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Abstract

In this paper the impact of market reforms on economic growth has been analyzed using the panel data for 26 post-socialist economies over the period between 1989 and 2005. Taking into account the dynamic properties of the data, the concepts of cointegration and equilibrium correction model for panel data has been used as the analytical framework. First, well-specified regression models have been obtained. Second, long and short run aspects of 'reforms-growth' relationship have been considered. Out analysis has detected the existence of cointegration between the level of ERBD reform index and the level of real GDP per capita. This is interpreted as the presence of the long run relationship between these indicators. Third, it has been found that there is a statistically significant positive influence of economic reforms on economic growth in the long run. In addition, market reforms positively influence economic growth in the short-run, but with a one-year lag. The equilibrium correction mechanism in corresponding regressions reflects existing biases of the analyzed indicators from the equilibrium trajectory, as well as direction and speed of adjustment to this trajectory. Our approach to modeling of the relationship between market reforms and economic growth explains a puzzle of high rates of economic growth in some countries with a relatively low level of ERBD reform index. Finally, in contrast to other studies employing a different methodology, statistically significant influence of economic growth on market reforms has been established both in the long and short run, our study shows that there is no such relationship.

JEL classification: C23, C33, P21, P30

***Keywords*:** post-socialist economies, market reforms, economic growth, panel cointegration, equilibrium correction model, EBRD transition indicators

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Non-technical summary

The superiority of market economy over centralized planning has been historically 'verified' by the collapse of socialism in the countries of Central and Eastern Europe and the former USSR. Additionally, the transition of the former socialist countries to a market economy provides further empirical evidence of the impact of economic freedom on economic growth. Over the last decade, this evidence has been extensively studied. The aim of this study is to analyze the relationship between the progress in market reforms and economic growth in post-socialist economies taking into consideration the properties of the available time series and using state of the art econometric techniques.

Our analysis establishes that the level of the EBRD index of market reforms and the level of real GDP per capita are integrated variables with an order of integration $I(1)$. Moreover, these variables are cointegrated, which indicates the existence of a long-run relationship between them and an equilibrium trajectory of economic growth determined by market reforms. Accordingly, an equilibrium correction model can be utilized in order to analyze the relationships between market reforms and economic growth. In the regression models, the equilibrium correction mechanism reflects the discrepancy between the level of market reforms and the level of economic growth and a movement towards the steady-state trajectory correcting disequilibrium states as well.

The main findings of our study are as follows. First, market reforms exert a statistically significant positive influence upon economic growth in the long run. At the same time, a positive influence of market reforms on economic growth in the short run is also found, with a one-year lag. However, in contrast to some other studies where different a methodology is used, we have found no statistically significant feedback between market reforms and economic growth. In other words, economic growth does not influence market reforms, both in the long-run, and in short-run.

1. INTRODUCTION

Over the last decades, the empirical relationship between economic freedom and growth has been extensively studied. Theoretically, the analysis is grounded on the classical liberalism of Adam Smith, and the works of Hayek (1960), Friedman (1962), Buchanan (1975), and some other authors. These authors share a view that economic freedom promotes profit-seeking resulting in bigger 'wealth of nations'. In contrast, economic policies repressing economic freedom restrict economic growth and development. This argument is supported empirically by numerous studies used various indexes of economic freedom. The superiority of market economy over centralized planning has been historically 'verified' by the collapse of socialism in the countries of Central and Eastern Europe and the former USSR. Additionally, the transition of the former socialist countries to a market economy provides additional empirical evidence of the impact of economic freedom on economic growth.

Currently a dataset needed to explore the impact of market reforms on economic growth in post-socialist countries is sufficiently large. For these countries various indexes characterizing the level of economic freedom are also available. In this study we consider only a set of the European Bank for Reconstruction and Development (EBRD) transition indicators, characterizing progress in market reforms. We do not discuss whether they adequately characterize the depth of market reforms or not. The aim of this study is to analyze the relationship between the progress in market reforms and economic growth taking into consideration the properties of the available time series and using state of the art econometric techniques.

Despite the voluminous body of econometric studies pointing to the positive influence of economic reforms on growth (see, for instance, Falcetti, Lysenko and Sanfey (2006) for a review), there are still controversies over several aspects of this issue. In particular, Babetskii and Campos (2007) considered the results of 43 econometric studies of the relationships between market reforms and growth in transition economies using meta-regression analysis. The results of this analysis shows that of 321 coefficients characterizing the effects of reforms on economic growth, approximately one third is positive and statistically significant, another third is negative and statistically significant, and the final third of these coefficients is statistically insignificant. The authors explain such evidence by a range of factors, including the model specification, modeling techniques, and the endogeneity problem of reforms vis-à-vis economic growth. In our study, special attention is paid to these issues.

The peculiarity of practically all studies of 'reforms-growth' nexus is that dynamic characteristics of the data are not taken into consideration (with exception of the papers by Staehr (2006) and Fish, Choudhry (2007)) dealing with the relationship between political and economic reforms). In this study, we attempt to fill this gap. This task has required an essential revision of specification of regression models and approach to the analysis of endogeneity of analyzed variables.

A distinctive feature of our study is the application of the concept of cointegration and equilibrium correction model (Engle, Granger (1987)) for the panel data for analysis of 'reforms-growth' relationship. This approach enables, on the one hand, a more correct specification of appropriate regression models and, on the other hand, consideration of both the short-run and long-run relationship between market reforms and economic growth.

The main objectives of this study are: (i) estimation of the dynamic characteristics of the data (the panel tests for unit root and stationarity) and choice of a method of econometric analysis; (ii) analysis of the long-run relationship between market reforms and economic growth (panel cointegration test); (iii) choice of the specification of the econometric model characterizing the relationship between market reforms and economic growth (equilibrium correction model) and an

estimation of short-run and long-run impact of market reforms on economic growth; (iv) analysis of the interrelationship between market reforms and economic growth (problem of endogeneity of the analyzed variables)

The paper has the following structure. In the second section we offer a critical review of existing approaches to the modeling of the relationships between market reforms and growth, we explicate our analytical framework, and formulate major hypotheses. In the third section, the empirical data are described and their dynamic characteristics investigated by using panel tests for unit root and stationarity. The fourth section discusses the results of econometric analysis of the relationships of 'reforms-growth' nexus. The final section concludes.

2. METHODOLOGY AND HYPOTHESES

The empirical analysis of the relationships between market reforms and economic growth in the transition economies goes back to 1996. Falcetti, Lysenko, and Sanfey (2006) provide a comprehensive survey of the literature on the topic. Early studies stress a number of essential preconditions for a sustainable economic growth: (1) initial conditions; (2) macroeconomic stabilization leading to low inflation; (3) comprehensive economic reforms, including price and trade liberalization, small-scale privatization, and deep institutional reforms, such as enterprise restructuring, financial sector policy, and competition policies (Fischer et al. (1996); Fischer, Sahay (2000; 2004); De Melo et al. (2001); Havrylyshyn, van Rooden (2003)). A number of authors pay attention to the problem of endogeneity (Heybey, Murrell (1999); Berg et al. (1999)) suggesting that not only reforms affect economic growth, but also reverse relationships are observed, in particular, higher rates of growth induce further economic reforms.

Recently, there is a consensus on at least three major points. First, macroeconomic stabilization is considered to be a necessary condition for recovery and growth. Second, the role of initial conditions seems to be declining over time. Third, the influence of structural reforms is strong and robust. Nevertheless, controversies over 'reforms-growth' nexus still exist (Falcetti, Lysenko and Sanfey (2006); Babetskii, Campos (2007)).

The most recent publications that use the latest available data are the most interesting to look at. One of such papers by EBRD researchers (Falcetti, Lysenko and Sanfey (2006)) concludes that a robust relationship between reforms and growth exists in transition economies with a one-year lag. Although similar results are typical for many other studies, in several papers such a relationship is called into question (see, for example, Radulescu, Barlow (2002)). However, in their paper, Falcetti, Lysenko and Sanfey (2006) emphasize that such skepticism is subject to wrong specification of the models; in particular, when different indexes of reforms are included in the model, this leads to the multicolinearity problem. They also stress that the relationship 'market reforms – economic growth' in transition countries is complex: besides market-oriented reforms other factors affect economic growth. Additionally, Falcetti, Lysenko and Sanfey (2006) conclude that there is probably an interrelationship between market reforms and economic growth, i.e. reforms have a positive influence on economic growth which, in turn, leads to further economic liberalization. Since the paper of Falcetti, Lysenko and Sanfey (2006), in our view, is one of the most comprehensive on this issue (in the context of the used data set, and utilized econometric methods), we will consider this paper as a starting point of our further analysis.

The vast majority of papers dealing with the 'reforms-growth' relationship usually employ the following specification of panel regression equations:

$$(\Delta Y / Y)_{i,t} = a_0 + a_1 ref_{i,t-1} + (control\ and\ dummy\ variables) + \varepsilon_{i,t}, \quad (1)$$

$$(\Delta Y / Y)_{i,t} = a_0 + a_1 ref_{i,t-1} + a_2 \Delta ref_{i,t} + (control\ and\ dummy\ variables) + \varepsilon_{i,t}, \quad (2)$$

$$(\Delta Y / Y)_{i,t} = a_0 + a_1 \Delta ref_{i,t-1} + (control\ and\ dummy\ variables) + \varepsilon_{i,t}, \quad (3)$$

where $Y_{i,t}$ is real GDP per capita of country i at time t; $(\Delta Y/Y)_{i,t}$ is annual growth of real GDP per capita of country i at time t; $ref_{i,t-1}$ is index of market reforms of country i at time t–1; $\Delta ref_{i,t}$ and $\Delta ref_{i,t-1}$ are growth of index of market reforms of country i at time t and t–1, respectively; a_0, a_1, a_2 are regression coefficients; $\varepsilon_{i,t}$ are regression residuals. Control variables can include indicators characterizing initial conditions and macroeconomic environment as well as other factors affecting economic growth.

The use of both levels and growth rates of variables in the regression equations (equation (2)) has already been criticized in De Haan, Lundstrom, and Sturm (2005). However, in our view there is another important aspect concerning model specification, namely the problem of a balanced regression. In particular, the left-hand and the right-hand left variables of the regression model should have the same order of integration. For instance, in the equation (1) annual growth rate of real GDP per capita can be a stationary variable. At the same time, the level of market reforms index can appear to be non-stationary. It is well-known that the use of level variables in the regression model could lead to the problem of spurious regression. In addition, if only growth rates of variables are included in regression, then there is a danger of loss of long-run information contained in the data. All these issues lead us to utilize the concept of cointegration in order to investigate the relationships between reforms and growth.

If the level of real per capita GDP ($Y_{i,t}$) and the level of market reforms index[1] ($ref_{i,t}$) are variables with order of integration $I(1)$, then it is very likely that a long-run relationship can exist between them. Let $Y_{i,t}$ be a function of $ref_{i,t}$, then the relationship between them can be expressed as $Y_{i,t} - f(ref_{i,t}) = \varepsilon_{i,t}$. If variables $Y_{i,t}$ and $ref_{i,t}$ are non-stationary with order of integration $I(1)$, while the residuals $\varepsilon_{i,t}$ are stationary, then the variables $Y_{i,t}$ and $ref_{i,t}$ are cointegrated. The concept of cointegration is the statistical expression of the economic concept of equilibrium, so it can be applied to investigate long-run relationship between economic growth and market reforms. The residuals $\varepsilon_{i,t}$ characterize deviations of a level of real GDP per capita from the equilibrium trajectory. Their stationarity denotes the existence of the equilibrium correction mechanism that restores the equilibrium level of real GDP per capita.

Cointegration between economic growth and market reforms supposes causality at least in one direction, and the existence of an appropriate equilibrium correction model (Engle, Granger (1987)). Accordingly, this model allows us to conduct an analysis of both long-run and short-run relationships between market reforms and economic growth. In contrast to the paper by Falcetti, Lysenko and Sanfey (2006) that uses specification (1), we suggest the following methodology to analyze the 'reforms-growth' nexus:

1. The analysis of the order of integration of the data used (panel tests for unit root and stationarity) is conducted.

2. If variables have the order of integration $I(1)$, i.e. they are non-stationary in the levels and stationary in the first differences, the following model is applied to test for cointegration and to estimate the parameters of the long-run relationship:

$$y_{i,t} = a_i + \delta_t + \beta ref_{i,t} + \varphi RECOV_{i,t} + \varepsilon_{i,t}, \quad (4)$$

where $y_{i,t}$ is the level (logarithmic) of real per capita GDP of country i at time t, α_i are individual effects, δ_t are period effects, $ref_{i,t}$ is the value of market reforms index of country i at time t, β_i is regression coefficient which characterizes an impact of $ref_{i,t}$ on $y_{i,t}$ in the long-run, $RECOV_{i,t}$ is a

[1] See section 3.1 for details.

variable, characterizing the influence of factors affected in the period of recovery growth, and $\varepsilon_{i,t}$ are the regression residuals. If the residuals $\varepsilon_{i,t}$ are stationary, then $y_{i,t}$ and $ref_{i,t}$ are cointegrated, i.e. there is a long-run relationship between them. The residuals $\varepsilon_{i,t}$ characterize deviations of $y_{i,t}$ from an equilibrium trajectory.

3. If there is a cointegration between the logarithmic level of real GDP per capita and the value of market reforms index, the analysis of the relationships between market reforms and economic growth can be carried out within the framework of the following equilibrium correction model:

$$\Delta y_{i,t} = \mu + \varphi \Delta y_{i,t-1} + \gamma \Delta ref_{i,t-1} + \delta \Delta RECOV_{i,t} + \alpha \varepsilon_{i,t-1} + u_{i,t}, \quad (5)$$

where $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$; $\Delta ref_{i,t} = ref_{i,t} - ref_{i,t-1}$; $\Delta RECOV_{i,t} = RECOV_{i,t} - RECOV_{i,t-1}$; $\varepsilon_{i,t-1}$ is equilibrium correction mechanism; α_i are the feedback coefficients, characterizing the speed of equilibrium correction; μ, φ, γ, δ are the regression coefficients; u_{it} are the regression residuals.

The equation (5) is the balanced regression, in which all of the variables (both the left-hand and the right-hand ones) are stationary. In the case of cointegration, coefficient α at the equilibrium correction mechanism is both negative and statistically significant. If $\alpha \neq 0$ (equation (5)), then market reforms produce an impact on economic growth over the long-run; if $\gamma \neq 0$, the impact lasts only in the short run. When $\alpha \neq 0$ and $\gamma \neq 0$, market reforms influence economic growth *both* in the long-run and short-run.

4. If there is no cointegration between $y_{i,t}$ and $ref_{i,t}$, the analysis of 'reforms-growth' nexus should be carried out using the following specification:

$$\Delta y_{i,t} = \mu + \varphi \Delta y_{i,t-1} + \gamma \Delta ref_{i,t-1} + \delta \Delta RECOV_{i,t} + u_{i,t}. \quad (6)$$

In this case regression is also a balanced one, thereby reflecting the existence of a short-run relationship only.

5. In case of cointegration between $y_{i,t}$ and $ref_{i,t}$ the analysis of exogeneity (endogeneity) and causality between the variables is carried out by using the Granger test within the following system the regression equations:

$$\Delta y_{i,t} = \mu_1 + \varphi_1 \Delta y_{i,t-1} + \gamma_1 \Delta ref_{i,t-1} + \delta_1 \Delta RECOV_{i,t} + \alpha_1 \varepsilon_{i,t-1} + u_{1i,t}, \quad (7a)$$

$$\Delta ref_{i,t} = \mu_2 + \varphi_2 \Delta y_{i,t-1} + \gamma_2 \Delta ref_{i,t-1} + \delta_2 \Delta RECOV_{i,t} + \alpha_2 \varepsilon_{i,t-1} + u_{2i,t}. \quad (7b)$$

If in the equation (7b) $\varphi_2 \neq 0$, and $\alpha_2 = 0$, the variable is $ref_{i,t}$ is weakly exogenous relative to $y_{i,t}$. It means that the value of the market reforms index does not depend on the level of real GDP per capita in the long-run, but in the short-run the relationship still exists. When $\varphi_2 = 0$, and $\alpha_2 = 0$, then the variable $ref_{i,t}$ is strongly exogenous relative to $y_{i,t}$. In this case the value of the market reforms index depends on the level of real GDP per capita neither in the long run nor in the short run. There is an interrelationship between economic growth and market reforms (i.e. endogeneity of the variables), if $\alpha_2 \neq 0$ (long-run interrelationship), $\varphi_2 \neq 0$ (short-run interrelationship), $\alpha_2 \neq 0$ and $\varphi_2 \neq 0$ (interrelationship both in the long-run and short-run).

Given all of the abovementioned considerations, the following major hypotheses can be formulated:

1. The level (logarithmic) of real GDP per capita and the level of market reforms index are the non-stationary variables with the order of integration $I(1)$. Therefore, the first differences of these variables are stationary with the order of integration $I(0)$.

2. The level (logarithmic) of real GDP per capita and the level of the market reforms index are

cointegrated. In other words, market reforms influence economic growth in the long-run.

3. Market reforms influence economic growth in the short-run.

4. The relationship between market reforms and economic growth can be expressed by using an equilibrium correction model that characterizes both the long-run and short-run aspects of such a relationship.

5. Market reforms and economic growth are interrelated, i.e. the investigated variables are endogenous.

It has to be noted that the hypotheses specified above correspond to a large extent to the results presented in Falcetti, Lysenko and Sanfey (2006), specifically: a positive influence of market reforms on economic growth, an influence of market reforms on economic growth with a one year lag, endogeneity of economic growth and market reforms. But in this study, the independent variable (real per capita GDP growth rate) is probably a stationary variable, while the main independent variable (EBRD index of market reform), is evidently a non-stationary variable. As a result, there is a problem of specification (unbalanced regression). Our approach to analyzing the relationship between reforms and growth suggests ways of solving this problem along with investigating relationship between variables not only in the short run, but also in the long run.

3. THE DATA AND ITS DYNAMIC PROPERTIES

3.1. The data

Data from 26 post-socialists countries[2] for the period 1989–2005 (balanced panel)[3] were used in this study. The analyzed indicators and their sources are presented in Table 1.

Table 1: The data

Abbreviation	Indicator	Source
GDPPC	GDP per capita in constant Euros of 2000	Estimates on the basis of the EBRD data[1] (real GDP growth rates), World Economic Outlook[2] (GDP level in 2000, USD), Eurostat[3] (average exchange rate EUR/USD in 2000), and World Development Indicators[4] (population)
EBRD transition indicators:[5]		
CP	Competition policy	EBRD
BRIRL	Banking reform and interest rate liberalization	EBRD
ER	Enterprise restructuring	EBRD
PL	Price liberalization	EBRD
SMNB	Securities markets and non-bank financial institutions	EBRD
SSP	Small scale privatization	EBRD
TFES	Trade and Forex system	EBRD
OIR	Overall infrastructure reform	EBRD
LSP	Large scale privatization	EBRD
EBRD	EBRD market reforms index	Estimations on the basis of EBRD data (arithmetic average from nine EBRD indexes of transformation)

Notes:

[2] Bosnia and Herzegovina is excluded from the list of countries which are analyzed in the EBRD Transition Reports since the data on GDP growth for this country are available only since 1996 and cause certain doubts. Thus, the following countries were analyzed: Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Hungary, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Russia, Romania, Serbia and Montenegro, Slovakia, Slovenia, Tajikistan, Turkmenistan, Uzbekistan, Ukraine, Croatia, the Czech Republic and Estonia.

[3] For all objects there is the same number of observations.

[1] http://www.ebrd.com/country/sector/econo/stats/sei.xls.
[2] http://www.imf.org/external/pubs/ft/weo/2006/02/data/index.aspx, the database of September 2006.
[3] http://epp.eurostat.ec.europa.eu/pls/portal/.
[4] http://devdata.worldbank.org/data-query/. For Serbia and Montenegro the data exclude Kosovo-Metohija; for 1989–1997 the data are estimated on the basis of population growth in the Yugoslav Federation as a whole.
[5] http://www.ebrd.com/country/sector/econo/stats/tic.xls.

In contrast to numerous papers on economic growth in post-socialist countries, the level of real GDP per capita (as a measure of growth) is used in this paper, instead of GDP growth rates. This indicator has been calculated on the basis of the growth rates data collected by the European Bank of Reconstruction and Development (EBRD). These data are also used in similar studies. As for the measure of progress in market reforms, the EBRD indexes of transformation are used. The value of the index varies from 1 up to 4+ ('1' is to denote a Soviet-type economy, while '4 +' means the standards and characteristics of a developed market economy, see, for example, EBRD (2006) for a detailed description of the approach). It has to be noted that an assessment with a negative sign means the value of the index 'minus 1/3', while for a positive sign the value of the index 'plus 1/3' is used. Accordingly, the values of the index of transformation range from 1.00 to 4.33.

In order to avoid the problem of multi-collinearity different EBRD indexes of transformation are not included as right hand variables in the regressions simultaneously (Staehr (2005), Falcetti, Lysenko and Sanfey (2006), Chubrik (2003)). These indexes are closely correlated with each other (the minimal and average coefficient of correlation is equal to 0.56 and 0.82 respectively). To solve this problem, some authors propose utilization of factor analysis (method of principal components) which allows obtaining the factors (components) which have been not correlated with each other. The factor analysis is conducted, as a rule, for eight out of nine EBRD indexes of reforms (excluding overall infrastructure reform); then the obtained factors are used in the equations of growth. In our study the factor analysis (method of principal components) was conducted for nine indexes of reforms[4] (Table 2).

Table 2: Principal components of EBRD transition indicators

	Components:								
	PC 1	**PC 2**	**PC 3**	**PC 4**	**PC 5**	**PC 6**	**PC 7**	**PC 8**	**PC 9**
Eigenvalues	7.18	0.68	0.29	0.23	0.16	0.15	0.13	0.11	0.07
Variance proportion	0.80	0.08	0.03	0.03	0.02	0.02	0.01	0.01	0.01
Variable	Eigenvectors (loadings):								
CP	0.32	–0.34	0.70	–0.25	–0.11	0.34	–0.19	–0.24	0.01
BRIRL	0.35	–0.11	–0.27	0.07	–0.30	–0.11	–0.07	–0.24	–0.79
ER	0.35	–0.05	–0.26	–0.48	–0.24	–0.27	0.42	–0.34	0.41
PL	0.30	0.58	0.38	0.35	–0.08	0.06	0.54	0.02	–0.08
SMNB	0.32	–0.48	0.19	0.24	0.08	–0.55	0.11	0.49	0.06
SSP	0.34	0.31	0.04	–0.03	0.64	–0.34	–0.39	–0.33	0.03
TFES	0.34	0.32	–0.12	0.09	–0.52	0.03	–0.56	0.29	0.31
OIR	0.33	–0.31	–0.36	0.54	0.21	0.47	0.07	–0.20	0.27
LSP	0.34	0.09	–0.20	–0.48	0.34	0.39	0.12	0.55	–0.18

Since the aim of this paper is to investigate the relationship between economic growth and reforms as a whole (instead of their separate components) the variable 'EBRD market reforms index', calculated as an arithmetic average of indexes, will be used in the further analysis. The utilization of such a variable seems reasonable because the first factor explains 80% of the variation of the analyzed indexes and the factor loadings of the indexes entering into this factor are practically identical and equal to approximately 1/3.

[4] The calculations have been done using EViews 6.0.

The figures A1–A26 in the Appendix show that all transition economies investigated in our research demonstrate the U-shaped dynamics of real GDP per capita. At the beginning of transition, structural distortions inherited from the socialist past had been corrected in the course of adaptation recession. As soon as this period was over, economic growth entered the recovery phase (Gaidar (2005)). Over that period, GDP growth had been determined by the economic policies implemented along with a range of other factors, including the initial conditions (De Melo et al. (1997)), dynamics of exports and prices for raw materials, and government expenditures (Falcetti, Lysenko, and Sanfey (2006)). The recovery growth has been fed by the allocation effects unleashed by the first wave of reforms, exogenous factors and also – in some cases – initial conditions (Chubrik (2006)). Accordingly, the scope of adjustment can be explained by the scope of structural distortions a transition economy had been faced with. In its turn, the duration of adjustment is determined by the speed of market reforms. The U-shaped relationships between the speed of reforms and the duration and scope of adaptation recession have already been established in some earlier works on transition. It has been noted that the adaptation recession was short in the countries that implemented first-wave reforms rather quickly, but protracted in those countries that opted for a partial change of the previous system (Havrylyshyn (2001)).

The following technical and theoretical problems should be taken into account while explaining output dynamics in post-socialist countries. First, the right-hand variables of the regression often have a different order of integration, which produces an unbalanced regression. Secondly, the theoretical considerations of simultaneous inclusion of traditional variables in the right-hand part of regression equations usually do not go beyond the explanation of growth by 'stylized facts'. Thirdly, a negative influence of the initial conditions on growth decreases in time (Havrylyshyn, van Rooden (2000)), and this should be adequately taken into account while estimating appropriate regressions. In particular, the above-mentioned authors found a relationship between speed of adjustment of structural distortions and speed of market reforms that makes an incorrect simultaneous inclusion of these variables in regression. Lastly, the influence of initial conditions on economic growth can be positive as, for example, in the case of Belarus, Turkmenistan and Uzbekistan (Chubrik (2006)). This creates additional problems while estimating the regression coefficients.

In order to solve these problems, we suggest construction of the following variable:

$$RECOV = \begin{cases} 0, \text{ if } T \le T_B \\ T - T_B, \text{ if } T > T_B \end{cases}, \tag{8}$$

where T_B is the last year of adaptation recession (exogenously determined); T is the current year. This variable characterizes the influence of factors which are effective in the period of recovery growth. In its turn, adaption recession is estimated by inclusion of the individual trends in the model. Thus, in this research we do not make an attempt to provide a theoretical explanation or an empirical investigation of other factors of economic growth apart from the market reforms.

3.2. Dynamic properties of the data

It has to be stressed that the vast majority of the studies on the subject tends to ignore the problem of dynamic characteristics of the data used. The papers by Staehr (2006) and Fish, Choudhry (2007) the indicators characterizing the level of economic reforms are tested for unit root; however these studies are devoted to analysis of the relationship between political and economic reforms. In addition, Staehr (2006) considers the EBRD index of market reforms as a stationary variable.[5] But in our view, the graphical depiction of this indicator (see Appendix A) both for individual countries

[5] Despite such a result, the author also uses specifications of various models and tests assuming non-stationarity of the EBRD index of market reforms.

and on average for the entire sample suggests that the EBRD index of market reforms is probably a non-stationary variable.

Table 3: Panel unit root tests

Test	*EBRD*		*gdppc*	
	statistic	***p*-value**	**statistic**	***p*-value**
H_0: *unit root (assumes common unit root process)*				
Levin-Lin-Chu (*t**)	–14.34	0.00	–5.04	0.00
Breitung (*t*-statistic)	0.87	0.81	5.38	1.00
H_0: *no unit root (assumes common unit root process)*				
Hadri (*Z*-statistic)	11.38	0.00	12.39	0.00
H_0: *unit root (assumes individual root process)*				
Im-Pesaran-Shin (*W*-statistic)	0.72	0.76	–0.66	0.25
ADF – Fisher (χ^2)	44.79	0.75	83.86	0.00
ADF – Choi (*Z*-statistic)	4.57	1.00	0.91	0.82
PP – Fisher (χ^2)	33.87	0.98	99.79	0.00
PP – Choi (*Z*-statistic)	4.95	1.00	0.15	0.56
	Δ*EBRD*		**Δ*gdppc***	
	statistic	***p*-value**	**statistic**	***p*-value**
H_0: *unit root (assumes common unit root process)*				
Levin-Lin-Chu (*t**)	–6.98	0.00	–4.05	0.00
Breitung (*t*-statistic)	–7.80	0.00	–3.92	0.00
H_0: *no unit root (assumes common unit root process)*				
(*Z*-statistic)	5.31	0.00	5.23	0.00
H_0: *unit root (assumes individual root process)*				
Im-Pesaran-Shin (*W*-statistic)	–3.99	0.00	–2.23	0.01
ADF – Fisher (χ^2)	105.13	0.00	68.56	0.06
ADF – Choi (*Z*-statistic)	–3.59	0.00	–2.52	0.01
PP – Fisher (χ^2)	204.11	0.00	96.90	0.00
PP – Choi (*Z*-statistic)	–8.88	0.00	–3.96	0.00

Note. The calculations have performed by using EViews 5.1. The specifications of all tests included individual effects and individual linear trends. The choice of the lag length was made on the basis of modified Akaike information criteria with a maximum lag length equal to 3; The Newey-West bandwidth selection has been done by using a Bartlett kernel (see QMS (2005)). *p*-statistics for Fisher tests are computed by using an asymptotic χ^2 distribution. All other tests assume asymptotic normality. The grey color indicates that unit root hypothesis is rejected (stationarity hypothesis is not rejected) at a 5% significance level.

Since the time series for each of 26 countries are rather short (17 observations), we, following Staehr (2006), start the empirical analysis by testing the variables for unit root and stationarity. In Table 3 the results of the appropriate panel tests for unit root and stationarity (the review of used tests see in QMS (2005)) are presented. We used both tests with common and individual unit root process. The specifications of all tests included individual effects and individual linear trends. The choice of lag length in the corresponding tests was made automatically on the basis of modified Akaike information criteria with maximum lag length equal to 3; Newey-West bandwidth selection using Bartlett kernel is implemented. To visualize the results, the grey color in Table 3 indicates the cases when the unit root hypothesis is rejected (stationarity hypothesis is not rejected) at a 5% significance level. Although there are some contradictions in the results of panel tests for unit root and stationarity, the following conclusions can be formulated:

1. The level of the EBRD index of market reforms (*EBRD*) and a logarithmic level of real GDP per capita (*gdppc*) are the variables containing unit root. For the *EBRD* variable, a unit root hypotheses is rejected only in one case out of eight (Levin-Lin-Chu test). For the *gdppc* variable, a unit root hypotheses is rejected in three cases out of eight. Besides the Levin-Lin-Chu test, the *ADF* – Fisher (χ^2) test and the *PP* – Fisher (χ^2) tests also reject the null hypotheses of unit root. However, a modification of these tests (*ADF* – Choi (*Z*-statistic) and *PP* – Choi (*Z*-statistic)) clearly indicates non-stationarity of the *gdppc* variable.

2. The differences of the EBRD index of market reforms ($\Delta EBRD$) and the logarithmic differences of the level of real GDP per capita ($\Delta gdppc$) are stationary variables. For $\Delta EBRD$ only the Hadri test rejects the null hypotheses of stationarity. For $\Delta gdppc$ this test also rejects the stationarity hypothesis, the *ADF* – Fisher (χ^2) rejects unit root hypotheses only at a 10% significance level. In general, the tests applied suggest that $\Delta EBRD$ is a stationary variable in seven cases out of eight; $\Delta gdppc$ is stationary variable in six cases out of eight at a 5% significance level and in seven cases out of eight at a 10% significance level.

Hence, panel unit root tests presented in Table 3 show that *EBRD* and *gdppc* are integrated variables with the order of integration *I*(1); $\Delta EBRD$ and $\Delta gdppc$ are stationary variables with the order of integration *I*(0). This means that a long-run relationship can exist between the level of real GDP per capita and the EBRD index of market reforms. This leads us to the application of panel techniques of cointegration analysis

4. THE ECONOMETRIC RESULTS

4.1. Panel cointegration: Pedroni tests

In the previous section it has been found that the level of real GDP per capita and the level of EBRD index of market reforms are the variables with an order of integration *I*(1). Therefore, a long-run relationship between them can exist. According to the methodology proposed in the Section 2, this suggests the use of panel cointegration analysis.

The main aim of this section is testing of the hypothesis that variables *gdppc* and *EBRD* are cointegrated. For that purpose, a method elaborated by Pedroni (1997; 1999; 2001)) for panel data in the framework single regression equation is applied. Specifically, Pedroni has suggested seven panel cointegration tests: four tests are the so-called within-dimension ones, three tests are between-dimension ones. Within-dimension cointegration tests are statistics based on common autoregression coefficients in corresponding unit root for different countries (panel cointegration test). Between-dimension cointegration tests are simple averages from individual tests for different countries (panel group cointegration test). A null hypothesis of no cointegration is set for all seven tests. The alternative hypothesis assumes the existence of cointegration between examined variables.

Given the dataset, we utilized Pedroni test for panel cointegration based on the equation (7):

$$gdppc_{i,t} = \alpha_i + \delta_i T + \beta EBRD_{i,t} + \varphi RECOV_{i,t} + \varepsilon_{i,t}, \tag{9}$$

where i = 1, 2…26 (countries); t = 1989, 1990, …, 2005 (years). This specification assumes the existence of various aspects heterogeneity captured via the fixed individual effects (α_i), and individual time trends ($\delta_i T$).

The cointegration test based on the equation (9) is calculated using the following regression:

$$\varepsilon_{i,t} = \rho_i \varepsilon_{i,t-1} + u_{i,t}, \tag{10}$$

where $\rho_i = 1 \; \forall i$; H_0: no cointegration; ρ_i is autoregression coefficient.

The difference between panel and panel group test for cointegration follows from the specification of alternative hypothesis concerning the existence of cointegration:

(i) For panel cointegration test $H_0 : \rho_i = 1 \; \forall i; \; H_1 : \rho_i = \rho < 1 \; \forall i$;

(ii) For panel group cointegration test $H_0 : \rho_i = 1 \; \forall i; \; H_1 : \rho_i < 1 \; \forall i$.

Thus, the panel group cointegration test is a more general test because it allows heterogeneity of the coefficients under an alternative hypothesis.

The results of the panel cointegration tests are presented in Table 4. The specifications of all tests assumed the existence of deterministic constants and trends. The choice of a lag length has been done automatically on the basis of the modified Akaike information criteria with a maximum lag length equal to 2; the Newey-West bandwidth selection is applied by using a Bartlett kernel. In order to visualize the results, rejection of the null hypothesis of no cointegration at a 5% a significance level is marked in grey (Table 4).

Table 4: Panel cointegration tests

	Statistic	***p*-value**	**Weighted statistic**	***p*-value**
Alternative hypothesis: common AR-coefficients (within-dimension)				
Panel *v*-statistic	23.04	0.00	2.36	0.02
Panel *rho*-statistic	1.08	0.22	2.36	0.02
Panel *PP*-statistic	–4.89	0.00	–3.81	0.00
Panel *ADF*-statistic	–6.77	0.00	–7.91	0.00
Alternative hypothesis: individual AR-coefficients(between-dimension)				
Group *rho*-statistic	3.26	0.00		
Group *PP*-statistic	–5.45	0.00		
Group *ADF*-statistic	–7.18	0.00		

Note. The calculations have been performed by using EViews 6.0. H_0: no cointegration. The specifications of the test assume the existence of deterministic constants and trends. The choice of the lag length was made on the basis of the modified Akaike information criteria with a maximum lag length equal to 2; the Newey-West bandwidth selection is done by using a Bartlett kernel. Grey color indicates the cases when the null hypothesis of no cointegration is rejected at 5% significance level.

As follows from Table 4, five tests out of seven reject the null hypothesis of no cointegration between the level of real GDP per capita and the level of EBRD index of market reforms (null hypothesis is rejected if the statistics has a statistically significant negative value; *v*-statistics is an exception: in this case the null hypothesis is rejected, if the statistics has a statistically significant positive value). It should be noted that for small samples (in our case $t = 26$) group parametric *t*-statistics (group *ADF*-statistics) is a more powerful test than other tests (Pedroni (1997)). This claim along with results obtained, lead to the conclusion of cointegration between the variables *gdppc* and *EBRD*. Therefore, there is a long-run relationship between the level of real GDP per capita and the level of EBRD index of market reforms. In its turn, the existence of cointegration between the variables *gdppc* and *EBRD* allows to use cointegrating regression (9) in order to estimate the parameters of long-run relationship.

4.2. Estimation of long-run parameters

In order to estimate the parameters of the long-run relationship we used regression equation (9). Our approach has the following peculiarities in the model specification: 1) the estimation of regression was carried out using pooled least squares (PLS); 2) the coefficients at the variables *EBRD* and *RECOV* are common for all countries; 3) the model assumes individual trends for different countries (a testable hypothesis); 4) the model assumes fixed effects (a testable hypothesis). Although utilization of PLS in estimation of the long-run equation can appear to be problematic, and fully modified least squares method in such case gives more reliable estimates (Pedroni (2001)), we aim to estimate the parameters of the long-run relationship using specification that corresponds as much as possible to the model used while testing for panel cointegration.

Table 5: Market reforms and economic growth: Long-run relationship (dependent variable: *gdppc*)

Variables	Coefficient	*t*-statistic	*p*-value
Constant	7.620	275.9	0.00
EBRD	0.105	4.5	0.00
RECOV	0.208	25.6	0.00
	statistic	**degree of freedom**	***p*-value**
Redundant fixed effects tests:			
F-test	253.0	25, 388	0.00
χ^2-test	1260.1	25	0.00
Redundant individual trends test:			
F-test	42.0	26, 388	0.00
Log likelihood ratio, χ^2	591.7	26	0.00

Note. The calculations have been performed by using EViews 5.1. The model includes fixed effects and individual trends that are not shown in this table. The estimation method is pooled least squares (PLS).

The estimated parameters of the long-run relationship between reforms and growth are provided in Table 5. It appears that the coefficient of the *EBRD* variable is positive and statistically significant. Therefore, it can be concluded that the increase in the value of the EBRD index of market reforms positively affects economic growth in the long-run. A dummy variable characterizing the impact of recovery growth is also statistically significant and has an expected sign. The tests for redundant fixed effects and individual trends testify to the chosen specification of the model. Therefore, the equation of the long-run relationship between the level of real GDP per capita and the level of the EBRD index of market reforms in our specification is the following:

$$gdppc_{i,t} = 7.620 + 0.105 EBRD_{i,t} + 0.208 RECOV_{i,t} + \varepsilon_{i,t}. \quad (11)$$

Cointegration between *gdppc* and *EBRD* assumes that the residuals of this regression ($\varepsilon_{i,t}$) are stationary, and these residuals with a lag 1 represent equilibrium correction mechanism adjusting *gdppc* to its equilibrium trajectory. The results of the formal tests of the residuals of cointegration relationship (11) for unit root are presented in Table 6.[6] These results show that the residuals of the regression equation (11) are a stationary variable. The residuals characterize an equilibrium correction mechanism that should be used while modeling the relationship 'market reforms – economic growth' both in the long-run and short-run (equilibrium correction model, *ECM*).

Table 6: Equilibrium correction mechanism: Panel unit root test

Test	Exogenous variables	Statistic	*p*-value
H_0: *unit root (assumes common unit root process)*			
Levin-Lin-Chu (*t**)	no	–11.95	0.00
H_0: *unit root (assumes individual root process)*			
Im-Pesaran-Shin (*W*-statistic)	individual fixed effects	–4.55	0.00
ADF – Fisher (χ^2)	no	228.92	0.00
ADF – Choi (*Z*-statistic)	no	–10.75	0.00
PP – Fisher (χ^2)	no	233.82	0.00
PP – Choi (*Z*-statistic)	no	–11.03	0.00
H_0: *no unit root (assumes common unit root process)*			
Hadri (*Z*-statistics)	individual fixed effects	–0.60	0.73

Note. The calculations have been performed by using EViews 5.1. The choice of the lag length was made on the basis of the modified Akaike information criteria with a maximum lag length equal to 2, in the tests without the individual effects and with maximum lag length equal to 3, in the tests with the individual effects; the Newey-West bandwidth

[6] Strictly speaking, unit root tests whose results are presented in Table 6 are not tests for cointegration. Nevertheless, they unambiguously show that the residuals of equation (11) are stationary. This is an additional evidence of existence of cointegration between the level of real GDP per capita and the EBRD index of market reforms.

selection is implemented by using a Bartlett kernel (see QMS (2005)). *p*-statistics for Fisher tests are computed by using an asymptotic χ^2 distribution. All other tests assume asymptotic normality.

4.3. Cointegration and an estimation of the long-run parameters: An alternative approach

In the previous section, a panel least squares is applied to estimate panel regression equation in order to estimate the parameters of the relationship between reforms and growth. Strictly speaking, this approach is valid as long as the regression coefficients for different countries are homogenous. Therefore, a somewhat more careful approach is needed to account for the difference in the short-run dynamics across the countries studied. For that purpose, the approach originally suggested by Pesaran, Shin, and Smith (1999) has been applied. This approach allows simultaneously running the tests for cointegration between the variables and estimating the parameters of the long-run relationship.

The approach is grounded in two methods of statistical estimation: (i) mean group estimations and (ii) pooled mean group estimations. The method of mean group estimations of the long-run parameters of the panel data takes an average value of the parameters of long-run relationships calculated for individual countries. The method of pooled mean group estimations is an intermediate technique between the mean group estimation (where the regression coefficients and constants are different for individual countries) and a regression with fixed effects (where the coefficients are fixed and only constants can vary). In the pooled mean group method only the parameters of the long-run relationship are the same for all countries in the panel, while the coefficients of the short-run dynamics can vary across countries included in the panel.

The method of pooled mean group estimations can be applied to our data set in the following way. The autoregression model with a distributed lag without restrictions has the following form:

$$gdppc_{it} = \sum_{j=1}^{m} \lambda_{ij} gdppc_{i,t-j} + \sum_{j=0}^{n} \delta_{ij} EBRD_{i,t-j} + \sum_{j=0}^{n} \varphi_{ij} RECOV_{i,t-j} + \mu_i + \varepsilon_{it} \tag{12}$$

This model can then be re-parameterized as an equilibrium correction model:

$$\begin{aligned} \Delta gdppc_{it} &= \theta_i (gdppc_{i,t-1} + \beta_{1i} EBRD_{i,t-1} + \beta_{2i} RECOV_{i,t-1}) + \\ &+ \sum_{j=1}^{m-1} \phi_{ij} \Delta gdppc_{i,t-j} + \sum_{j=1}^{n-1} \phi_{ij} \Delta EBRD_{i,t-j} + \sum_{j=1}^{m-1} \gamma_{ij} \Delta RECOV_{i,t-j} + \mu_i + u_{it}, \end{aligned} \tag{13a}$$

where β_{1i} and β_{2i} are the parameters denoting the long-run relationship; θ_i is a feedback coefficient, characterizing adjustment to the steady-state; the equilibrium correction mechanism (*ECM*) is in parentheses.

The method of pooled mean group estimates imposes a limitation on (13a): the parameters of the long-run relationship β_{1i} and β_{2i} are the same for all countries in the panel. Then, the model can be described as follows:

$$\begin{aligned} \Delta gdppc_{it} &= \theta_i (gdppc_{i,t-1} + \beta_1 EBRD_{i,t-1} + \beta_2 RECOV_{i,t-1}) + \\ &+ \sum_{j=1}^{m-1} \phi_{ij} \Delta gdppc_{i,t-j} + \sum_{j=1}^{n-1} \phi_{ij} \Delta EBRD_{i,t-j} + \sum_{j=1}^{m-1} \gamma_{ij} \Delta RECOV_{i,t-j} + \mu_i + u_{it}. \end{aligned} \tag{13b}$$

In (13b) all the coefficients of the short-run relationship and the feedback coefficients can vary between individual countries. The estimations of the coefficients in this case are consistent and asymptotically normal both for variables with order of integration *I*(1) and variables with order of integration *I*(0). The model is estimated using the maximum likelihood method. The lag length in

the model can be chosen on the basis of various information criteria or using the 'general-to specific' approach which reduced the model so to leave only statistically significant coefficients. The validity of utilization of polled mean group estimations can be determined by the Hausman test (null hypothesis – it is possible to use pooled mean group estimations (poolability)).

The results obtained on the basis of model (13b) are presented in Table 7. First, the individual tests and joint Hausman test do not reject a null hypothesis of data poolability and validity of utilization of pooled mean group estimations. Thus, the results presented in Table 7, adequately describe our panel data. Second, the investigated variables are cointegrated, i.e. there is the long-run relationship between them. The negative and statistically significant at 1% level feedback coefficient (–0.318) for equilibrium correction mechanism confirms this. The coefficients of the long-run relationship at *EBRD* and *RECOV* are statistically significant and have expected signs. Moreover, the value of the coefficient at *EBRD* (0.114) is very close to the results obtained earlier within the static panel regression with fixed effects (0.105). The parameters of the short-run relationship in this case are not of special interest, although all of them are statistically significant, which follows from the method of lag selection in the model ('general-to-specific'). Therefore, the two different methods do not contradict each other: they clearly indicate the existence of cointegration between the level of real GDP per capita and the level of the EBRD index of market reforms and the statistically significant influence of market reforms on economic growth in the long-run. Based on these results, we will use the equilibrium correction mechanism ($\varepsilon_{i,t}$), obtained in Section 4.2, for analysis of causality and endogeneity of investigated variables.

Table 7: Cointegration test and estimation of the coefficients of the long-run relationship: The pooled mean group estimations (dependent variable: *gdppc*)

Variables	Coefficient	*t*-statistic	*h*-test	*p*- value
The long-run coefficients:				
EBRD	0.114	5.87	0.87	0.35
RECOV	0.092	30.33	0.84	0.36
Joint Hausman test			0.88	0.64
Equilibrium correction mechanism:				
ECM	–0.318	–4.40		
The short-run coefficients:				
Constant	0.040	0.67		
$\Delta gdppc_{t-1}$	0.271	3.76		
$\Delta EBRD$	–0.103	–2.31		
$\Delta RECOV$	0.097	4.11		

Note. The calculations have been performed by using Gauss 8.0, program JASA[7]. The data for every country have been demeaned. The lag length has been chosen by using a 'general-to-particular' approach. As a result, the following autoregression model with the distributed lag has been selected: (1,0,0). The model is estimated by using a Newton-Raphson algorithm. *h*-test: Hausman test.

4.4. Analysis of causality and endogeneity: The short- and long-run aspects

Since we have obtained results confirming the existence of the long-run relationship between investigated variables, the following analysis should be done in the framework of the equilibrium correction model allowing to consider the short-run and long-run aspects of the relationship 'market reforms – economic growth'. Taken into account (7a) and (7b), the hypothesis for testing the following regressions will be used:

$$\Delta gdppc_{i,t} = \mu_1 + \phi_1 \Delta gdppc_{i,t-1} + \gamma_1 \Delta EBRD_{i,t-1} + \delta_1 \Delta RECOV_{i,t-1} + \alpha_1 ECM_{i,t-1} + u_{1i,t}, \qquad (14a)$$

$$\Delta EBRD_{i,t} = \mu_2 + \phi_2 \Delta gdppc_{i,t-1} + \gamma_2 \Delta EBRD_{i,t-1} + \delta_2 \Delta RECOV_{i,t-1} + \alpha_2 ECM_{i,t-1} + u_{2i,t}. \qquad (14b)$$

[7] http://www.econ.cam.ac.uk/faculty/pesaran/jasa.exe.

On the basis of these regressions it is possible to reveal the direction of the relationships between variables both in the short-run and long-run (Granger tests), and to consider the problem of endogeneity (exogeneity) of the variables included in the model. The results of the estimations of the regressions (14a) and (14b) using panel least squares (model includes fixed period effects) are presented in Table 8.

Table 8: The relationship between market reforms and growth: The short- and long-run dimensions (PLS)

Variables	Dependent variable					
	$\Delta gdppc$			$\Delta EBRD$		
	coefficient	***t*-statistic**	***p*-value**	**coefficient**	***t*-statistic**	***p*-value**
Constant	–0.090	–7.775	0.000	0.145	4.480	0.000
$\Delta gdppc_{t-1}$	0.323	4.790	0.000	0.240	1.610	0.108
$\Delta EBRD_{t-1}$	0.054	3.015	0.003	0.141	2.590	0.010
$\Delta RECOV$	0.123	8.260	0.000	–0.054	–1.310	0.191
ECM_{t-1}	–0.387	7.004	0.000	–0.002	–0.012	0.990
	statistic	**degree of freedom**	***p*-value**	**statistic**	**degree of freedom**	***p*-value**
Redundant fixed period effects tests:						
F-test	2.399	14, 371	0.003	3.608	14, 371	0.000
χ^2-test	33.794	14	0.002	49.784	14	0.000

Note. The calculations have been performed by using EViews 5.1. The model includes fixed period effects. The estimation method is the panel least squares (PLS).

As it is shown in Table 8, market reforms influence economic growth both in the short-run and long-run. The first differences of the EBRD reform index (taken with a one year lag) positively influence real per capita GDP growth rates. The coefficient at the equilibrium correction mechanism is also statistically significant at a 1% level and has a 'correct' sign (minus). Its value means that adjustment of the dependent variable towards equilibrium takes approximately 2.5 years (1/0.378 = 2.584).

The results presented in Table 8 show that economic growth do not accelerate market reforms. In regression (14b) coefficients at the equilibrium correction mechanism and $\Delta gdppc_{t-1}$ are statistically insignificant. This rejects the assumption of market reforms and economic growth endogeneity. According to the results obtained, the EBRD index of market reforms is a strictly exogenous variable relative to economic growth.

The estimations of the coefficients of the regressions (14a) and (14b) can be inconsistent while using a panel least squares in the models containing both fixed effects and lags of dependent variables (Nickell (1981)). In this case there is an estimation bias of the order $1/t$, where t is the length of the time series in the panel. To obtain more reliable results we additionally used the generalized method of the moments (GMM) for an estimation of the models (14a) and (14b). In our study the so-called system generalized method of moments (GMM-SYS) has been used (see Blundell, Bond (1998)).

The results of these calculations are presented in Table 9. The tests show that the model is well specified: Sargan test revealed a validity of chosen instruments; additionally, the presence of the first order and absence of the second order autocorrelation also confirms the correctness of model specification.

In general, the results obtained using GMM-SYS correspond to those presented in Table 8. The EBRD index of market reforms positively influences economic growth in the short-run (with a one year lag) and the long-run. Moreover, values of the coefficients in the equation for $\Delta gdppc$ are very

close to the values that have been obtained on the basis of panel least squares. As for a feedback, estimation of (14b) by GMM-SYS has not changed the results obtained earlier: economic growth does not influence market reforms neither in the long-run, nor in the short-run.

Table 9: The relationship between market reforms and growth: The short- and long-run dimensions (GMM-SYS)

Variables	Dependent variable					
	$\Delta gdppc$			$\Delta EBRD$		
	coefficient	***t*-statistic**	***p*-value**	**coefficient**	***t*-statistic**	***p*-value**
Constant	–0.098	–6.470	0.000	0.253	3.750	0.000
$\Delta gdppc_{t-1}$	0.314	3.240	0.001	0.144	0.455	0.649
$\Delta EBRD_{t-1}$	0.074	2.580	0.010	0.180	1.670	0.095
$\Delta RECOV$	0.131	7.770	0.000	–0.213	–2.710	0.007
ECM_{t-1}	–0.420	–3.930	0.000	0.037	0.135	0.893
Transformation used: first differences						
GMM-SYS estimations: combined transformed and level equations						
Instruments for transformed equations:						
Transformed instruments: *ECM*; *ECM*(–2).						
Level instruments: Gmm(*gdppc*, 2, 99); Gmm(*EBRD*, 2, 99); Gmm(*RECOV*, 2, 99); Gmm(*ECM*, 2, 99).						
Instruments for level equations: *ECM*; *ECM*(–2); GmmLevel(Δ*gdppc*, 1, 1); GmmLevel(Δ*EBRD*, 1, 1); GmmLevel(Δ*RECOV*, 1, 1); GmmLevel(*ECM*, 1, 1).						
Wald (joint): χ^2 (4) = 802.3[0.000]				Wald (joint): χ^2 (4) = 46.4[0.000]		
Wald (dummy): χ^2 (1) = 41.9[0.000]				Wald (dummy): χ^2 (1) = 14.0[0.000]		
Sargan test: χ^2 (534) = 24.4[1.000]				Sargan test: χ^2 (534) = 21.7[1.000]		
AR(1) test: N(0.1) = –2.1[0.032]				AR(1) test: N(0.1) = –2.9[0.003]		
AR(2) test: N(0.1) = 0.8[0.414]				AR(2) test: N(0.1) = 0.3[0.733]		

Note. The calculations have been performed by using PDP 1.24 of econometric software PcGive 10.3 (Doornik, Hendry (2001)). Wald (joint) is a joint test for significance of the variables in the model (H_0: the variables are statistically insignificant); Wald (dummy) is a joint test for significance of dummies (constants) in the regression (H_0: dummies are statistically insignificant; Sargan test is a test for the validity of the model instruments (H_0: the instruments are valid in the model); AR(1) and AR(2) are the tests for autocorrelation of the first and second order, respectively (H_0: no autocorrelation). In Table 8 the results (coefficients and tests) of the second step of GMM-SYS estimation are shown. The *t*-statistic is calculated using finite sample corrected standard errors.

5. CONCLUSION

In this study a new approach to the analysis of the relationship 'market reforms – economic growth' is put forward. Taken into account the dynamic characteristics of the data used (the level of real GDP per capita and the level of the EBRD index of market reforms), cointegration analysis has been chosen for investigation of this relationship. The usage of the equilibrium correction model has allowed getting some new results on the issue.

Within our research we tested five main hypotheses and obtained the following results:

Hypothesis 1. The logarithmic level of real GDP per capita and the level of the EBRD index of market reforms are non-stationary variables and have the order of integration *I*(1). Consequently, the first differences of these variables are stationary variables with order of integration *I*(0).

Result. The set of panel tests for unit root and stationarity used in this research demonstrates that the investigated variables have an order of integration *I*(1). Their first differences are stationary variables. Thus, it would not be correct to utilize variables with different orders of integration in regressions characterizing the relationship 'market reforms – economic growth'. This could lead to incorrect model specification.

Hypothesis 2. There is a cointegration between the logarithmic level of real GDP per capita and the level of the EBRD index of market reforms.

Result. Utilization of different methods of analysis demonstrates that the level of real GDP per capita and the revel of the EBRD index of market reforms are cointegrated variables, i.e. there is the following long-run relationship between them (*t*-statistics in parentheses):

$$gdppc_{it} = \underset{(275.9)}{7.620} + \underset{(4.5)}{0.105}\, EBRD_{i,t} + \underset{(25.6)}{0.208}\, RECOV_{i,t} + \varepsilon_{it}.$$

Thus, increase in the index of market reforms has a statistically significant positive impact on GDP per capita dynamics in the long-run.

Hypothesis 3. The relationship 'market reform – economic growth' can be described using an equilibrium correction model, characterizing the long-run and short-run aspects of this relationship.

Hypothesis 4. Market reforms have a statistically significant positive influence on economic growth in the short-run with a one year lag.

Result. Within our study the following equilibrium correction model, characterizing the relationship 'market reform – economic growth' has been obtained:

$$\Delta gdppc_{i,t} = \underset{(-7.775)}{-0.090} + \underset{(4.790)}{0.323}\, \Delta gdppcy_{i,t-1} + \underset{(3.015)}{0.054}\, \Delta EBRD_{i,t-1} +$$
$$+ \underset{(8.260)}{0.123}\, \Delta RECOV_{i,t-1} - \underset{(-7.004)}{0.387}\, ECM_{i,t-1} + u_{1i,t}.$$

As one can see, we have obtained a well-specified model confirming hypotheses 3 and 4. Market reforms have a statistically significant positive influence on economic growth in the short-run with a one year lag. The statistically significant coefficient at the equilibrium correction reflects the long-run relationship between the variables and characterizes the speed of adjustment of the economic growth indicator towards a steady state. These hypotheses are validated by using different estimation methods of appropriate regressions.

Hypothesis 5. Market reforms and economic growth are interrelated, i.e. the investigated variables are endogenous.

Result. Within our methodology of analysis of the relationship 'market reforms – economic growth' the hypothesis concerning the exogeneity of investigated variables is not supported empirically. In accordance with obtained results, the EBRD index is a strictly exogenous variable relative to the indicator of economic growth. Thus, economic growth does not statistically significant influence market reforms; neither in short-run, nor in the long-run.

In general, our results do not contradict recent studies on this issue (for example, Falcetti, Lysenko and Sanfey (2006)). Our main conclusion is that market reforms have a positive effect on economic growth in post-socialist countries. However, our econometric approach allows analyzing the relationship 'market reforms – economic growth' more correctly, as well as allows considering its various aspects (short-run and long-run dynamics) in more detail. In our opinion, this approach provides more intelligible results and may be used in comparable future research, for example, while analyzing the influence of various indexes of economic freedom on economic growth in all countries as a whole and in their different groups.

REFERENCES

Babetskii, I., Campos, N.F. (2007). Does Reform Work? An Econometric Examination of the Reform-Growth Puzzle, *IZA Discussion Paper* No.2638.

Berg, A., Borensztein, E., Sahay, R., Zettelmeyer, J. (1999). The Evolution of Output in Transition Economies: Explaining the Differences, *IMF Working paper*, WP/99/73.

Buchanan, J. M. (1975). *The Limits of Liberty*, Chicago, Chicago University Press.

Chubrik, A. (2003). Rynochnye reformy i ekonomicheskiy rost v stranah s perehodnoy ekonomikoy [Market Reforms and Economic Growth in Transition Economies], *Belorusskiy Ekonomicheskiy Zhurnal*, 3, 42–50.

Chubrik, A. (2006). Obschiy obzor razvitiya ekonomik stran SNG v 1991–2003 gg. [A General Survey of CIS Economies Development in 1991–2003], *ECOWEST*, 2, 318–342.

Chubrik, A., Rakova, E., Pelipas, I. (2002). Ekonomicheskaya svoboda i economicheskoe blagosostoyanie (otlozhennye reformy: izderzhki upuschennyh vozmozhnostey) [Economic Freedom and Economic Welfare (Alternative Costs of Delayed Reforms)], *ECOWEST*, 1, 4–44.

De Haan, J., Lundstrom, S., Sturm, J-E. (2005). Market oriented institutions and policies and economic growth: A critical survey, *Thurgauer Wirtschaftsinstitut*, *Research Paper Series*, No.5.

De Melo, M., Denizer, C., Gelb, A., Tenev, S. (2001). Circumstance and Choice: the Role of Initial Condition and Policies in Transition Economies, *World Bank Economic Review*, 15, 1–31.

Doornik, J.A., Hendry, D.F. (2001). *Econometric Modelling Using PcGive 10*, Vol. III, London, Timberlake Consultants.

EBRD (2006). *Transition Report 2006: Finance in Transition*, London, European Bank for Reconstruction and Development.

Engle, R., Granger, C. (1987). Co-integration and error correction: Representation, Estimation and Testing, *Econometrica*, 55, 251–276.

Falcetti, E., Lysenko, T., Sanfey, P. (2006). Reforms and Growth in Transition: Re-examining the Evidence, *Journal of Comparative Economics*, 34, 421–445.

Fischer, S., Sahay, R. (2000). The Transition Economies after Ten Years, *IMF Working paper*, WP/00/30.

Fischer, S., Sahay, R. (2004). Transition Economies: The Role of Institutions and Initial Conditions, *IMF mimeo*.

Fischer, S., Sahay, R., Vegh, C. (1996). Stabilization and Growth in Transition Economies: The Early experience, *Journal of Economic Perspectives*, 10, 45–66.

Fish, M., Choudhry, O. (2007). Democratization and Economic Liberalization in the Postcommunist World, *Comparative Political Studies*, 40, 254–282.

Friedman, M. (1962). *Capitalism and Freedom*, Chicago, Chicago University Press.

Gaidar, Y. (2005). Recovery Growth as a Stage of Post-Socialist Transition? CASE – Center for Social and Economic Research, *Studies and Analyses*, No.292.

Havrylyshyn, O. (2001). Recovery and Growth in Transition: A Decade of Evidence, *IMF Staff Papers*, 48, 53–87.

Havrylyshyn, O., van Rooden, R. (2003). Institutions Matter in Transition, But so Do Policies. *Comparative Economic Studies*, 45, 2–24.

Hayek, F. A. von (1960). *The Constitution of Liberty*, Chicago, Chicago University Press.

Heybey, B., Murrell, P. (1999). The Relationship between Economic Growth and the Speed of Liberalization During Transition, *Journal of Policy Reform*, 3, 121–137.

Pedroni, P. (1997). Panel Cointegration, Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis: New Results, *Indiana University Working Paper in Economics.*

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple repressors, *Oxford Bulletin of Economics and Statistics*, Special issue, 61, 653–670.

Pedroni, P. (2001). Panel Cointegration, Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis, *Indiana University Working Paper in Economics*.

Pesaran, M., Shin, Y., Smith, R. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels, *Journal of the American Statistical Association*, 94, 621–634.

QMS (2005). *EViews 5.1 User's Guide*, Quantitative Micro Software, LLC.

Radulescu, R., Barlow, D. (2002). The Relationship Between Policies and Growth in Transition Countries, *Economics of Transition*, 10, 719–745.

Staehr, K. (2005). Reforms and Economic Growth in Transition Economies: Complementarily, Sequencing and Speed, *The European Journal of Comparative Economics*, 2, 177–202.

Staehr, K. (2006). Linkages between Political and Economic Reforms in the Postcommunist Countries, Paper Presented at the European Association for Comparative Economics Studies (EACES) 9th Bi-Annual Conference *'Development Strategies – A Comparative View'*.

ANNEX A: DYNAMICS OF GDP AND EBRD REFORM INDEX

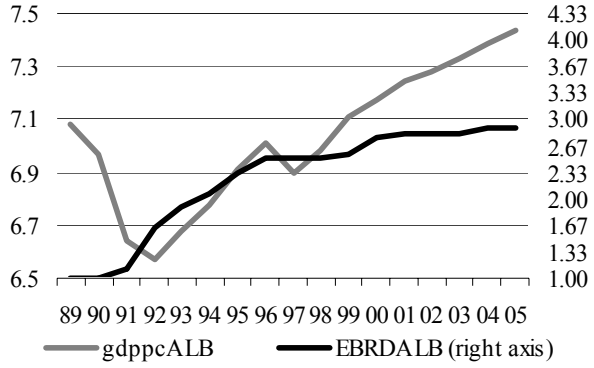


Figure 1. Albania

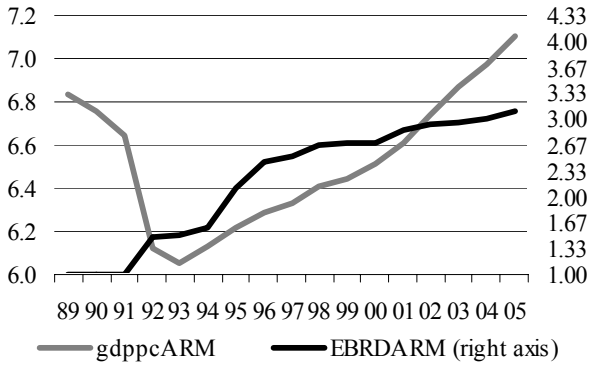


Figure 2. Armenia

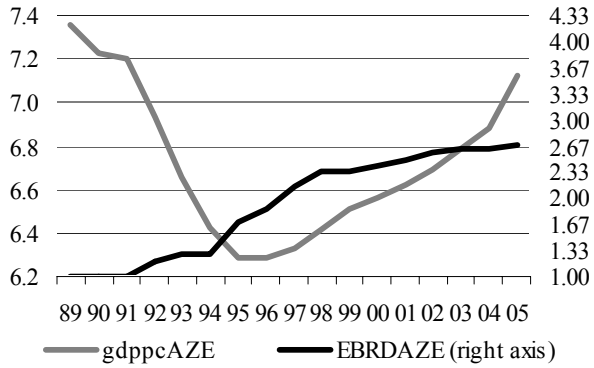


Figure 3. Azerbaijan

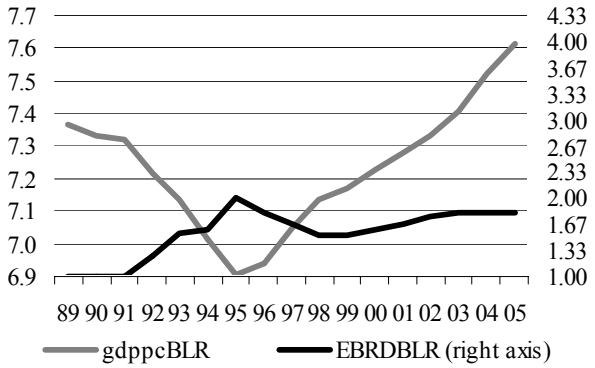


Figure. 4. Belarus

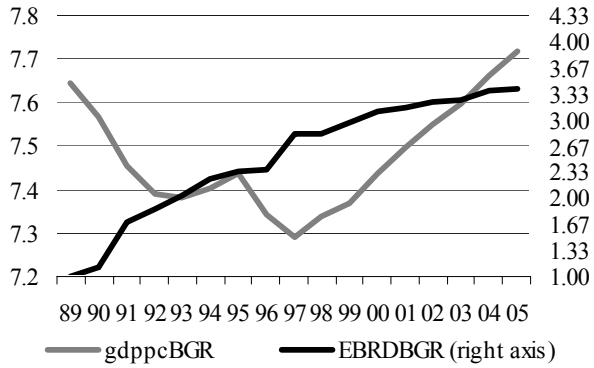


Figure 5. Bulgaria

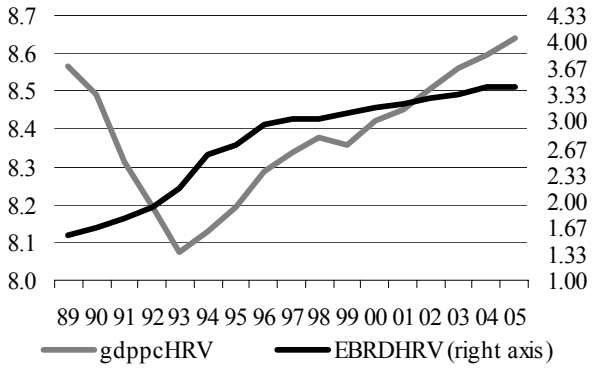


Figure 6. Croatia

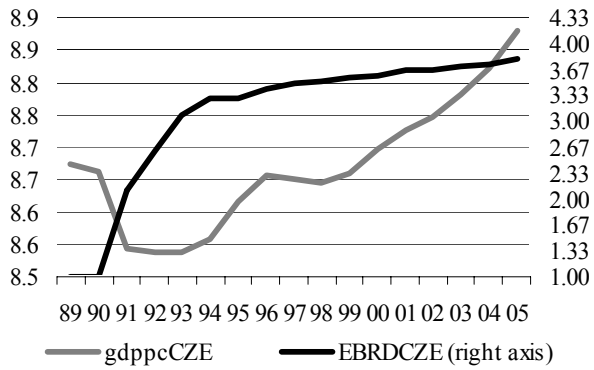


Figure 7. Czech Republic

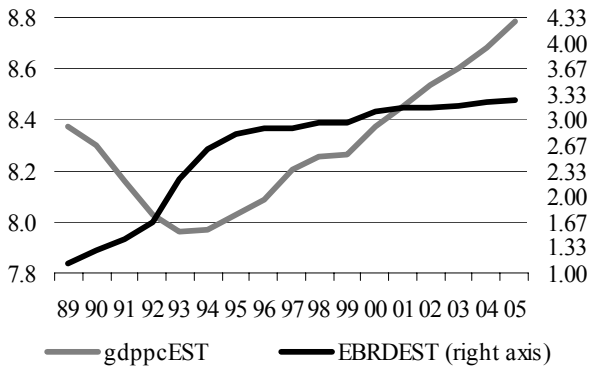


Figure. 8. Estonia

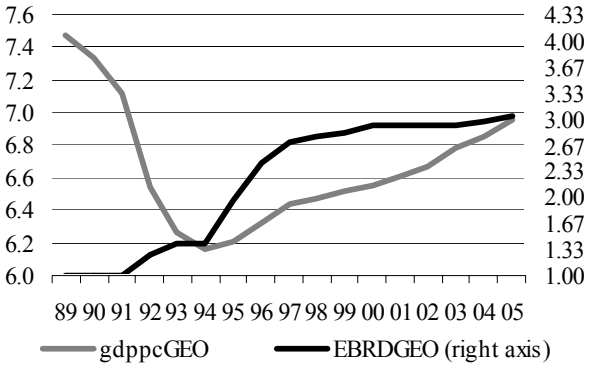
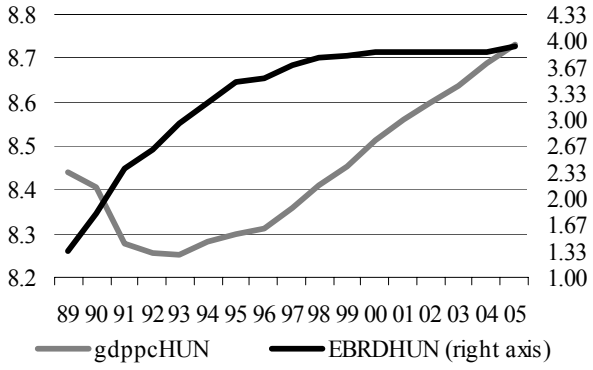


Figure 9. Georgia



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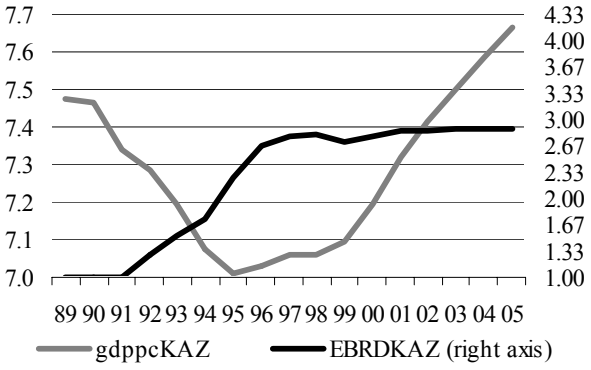


Figure 11. Kazakhstan

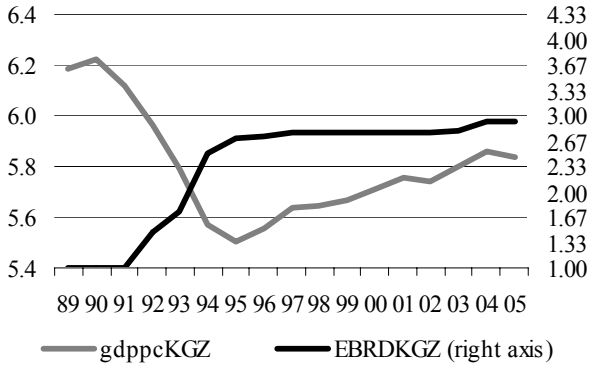


Figure 12. Kirgizstan

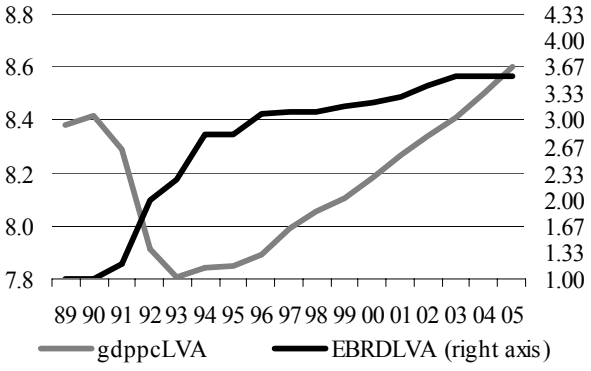


Figure 13. Latvia

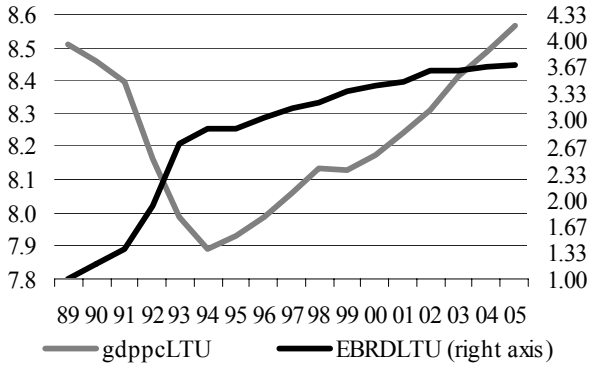


Figure 14. Lithuania

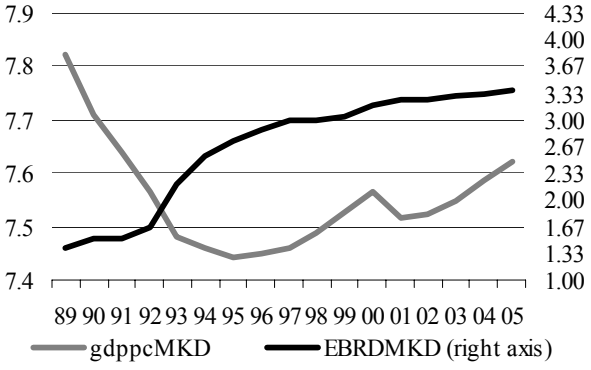


Figure 15. Macedonia

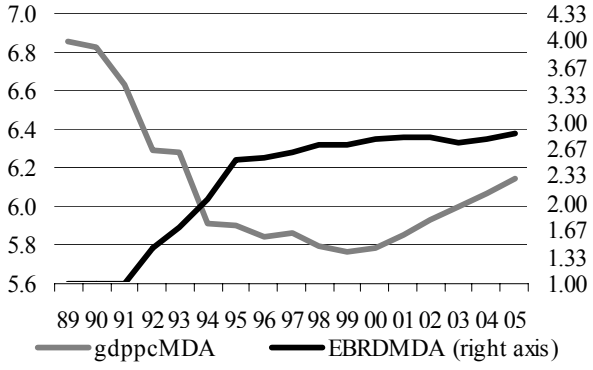


Figure 16. Moldova

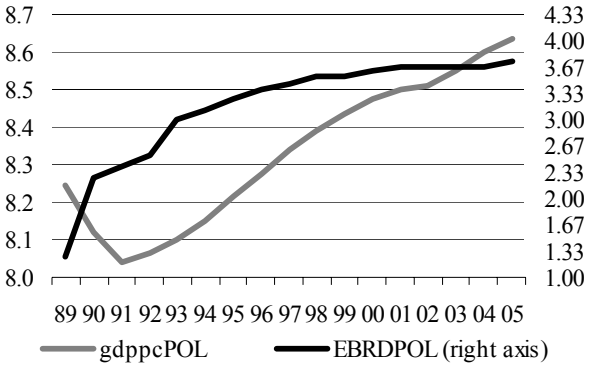
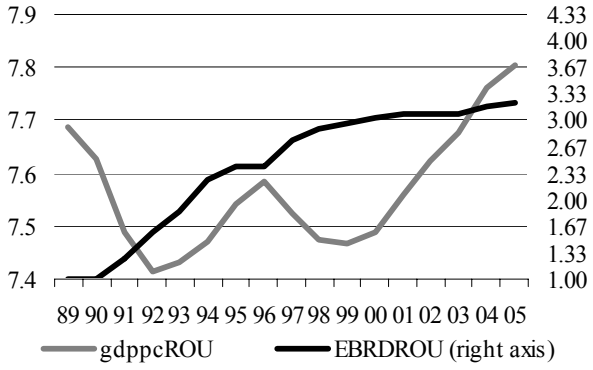


Figure 17. Poland



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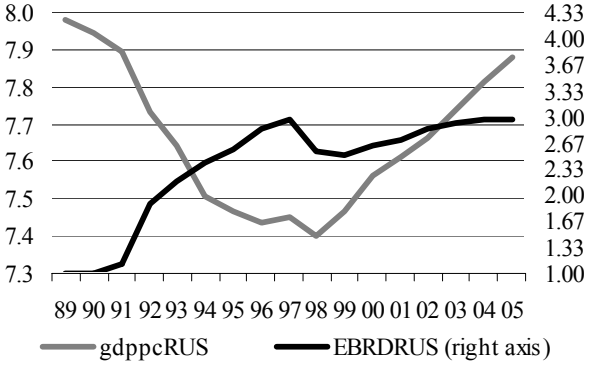

Figure 19. Russia

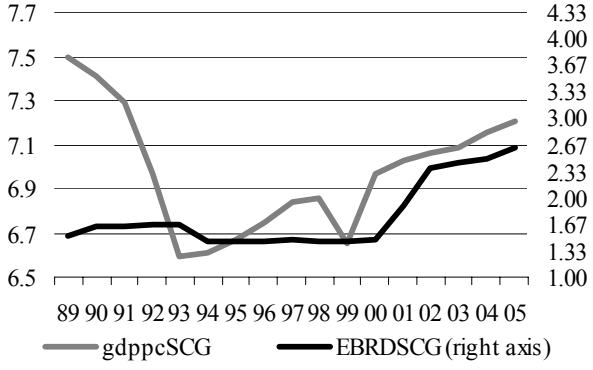

Figure 20. Serbia and Montenegro

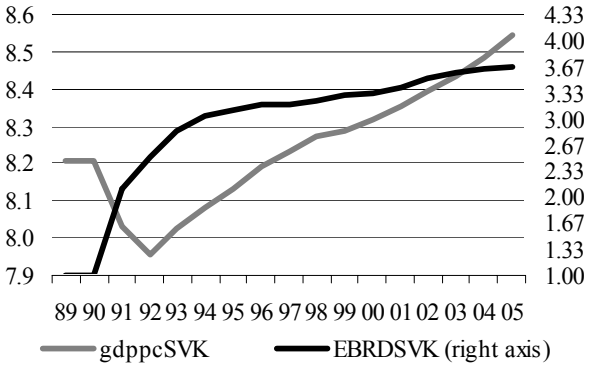

Figure 21. Slovakia

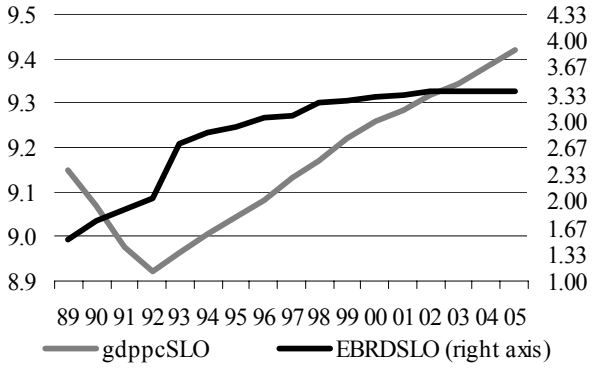

Figure 22. Slovenia

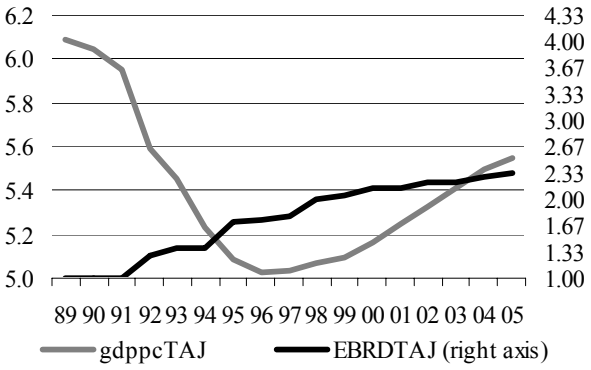

Figure 23. Tajikistan

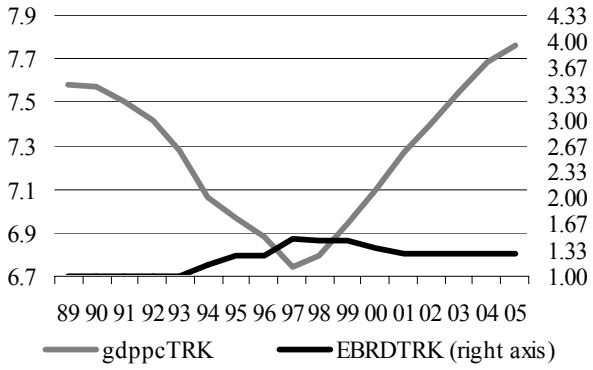

Figure 24. Turkmenistan

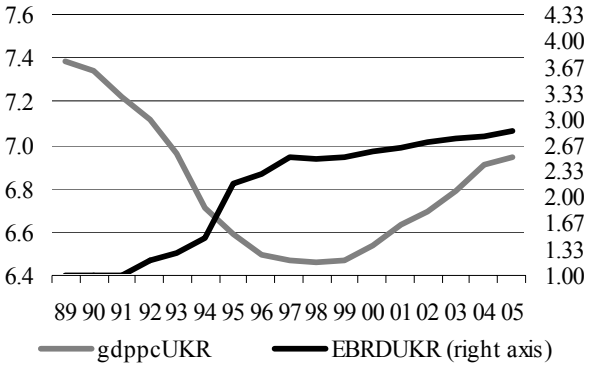

Figure 25. Ukraine

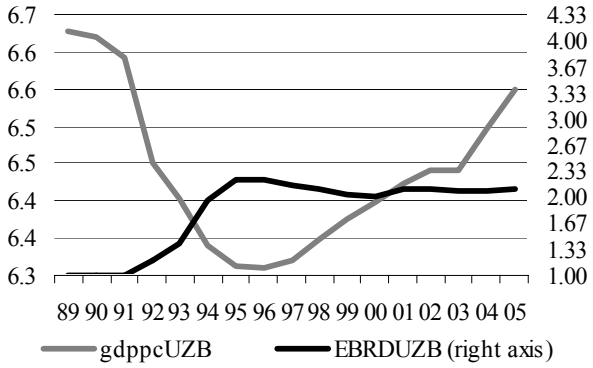

Figure 26. Uzbekistan

ANNEX B: LONG-RUN RELATIONSHIP BETWEEN MARKET REFORMS AND ECONOMIC GROWTH

Dependent Variable: LOG(GDPPC?)
Method: Pooled Least Squares
Sample: 1989 2005
Included observations: 17
Cross-sections included: 26
Total pool (balanced) observations: 442
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Intercept	7.620	0.028	275.883	0.000
EBRD?	0.105	0.023	4.470	0.000
RECOV?	0.208	0.008	25.648	0.000
ALB--@TREND	–0.157	0.010	–15.976	0.000
ARM--@TREND	–0.159	0.013	–12.536	0.000
AZE--@TREND	–0.153	0.009	–16.586	0.000
BLR--@TREND	–0.130	0.008	–15.895	0.000
BGR--@TREND	–0.180	0.011	–17.109	0.000
HRV--@TREND	–0.168	0.009	–18.000	0.000
CZE--@TREND	–0.172	0.011	–16.278	0.000
EST--@TREND	–0.150	0.009	–15.807	0.000
GEO--@TREND	–0.187	0.015	–12.388	0.000
HUN--@TREND	–0.161	0.010	–16.311	0.000
KAZ--@TREND	–0.143	0.009	–15.470	0.000
KGZ--@TREND	–0.172	0.009	–18.429	0.000
LVA--@TREND	–0.168	0.011	–15.068	0.000
LTU--@TREND	–0.165	0.010	–16.809	0.000
MKD--@TREND	–0.161	0.011	–14.318	0.000
MDA--@TREND	–0.182	0.008	–21.562	0.000
POL--@TREND	–0.172	0.010	–17.447	0.000
ROU--@TREND	–0.191	0.011	–17.328	0.000
RUS--@TREND	–0.142	0.008	–18.497	0.000
SCG--@TREND	–0.184	0.009	–19.520	0.000
SVK--@TREND	–0.172	0.010	–17.167	0.000
SLO--@TREND	–0.171	0.010	–17.278	0.000
TAJ--@TREND	–0.166	0.008	–20.890	0.000
TRK--@TREND	–0.101	0.006	–17.142	0.000
UKR--@TREND	–0.132	0.007	–20.226	0.000
UZB--@TREND	–0.135	0.010	–13.160	0.000

Effects Specification: Cross-section fixed (dummy variables)

R-squared	0.992	Mean dependent var	7.401
Adjusted R-squared	0.991	S.D. dependent var	0.954
S.E. of regression	0.092	Akaike info criterion	–1.824
Sum squared resid	3.270	Schwarz criterion	–1.325
Log likelihood	457.198	F-statistic	891.597
Durbin-Watson stat	0.703	Prob(F-statistic)	0.000

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