. The impact of foreign direct investment in post-communist society on economic performance was investigated by King [8] on the example of Hungary. Biegelbauer [3] suggested some measures aimed at proper usage of industrial R&D for full realization of economic potential of Hungary. In general, we do agree that transition paths differ between the former socialist countries and this effect can be related to various exogenous and endogenous forces. However, we would like to stress again that no of these forces can disturb the form of defining equations, only relevant coefficients are different.

Hoelscher [7] studied the evolution of income distribution and inequality during the transition change from socialism to capitalism and its effect on the overall performance. The following countries had been chosen: the Czech Republic, Hungary, Poland, and Russia with Germany taken as a benchmark. For the former three countries, income distribution remained relatively stable before and throughout the transition. Russia is characterized by a sharp increase in income inequality. In view of the importance of income distribution for the definition of economic system claimed above, this observation is in overall agreement with the behavior of real GDP per capita. Russia has been suffering a much deeper GDP downturn and a larger change in income distribution than that observed in Central European countries.

We have developed a microeconomic model for personal income distribution in developed countries and its evolution over time [9, 10]. When aggregated over the population above 15 years of age, the model transforms into a macroeconomic model describing evolution of GDP and per capita GDP. The macroeconomic model characterizes the capitalist system which has no artificial limit to personal income. The limitation on personal income is a characteristic feature of socialist economic system and might indicate the source of its relatively lower GDP growth rate compared to that in the capitalist system [11].

Nonlinear dynamic analysis carried out in [1] partially describes several episodes of discontinuity and turbulence during the transition process. We also observe some deviations of actual GDP trajectories from those predicted by our model. Apparently, these discrepancies need quantitative and qualitative explanation in a wider economic and social context. However, the deviations are measured relative to the predicted curves and it is the model what provides a reference. On the other hand, no model can pretend to exact prediction. The purpose of any model is to reduce the discrepancy to the lowermost possible level.

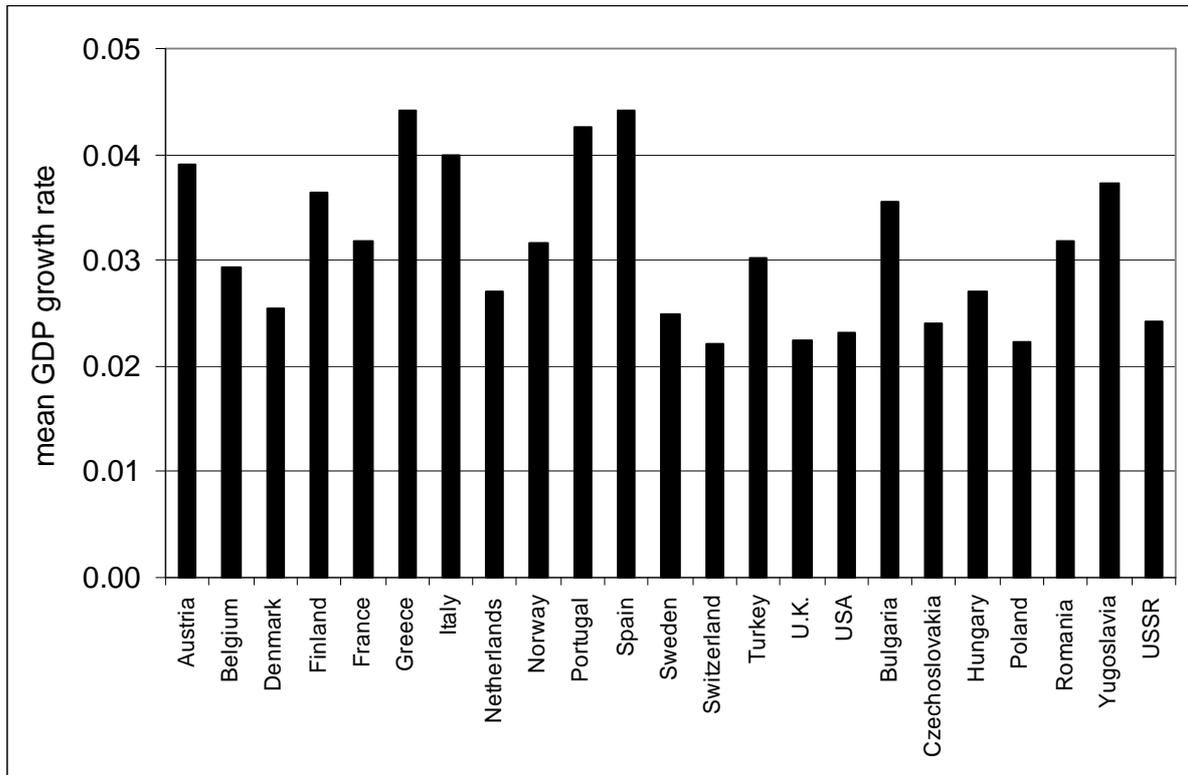
In this paper, we develop and validate a quantitative self-consistent model of the transition from a socialist to capitalist economic system. The model is comprehensive and describes the evolution of only one measured macroeconomic variable – real GDP per capita. Accordingly, at the given level of aggregation, the model disregards the influence of any other micro and macro-economic parameters: financial, institutional, social, demographic, and any other type of forces and/or processes on the evolution of GDP. However, empirical coefficients obtained during the modelling are country-dependent. This allows further interpretation of the coefficients as related to the parameters and processes. The functional form of the model, i.e. the set of defining equations, is the same for all former socialist countries. The development and validation of these equations is the principal target. Therefore, any interpretation of relevant coefficient in terms not related to the model is avoided. Nevertheless, we permit some brief discussion of the most prominent differences between the coefficients.

## **2. Per capita GDP in the former socialist countries between 1950 and 2007**

There is a question one can promptly formulate about economic efficiency of the socialist system during the period of existence: What was the average rate of economic growth in these countries compared to that in the most successful capitalist countries? In order to simplify such analysis and to avoid potential geographic effects, only European developed countries and the United States are used in this comparison. Figure 1 displays mean growth rates of real GDP per capita for the period between 1951 and 1989. Original GDP data were obtained from the Conference Board [6] and are represented by PPP estimates in 1990 (Gary-Khamis) dollars. The complete set of annual GDP readings spans the period from 1950 to 2007 for the OECD members and some former socialist countries. Hence, the start date for the growth rate readings is 1951. The end of the averaging period is chosen to separate two principally different periods - the socialist period and the transition to capitalism. This is not an exact date, however. When modelling, we derive the start date of the transition numerically and use for each country separately. Therefore, the year of 1989 is a watershed between two epochs. We also constrain the comparison to continuous observations only and do not consider the countries with any data gaps between 1950 and 1989. As a result, the U.S.S.R, Poland, Hungary, Czechoslovakia, Bulgaria, Yugoslavia, and Romania are the only countries qualified for the analysis.

At first glance, the former socialist countries demonstrated relatively high rates of growth in real GDP per capita. The average rate of growth in the FSC is measured between 2% and 4% per year and lies (except for Poland and the U.S.S.R) slightly above that in the most developed countries such as the U.S., Switzerland, the UK, etc. On the other hand, the average growth rate in less successful (in terms of per capita GDP) capitalist countries such as Greece, Spain, and Portugal exceeds 4% and is clearly higher than that in the FSC. This observation supports the concept of economic trend we developed in [12, 13] and briefly discuss in Section 3: the larger real GDP per capita the lower the level of economic trend. Thus, the concept implies that the rate of growth in the FSC was consistently lower than that expected from real GDP per capita in these countries from 1950 to 1989. In other words, the socialist countries heavily underperformed compared to capitalist countries in the same range of GDP per capita. A sad side of this underperformance consists in the permanence of the lag behind and the impossibility to catch up developed countries. The opportunity of high growth rate, as related to low GDP per capita, has been completely misused. In any case, the transition to capitalism plays a positive economic role: when all traces of socialism as an economic system are completely

removed from a given economy it has a chance to retain the cumulated lag (the difference in real GDP per capita) behind developed countries. Otherwise, the gap would have been increasing.



**Figure 1** - Average growth rate of real GDP per capita in some developed countries and the FSC for the period from 1951 to 1989. Greece, Portugal, and Spain have the highest average growth rate (Ireland is not presented). The rates in the FSC match the level in the countries with the highest GDP per capita.

Figure 2 displays the evolution of real GDP per capita in the FSC in comparison with the U.S., Japan, and Greece. During the entire period from 1950 to 2007, the FSC had GDP well below that in the U.S. in 1950. Greece represents a country which has been developing along the capitalist path but with some temporary difficulties, i.e. underperformed during extended periods. Except in the 2000s, the rate of economic growth in Greece was not high enough even to retain the absolute lag behind the U.S. In Section 4, we use the estimates of GDP per capita shown in Figure 2 in modelling the transition period. One can easily recognize J-curves after 1989 in the FSC.

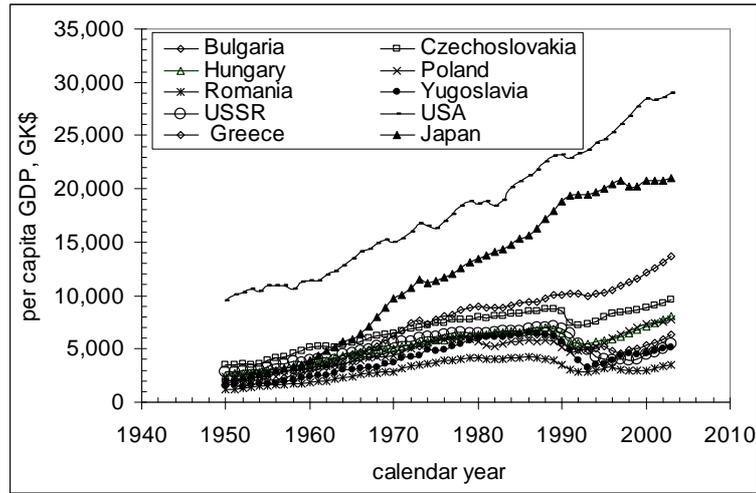
By definition, the GDP per capita is determined as total GDP divided by total population. Because only people of 16 and above years of age contribute to the GDP or counted by official statistics as such, the per capita GDP has to be corrected for the ratio of the population above 15 years of age to the total population. This correction was of high importance for the analysis of the evolution of GDP in the U.S. [12]. In many countries, relevant population data are not available, however. Therefore, the per capita estimates based on total population are used instead. This substitution may result in a slightly biased prediction of the growth rate.

The underperformance of the FSC during the socialist era is obvious if we consider the relationship between the growth rate of real GDP per capita and the attained level of GDP per capita. From this observation, the following question arises:

What is the maximum theoretical rate of GDP growth that one could expect in the FSC if they would have been developing as capitalist countries?

Or:

- How much did they lose during the socialist years?



**Figure 2** - Evolution of real GDP per capita in the FSC in comparison with that in the U.S., Japan, and Greece for the period from 1950 to 2007. The absolute gap between the U.S. and other countries (except Japan) has been increasing over time and demonstrating a more efficient economy in the U.S...

### 3. Macroeconomic model for the evolution of capitalist system

The growth rate of real GDP per capita can be accurately represented as a sum of two components – a monotonically decreasing economic trend and random fluctuations related to the change in the number of people of some country-specific age [11]. The economic trend is modeled by an inverse function of real GDP per capita with a constant (but varying among countries) numerator for the largest developed economies. A thorough statistical analysis for the period between 1950 and 2004 has shown a negligible linear trend, both positive and negative, in the annual increment of GDP per capita for the largest economies: the U.S., Japan, France, Italy, and Spain [13]. The fluctuations around these trends are characterized by a quasi-normal distribution with potentially Levy distribution for far tails.

Accordingly, the growth rate of real GDP per capita in the U.S. is defined by the following relationship:

$$dG(t)/(G(t) \cdot dt) = A/G(t) + 0.5dN_9(t)/(N_9(t) \cdot dt) \quad (1)$$

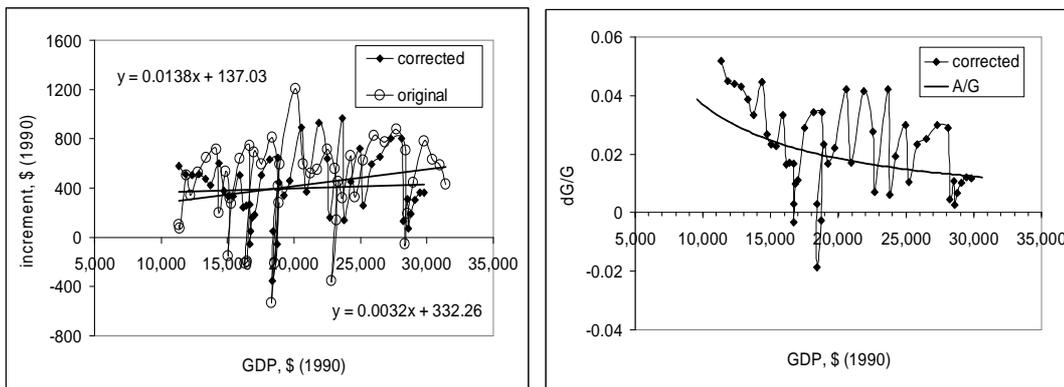
where  $dG(t)/(G(t) \cdot dt)$  is the growth rate of real GDP per capita,  $A$  is an empirical constant, which is country-specific for developed economies,  $N_9(t)$  is the number of 9-year-olds, which is the defining age for economic growth in the U.S.. As a consequence, the population independent economic trend,  $q(t)$ , is numerically equal to the reciprocal value of the GDP per capita:

$$q(t) = A/G(t) \quad (2)$$

Figure 3 depicts the evolution of the annual increment (left panel) and growth rate (right panel) of real GDP per capita in the U.S. between 1960 and 2007 as a function of GDP per capita. This is a natural representation for Eq. (1) because both variables (the increment and the rate) depend only on GDP per capita and the number of 9-year-olds. In developed countries, the latter has a zero cumulative input in the long run. Relevant population data were obtained from the Census Bureau [15, 16]. The correction for the population above 15 years of age discussed above was also applied to the original per capita GDP data.

In the left panel, there are drawn two linear regression lines associated with two different sets of annual increments. First set is the original one. Second set is the original one but corrected for the input of 9-year-olds. The regression line for the original curve is characterized by a relatively high positive slope  $=+0.014$ . This slope indicates that the annual increment increases with increasing GDP per capita. For the corrected curve, the regression line drops to a practically horizontal position: slope  $=+0.003$ . This observation supports our finding that economic trend is defined only by real GDP per capita.

The original GDP time series has the average annual increment \$420 (1990\$). After the correction for the number of 9-year-olds, the mean increment falls to \$397. Thus, the cumulative input from the change in the number of 9-year-olds is approximately 5% of that provided by economic trend,  $A/G$ . Obviously, one can neglect the second term and assume that in the long run the growth rate of GDP is defined only by economic trend, with  $A=\$370$ . Corresponding curves are presented in the right panel of Figure 3.



**Figure 3** – The evolution of real GDP per capita: left panel - annual increment; right panel – growth rate. The original data are corrected for the number of 9-year-olds and presented in both panels. Linear regression of the corrected annual increments demonstrates just a slight slope of  $+0.003$ , unlike the original readings. The growth rate of the corrected time series in the right panel is shown together with  $A/G$ , where  $A=\$370$ .

Equation (1) defines the growth of GDP per capita in developed countries or, equivalently, in capitalist economies. Therefore, during the transition from socialism to capitalism, the capitalist sub-system should evolve according to (1). Continental Europe is characterized by defining age of 18 years, not 9 years as in the U.S. and UK [11]. Because the transition period is relatively short, one do not expect any dramatic change in the defining age population and, thus, can neglect the input from second term in (1) without any significant loss of accuracy. Moreover, from the start of the transition, real GDP per capita has been changing in a narrow range around its initial value in a given country. Hence, the economic trend,  $A/G$ , can be approximated by constant rate. Then, the growth of GDP in the capitalist sub-system can be approximated by an exponential function.

In the framework of micro-/macroeconomic interaction, there is a strict relationship between the efforts to increase personal income (and, thus, gross domestic income, as represented by the sum of all personal incomes) and the rate of the GDI growth [9, 11]. It is likely that the development of the socialist economic system is in many aspects similar to that of the capitalist system. There is a fundamental difference, however. Personal incomes in the socialist system have an upper limit and people with the highest possible incomes contribute less to the GDP than they would be able to contribute under capitalism. The overall income deficiency arising from this upper income limit is estimated as 15% of GDP [9, 10]. This deficiency has resulted in a slower economic growth and the increasing lag behind the developed countries from 1950 to 1989. So, the transition from capitalism to socialism is the transition from a lowered to normal economic growth.

Due to the uncertainty in the level of personal income suppression, the modelling of the growth in the socialist system is a sophisticated problem. From Figure 2, one could assume that the FSC had been growing at a lower rate than that in developed countries. Moreover, there was no visible sign of an exponential growth between 1950 and 1989 - a straight line would be a better interpolation for the socialist curves. The main task of this paper is a slightly simpler one - to model the free fall of the socialist system. Apparently, the disintegration of socialism in the FSC is a very intensive process compared to the inherent growth, which is likely to disappear after the start of the transition. One can easily neglect the input from the internal growth during the transition.

#### 4. Modelling the evolution of real GDP per capita during the transition

We presume that the FSC stepped into the transition period between 1989 and 1991. At this point (corresponding start time  $t_0$ ), relevant working age population,  $N(t_0)$ , was entirely in the socialist economic system. In other words, the portion of working age population in the socialist system,  $P_s(t_0)$  or  $P_s^0$ , was equal to 1.0. After the start of the transition, this portion has been experiencing a free fall and, quantitatively, has been exponentially decaying with some index  $\alpha_{sp}$ , which is likely country-specific and has to be determined empirically. In physical terms, the process of disintegration of socialist system is similar to radioactive decay with constant probability:  $-dm/m=\lambda$ , where  $m$  is the total number of radioactive atoms and  $dm$  is the number of atoms decayed per unit time. By analogy with physics, one can describe the process of “depopulation” of the socialist system using a simple relationship:  $N(t)P_s(t)=N(t)P_s^0 \exp(-\alpha_{sp}t)$ , where  $N(t)P_s(t)$  is the number of people left in the socialist system at elapsed time  $t$ .

There is a process of the decrease in GDP per capita (mean income),  $A_s(t)$ , in the socialist system accompanying the depopulation. We also assume that the capability to earn money for all people left in the socialist system drops to zero at  $t_0$  and, according to [9], the mean income starts a free fall from its initial value  $A_s(t_0)=A_s^0$ . This process is similar to cooling of a preheated solid body and is described by an exponential function with index  $\alpha_{si}$ :  $A_s(t)=A_s^0 \exp(-\alpha_{si}t)$ . As a result, the input of the socialist economic system in the total GDP in a given country during the transition period is  $N(t)P_s(t)A_s(t)$ . Since both processes are represented by an exponential decay, one can replace two indices  $\alpha_{sp}$  and  $\alpha_{si}$  with one:  $\alpha_{sp}+\alpha_{si}=\alpha_s$ . Thus,

$$N(t)P_s(t)A_s(t) = N(t)P_s^0 A_s^0 \exp(-\alpha_s t). \quad (3)$$

The capitalist system starts with a zero portion in the working age population,  $P_c(t_0)=P_c^0=0$ . One can consider the case of a nonzero  $P_c^0$ . Then,  $P_s^0$  is less than 1.0, and both portions should make a unit:  $P_s^0+P_c^0=1.0$ . We neglect this possibility because the quantitative results of our modelling do not demonstrated any necessity of additional parameters, but we retain relevant terms in the equations derived below. With the first person leaving the socialist system, there is a nonzero probability,  $\alpha_c$ , for her or him to join the emerging capitalist system. This probability is also presumed to be constant for the population out of the capitalist system and differs from that to leave the socialist system,  $\alpha_{sp}$ . Moreover, the sum of  $\alpha_c$  and  $\alpha_{sp}$  is not equal to 1. One might stay out of both available economic systems for some time. Such persons also create a reserve for joining the capitalist system. The number of people,  $dn$ , entering the capitalist system per year is proportional with coefficient  $\alpha_c$  to the number of people out of the capitalist system so far,  $n(t)=N(t)(1-P_c(t))$ :  $dn=\alpha_c \cdot n(t)$ ; or  $dn/n=\alpha_c$ . Over time, more and more people join the capitalist system and less people retain positions in the socialist system or in the reserve. The evolution of the portion of population in the capitalist system can be described (in general case, when  $P_c^0 \neq 0$ ) as a satiation process:

$$P_c(t) = P_c^0 + (1 - P_c^0)(1 - \exp(-\alpha_c t)) \quad (4)$$

Opposite to the free fall of GDP per capita in the socialist system, the capitalist system undergoes an intensive growth. As discussed in Section 3, for a relatively short period of the

transition, one can use a constant rate of growth,  $\alpha$ , instead of the decelerating one, as defined by Eq. (2). This constant rate defines an exponentially growing GDP per capita,  $A_c(t)=A_c^0 \exp(\alpha t)$ , where constant  $A_c^0$  is the initial value of real GDP per capita in the emerging capitalist system. The model assumes that  $A_c^0=A_s^0$ . Simplistic intuition behind this assumption is as follows. In the very beginning of the transition, the same people work at the same physical places and their products have the same initial price as before in the socialist system. In other words, the start point of the capitalist growth is the level attained by the socialist economic system. This equality implies the normalization of real GDP per capita to  $A_s^0$ . This makes a dimensionless model of the evolution of GDP per capita in a given country, with  $A_s^0$  as a unit of measurement.

In average, the input of each and every person in the capitalist sub-system into GDP grows at a country-specific rate. (Figure 2 shows that, in the long run, the upper limit of growth rate (economic trend) of a capitalist economy at a given level of real GDP per capita is likely defined by the rate observed in the U.S., i.e. the growth rate in the is the highest possible.) The first person starts with GDP per capita equal to  $A_s^0$ , and the followers start at the level of real GDP per capita already attained in the capitalist sub-system. Total input of the capitalist system is defined by the following expression:

$$N(t)P_c(t)A_c(t) = N(t)A_c^0 \{P_c^0 + (1 - P_c^0)[1 - \exp(-\alpha_c t)]\} \exp(\alpha t) \quad (5)$$

Obviously, the input to the GDP per capita of those people who are out of both systems is zero. It does not mean, however, that they have zero income. Better consider them as avoiding formal rules, not real life. There always exist some elements of shadow economy and black market out of any official statistics. The portion of these people,  $1-P_c(t)-P_s(t)$ , decays over time, with  $P_c(t)$  asymptotically approaching unit. In some countries, this portion can be large enough for decades, as our analysis has shown.

By definition, GDP is the sum of three components: the inputs from the socialist system, the capitalist system and the shadow economy:

$$\begin{aligned} \text{GDP}(t) = & N(t) \cdot A_c^0 \cdot \{P_c^0 + (1 - P_c^0) \cdot [1 - \exp(-\alpha_c t)]\} \cdot \exp(\alpha t) + \\ & + P_s^0 \cdot A_s^0 \cdot \exp(-\alpha_s t) + 0 \cdot (1 - P_c(t) - P_s(t)) \end{aligned} \quad (6)$$

Dividing both sides in (6) by  $N(t)$  and  $A_s^0$ , one obtains real GDP per capita normalized to its initial value,  $M(t)=\text{GDP}(t)/(A_s^0 N(t))$ , i.e. a dimensionless variable. Finally, the complete set of defining equations describing the evolution of GDP per capita during the transition from socialism to capitalism is as follows:

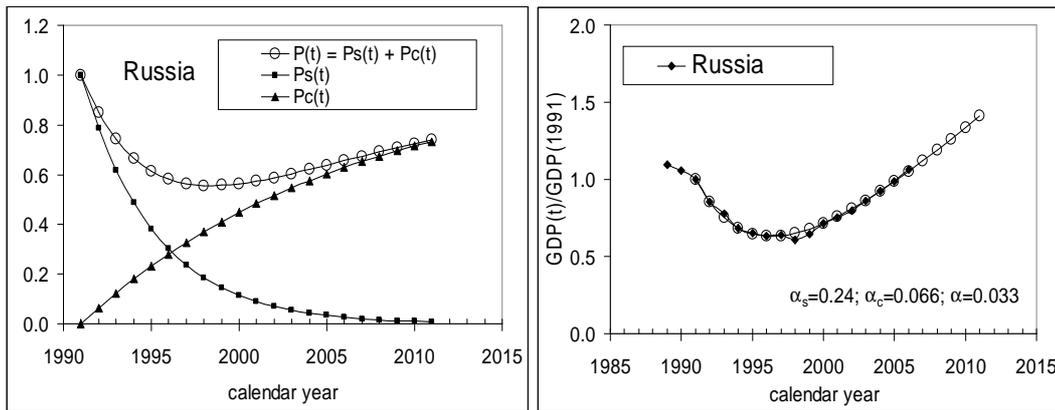
$$\begin{aligned} M(t) &= M_s(t) + M_c(t) \\ M_s(t) &= P_s^0 \exp(-\alpha_s t) \\ M_c(t) &= \{P_c^0 + (1 - P_c^0)[1 - \exp(-\alpha_c t)]\} \exp(\alpha t) \end{aligned} \quad (7)$$

where  $M_s(t)$  and  $M_c(t)$  are dimensionless GDP per capita in the socialist and capitalist sub-system, respectively.

According to (7), the evolution of GDP per capita during the transition is completely defined by three parameters:  $\alpha_s$ ,  $\alpha_c$ , and  $\alpha$ . Initial values,  $P_s^0=1$  and  $P_c^0=0$ , are the same for all the FSC, and because of the normalization:  $M_s^0=1$  and  $M_c^0=0$ . Therefore, the modelling consists in the estimation of best-fit values of the defining parameters using actual data. Approximate values can be determined by a standard or trail-and-error process with visual fir: the parameters are varied in some reasonable range before the best visual fit between observed and predicted time histories of  $M(t)$  is achieved. We did not apply any formal statistical procedure, but only the visual fit, because the latter usually provides accuracy compared to that associated with the RMS technique. Our principal goal is not to

find the exact values of the defining parameters, but to demonstrate the consistency of the functional form of the model.

Figure 4 illustrates some results of the matching procedure, as applied to Russia. The starting point of the transition is 1991, when the largest republics of the Former Soviet Union announced their independence and initiated a new economic policy aimed at the construction of capitalism. The Conference Board [6] provides relevant measurements of per capita GDP for the studied period. In the left panel, the initial portion of the socialist system  $P_s(1991)=1.0$ , i.e. no elements of capitalism had been permitted in Russia before 1991:  $P_c(1991)=0.0$ . The best-fit model is characterised by the following defining parameters:  $\alpha_s=0.24$ ,  $\alpha_c=0.066$ ,  $\alpha=0.033$ . The index  $\alpha_s$  is relatively low compared to that in Central European countries, and the portion of population in the socialist system decays relatively slow. In 2005, the portion was approximately 2%. There was a large segment of socialist economy in the mid 1990s, however, when the sharpest economic decrease was observed.



**Figure 4 –**

Left panel: The evolution of GDP per capita,  $M(t)$ , in Russia since 1991. There are two portions of the overall GDP per capita – socialist,  $M_s(t)$ , and capitalist,  $M_c(t)$ . The number of people leaving the socialist systems at is proportional to the portion of total population left in the socialist system,  $P_s(t)$ . The input of the capitalist system,  $M_c(t)$ , grows proportionally to the portion of total population in this system,  $P_c(t)$ . There are many people neither in the capitalist nor in the socialist system:  $P_s+P_c$  is less than 1.0. In 2005, approximately 2% of the total population was still in the socialist system, and the portion of capitalist system,  $P_c(t)$ , is was 65%. The input of the capitalist system,  $M_c(t)$ , grows proportionally to the portion of total population in this system,  $P_c(t)$ . Right panel: The best-fit parameters are:  $\alpha_s=0.24$ ,  $\alpha_c=0.066$ , and  $\alpha=0.033$ . The capitalist system in Russia has been growing since 1991. The predicted trajectory (open circles here and below) is in a good agreement with the observed one (solid diamonds). In 2005, the influx of population in the capitalist system,  $dP_c/P_c$ , was  $0.022 \text{ y}^{-1}$  and the economic trend in the model is always  $0.033 \text{ y}^{-1}$ . Thus, the growth rate as a whole was  $1.022 \times 1.033 = 1.056$  or 5.6%.

The build-up of the capitalist system in Russia is also characterised by a relatively slow rate. The index  $\alpha_c=0.066$  provides only about 65% of the total population to be in the capitalist system 15 years after the start. The residual 33% of the total population are formally included in neither of the main systems. This reservoir is potentially feeding shadow economy or represents unused workforce. The growth rate of the capitalist portion in Russia is currently low (~2% per year) and additional efforts from main political powers are urgently needed to create conditions to enable a third of the total population join the capitalist system of production and distribution. Otherwise, the performance of the Russian economy is highly undermined. The author has no idea about any possible measures, but the model shows that the portion of "non-attributed" population in Russia is one of the largest among the former socialist countries.

The right panel in Figure 4 displays the evolution of the predicted and measured per capita GDP in Russia. A good agreement is observed, given the simplicity of the model and the uncertainty

in the PPP estimates of per capita GDP. In general, only relatively smooth and coordinated changes have occurred in the Russian economy since 1991. The transition process has two branches: a downward one (from 1991 to 1998) and an upward one (since 1998). Currently, the economic growth is fuelled by two processes: the internal growth (economic trend) of about  $1.033 \text{ y}^{-1}$  and the growth of the capitalist portion,  $P_c$ , at a rate of about  $1.022 \text{ y}^{-1}$ , making about 5.6% per year ( $=1.022 \times 1.033$ ) in 2005. Both factors of growth will be decaying with time. The first one is limited by the attained level of per capita GDP. The limit of the internal growth rate corresponding to the initial per capita GDP in Russia of \$7373 in 1991 was 5.1% per year ( $=\$370/\$7373$ , see Section 2). In 2006, the limit was about 4.7%. Hence, even in this element of the overall growth, the Russian economy has been highly underperforming, if to bear in mind the best-fit economic trend of 3.3 % for all years after 1991. The Russian Federation has some potential to accelerate the growth both by increasing the portion of the capitalist system and by using the entire potential of the capitalist system growth.

The shape of the observed curve and the best-fit parameters reveal some principal features of the transition. The shape clearly corresponds to J-curve behaviour. The curve can be split into three different segments. The transition during the initial period is mainly driven by the fall of sub-socialist system. The input of the capitalist sub-system is relatively small because only few people have joined it. This is the period of “free-fall” defined by index  $\alpha_s$ . Hence, the estimation of this index is, chiefly, based on few initial years of the transition. Considering the uncertainty of economic measurements during these turbulent years, the prediction of  $M(t)$  for Russia between 1991 and 1995 is excellent.

The rate of decay of the overall GDP per capita would be constant if not the input of the capitalist economy growing in size and productivity. The second segment of the curve reflects the fight of two tendencies – the disintegration of socialism and the growth of capitalism. The depth of economic downturn, i.e. the lowermost level of the  $M(t)$ , depends on all three defining parameters. However,  $\alpha_c$  is more important than  $\alpha$  because in (5) the change in the portion of population in the capitalist sub-system is larger than the growth in productivity. Having an estimate of  $\alpha_s$  from the first segment, one can obtain a reliable value of  $\alpha_c$ . In 1996, the Russian GDP per capita fell to 0.63 of its level in 1991. This would be the bottom of the fall if not the Russian financial crisis in 1998 with the lowermost GDP per capita value of 0.607. The deviation from the predicted curve associated with the crisis was completely recovered in the following two years. Hence, one should consider the year of 1996 as the turning point, where the growth of capitalism overcome the disintegration of socialism in Russia.

The third (open-end) segment of the curve should be dominated, in the long-run, by the internal growth of the capitalist sub-system, i.e. by economic trend. Effectively, the third stage is a pure capitalist growth. But for Russia this stage has not come yet, and the extensive component of growth associated with the increasing portion of population transferred from the reserve is still large. In Central European countries, all processes related to the migration of population from the socialist to capitalist system are finished. One can obtain unbiased estimates of  $\alpha$  and compare them to those predicted by Eq. (2), with  $A=\$370$ . As mentioned above, the economic performance of Russia is far from stellar one and it reached the level of 1991 only in 2006.

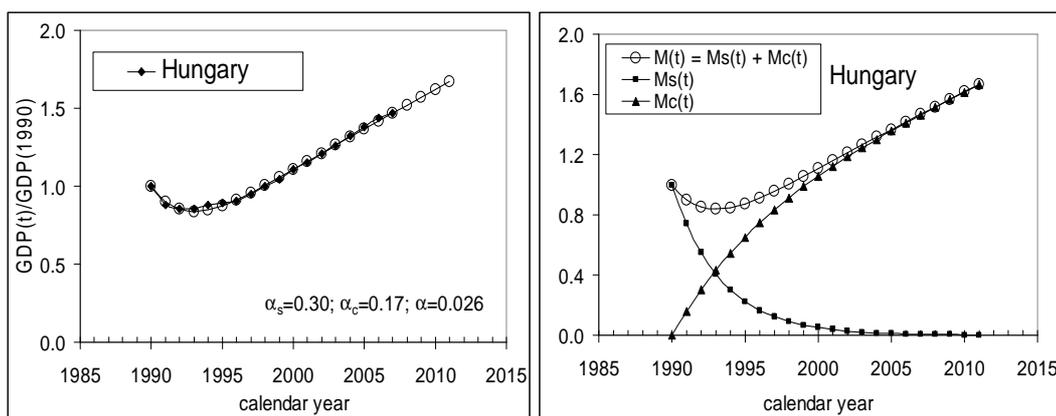
Figure 5 displays the observed and predicted time history of GDP per capita in Hungary. The start point is 1990 – one year before that in Russia. The estimates of the defining parameters are as follows:  $\alpha_s=0.30$ ,  $\alpha_c=0.17$ ,  $\alpha=0.026$ . The evolution of GDP is smooth, as in Russia. The largest, but positive, short deviation from the predicted curve occurred in 1994 and might be associated with the effects of the changes in specific-age population in (1). Hungary reached the bottom in 1993,  $M(1993)=0.853$ , and recovered to the pre-transition level of real GDP per capita in 1998, i.e. eight years before Russia. An outstanding feature of the measured curve is the absence of any negative deviation between 1995 and 2000, which is a common observation for other FSC.

Because the indexes  $\alpha_s$  and  $\alpha_c$  are larger than those for Russia, the evolution of the capitalist and socialist portions is much faster. In 2007, there was nobody in the socialist sub-system in Hungary (its portion was well below 0.5%) and the population in the capitalist systems was around 96%. The population reserve for joining the capitalist sub-system was as small as 4%. Therefore, the

observed growth of the Hungarian economy is totally due to the inherent growth of the capitalist economy, as shown in the right panel of Figure 5.

Since 1996, the observed and predicted curves have been in a very good agreement and one can expect the future GDP per capita heading along the predicted line at a rate of 0.026. This is the current economic trend in Hungary, but it will be decelerating in the future according to (2). In 2007, the highest possible rate could be  $\$370/\$9488=0.039$ , or 3.9% per year. Hence, Hungary is also far from the ultimate performance.

The case of Hungary provides a good illustration of the principal importance of each of the defining parameters. The initial and final stages of the transition are driven purely by  $\alpha_s$  and  $\alpha$ , respectively. In practice, one can obtain their accurate estimates independently. Since the amplitude of the fall is very sensitive to the third parameter, it is also well constraint. In some countries, all three parameters were important during the intermediate stage.



**Figure 5 –**

Left panel: The evolution of GDP per capita,  $M(t)$ , in Hungary since 1990. The best fit parameters are:  $\alpha_s=0.30$ ,  $\alpha_c=0.17$ , and  $\alpha=0.026$ . Currently, the per capita GDP grows at a long-run rate of 2.6% per year.

Right panel: Relative input of the socialist,  $M_s(t)$ , and capitalist,  $M_c(t)$ , sub-systems to the overall GDP per capita,  $M(t)$ . The economy grows currently due to the inherent development of the capitalist system.

Russia and Hungary represent two different cases of the transition from socialism to capitalism. Hungary demonstrates a shallower sink and a faster economic recovery. From the estimates of the defining indexes, one can conclude that the key parameter for a relative success in the reshaping of economy is the rate  $\alpha_c$ , at which the capitalist system is populated. In ideal case, all people leaving the socialist sub-system at a rate  $\alpha_{sp}$  should simultaneously join the capitalist economic sub-system, i.e.  $\alpha_c$  should be as large as possible.

Both countries show the long-term economic performance below the potential one, as defined by (2) with  $A=\$370$ . This feature is common among developed countries as well. For example, Spain, Greece and Portugal did not perform well between 1950 and 1990. At the same time, there should be some (political, economic, social, etc.) measures, which can provide additional acceleration to the economies of the FSC. A comparative analysis could reveal relevant toolkits. The size of the gap between the observed and potential rate of growth is a good measure of the performance of national authority. In 2006, Russia performed at 70% ( $=3.3/4.7$ ) of its potential, and Hungary only at 65% ( $=2.6/4.0$ ). As discussed below, there are severe problems with the Gary-Khamis PPP values, which make the estimates of performance in some countries unreliable.

We have modelled the transition for all European FSC and those from the Former Soviet Union. There are 27 countries including two virtual ones – the U.S.S.R and Czechoslovakia, as published by the Conference Board. Each of the countries deserves a special and detailed examination. The purpose of this paper is a narrow one and we intentionally avoid any extended

discussion of specific circumstances and external factors affecting the values of defining parameters. So, we are constrained to empirical and theoretical estimates and time histories of the observed and predicted GDP per capita. A complete list of the estimates is presented in Table 1. It allows a sound cross-country comparison in the framework of our concept of the transition, as depicted in Figures 6 through 8. Figure 9 illustrates the uncertainty associated with the modelling of GDP per capita.

Table 1 lists the following estimates for each of 27 countries: GDP per capita in 2006 (GK PPP); theoretical ceiling,  $\alpha_t = \$370/G(2006)$ , of the long-term growth rate in 2006; empirical estimates of  $\alpha_s$ ,  $\alpha_c$ , and  $\alpha$ ; ratio  $\alpha_s/\alpha_c$ , which define the duration of the disintegration and the depth of the fall; ratio  $\alpha/\alpha_t$ , which shows the level of economic performance relative to that in the U.S.. The FSC are ordered alphabetically.

**Table 1.** Empirical and theoretical indexes, as obtained for the Former Socialist Countries

Country	G(2006), \$	$\alpha_t = \$370/G$	$\alpha_s$	$\alpha_c$	$\alpha$	$\alpha_s/\alpha_c$	$\alpha/\alpha_t$
Albania	3658	0.101	0.73	0.280	0.030	0.384	0.297
Armenia	9554	0.039	0.70	0.180	0.037	0.257	0.956
Azerbaijan	7810	0.047	0.38	0.046	0.057	0.121	1.204
Belarus	10481	0.035	0.24	0.080	0.048	0.333	1.360
Bulgaria	7780	0.048	0.29	0.140	0.025	0.483	0.526
Croatia	8279	0.045	0.45	0.160	0.015	0.356	0.336
Czechoslovakia	11458	0.032	0.50	0.310	0.017	0.620	0.527
The Czech Rep.	11681	0.032	0.45	0.290	0.017	0.644	0.537
Estonia	20762	0.018	0.40	0.200	0.050	0.500	2.807
Georgia	5180	0.071	0.75	0.090	0.025	0.120	0.350
Hungary	9300	0.040	0.30	0.170	0.026	0.567	0.654
Kazakhstan	9849	0.038	0.22	0.046	0.057	0.209	1.518
Kyrgyzstan	2498	0.148	0.37	0.105	0.000	0.284	0.000
Latvia	13514	0.027	0.55	0.160	0.030	0.291	1.096
Lithuania	10361	0.036	0.45	0.135	0.025	0.300	0.700
Macedonia	3634	0.102	0.17	0.051	0.030	0.300	0.295
Moldova	3180	0.116	0.28	0.028	0.021	0.100	0.181
Poland	9028	0.041	0.39	0.230	0.030	0.590	0.732
Romania	4305	0.086	0.30	0.120	0.030	0.400	0.349
Russia	7824	0.047	0.24	0.066	0.033	0.275	0.698
Slovakia	11037	0.034	0.50	0.270	0.019	0.540	0.567
Slovenia	16364	0.023	0.30	0.165	0.020	0.550	0.885
Tajikistan	1379	0.268	0.45	0.043	0.005	0.096	0.019
Turkmenistan	2792	0.132	0.28	0.070	0.017	0.250	0.128
Ukraine	4480	0.083	0.24	0.030	0.057	0.125	0.691
Uzbekistan	4433	0.083	0.31	0.150	0.006	0.484	0.072
U.S.S.R	6025	0.061	0.24	0.060	0.0365	0.250	0.595

In 2006, the largest GDP per capita, \$20762, was measured in Estonia, and the lowest, \$1379, in Tajikistan. The Estonian estimate seems to be a highly biased. The estimate of GDP per capita in 2007 dollars, also provided by the Conference Board, is only \$19927, i.e. less than in 1990 dollars. This is a clear mistake and a good example of low reliability of PPP estimates *per ce*, and specifically, in the countries without long history of accurate measurements. In this paper, we do not pay any additional attention to problems in the PPP estimates, but bear in mind that striking outliers are possible.

The largest  $\alpha_s=0.75$  and the first place for the quickest disintegration of socialism belongs to Georgia. The smallest disintegration process with  $\alpha_s=0.17$ , has been observed in Macedonia. Kazakhstan is characterized by  $\alpha_s=0.22$ . Belarus, Russia and Ukraine are similar with  $\alpha_s=0.24$ . At the highest rate, population has been joining capitalist sub-system in the Czech Republic ( $\alpha_c=0.29$ ), Albania (0.28), Slovakia (0.27), and Poland (0.23). (We omit the case of Czechoslovakia with  $\alpha_c=0.31$  as a virtual country.) Moldova ( $\alpha_c=0.028$ ) and Ukraine ( $\alpha_c=0.030$ ) lead the list of the most capitalism-resistant countries. Kazakhstan, Belarus and Russia again demonstrate low rates of the growth of capitalism:  $\alpha_c=0.046$ , 0.080 and 0.066, respectively. Tajikistan, Azerbaijan and Turkmenistan join the club. Figure 6 displays a scatter plot  $\alpha_s$  vs.  $\alpha_c$ . There is one distinct outlier-Georgia. Other countries follow a linear trend, not prominent, however.

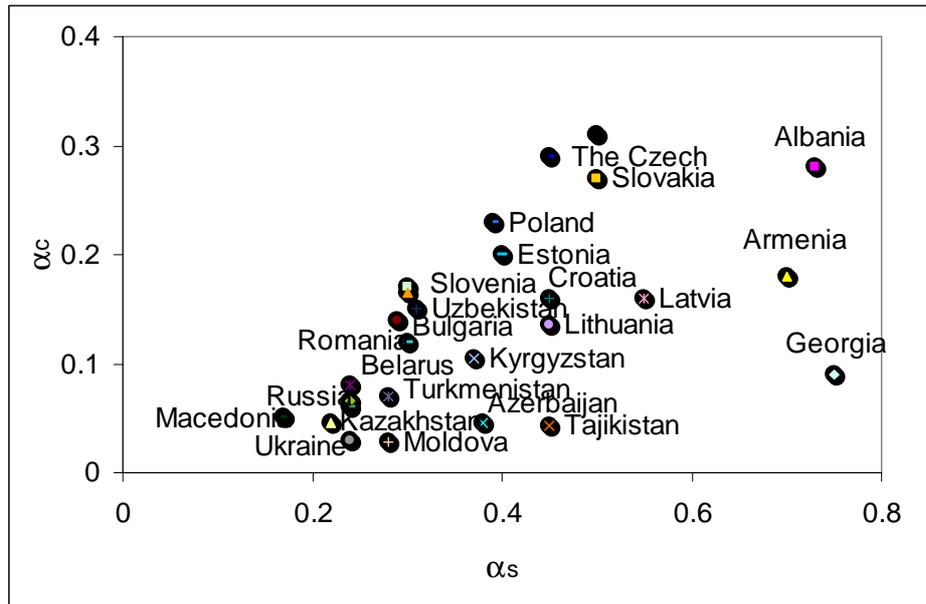


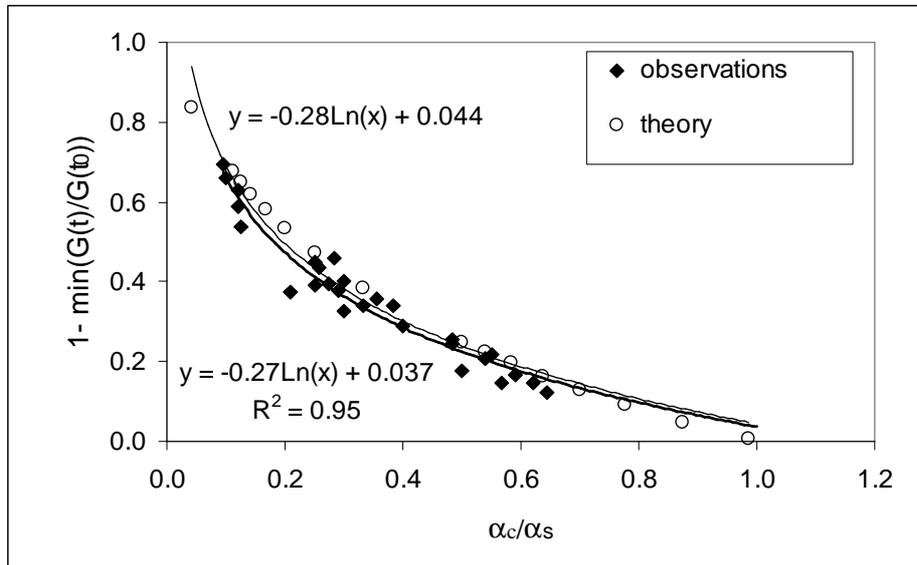
Figure 6 - Scatter plot:  $\alpha_c$  vs.  $\alpha_s$  in the former socialist countries

As mentioned above, the depth of trough in the J-curve is correlated with the ratio  $\alpha_s/\alpha_c$ . The larger is the ratio the shallower is the trough. Central European countries are characterized by high ratios – between 0.644 in the Czech Republic and 0.30 in Macedonia. Estonia and Uzbekistan with  $\alpha_s/\alpha_c=0.5$  and 0.48, respectively, are in the middle of the distribution for Central European countries. Many countries of the Former Soviet Union, including Latvia and Lithuania, create a cluster around 0.3. Tajikistan and Moldova demonstrate very low ratios around 0.1.

Figure 7 presents (solid diamonds) the observed dependence of the depth of trough,  $d=1-\min_t(G(t)/G(t_0))$ , on  $\alpha_c/\alpha_s$ , where  $\min_t(G(t)/G(t_0))$  is the bottom level of the  $G(t)/G(t_0)$ -curve during the transition. There is a reliable logarithmic regression  $d=-0.27\ln(\alpha_c/\alpha_s)-0.037$ , with  $R^2=0.95$ . Theoretical dependence  $d=f(\alpha_c/\alpha_s)$  (with  $\alpha=0$ ) is shown by open circles and has a very close regression  $d=-0.28\ln(\alpha_c/\alpha_s)-0.044$ . The actual dependence is slightly biased by the input of the internal growth of capitalism associated with nonzero  $\alpha$ , and apparently, neither actual nor theoretical dependence is a logarithmic one. The depth of trough approaches zero, when the satiation index,  $\alpha_c$ , reaches the disintegration one,  $\alpha_s$ , i.e.  $d \rightarrow 0$ , when  $\alpha_c/\alpha_s \rightarrow 1$ . For the conservation of total population, ratio  $\alpha_c/\alpha_s$  can not be more than 1, i.e. the number of people who joining capitalism can not exceed the number of people leaving the socialist sub-system. Obviously, when  $\alpha_c/\alpha_s \rightarrow 0$ ,  $d \rightarrow 1$ .

In any case, the behaviour of the depth as a function of  $\alpha_c/\alpha_s$  is mathematically trivial. But the existence of a robust relation between the depth and the ratio in real transition from socialism to capitalism is a fundamental finding. One could reach a zero-depth trough with  $\alpha_c/\alpha_s$  around 1. This

mathematical fact has not only pure theoretical and historical significance, but also of a large importance for current and future practices. Responsible authorities must minimize the depth of trough in any transition process by retaining the ratio of the rates of disintegration of old and creation of new system near 1. It is an obvious target during large-scale economic and social reforms and the process of modernization, which are often associated with displacement of large portions of population. It might be useful for developing countries as well.



**Figure 7** – The depth of trough,  $1 - \min_t(G(t)/G(t_0))$ , as a function of  $\alpha_c/\alpha_s$ .

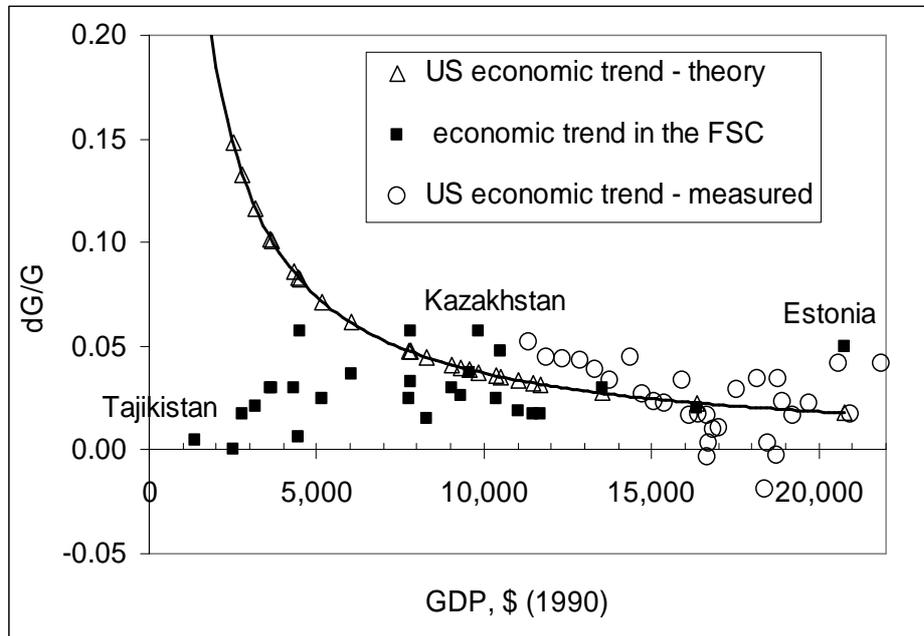
Figure 8 compares economic trends: the estimated from the GDP data for the FSC and that predicted according to (2) with  $A=\$370$ . The latter trend can be called theoretical one and is related to the trend observed in the U.S. at the same level of GDP per capita. In a sense, this trend is the maximum possible because no other (large) developed country has demonstrated a larger trend in the long-run. The example of Japan (see Figure 2) shows that the countries with a very high mid-term growth rate usually end-up in a long period of weak growth. (Ireland represents a small economy with strong dependence on the demand from neighboring countries, but it likely will not avoid the faith of Japan.)

The distance from the theoretical economic trend, i.e. the line  $\$370/G_{U.S.}(t)$  drawn through actual GDP per capita data, is a good measure of success or failure of a given economy to catch up the All countries above the line are exceptionally successful: Kazakhstan (1.52), Belarus (1.36), Azerbaijan (1.20), and Latvia (1.10). The case of Estonia with an extremely large ratio  $\alpha/\alpha_t=2.8$  is not reliable. Armenia has  $\alpha/\alpha_t=0.96$ , which is by all means very high. There is some doubt, however, that GDP per capita in Armenia was around \$9500 in 2006, i.e. more than in Hungary. This case also needs to be investigated regarding the accuracy of PPP estimation.

The worst performance of the capitalist sub-system is demonstrated by Kyrgyzstan (0.000 - no internal growth!), Tajikistan (0.02), Turkmenistan (0.07), Uzbekistan (0.13) and Moldova (0.18). Effectively, there has been no growth of capitalist sub-systems in these countries and economic growth was related to the increasing portion of population. Central European countries demonstrate  $\alpha/\alpha_t$  between 0.5 and 0.88 (Slovenia), except Macedonia (0.30), Croatia (0.34) and Romania (0.35).

All in all, there are two distinct clusters. Successful countries demonstrate economic growth at rates close to the maximum one. For these countries, the gap with the does not increase fast. Moreover, due to the difference in the attained level of GDP per capita, it seems that these countries are catching up. But the logic of real economic growth expressed in Eq. (1), requires higher rates for a

non-increasing long-run gap, as discussed in Section 5. GDP per capita in other FSC such as Kyrgyzstan, Tajikistan and Moldova, lags behind that in the U.S. at a progressive rate. In the case of normal capitalist evolution, i.e. in the absence of worldwide catastrophes, all FSC will never catch up the U.S. and other developed countries due to severe underperformance during the socialist years.



**Figure 8** - Comparison of the estimated (Eq. 7) and predicted (Eq. 2) economic trends in the Former Socialist Countries.

Each and every FSC has own bleeding history of struggling through socialism. Each of them deserves detailed historiography of all aspect related to the struggle, including those associated with economic development. In terms of industrial production and fast increase in quality and nomenclature of services, the transition to capitalism was an unambiguous blessing for all of them. There were different trajectories, however, and the transition process has not finished yet in many countries. Therefore, we decided to present all time histories of real GDP per capita and that predicted by our model. Figure 9 displays in alphabetic order 25 panels with relevant curves. In addition to the recognition of difficult history one can observe the discrepancy between measured and predicted trajectories and to assess the uncertainty related to the model. We do not discuss all FSC in this paper, however, and focus only on some examples, which illustrate important and exotic features of the transition.

Albania demonstrates a very high rate of disintegration with  $\alpha_s=0.73$ . Accordingly, the first year of the transition (1991) is characterized by an enormous fall in GDP per capita - from 1.0 to 0.72. Fortunately, the mechanism of compensation expressed in an intensive growth of capitalism with  $\alpha_c=0.28$  limited the period of fall to two years. A positive growth rate was observed in 1993. Hence, the transition to capitalism was as quick as possible with a relatively shallow through of 0.31 ( $\alpha_c/\alpha_s=0.384$ ): in 1999, the Albanian economy reached the level of 1990. There was a jerk in 1997, with the GDP per capita dropped from 0.942 to 0.836. Such sharp negative changes are a common feature for the FSC, as Figure 9 evidences. Albania would reach the level of 1990 two years earlier if not this sudden step down. After the downturn, the economy has been evolving at a rate of approximately 3.5% per year, almost in parallel to the predicted curve with  $\alpha=0.03$ . Considering the level of GDP per capita, one could expect the rate of growth near 10% per year. Therefore, Albania did build up a capitalist system, but not a very effective version.

Armenia started the disintegration in 1991 and dropped down to  $G(1992)/G(1991)=0.59$  during the first year because of  $\alpha_s=0.70$  and  $\alpha_c=0.18$ , similar to those in Albania. However, the evolution of GDP per capita is characterized by large deviations from that predicted by our model. There are two major bends in the curve – in 1996 and 2000. The former is a negative deviation and the latter is a positive one. The modelled long-term economic trend in Armenia is 3.7% per year. The changes in the observed curve are too large to determine true economic trend. One needs long-term observations. As mentioned above, the level of GDP per capita in Armenia seems to be highly overestimated.

The model demonstrates an excellent predictive power for Azerbaijan: all solid diamonds are inside open circles between 1991 and 2004. The oil price boom has given an outstanding chance to all oil exporting countries and the growth rate in Azerbaijan between 2005 and 2007 was extremely high. It has manifested in a strong deviation from the predicted curve. In 2008, the price dropped to the level of 2005, partially because of the recession in the U.S. [14]. One can expect the actual curve will bend back to the predicted one, as Azerbaijan is a mono-product economy. Otherwise, the evolution of economy is standard for the FSU. The disintegration has been relatively fast with  $\alpha_s=0.38$ , but the rate of capitalism development was extremely low  $\alpha_c=0.046$ . So, many people are still joining the capitalist sub-system in Azerbaijan. The depth of economic fall was very large:  $G(1995)/G(1991)=0.41$ . The rate on internal growth of the economy is high,  $\alpha=0.057$ , and even larger than the maximum possible of 0.047. Due to the influx of population from the reserve into the capitalist sub-system at a rate of 3% per year, the measured rate of economic growth in Azerbaijan is around 8% per year. Despite these two factors the level of 1991 was reached only in 2004.

All in all, the Belarusian economy follows the predicted curve with only small and short-term deviations. It presents a typical case of a slow capitalism build up. Because of a higher degree of diversification of national economy and the absence of gas and oil fields, Belarus had no peaks and troughs in real growth. It is expected that it will be growing at an average rate of 4% to 5% during the next decade.

Bulgaria and Romania have similar defining parameters and are characterized by the smallest GDP per capita among the countries joined the EU. The expected growth rate of the capitalist in 2006 was 4.8% and 8.6%, respectively. Actual trend values (see Table 1) were 2.5% for Bulgaria and 3.0% in Romania. Thus, Bulgaria and Romania really struggle to use all advantages of the capitalist growth.

As expected, the Czech Republic and Slovakia are close in defining parameters. Slovakia has slightly lower GDP per capita and a slightly higher (long-term) growth rate. The Czech Republic had a more pronounced slowdown period between 1995 and 1997, but then returned to the asymptotic growth with  $\alpha=0.017$ . The predicted growth rate is lower than the expected value of 3.2%. In 1990, the expected growth rate was 3.4%. Slovakia also had a short period of deceleration in 1998 and 1999. Since then it has been consistently returning to the predicted curve with  $\alpha=0.019$ . Theoretical growth rate in Slovakia has changed from 3.8% in 1990 to 3.4% in 2006.

The evolution of Polish GDP per capita is well predicted between 1989 and 2000. Only minor discrepancies were observed during this period. In 2000, a major deviation from the predicted curve started with two years of a slower growth. The observed economic growth apparently has been returning to the predicted line after 2002.

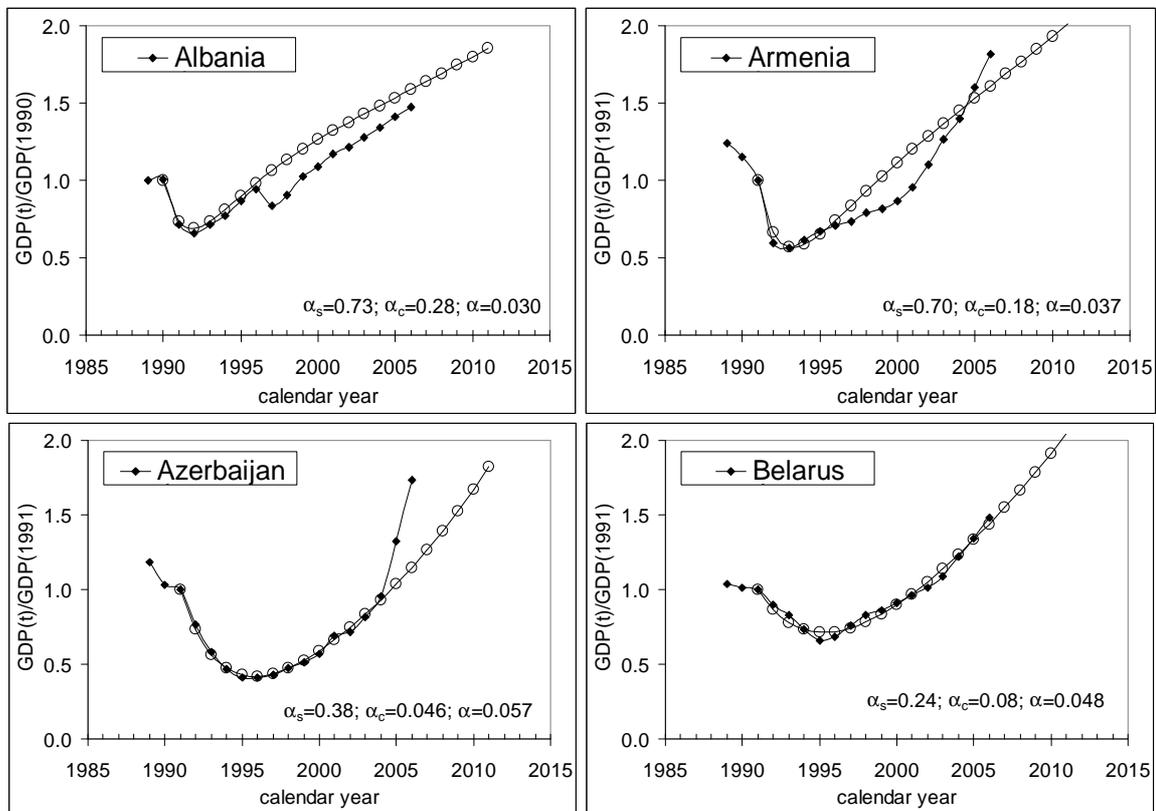
Slovenia is the most prosperous country among the FSC, with GDP per capita in 2006 of \$16364. It has avoided any deep downturn (the bottom at 0.78 in 1992) and recovered to the pre-transition level in 1999. Its economy is entirely capitalistic and evolved between 1992 and 2004 at a rate of 2.0% per year, as a Swiss watch. In 2005, a positive deviation from the predicted curve was registered.

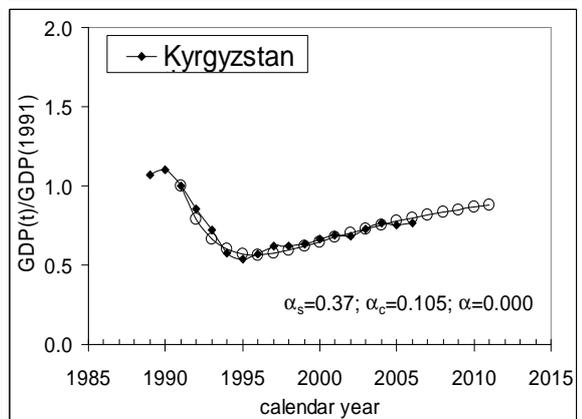
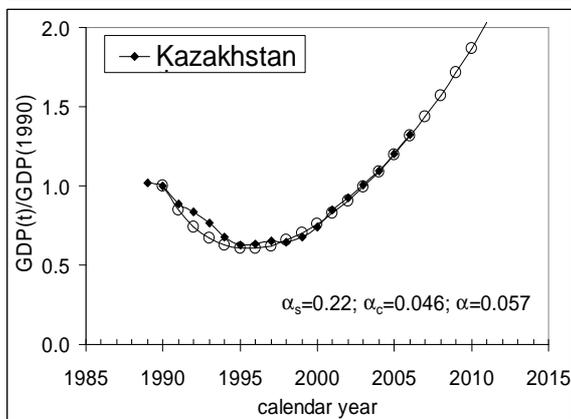
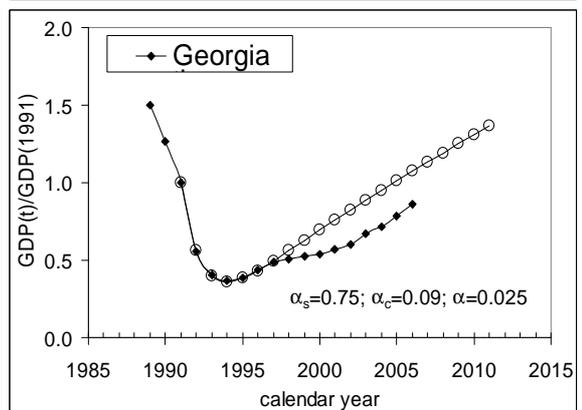
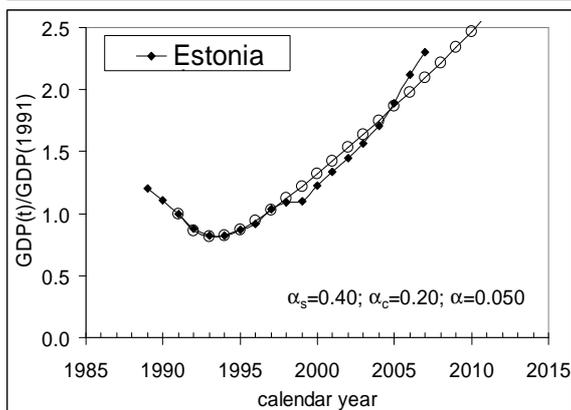
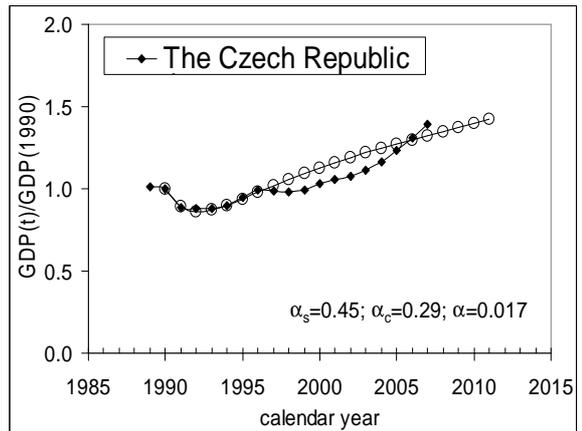
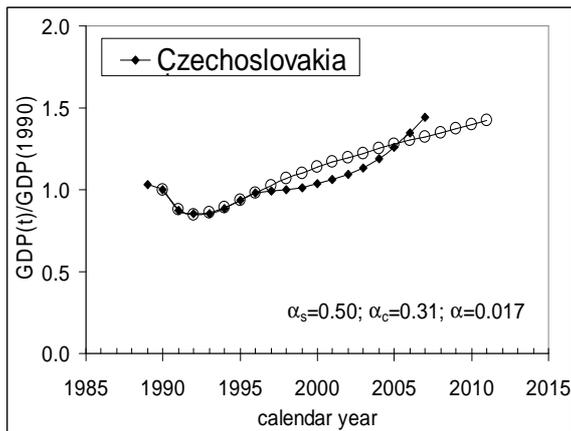
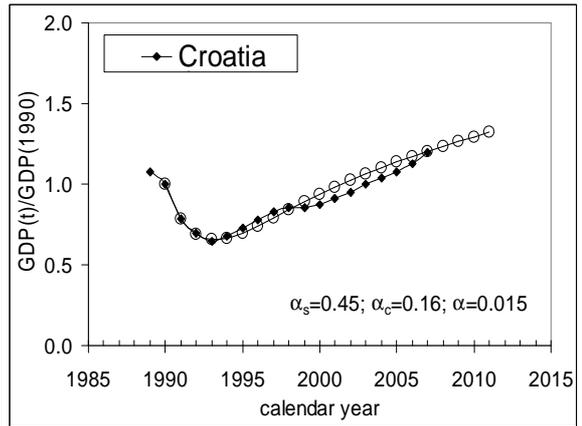
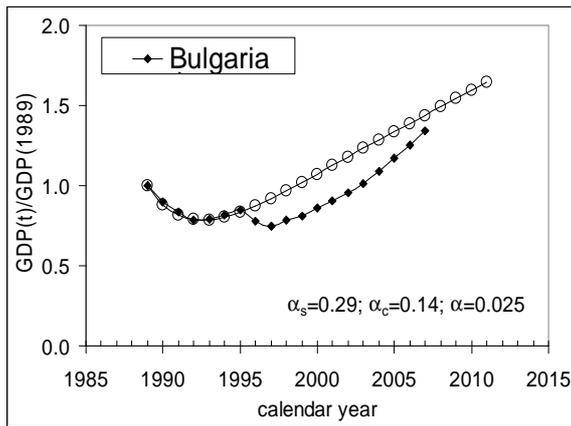
The deviation between predicted and observed curves in the countries joined the EU is likely associated with the changes in defining-age population in (1). This component of economic growth becomes more and more important in the course of the replacement of socialist economy with capitalist one. When the latter occupies whole working age population, the internal growth of the

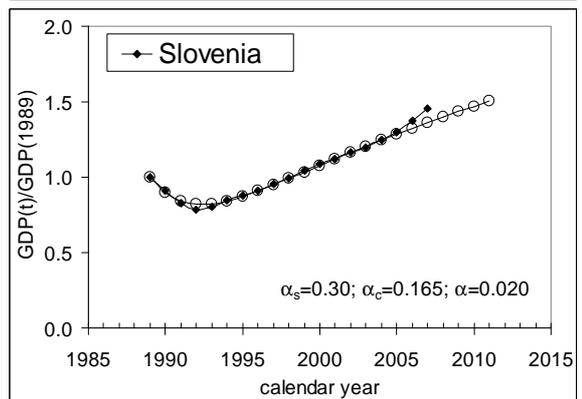
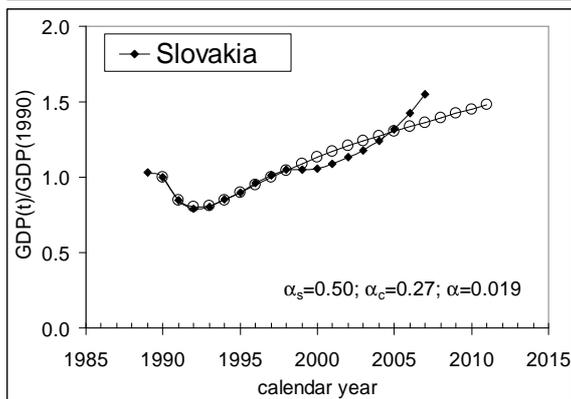
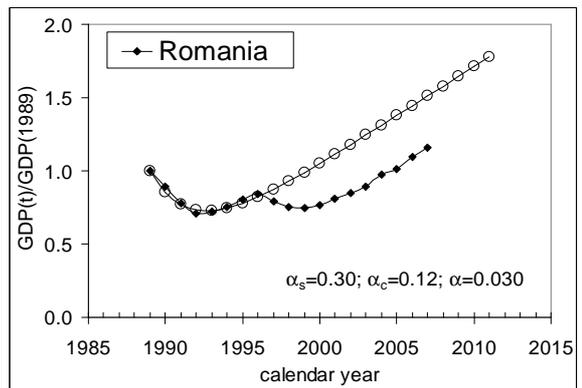
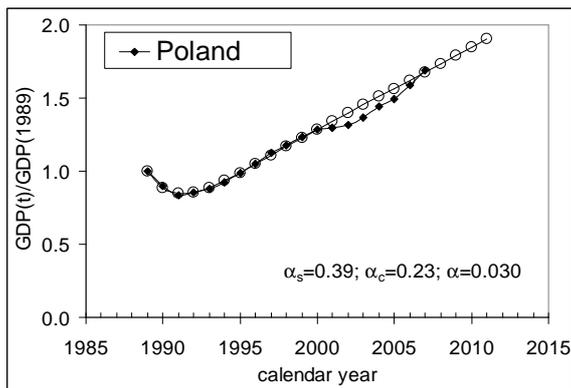
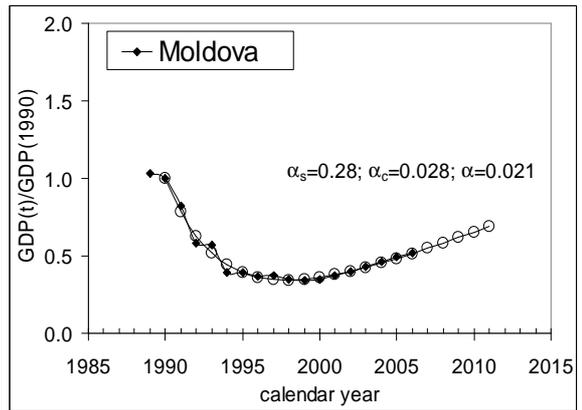
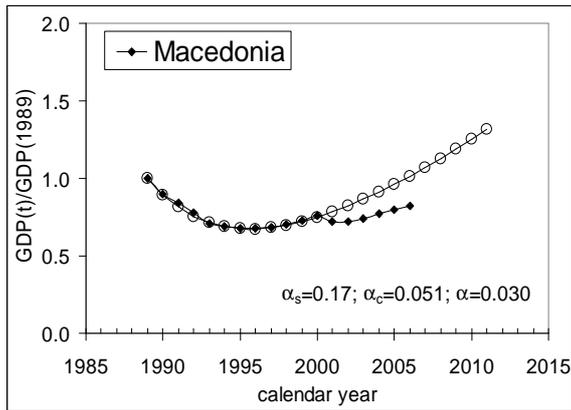
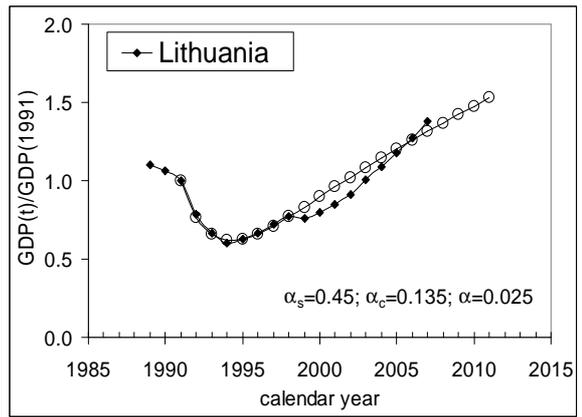
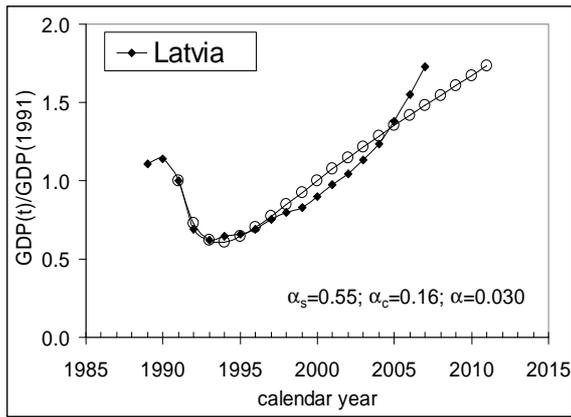
capitalist sub-system prevails over all other processes and Eq. (1) is fully applicable. In other words, when the transition period is over, the resulting capitalist economy evolves on its own.

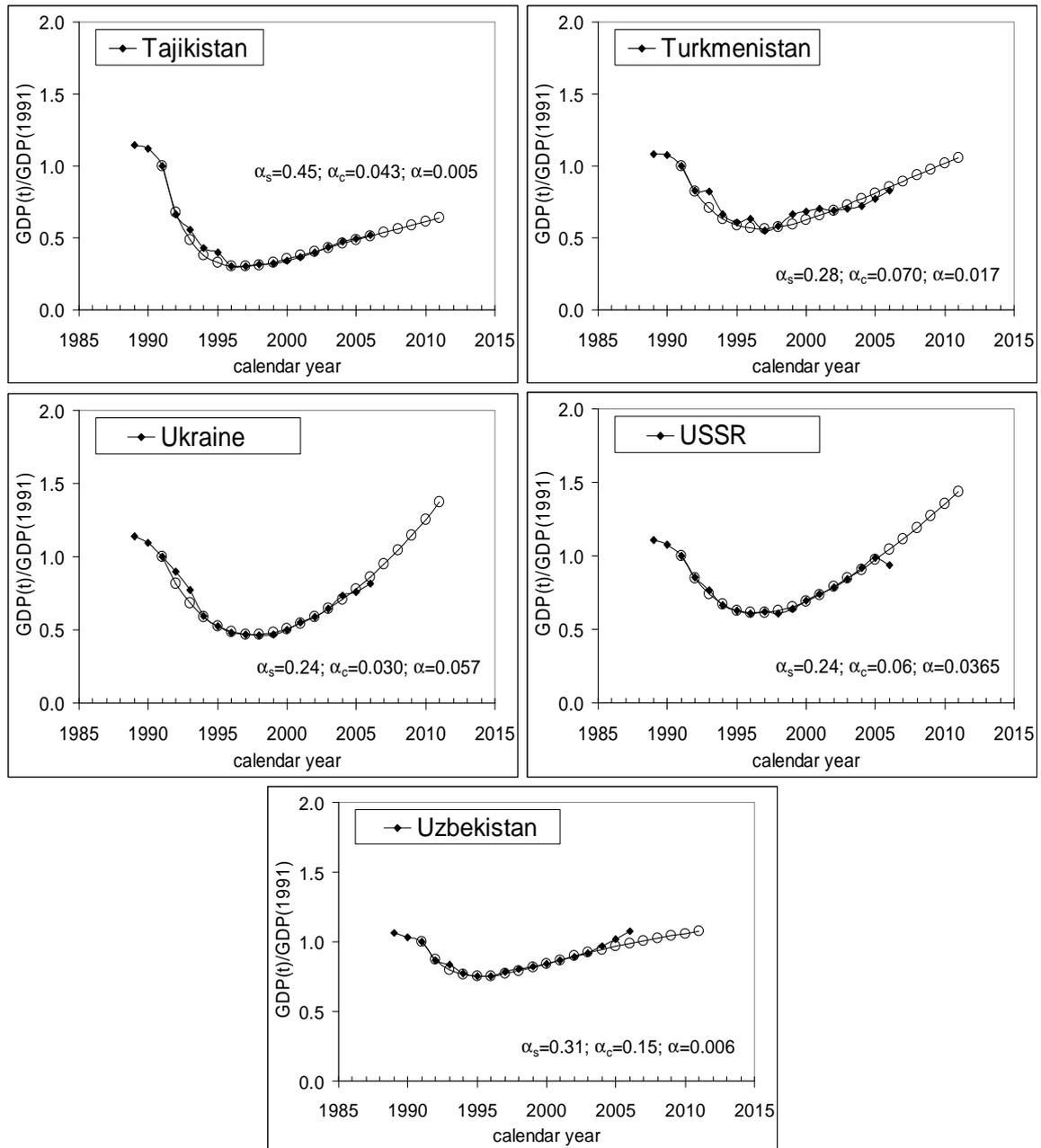
Among the FSU countries, the most striking result of poor performance is demonstrated by Kyrgyzstan. It is characterized by the long-term rate of economic growth,  $\alpha$ , equal to zero! The socialist sub-system has completely disintegrated,  $\alpha_s=0.3$ , and the formation of capitalist sub-system is close to completion,  $\alpha_c=0.105$ . As a result, there is no source of economic growth and the future of Kyrgyzstan seems not to be bright. In the current situation, one can not predict when Kyrgyzstan will recover to its economic level in 1991. Very close to Kyrgyzstan are Tajikistan, Turkmenistan, Uzbekistan and Moldova. Surprisingly, Macedonia joins the club of poorly performing countries despite it certainly belongs to Central European countries.

Kazakhstan and Ukraine are very dynamic economies with the growth rate,  $\alpha$ , above 5% per year. Both countries suffer a very painful process of the attraction of people to capitalism with  $\alpha_c$  of 0.046 and 0.030, respectively. In respect that only a half of working age population has joined the capitalist sub-system in Ukraine, the performance during the transition might be much more effective. By avoiding deep economic troughs, Ukraine and Kazakhstan could reach the level of 1991 long time ago and even to double it by 2010.









**Figure 9** - Comparison of the observed and predicted transition process in the FSC. Defining parameters are presented. The start point varies between 1989 and 1991.

We have modelled the evolution of GDP per capita in 27 former socialist countries, including two virtual countries: the U.S.S.R and Czechoslovakia. These countries have quite different social, cultural, ethnical, racial, demographical, religious, and technological histories. As a result, our model demonstrates a varying degree of success in the overall prediction between the start point and the year of 2006(7). In all cases, the most accurate prediction is associated with the initial segment of the transition, when socialism was dynamically replaced by capitalism. The initial stage is characterized by the largest changes in GDP per capita, and thus, provides a wide dynamic range as a crucial condition for accurate modelling. At later stages, some exogenous forces, such as the change in defining-age population or in oil price, might disturb the agreement between measured and predicted

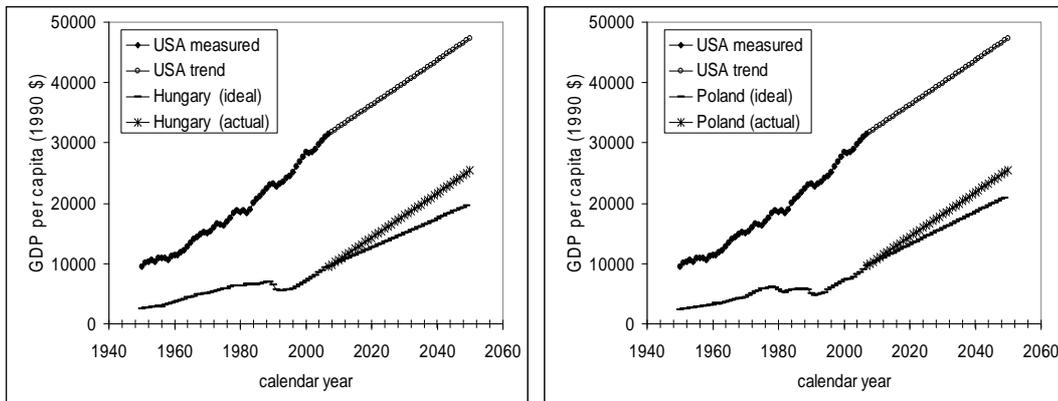
GDP and introduce some bias in the estimation of the defining parameters. This later stage, however, is of lower relevance to the transition itself and rather demonstrates the behaviour of a regular capitalist economy. Therefore, further observations are of a marginal usefulness for the transition modelling. But the evolution of capitalism in the FSC is of certain importance for theoretical consideration and practical application.

### 5. The future of the FSC

In Section 4, we concluded that the transition process has effectively finished in Central and Eastern European countries. Thus, the long-term growth rate of GDP per capita in these countries is limited by the attained level of the GDP per capita, as in developed countries. Any deviations from the long-term rate can be explained only by variations in defining age or by inefficient economic performance. The former can only be of a short-term nature. The latter is expressed in the fact that many developed countries are characterized by lower values of economic trend than that in the U.S. at the same level of GDP per capita.

Here we assume that the future economic growth in the FSC will follow the either potential or current value, as listed in Table 1. When no inefficiency is allowed, the best case scenario of economic growth is realized. In the case of the actual rate of growth,  $\alpha < \alpha_t$ , the performance is not perfect. In both cases, Eq. (2) completely defines the future evolution of the FSC. The level of GDP per capita in 2006 is used as initial value.

Figure 10 shows the past and future evolution in Hungary and Poland compared to that the U.S. All other FSC have time histories similar to those in Hungary and Poland, but with different initial values and actual slopes. Theoretical slopes are equal:  $A = \$370$ , i.e. annual increment in GDP per capita is \$370 (1990 \$). Actual increments are obtained as \$370 times  $(\alpha/\alpha_t)$ . After 2006, the GDP per capita curves are predicted, and thus, are represented by straight lines with different slopes in coordinates: calendar year - GDP per capita.



**Figure 10 –**

Left panel: The evolution of per capita GDP in Hungary compared to that in the U.S. The gap between the countries has been increasing since 1950. In the ideal case, when Hungary performs at the theoretical level ( $A = \$370$ ), it will be able to retain the gap. The absolute gap between the U.S. and Hungary can theoretically be constant at the level \$22,000 in the future.

Right panel: Same as in the left panel for Poland. The absolute gap between the U.S. and Poland is currently \$22,300.

The U.S. curve is much higher and has no prominent horizontal or downward segments, as observed in Hungary and Poland. In Poland, the stagnation process started in the late 1970s. Hungary is characterized by a shorter period of weak performance. Apparently, the years between 1950 and 1989 are characterized by a reduced rate of economic growth with an increasing gap between the FSC

and the U.S. The best case scenario would allow maintaining a constant lag behind the U.S.,  $X$ . In relative terms, the lag will decrease as a function  $G_{FSC}/(X+G_{FSC})$ , where  $G_{FSC}$  is the GDP per capita in a given FSC. If the growth rate from Table 1 persists, the lag will be growing.

## 6. Conclusion

The principal result of this study is the model for the transition from a socialist to capitalist system. The model is intentionally simplified and is defined by only three parameters, which have clear analogies in natural sciences. The depopulation of the socialist system is an analogue of the radioactive decay with the same meaning of the decay rate,  $\alpha_s$ , i.e. the share of population leaving the parent system per unit time. The socialist economy also suffers a natural decline similar to cooling a preheated body. The socialist GDP per capita does not drop to zero momentarily after the start of the transition, but attenuates exponentially over time. The growth of the capitalist system is modelled as the process of saturation during phase transition.

Hence, the interpretation of the model could also be simple in terms of physics. But economic, sociological, political, and so on, interpretation of the defining parameters for a given country is a big challenge and a subject for thorough investigations in the future. Currently, one can not estimate the defining parameters beforehand. Every country has a specific set of conditions and internal cultural relations between people and interactions with and between state and political powers. Technological issues can not be disregarded [3]. The author can witness the tremendous influence of mass-media in Russia during the initial stage of the transition. All these and many others processes and phenomena determine country-specific values of the indices. It is also difficult to judge whether it is possible to change the indices for the countries still in the transition.

However, the defining parameters reported for the FSC in this paper create an indispensable framework and firm basis for qualitative and quantitative speculations on relative importance of various factors for the observed differences between the countries. Moreover, the model does not imply the existence of any inherent features defining capitalism or socialism *per ce*. It does not include any measured macro-variable, which can be associated with only one of the two systems. Technically, it is completely constrained to *measured* GDP per capita irrelevant to the name of the country of economic system. Hence, the (economic) terms *socialism* and *capitalism* can be easily replaced, if the transition between any two systems is governed by the same equations.

When transition processes in a society are examined and modelled, any sound power must be aimed at the minimization of negative consequences, such as deep economic troughs, and the enhancement of positive processes, such as the creation of new system. One should not permit people to be out of both systems during the transition process. The best recipe is to retain the ratio of the rates of disintegration of old and creation of new system near 1. It is an obvious target during large-scale economic and social reforms and the process of modernization, which are often associated with displacement of large portions of population. It might be useful for developing countries as well. The author has no recipe helping to achieve the target ratio.

At first glance, the above consideration results are similar to those obtained by other researchers, who use sophisticated interpolation and extrapolation procedures in order to describe observed economic time series. There are several aspects, however, which are inherently different between this study and other interpolations. It was found that exponential functions not only well describe economic processes, but also are the solutions of the model equations. Therefore, one can consider these solutions as basic functions or eigenfunctions of the transition, and actually we have carried out an interpolation of observed time series using a full set of eigenfunctions.

Per capita GDP is a fundamental parameter defining the economic state in any given country. Total GDP depends on the size of population and is often misused to express the level of economic development. This misuse is unveiled by the fact that GDP per capita is the only parameter defining the long-term rate of economic growth or economic trend. As a result, a high growth rate is not a large achievement for countries with low GDP per capita, because it is expected. And a slow growth in some developed countries is not a characteristic of underperformance. Economies have to be

evaluated by their performance relative to the potential one. As we have seen above, not many FSC follow their potential path of growth. The majority find themselves below the potential and only a few have a short term growth rate above the potential.

### Acknowledgments

The author is grateful to Dr. Wayne Richardson for his constant interest in this study, help and assistance, and fruitful discussions. The manuscript was greatly improved by his critical review.

### 7. References

- [1] Barkley Rosser, J., Jr., Vcherashnaya Rosser, M., (2004). *Complex Dynamics of Macroeconomic Collapse and Its Aftermath in Transition Economies*, Eastern Economic Journal, Eastern Economic Association, vol. 30(2), pages 207-221, Springer.
- [2] Bezemer, D., Dulleck, U., Frijters, P., (2003). *Socialism, Capitalism, and Transition-Coordination of Economic Relations and Output Performance*, Vienna Economics Papers 0305, University of Vienna, Department of Economics
- [3] Biegelbauer, P., (1996). *Realizing Hungary's Potential - The Country's Industrial R&D System in Transition*, East European Series 32, Institute for Advanced Studies
- [4] Brada, J., King, A., (1992). *Is There a J-Curve for the Economic Transition from Socialism to Capitalism?*, Economic Change and Restructuring, Springer, vol. 25(1), pages 37-53.
- [5] Bureau of Economic Analysis, (2008). *National Income and Product Accounts. Table 1.1.6. Real Gross Domestic Product, Chained Dollars*, retrieved in November 2008 from <http://bea.gov/be/dn/nipaweb/>
- [6] The Conference Board, (2008). *Total Economy Database*, retrieved in November 2008 from <http://www.conference-board.org/economics/downloads/TED08I.xls>
- [7] Hoelscher, J., (2006). *Income Distribution and Convergence in the Transition Process; A Cross-Country Comparison*, Comparative Economic Studies, Palgrave Macmillan Journals, vol. 48(2), pages 302-325, June.
- [8] King, L., (1999). *The Developmental Consequences of Foreign Direct Investment in the Transition from Socialism to Capitalism: The Performance of Foreign Owned Firms in Hungary*, William Davidson Institute Working Papers Series 277, William Davidson Institute at the University of Michigan Stephen M. Ross Business School.
- [9] Kitov, I., (2005). *A model for microeconomic and macroeconomic development*, Working Paper 05, ECINEQ, Society for the Study of Economic Inequality.
- [10] Kitov, I., (2005). *The personal income distribution in the U.S.. High incomes.* (2005) Working Papers 02, ECINEQ, Society for the Study of Economic Inequality.
- [11] Kitov, I., (2006). *GDP growth rate and population*, Working Papers 42, ECINEQ, Society for the Study of Economic Inequality.
- [12] Kitov, I., (2009). *The evolution of real GDP per capita in developed countries*, Journal of Applied Economic Sciences, Craiova, Romania. (submitted)
- [13] Kitov, I., Kitov, O., Dolinskaya, S., (2007). *Modelling real GDP per capita in the U.S.: cointegration test*, MPRA Paper 2739, University Library of Munich, Germany.
- [14] National Bureau of Economic Research, (2008). *Business Cycle Expansions and Contractions*, retrieved March 5, 2007 from <http://www.nber.org/cycles/cyclesmain.html#announcements>
- [15] U.S. Census Bureau, (2004). *National intercensal estimates (1990-2000)*, retrieved February 26, 2007 from [http://www.census.gov/popest/archives/methodology/intercensal\\_nat\\_meth.html](http://www.census.gov/popest/archives/methodology/intercensal_nat_meth.html)
- [16] U.S. Census Bureau, (2007). *Population Estimates*, retrieved February 26, 2007 from <http://www.census.gov/popest/estimates.php>