Human capital—economic growth nexus in the former Soviet Bloc

Osipian, Ararat

Vanderbilt University

1 January 2007

Human Capital—Economic Growth Nexus in the Former Soviet Bloc*

Ararat L. Osipian†

* Osipian, A. Human Capital--Economic Growth Nexus in the Former Soviet Bloc. 51st Anniversary Conference of the Comparative and International Education Society (CIES), University of Maryland, Baltimore, MD, February, 2007.

† Contact: ararat.osipian@vanderbilt.edu; araratos@yahoo.com

This study analyses the role of education in economic development in the republics of the former Socialist Bloc and more specifically the impact of human capital on per capita economic growth in transition economies in the Russian Federation, and Ukraine. The factors that are associated with the human capital in terms of education levels are analyzed in order to measure this impact. Our approach is to estimate the significance of educational levels for initiating substantial economic growth. We estimate a system of linear and log-linear equations accounting for different time lags in the possible impact of human capital on economic growth.

Key words: education, human capital, growth, transition, Russia, Ukraine

JEL Codes: J24, O47, P24

Introduction

Sustainable GDP growth in Ukraine of 5.9 percent in 2000, 9.4 percent in 2003, and 12.1 percent in 2004 with predicted growth of around 5 percent for 2007 is impressive, indeed, especially as it happens along with the stable and continuing decline in population. While in the year 2000 Gross National Income per capita was only $690, it constituted $970 in 2003, and has risen to $1260 in 2004 with predicted increase in 2007. These numbers are in nominal USD. Same trends characterize recent economic development in the Russian Federation and other countries of the former Soviet Bloc.

Economic growth in the former Soviet Union was mostly extensive, and always required new injections of capital and labor. Volume of capital and labor increased over time. Human capital development as expressed by the level of educational attainment of population was among the highest in the world for the last five decades. Technical progress was also very impressive. At the same time, capacity utilization was very poor for all factors of production. For instance, products of research were utilized mostly in the military industry. In addition, allocative efficiency was low because the allocation mechanisms were based on plan and directives or orders.

Starting in 1991, the Russian Federation, Ukraine, and other New Independent States (NIS) were undergoing a deep socio-economic transformation. This transformation found its reflection not only in the economy, but in changing ideology, religion, culture, and other non-economic spheres of human activities. At the same time problems that appeared during the transition period were not caused by transition. Nor they were creations of the reform. These problems accumulated well before the reform and made the transition more complex than it would be otherwise. Nevertheless, by 1999, the Russian Federation, Ukraine overcome the

decline in productivity and turn to positive economic growth. This study analyses the role and impact of human capital on per capita economic growth in transition economies in the Russian Federation, and Ukraine. It estimates the system of linear and log-linear equations accounting for different time lags the significance of educational levels for initiating substantial economic growth.

Literature review

Romer, in his 1990 paper entitled "Endogenous Technological Change" includes technological changes into the model of growth. He considers technology as the method used in a production process that transforms inputs into output and specifies research and development as sources for technological changes. He also emphasized ideas that drive progress are specific types of goods considering them as non-rival in contrast to other goods. According to Romer, non-rivalry nature of ideas implies increasing returns to scale (Barro, 1995; Jones, 1998).

The implications of the Romer's model might be found to be very similar to the neoclassical ideas. His model can be viewed as a "semi-endogenous" model because it predicts sustainable growth only in the case of endogenous technological progress and exogenous population growth. The labor force participates in the production process making capital productive and produces ideas which drive technological progress and, therefore, economic growth. Hence, investments in human capital are necessary in order to increase the productivity of labor and capital. For Romer, education is the main source for knowledge and a guide for the implementation of this knowledge in the production process.

Measurement of human capital and issues of allocation are presented by Mincer (1996), Ruth (1998), Barro (1999), Mulligan and Sala-i-Martin (2000). Emphasis on measurement of

human capital and its implication for economic growth are made by Kalaitzidakis et al. (2001). Based on cross country growth regressions and measures of human capital, presented in studies by Mankiw, Romer, and Weil (1992), Benhabib and Spiegel (2000), Barro and Sala-i-Martin (1999), Pritchett (1996), Barro (1997), Krueger and Lindahl (2000), they argue that a semiparametric, partially linear regression model specification of the cross country growth regression function is a particularly useful way of studying the contribution of human capital to economic growth. The semiparametric partially linear regression model is written as:

$$Y_{it} = x_{it}^{T}\gamma + q\left(Z_{it}\right) + U_{it},$$

where x_{it} is a variable of dimension q, γ is $q \times 1$ vector of unknown parameters, Z_{it} is a continuous variable of dimension p and $g()$ is an unknown function. Z_{it} refers to various measures of human capital. Human capital is measured by the level of education and gender. They conclude that the effect of human capital accumulation on growth is nonlinear and that there are threshold levels of human capital and growth for each country.

Shioji (2001) incorporates human capital into his conception of public capital, and he estimates dynamic effects of public capital on output per capita. The other components of public capital are: infrastructure, conservation of national land, and agriculture and fishery. Based on an open economy growth model, he derives an income convergence equation augmented with public capital (*PUP*). The relationship between steady state output per unit (*Y*) of labor and public capital (*PUP*) is presented by following equation:

$$Y_{it}^{*} = \sum_{j=1}^{J} \phi_j \times PUP_{jit-\tau} + Y_i ,$$

where $\phi_i = C_i / (1 - a)$.

ϕ_i represents the long-run elasticity of output with respect to public capital per capita, and *C* is a short-run elasticity.

Shioji found that each component of *PUP* had positive effects on *Y*, but infrastructure was more important to growth than education and had a more significant positive effect on productivity than education. These results can be interpreted as support for endogenous growth.

Endogenous Model of Economic Growth

An endogenous model of economic growth appears to be the most appropriate for our evaluation. First, such model may be applied for cross sectional analysis, which is probably the best way to analyze economic growth in the countries in transition. Second, the model shows the influence and importance of human capital relative to other key inputs on economic growth and to differences across countries.

While both intuition and several theories of endogenous growth point towards a positive effect of human capital on economic growth, empirical evidence on this issue has been mixed. The purpose of the study is to provide a systematic investigation of the human capital--economic growth nexus. The impact of human capital on economic growth is incorporated according to the Mankiw et al. (1992) framework.

Mankiw et al. assume a production function of the form given below:

$$Y = K_t^{\alpha} - H_t^{\beta}\left(A_t L_t\right)^{1-\alpha-\beta},$$

where *Y*, *K*, *H*, and *L* represent total output, physical capital stock, human capital stock and labor, respectively. *A* is a technological parameter. Technology is assumed to grow exponentially at the rate ϕ.

Analysis of macroeconomic indicators often underestimates qualitative characteristics. Macroeconomic indicators are aggregates that focus on the quantitative characteristics of national production. More precise estimates of economic situation in the Russian Federation and Ukraine as well as other transition economies with its vectors and level of development over the last two decades requires consideration of such fundamental socio-economic characteristics as education and healthcare. Access to education and medical services is crucially important in characterizing living standards and level of personal consumption of the population. It is as important in analysis of reproduction of human capital. Higher education and medical services are two technologically complex branches of the economy that characterize developed nations. Their complexity serves as an indicator of level of economic development as well as presence of the necessary conditions for economic growth.

Access to Higher Education in the NIS

Number of students in higher education institutions per 10000 population is chosen to analyze access of population to higher education. This indicator reflects level or stock of human capital in the countries as well as dynamics of production of human capital during the significant periods of time. Number of students in higher education institutions per 10000 population in the former Soviet republics for the period of 1980-1999 is presented in Tables 1 and 2.

TABLE 1

Number of students in higher education institutions per 10000 population in NIS, 1980-1989

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Azerbaijan	172	172	172	169	163	158	155	149	140	140
Armenia	189	188	189	183	173	163	160	161	168	186
Belarus	183	183	185	185	186	181	179	177	175	185
Georgia	168	170	172	172	169	167	160	160	157	171
Kazakhstan	173	176	179	181	180	172	170	168	167	171
Kyrgyzstan	151	154	154	151	148	144	142	136	133	136
Moldova	127	129	130	128	128	126	123	121	122	127
Russia	219	219	218	216	213	206	200	194	190	193
Tajikistan	142	138	137	133	131	119	115	114	115	125
Turkmenistan	124	125	127	126	122	119	117	117	112	116
Uzbekistan	172	172	170	165	162	155	154	155	155	163
Ukraine	176	175	175	174	173	167	166	166	165	171

Source: Commonwealth of Independent States (CIS) - Official Statistics, retrieved from the database in August 8, 2006.

TABLE 2

Number of students in higher education institutions per 10000 population in NIS, 1990-1999

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Azerbaijan	146	147	134	125	117	128	132	127	134	147
Armenia	191	181	156	124	97	97	142	149	157	160
Belarus	184	180	179	169	181	191	203	219	239	258
Georgia	190	188	167	168	251	231	239	234	236	248
Kazakhstan	171	170	165	163	165	165	176	188	206	245
Kyrgyzstan	133	129	119	117	129	142	169	210	274	325
Moldova	125	120	109	108	114	149	159	180	199	212
Russia	190	186	177	171	171	188	201	221	245	280
Tajikistan	128	124	127	121	127	126	127	126	123	130
Turkmenistan	113	104	96	90	86	70	62	…	…	…
Uzbekistan	165	159	146	123	102	84	71	66	65	68
Ukraine	170	168	164	159	172	180	192	220	242	259

Source: Commonwealth of Independent States (CIS) - Official Statistics, retrieved from the database in August 8, 2006.

Contrary to the beliefs about the crisis situation in the Russian Federation and Ukraine, statistics point to the continuous growth in the number of students in higher education institutions per 10000 population. While during the independence and start of the market reforms in 1991 this indicator in Ukraine was equal to 168, by the year 1999 number of students enrolled in higher education institutions per 10000 population has reached 259. This indicator is slightly lower than in the Russian Federation, where number of students per 10000 thousand population grew from 186 in 1991 to 280 in 1999.

Dynamics of the number of students in higher education institutions per 10000 population in the NIS for the period of 1980-1999 are presented in Figure 1.

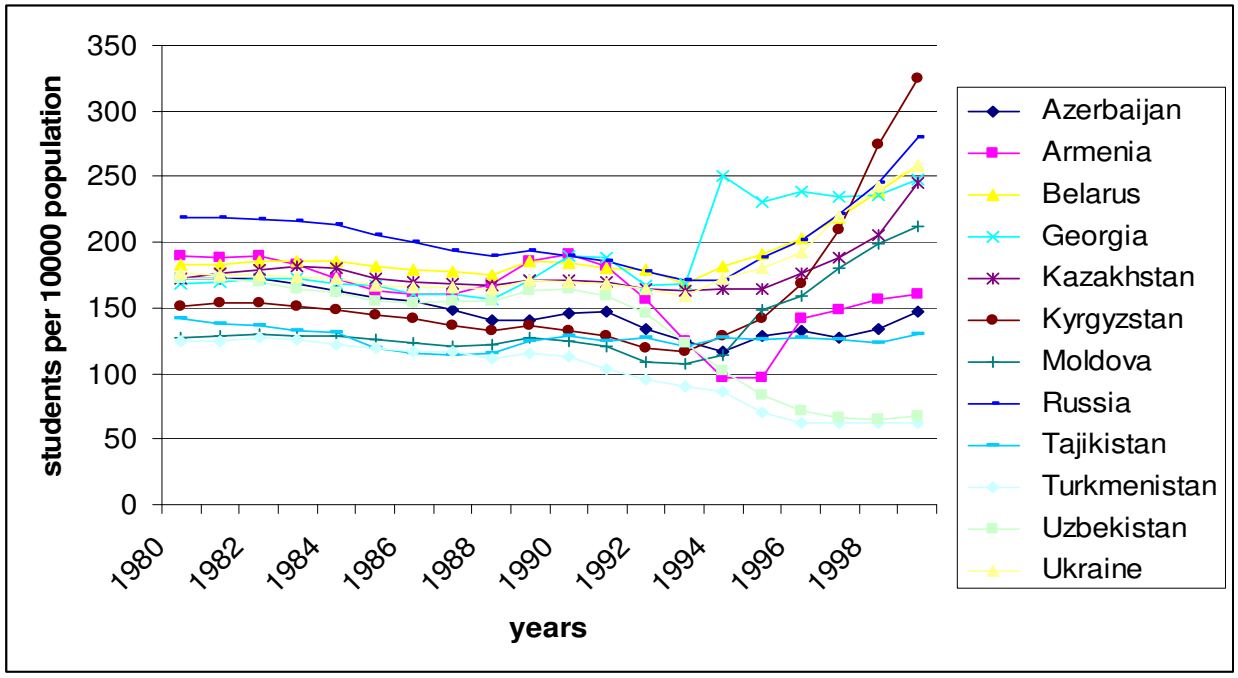

Figure 1. Number of students in higher education institutions per 10000 population in NIS, 1980-1999

Data for the Russian Federation and Ukraine indicate that during the transition total number of students in higher education institutions per every ten thousand of population was

increasing consistently since 1993 despite the decline in some other economic indicators. This proves not only the fact of the continuous positive developments in national systems of higher education based on the market reforms, but also shows continuous growth in accumulation and concentration of human capital in national economies.

Positive trends in the development of higher education industry and increasing access of population to higher education characterize such countries as Ukraine, the Russian Federation, and Belarus, but are not necessarily characteristics of all the former soviet republics. For instance, in Azerbaijan number of students in higher education institutions per every ten thousand of population as an indicator of access to higher education was declining till 1995 and reached level of 1991 only in 1999, comprising 147 students. This indicator is almost twice lower than in the Russian Federation and Ukraine. In Armenia value of this indicator declined from 191 in 1990 to 97 in 1995 and then increased to 160 in 1999.

In some other former republics situation with access to higher education did not regain its positions of 1991. Indicator of number of students in higher education institutions per every ten thousand of population declined in Uzbekistan from 170 in 1990 to 68 in 1999, and in Turkmenistan—from 113 in 1990 to 62 in 1996. This statistics should always be correlated with demographic and migratory processes in the NIS. One should also account for students receiving their education in other countries, predominantly in other member countries of the NIS.

The data indicate that despite the economic difficulties during the transition period, number of students in higher education institutions per every ten thousand of population was increasing consistently since 1993. This confirms not only continuous and consistent development of the education industry, but also stable increase in the total volume and concentration of human capital in the country.

Data and descriptive statistics

The data used in the empirical study are selected macroeconomic indicators for the Russian Federation, and Ukraine and cover the period of 1989-2010. Trajectories of the indicators over time taken as logs are presented in Figures 3, 5, 7, and 9. GDP per capita growth, gross fixed investment annual change, gross national savings rate (percent), and recorded unemployment (percent), for the Russian Federation, and Ukraine for the period of 1989-2010 are presented in Table 3.

TABLE 3

Real GDP growth per head (percent per annum), gross fixed investment (percent real change per annum), gross national savings rate (percent), and recorded unemployment (percent), in the Russian Federation and Ukraine, 1989-2010

Year	GDP per capita growth, percent		Gross fixed investment change, percent		Gross national savings rate, percent		Recorded unemployment, percent	
	Russia	Ukraine	Russia	Ukraine	Russia	Ukraine	Russia	Ukraine
1989	-	-	-	-	-	-	-	-
1990	-	-4.241	-	-	-	-	-	-
1991	-5.267	-8.954	-15.600	-	-	-	-	-
1992	-14.586	-10.225	-41.500	-13.030	-	-	-	-
1993	-8.669	-13.985	-25.800	-34.626	31.334	-	-	-
1994	-12.659	-22.322	-26.000	-50.263	28.358	32.659	7.017	-
1995	-4.065	-11.522	-15.267	-9.960	27.662	23.675	8.300	-
1996	-3.460	-9.217	-21.200	-20.036	26.434	20.037	9.258	1.300
1997	1.457	-2.240	-7.900	3.636	21.957	18.759	10.808	2.300
1998	-5.139	-1.124	-12.400	4.316	15.044	17.667	11.875	3.700
1999	6.730	0.597	6.400	0.720	27.393	22.729	12.617	4.200
2000	10.478	6.806	18.100	12.650	36.729	24.494	10.492	4.100
2001	5.613	11.001	10.200	9.350	32.972	25.482	9.033	3.600
2002	5.242	6.198	2.800	3.400	28.502	27.700	8.133	3.700
2003	7.757	10.398	12.800	15.800	29.010	27.800	8.625	3.500
2004	7.611	12.913	11.290	20.500	30.997	31.800	8.175	3.500
2005	6.823	3.371	10.499	-0.300	31.833	25.200	7.583	3.100
2006	6.700	6.100	10.200	5.000	31.400	20.000	7.000	3.500
2007	6.100	6.400	11.000	9.000	30.200	19.600	6.600	3.800
2008	5.400	6.500	10.600	10.000	27.400	19.500	6.400	4.100
2009	4.900	6.700	10.900	7.500	26.100	19.600	6.300	4.400
2010	4.600	6.300	10.000	8.500	26.300	21.700	6.100	4.800

Source: Economist Intelligence Unit. Retrieved from the database in August 12, 2006. Composed based on EIU calculations, US Census Bureau, Ministry of Economy and European Integration, State Committee of Statistics, RosStat, Statistical Yearbook, UN, IMF, International Financial Statistics.

Dynamics of the GDP per capita growth for Hungary, Poland, the Russian Federation, and Ukraine for the period of 1989-2010 are presented in Figure 2.

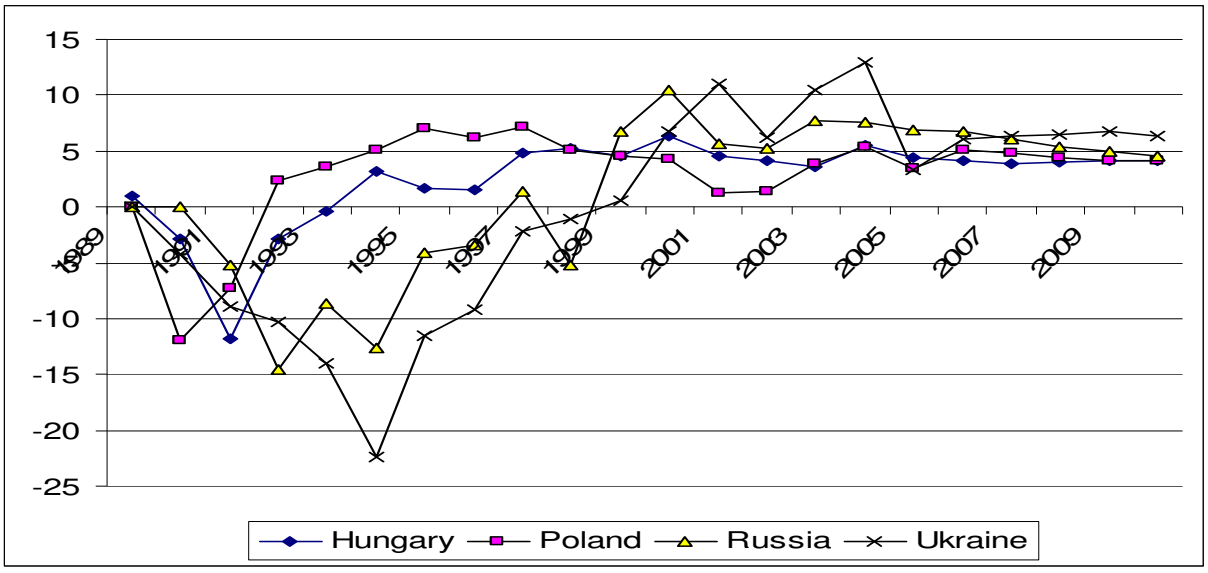

Figure 2. Real GDP per capita growth in Hungary, Poland, the Russian Federation, and Ukraine, 1989-2010

Dynamics of the GDP per capita growth for Hungary, Poland, the Russian Federation, and Ukraine for the period of 1989-2010 that accounts for the log trajectories are presented in Figure 3.

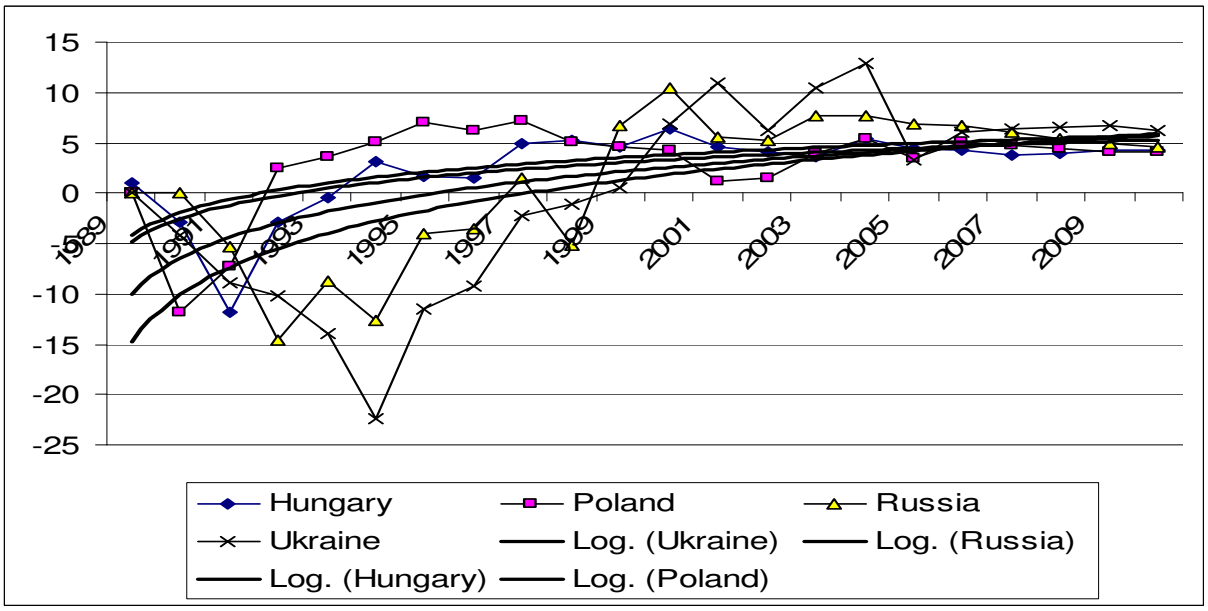

Figure 3. Real GDP per capita growth in Hungary, Poland, the Russian Federation, and Ukraine (with the log trajectories), 1989-2010

As shown in Figure 3, that uses trajectories of the logs, GDP per capita growth in Hungary, Poland, the Russian Federation, and Ukraine was in the different initial position in each country. The convergence of the GDP per capita growth rate in these countries occurs during the period of 1989-2010.

Dynamics of the gross fixed investment annual change for Hungary, Poland, the Russian Federation, and Ukraine for the period of 1989-2010 are presented in Figure 4.

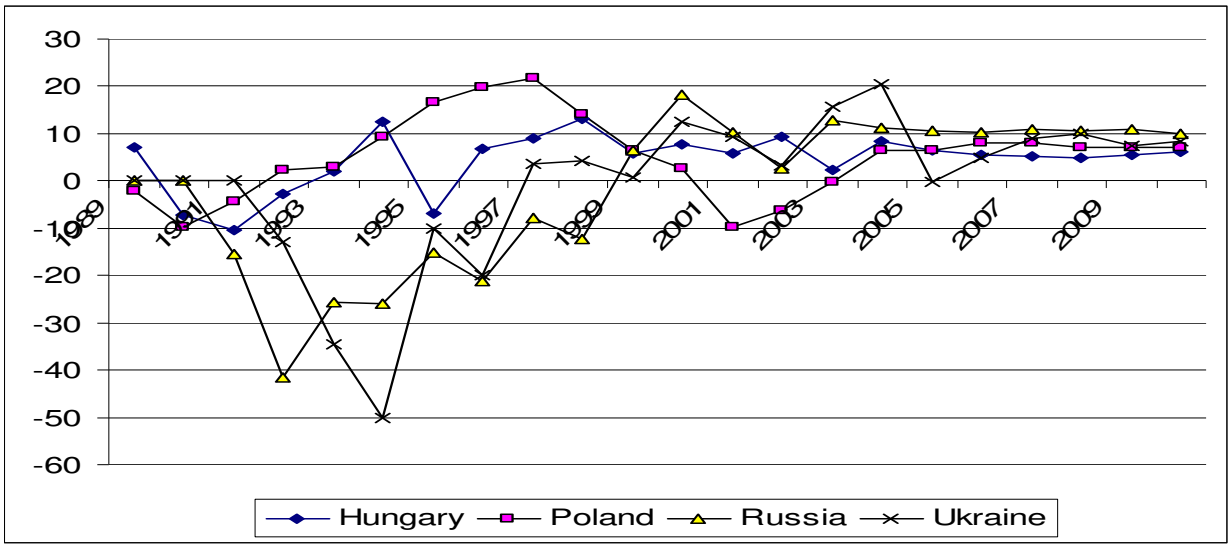

Figure 4. Investment in constant capital in Hungary, Poland, the Russian Federation, and Ukraine, 1989-2010

Dynamics of the gross fixed investment annual change for Hungary, Poland, the Russian Federation, and Ukraine for the period of 1989-2010 that accounts for the log trajectories are presented in Figure 5.

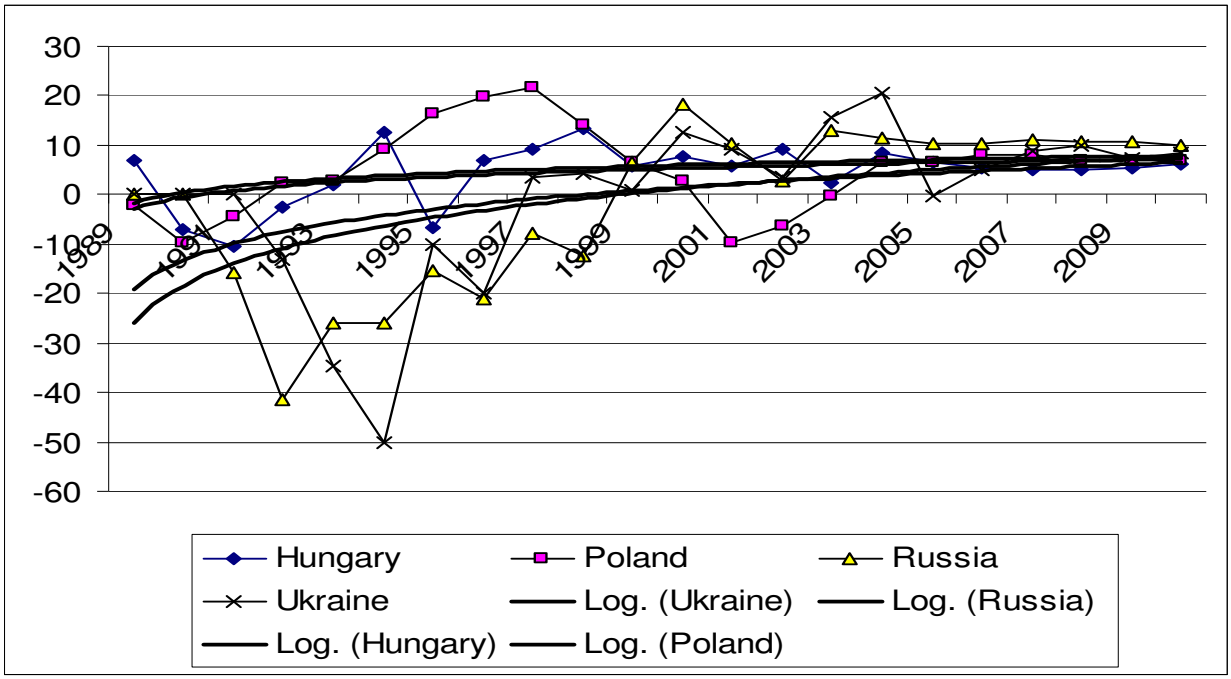

Figure 5. Investment in constant capital in Hungary, Poland, the Russian Federation, and Ukraine (with the log trajectories), 1989-2010

As shown in Figure 5 that uses trajectories of the logs, levels of the gross fixed investment in Hungary, Poland, the Russian Federation, and Ukraine were in the different initial positions in each country. However, gross fixed investment rates converge. The convergence of the gross fixed investment rates in these countries occurs during the period of 1989-2010. Gross fixed investment rates in Poland and Hungary were higher than in the Russian Federation and Ukraine. The process of convergence of the growth gross fixed investment rate coincides with the convergence of the GDP per capita growth in these countries that occurs during the period of 1989-2010. This confirms significant and positive effect of the investment on growth.

Dynamics of the savings rate annual change for Hungary, Poland, the Russian Federation, and Ukraine for the period of 1989-2010 are presented in Figure 6.

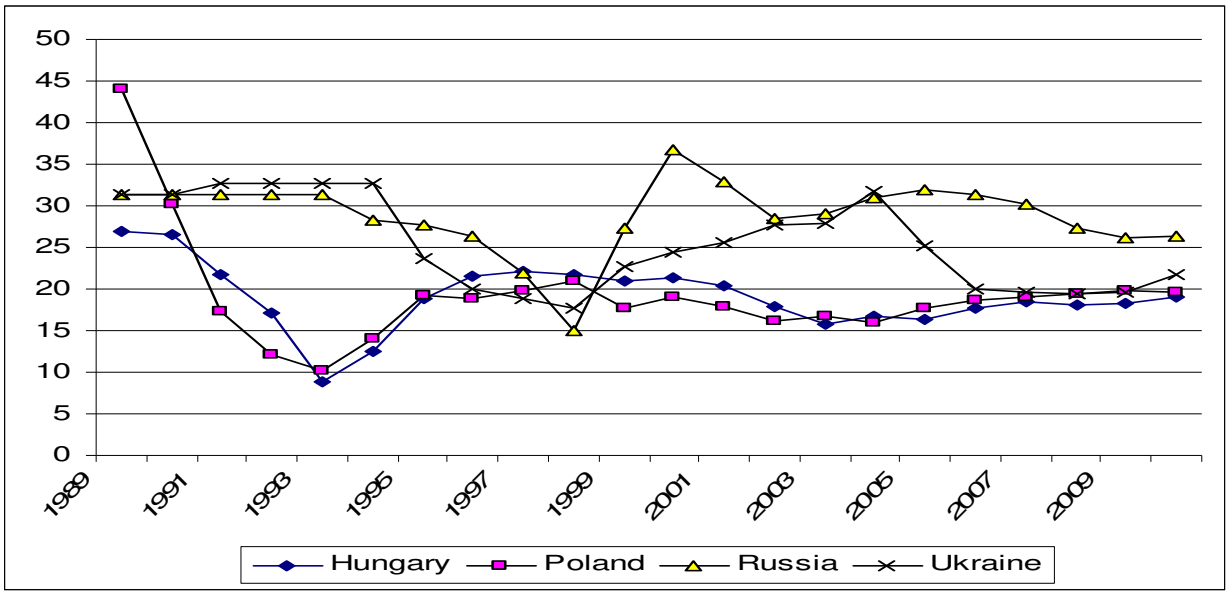

Figure 6. Savings rate in Hungary, Poland, the Russian Federation, and Ukraine, 1989-2010

Dynamics of the savings rate annual change for Hungary, Poland, the Russian Federation, and Ukraine for the period of 1989-2010 that accounts for the log trajectories are presented in Figure 7.

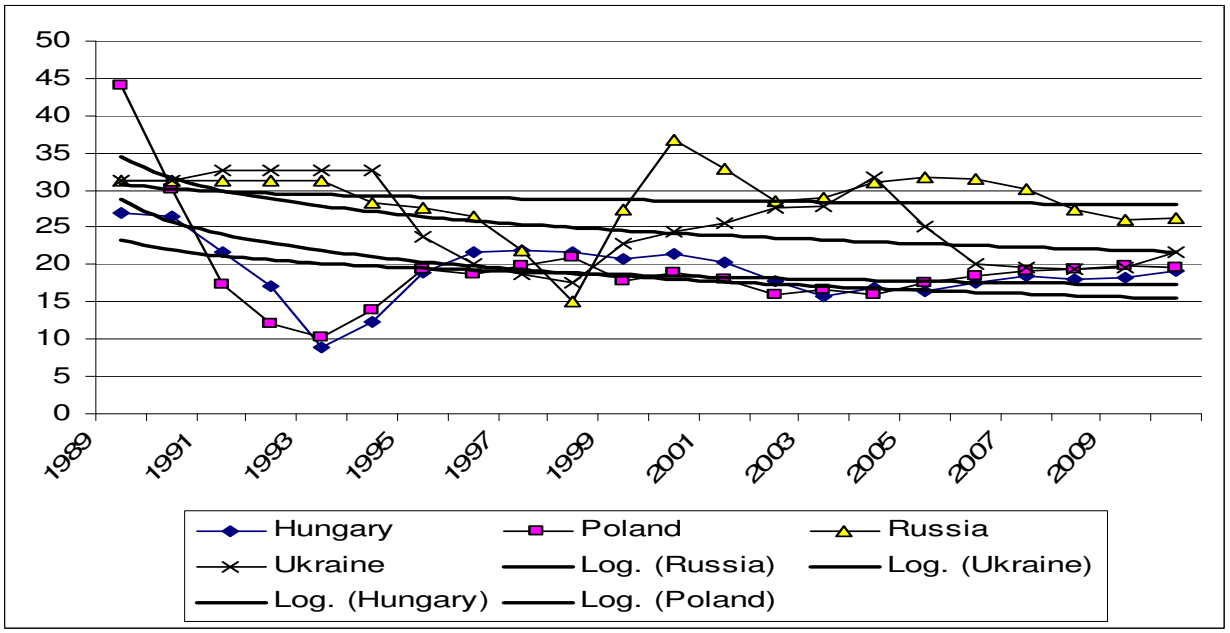

Figure 7. Savings rate in Hungary, Poland, the Russian Federation, and Ukraine (with the log trajectories), 1989-2010

As shown in the Figure 7 that uses trajectories of the logs, levels of the savings rate in Hungary, Poland, the Russian Federation, and Ukraine have not changed significantly during the period of 1989-2010. Sharp decline of the savings rate in the Russian Federation and Ukraine in 1999 can possibly be explained by the world financial crisis of 1997-1998.

Dynamics of the official rate of unemployment annual change for Hungary, Poland, the Russian Federation, and Ukraine for the period of 1989-2010 are presented in Figure 8.

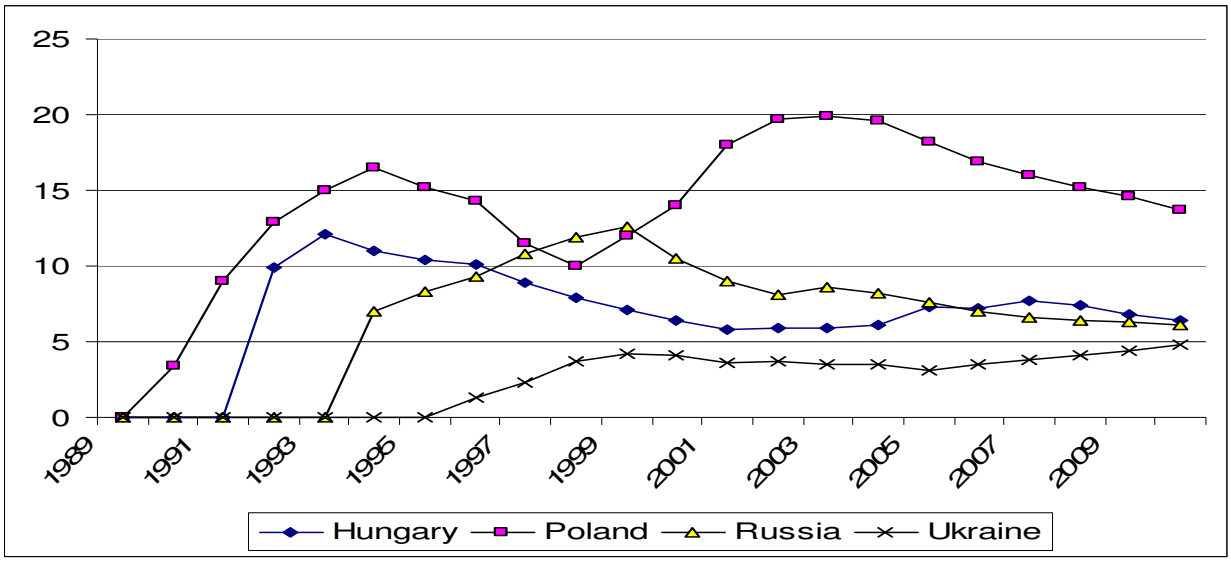

Figure 8. Registered level of unemployment in Hungary, Poland, the Russian Federation, and Ukraine, 1989-2010

Dynamics of the official rate of unemployment annual change for Hungary, Poland, the Russian Federation, and Ukraine for the period of 1989-2010 that accounts for the log trajectories are presented in Figure 9.

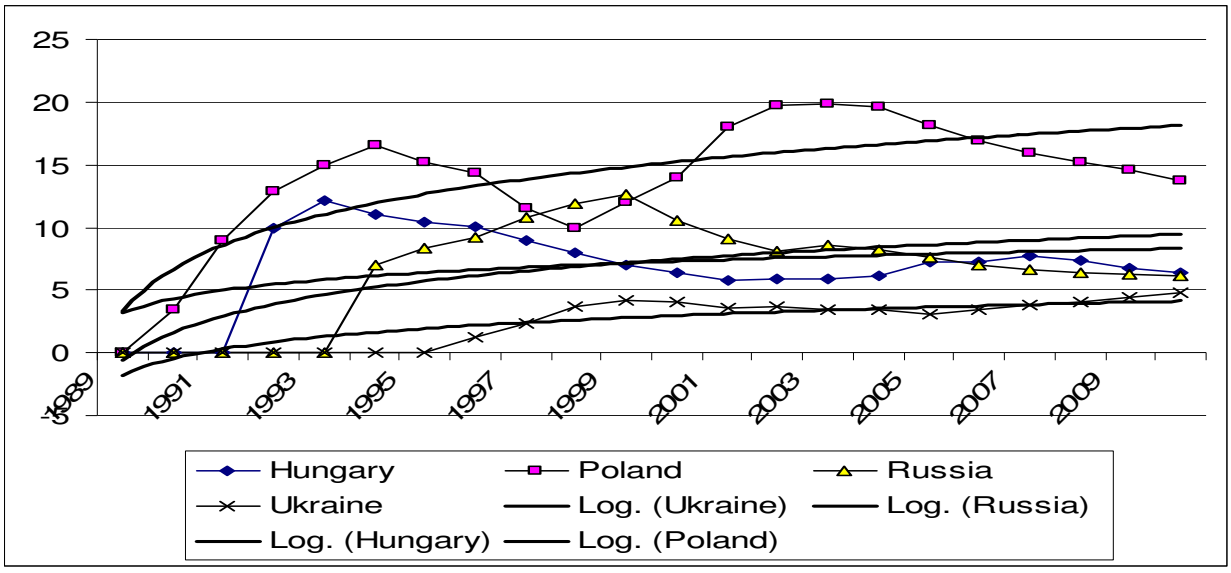

Figure 9. Registered level of unemployment in Hungary, Poland, the Russian Federation, and Ukraine (with the log trajectories), 1989-2010

As shown in Figure 9 that uses trajectories of the logs, levels of the official unemployment rate in Hungary, Poland, the Russian Federation, and Ukraine have risen dramatically in early 1990s and have stabilized later. Such a sharp increase in unemployment may be explained in part by the absence of the official unemployment in the USSR and Eastern Europe. Relatively low level of the registered unemployment in the Russian Federation and Ukraine in 1990s should be considered critically as it appears to be much lower than the real unemployment rate.

Empirical results

The presented calculations are based on the estimation of the system of linear and log-linear equations that account for changes in investment, savings, unemployment, education, and medical services. The independent variables were dropped consequently and the time lags were taken as five-, six, seven, and ten-year time lags. We comment only on the coefficients with 5 percent level of significance. Regression results of GDP per capita growth to investment, savings,

unemployment, education and healthcare for the Russian Federation and Ukraine for the period of 1990-2010 with the constant coefficient (1) and without the constant coefficient (2) are presented in Table 4. Indicators of the level of access to higher education and medical services are taken with the five year time lag.

TABLE 4

Regression results of GDP growth to investment, savings, unemployment, education and healthcare for the Russian Federation and Ukraine, 1990-2010

Country	Russian Federation		Ukraine	
	(1)	(2)	(1)	(2)
Estimation method	OLS	OLS	OLS	OLS
Independent variable				
Investment	0.544219**	0.349321*	0.341820**	0.384583**
	(0.151921)	(0.088695)	(0.153252)	(0.142531)
	[3.582251]	[3.938462]	[2.230438]	[2.698245]
Savings	-0.038764	0.226039	0.901649	1.196193
	(0.260842)	(0.213105)	(0.728499)	(0.637364)
	[-0.148611]	[1.060695]	[1.237682]	[1.876784]
Unemployment	-1.156294	1.021889	0.410878	0.130104
	(1.554713)	(0.645762)	(1.675531)	(1.609592)
	[-0.743735]	[1.582455]	[0.245223]	[0.080831]
Education	-0.014755	0.041590	-0.066783	-0.060944
	(0.050371)	(0.037368)	(0.089199)	(0.086963)
	[-0.292917]	[1.112996]	[-0.748699]	[-0.700799]
Healthcare	-2.180633	-0.474601	2.500816	-0.346361
	(1.176011)	(0.366858)	(3.148024)	(0.212904)
	[-1.854263]	[-1.293691]	[0.794408]	[-1.626842]
R-squared	0.959353	0.941654	0.954202	0.941654
Adjusted R-squared	0.918707	0.883307	0.877871	0.883307
Mean dependent var	1.778636	1.778636	3.925778	3.925778
S.D. dependent var	7.173865	7.173865	7.361281	7.361281

Notes: each column is a separate regression of the growth rate on investment, savings, unemployment, education, and healthcare.
Standard errors are reported in parentheses. t-statistics are reported in square brackets.
Asterisk * indicates statistical significance at the 1-percent level, ** at the 5-percent level, and *** at the 10-percent level.

Regression results of GDP per capita growth to investment, savings, education, and healthcare for the Russian Federation and Ukraine for the period of 1990-2010 with the constant coefficient (1) and without the constant coefficient (2) are presented in Table 5. Indicators of the level of access to higher education and medical services are taken with the five year time lag.

TABLE 5

Regression results of GDP growth to investment, savings, unemployment, education and healthcare for the Russian Federation and Ukraine, 1990-2010

Country	Russian Federation		Ukraine	
	(1)	(2)	(1)	(2)
Estimation method	OLS	OLS	OLS	OLS
Independent variable				
Investment	0.430864*	0.448183*	0.416201*	0.516480*
	(0.042274)	(0.052814)	(0.042274)	(0.105189)
	[10.19206]	[8.486119]	[3.862983]	[4.910021]
Savings	0.133635	0.015774	0.200090	0.394320
	(0.128833)	(0.151186)	(0.128833)	(0.488916)
	[1.037277]	[0.104332]	[0.453996]	[0.806520]
Education	0.017864	-0.001487	-0.040690	0.021822
	(0.022262)	(0.026335)	(0.022262)	(0.083934)
	[0.802457]	[-0.056456]	[-0.500659]	[0.259988]
Healthcare	-1.484476***	0.053926	5.761747	-0.298297
	(0.645769)	(0.143247)	(0.645769)	(0.186454)
	[0.05510]	[0.376454]	[1.692321]	[-1.599844]
R-squared	0.961679	0.929628	0.950381	0.924120
Adjusted R-squared	0.939781	0.903239	0.917301	0.891600
Mean dependent var	0.908000	0.908000	0.135273	0.135273
S.D. dependent var	7.475416	7.475416	10.96832	10.96832

Notes: each column is a separate regression of the growth rate on investment, savings, education, and healthcare.
Standard errors are reported in parentheses. t-statistics are reported in square brackets.
Asterisk * indicates statistical significance at the 1-percent level, ** at the 5-percent level, and *** at the 10-percent level.

Regression results of GDP per capita growth to investment, savings, education, and healthcare for the Russian Federation and Ukraine for the period of 1990-2010 with the constant

coefficient (1) and without the constant coefficient (2) are presented in Table 6. Indicators of the level of access to higher education and medical services are taken with the six year time lag.

TABLE 6

Regression results of GDP growth to investment, savings, and education and healthcare for the Russian Federation and Ukraine, 1990-2010

Country	Russian Federation		Ukraine	
	(1)	(2)	(1)	(2)
Estimation method	OLS	OLS	OLS	OLS
Independent variable				
Investment	0.452827*	0.454333*	0.430281*	0.523992*
	(0.053285)	(0.046954)	(0.066924)	(0.065638)
	[8.498240]	[9.676147]	[6.429377]	[7.983083]
Savings	-0.014128	-0.018440	0.472994*	0.420083
	(0.155924)	(0.137815)	(0.222495)	(0.273993)
	[-0.090609]	[-0.133805]	[2.125865]	[1.533188]
Education	-0.004705	-0.005694	-0.076373	0.021073
	(0.027358)	(0.022957)	(0.055225)	(0.043700)
	[-0.171966]	[-0.248051]	[-1.382946]	[-0.248051]
Healthcare	0.029059	0.092991	5.349698***	-0.303923***
	(0.818807)	(0.131469)	(2.468013)	(0.168933)
	[0.035490]	[0.707324]	[2.167614]	[0.109700]
R-squared	0.935410	0.935359	0.953802	0.919064
Adjusted R-squared	0.903115	0.913812	0.927403	0.888713
Mean dependent var	1.363000	1.363000	0.404917	0.404917
S.D. dependent var	7.342776	7.342776	10.49951	10.49951

Notes: each column is a separate regression of the growth rate on investment, savings, education, and healthcare.
Standard errors are reported in parentheses. t-statistics are reported in square brackets.
Asterisk * indicates statistical significance at the 1-percent level, ** at the 5-percent level, and *** at the 10-percent level.

Regression results of GDP per capita growth to investment, savings, and education for the Russian Federation and Ukraine for the period of 1990-2010 with the constant coefficient (1)

and without the constant coefficient (2) are presented in Table 7. Indicators of the level of access to higher education are taken with the five year time lag.

TABLE 7

Regression results of GDP growth to investment, savings, and education for the Russian Federation and Ukraine, 1990-2010

Country	Russian Federation		Ukraine	
	(1)	(2)	(1)	(2)
Estimation method	OLS	OLS	OLS	OLS
Independent variable				
Investment	0.456769*	0.436670*	0.507771*	0.596913*
	(0.050490)	(0.040954)	(0.104841)	(0.101002)
	[9.046741]	[10.66238]	[4.843235]	[5.909940]
Savings	-0.004268	0.048580	0.376908	0.562421
	(0.141282)	(0.117505)	(0.481814)	(0.521962)
	[-0.030207]	[0.413427]	[0.782269]	[1.077514]
Education	-0.006527	0.005975	0.022592	-0.068311
	(0.024251)	(0.016493)	(0.081200)	(0.068011)
	[-0.269131]	[0.362271]	[0.278230]	[-1.004410]
R-squared	0.932750	0.928382	0.926696	0.896375
Adjusted R-squared	0.907531	0.912466	0.895280	0.870469
Mean dependent var	0.908000	0.908000	0.135273	0.135273
S.D. dependent var	7.475416	7.475416	10.968320	10.96832

Notes: each column is a separate regression of the growth rate on investment, savings, and education.
Standard errors are reported in parentheses. t-statistics are reported in square brackets.
Asterisk * indicates statistical significance at the 1-percent level, ** at the 5-percent level, and *** at the 10-percent level.

Regression results of GDP per capita growth to investment, savings, and education for the Russian Federation and Ukraine for the period of 1990-2010 with the constant coefficient are presented in Table 8. Indicators of the level of access to higher education are taken with the six year time lag (1) and with the seven year time lag (2).

TABLE 8

Regression results of GDP growth to investment, savings, and education for the Russian Federation and Ukraine, 1990-2010

Country	Russian Federation		Ukraine	
	(1)	(2)	(1)	(2)
Estimation method	OLS	OLS	OLS	OLS
Independent variable				
Investment	0.451999*	0.449635*	0.517551*	0.513473*
	(0.045165)	(0.041511)	(0.064646)	(0.054756)
	[10.00766]	[10.83167]	[8.005908]	[9.377552]
Savings	-0.011663	-0.014491	0.431738	0.384124***
	(0.131625)	(0.124123)	(0.268069)	(0.204437)
	[-0.088608]	[-0.116749]	[1.610548]	[1.878933]
Education	-0.004157	-0.004167	0.018197	0.042449
	(0.021306)	(0.019454)	(0.040943)	(0.030395)
	[-0.195124]	[-0.214207]	[0.444446]	[1.396600]
R-squared	0.935400	0.935400	0.922793	0.922793
Adjusted R-squared	0.913866	0.913866	0.893841	0.893841
Mean dependent var	1.363000	1.363000	0.404917	0.404917
S.D. dependent var	7.342776	7.342776	10.499510	10.499510

Notes: each column is a separate regression of the growth rate on investment, savings, and education.
Standard errors are reported in parentheses. t-statistics are reported in square brackets.
Asterisk * indicates statistical significance at the 1-percent level, ** at the 5-percent level, and *** at the 10-percent level.

Regression results indicate positive effects of investments on the GDP per capita growth rate. An increase in investment leads to an increase in per capita GDP growth in all the countries. Other variables are not statistically significant. Effects of the variables that represent access of population to higher education and medical services are within the limits of statistical error. This statement holds when indicators of the level of access to higher education and medical services are taken with the five, six, and seven year time lags.

Positive effects of investment in fixed capital in the Russian Federation and Ukraine are obvious. One percent increase in investments in the Russian Federation and Ukraine leads to an increase of the per capita GDP within the limits of 0.37 to 0.55 percent. The dependency between the per capita GDP growth and the independent variables we use in the regressions may be nonlinear. We test system of log-linear equations, where all independent variables are taken as logarithms. Initially, we estimate an equation that includes logarithms of all independent variables, including investment, savings, unemployment, education, and health. Then variables of unemployment and health are consequently taken out from the equations. Indicators of the level of access of population to higher education and medical services are taken consequently with the five, six, seven, and ten year time lags for all the equations. All combinations of log-linear equations are estimated with and without the constant coefficient.

Regression results indicate positive effects of an increase in investment on the per capita GDP growth in the Russian Federation and Ukraine. Investment coefficients are positive and statistically significant in all of the equations with the goodness of fit within the limits of 0.8 to 0.95. The complete records of the regression results can be obtained from the author. We will consider the most interesting results.

Regression results of per capita GDP growth to logarithms of investment, savings, and education with the constant coefficient in the Russian Federation and Ukraine, for the period of 1990-2010, presented in Table 9, indicate positive effect of an increase in investment in fixed capital, savings, and access to education on the per capita GDP growth. All coefficients of the independent variables are statistically significant. Indicators of the level of access of population to higher education are taken with the ten year time lag.

Regression results of GDP per capita growth to investment, savings, and education for the Russian Federation and Ukraine for the period of 1990-2010 with the constant coefficient (1) and without the constant coefficient (2) are presented in Table 9. Indicators of the level of access to higher education are taken with the ten year time lag.

TABLE 9

Regression results of GDP growth to investment, savings, and education in Ukraine, 1990-2010

Country	Russian Federation	Ukraine	
	(2)	(1)	(2)
Estimation method	OLS	OLS	OLS
Independent variable			
Investment	1.461792***	2.141293**	3.389514*
	(0.708749)	(0.698971)	(1.035916)
	[2.062496]	[3.063492]	[3.271996]
Savings	6.209534**	19.06934*	6.853271***
	(1.937277)	(3.728733)	(3.637917)
	[3.205291]	[5.114161]	[1.883845]
Education	-3.356831**	11.31633**	-4.170212***
	(1.194651)	(4.021590)	(2.113641)
	[-2.809885]	[2.813894]	[-1.972999]
R-squared	0.674533	0.893438	0.673608
Adjusted R-squared	0.593166	0.853477	0.601077
Mean dependent var	6.668545	5.854083	5.854083
S.D. dependent var	1.575530	4.683886	4.683886

Notes: each column is a separate regression of the growth rate on investment, savings, and education.
Standard errors are reported in parentheses. t-statistics are reported in square brackets.
Asterisk * indicates statistical significance at the 1-percent level, ** at the 5-percent level, and *** at the 10-percent level.

Estimation of the equations that consider indicators of access to higher education and medical services with the seven year time lag does not bring statistically significant results. This supports our suggestion that an increase in access of population to higher education does not

bring positive results for the per capita GDP growth in the short term. Moreover, enrollment in a higher education institution equates to temporary withdrawal from the work force. Both the level of unemployment and the opportunity costs of obtaining education are of certain concern here. However, an increase in access of population to higher education brings positive results for the per capita GDP growth in the long term. Increasing number of college-educated specialists leads to sustainable economic growth. Apparently, background for the 2000-2005 rapid economic growth in Ukraine and in the Russian Federation was laid down in early 1990s. This contradicts commonly accepted perception about the crisis decade of 1990s.

Estimation of the system of equations where all the variables—dependent and independent—were presented in the form of logarithms confirms positive effect of an increase in investment and per capita GDP growth. For instance, one percent increase in investment in fixed capital in Ukraine leads to 0.639 percent increase in per capita GDP growth.

Concluding remarks

As follows from the regression results, presented in this chapter, investments in fixed capital have positive effect on the GDP per capita growth rate. Positive effect of investment on per capita GDP growth in Ukraine is more significant than that in the Russian Federation. The results support theoretical statement made earlier that in transition and post-transition economies savings are not analogous to investments. This means that savings are not necessarily invested in the national economy at full scale. Process of reinvestment is weak. This finding makes obvious underdevelopment of the national stock markets and proves necessity for further development of the capital market, including institutional reform and strengthening of the national banking sector and the stock market.

Regression results of per capita GDP growth to logarithms of investment, savings, and education with the constant coefficient in the Russian Federation and Ukraine for the period of 1990-2010 indicate positive effect of an increase in investment in fixed capital, savings, and access to education on the per capita GDP growth when indicators of the level of access of population to higher education are taken with the ten year time lag.

An increase in access of population to higher education brings positive results for the per capita GDP growth in the long term. Increasing number of college-educated specialists leads to sustainable economic growth. Apparently, background for the 2000-2005 rapid economic growth in Ukraine and in the Russian Federation was laid down in early 1990s. This contradicts commonly accepted perception about the crisis decade of 1990s. The regression results present strong empirical evidence in support of continuing investment in fixed capital in order to sustain economic growth. Investments in fixed capital are backed by the growing education quality of the work force.

The impact of human capital accumulation on economic growth remains controversial. In different research, conclusions reached depend on the definition of human capital, the methodology used and the time period and set of countries over which the model is estimated. Our objective in this research is to present a study of the link between human capital accumulation and GDP per capita growth in countries in transition. As anticipated, parametric estimates reveal no link between the two variables: for different measures of human capital, there is no significant growth effect.

The empirical results are supportive of the predictions from the endogenous growth models: an increase in human capital does not correlate with per capita economic growth in countries with a high level of human capital. High level of human capital in the Russian

Federation, Ukraine, and other NIS needs to be reproduced on a constant scale. Also, the process of accumulation of human capital will have a positive impact on GDP per capita growth in the long run.

The slow initial process of restructuring and institutional changes in the Russian Federation and Ukraine led to a low level of GDP per capita growth. Nevertheless, positive changes in the economy and the society overall, are the result of the structural changes in the economy, institutional reforms, development of the market type of behavior among population, development of market infrastructure, improved management, regional diversification, stabilization of the national currency, slowdown in both "brain drain" and capital outflow, and high level of human capital that was a ground for economic growth.

The next advancement in economic growth will become possible based on the process of renovation and investment into principal capital. From this perspective, one may suggest further institutional and structural changes in the transition economies. It will increase domestic and foreign investment, further develop domestic market, and sustain already achieved substantial GDP per capita growth.

References

Barro, R. (1997). Determinants of Economic Growth: A Cross-Country Empirical Study. New York: Cambridge University Press.

Barro, R. (2000). Inequality and Growth in a Panel of Countries. *Journal of Economic Growth*, 1, pp. 5-32.

Barro, R., & Lee, J. (1996). International Measures of Schooling Years and Schooling Quality. *American Economic Review*, 86, pp. 218-223.

Barro, R., & Sala-i-Martin, X. (1999). Economic Growth. Boston: The MIT Press.

Benhabib, J., & Spiegel, M. (2000). The Role of Financial Development in Growth and Investment. *Journal of Economic Growth*, 4, pp. 341-360.

Economist Intelligence Unit Database. New York: Bureau van Dijk Electronic Publishing.

Jones, C., & J. Williams. (2000). Too Much of a Good Thing? The Economics of Investment in R&D. *Journal of Economic Growth*, 1, pp. 65-86.

Kalaitzidakis, P., Mamuneas, T., Savvides, A., & Stengos, T. (2001). Measures of Human Capital and Nonlinearities in Economic Growth. *Journal of Economic Growth*, 3, pp. 229-254.

Krueger A., & Lindahl, M. (2000). Education for Growth: Why and For Whom? NBER Working Paper 7591.

Mankiw, G., Romer, D., & Weil, D. (1992). A Contribution to the Empirics of Economic Growth. *The Quarterly Journal of Economics*, 2, pp. 407-437.

Mincer, J. (1996). Economic Development, Growth of Human Capital, and the Dynamics of the Wage Structure. *Journal of Economic Growth*, 1, pp. 29-48.

Mulligan, C., & Xavier Sala-i-Martin. (2000). Measuring Aggregate Human Capital. *Journal of Economic Growth*, 3, pp. 215-252.

Pritchett, L. (1996). Where Has All the Education Gone? Washington, D.C.: World Bank, Working Paper 1581.

Romer, P. (1986). Increasing Returns and Long Run Growth. *Journal of Political Economy*, 5, pp. 1002-1037.

Romer, P. (1989). Capital Accumulation in the Theory of Long Run Growth. In R. Barro (Ed.). *Modern Business Cycle Theory*. (pp. 51-127). Cambridge: Harvard University Press.

Romer, P. (1989). Human Capital and Growth: Theory and Evidence. NBER Working Paper 3173.

Romer, P. (1990). Capital, Labor and Productivity. *Brookings Papers on Economic Activity*, Microeconomics Special Issue, pp. 337-367.

Romer, P. (1990). Endogenous Technological Change. *Journal of Political Economy*, 5, pp. 71-102.

Romer, P. (1994). The Origins of Endogenous Growth. *Journal of Economic Perspectives*, 1, pp. 3-22.

Ruth, J. (1998). Economic Growth and Investment in Education; How Allocation Matters. *Journal of Economic Growth*, 4, pp. 337-360.

Shioji, E. (2001). Public Capital and Economic Growth: a Convergence Approach. *Journal of Economic Growth*, 3, pp. 205-228.