CONVERGENCE OR DIVERGENCE IN ECONOMIC GROWTH OF COMMONWEALTH OF INDEPENDENT STATES (CIS)

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Abstract: In this study, the issue of economic growth and Convergence in the 12 countries of the CIS region has been investigated thoroughly for 27 years, from 1991-2017. The paper examines the absolute, sigma and conditional Convergence of the CIS region. Conditional Convergence is examined through the augmented Solow and extended Solow models. During the study period, the empirical results confirm no significant negative correlation between the initial ratio of the countries per capita GDP and the average yearly growth rate. Thus, indicating the absence of absolute β convergence across the CIS economies during 1991–2017. The results of the sigma convergence are consistent with the results derived from the absolute convergence model. Referring to the augmented Solow model estimations, we found the rate of conditional β-convergence (coefficient of initial GDP per capita) of value 0.028 among members of the CIS region after controlling GDP per capita, physical and human capital and population growth have important contributions to make in the growth and Convergence of countries. In Solow extended growth regression, the initial GDP per capita coefficient is 0.33. Therefore, besides the initial level of per capita income, physical and human capital and population growth, other factors have important contributions to make to the growth and Convergence of countries of CIS.

Keywords: CIS; growth; absolute Convergence; sigma convergence; conditional Convergence.

JEL codes: O11, Z32, C01

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58

1. Introduction

Convergence in the literature on growth economics implies the tendency of developing countries to grow faster relative to developed countries, eventually eliminating per capita income gaps across countries of different regions. This is a famous neoclassical concept based on their assumption of diminishing returns to capital. Owing to this assumption, marginal returns to investment in a developing country with a lower capital-labor ratio are expected to be higher than in a rich country with a higher capital-labor ratio. Thus all the countries over a period of time must fall into the same steady-state level of income provided that the growth rate of savings, population and technology remain constant across the countries. In technical terms, this is known as absolute or unconditional β Convergence. The test of total Convergence is empirically evidenced by a statistically significant negative relationship between income growth and the initial level of per capita income. Alternative to unconditional β Convergence is the concept of Sigma (σ) convergence measured in terms of dispersion of per capita incomes across the countries over a period of time. A lower magnitude of dispersion of per capita incomes over the period supports the unconditional convergence hypothesis.

According to this Neoclassical presumption, the development gap, interpreted as a difference in the level of per capita incomes between poor and rich countries, should ultimately be eliminated in time. However, this prediction is not supported by strong empirical evidence, except in the case of certain South East Asian countries that have remarkably come closer to the standards of industrialized countries. As documented in Mina (2013), the question of economic growth and Convergence has assumed significance not only because of the already wide gap between rich and poor countries but also because, for some poor countries, this gap is persistently showing an increasing tendency. This led to a serious debate on the neoclassical growth theory, and subsequently, many questions were raised against the growth model developed by Robert Solow (1956). The two major areas of concern were the assumption of diminishing returns to capital and the exogenous nature of technology. Technology was considered to be like a public good to which every economy has equal access. The assumption of diminishing returns to capital implied that each economy would reach a common steady state irrespective of whether the economy has a higher or lower equilibrium level of income. After falling into a common steady state, growth will be determined by the growth of technology considered to be exogenous in the model. Hence according to Romer (1986, 1991), Neoclassical Growth Model (NCGM) failed to explain the long-run growth path and also that in a greater sample of countries with heterogeneity (variations in the country-specific factors like savings and population growth rates), there will actually be different steady-state level of income for each country influenced by its savings and population growth rates. Interpreted in this sense, Convergence is said to be

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Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

59

STUDIA UNIVERSITATIS ECONOMICS SERIES
"Vasile Goldiş" Western University of Arad

Shah, I.A, Haq, I. (2022)
Convergence or divergence in economic growth of Commonwealth of Independent States (CIS)

conditional. According to this notion of conditional Convergence, rich countries may actually grow faster than poor countries leading to per capita income divergences. However, it must be noted that the presumption of unconditional Convergence is possible among the countries or regions that are homogenous sharing common characteristics like their preferences for savings (savings rate), population growth rates and production functions, etc. This lends credence to the empirical findings in support of unconditional Convergence exhibited by the homogenous group of OCED economies, the states of the U.S. and the E.U. union.

The lack of strong empirical support in favor of the unconditional convergence property of neoclassical growth theory, as exhibited in the Solow-Swan model (1956), led to a serious debate among economists during the 1980s to revisit the subject of economic growth and Convergence. This paves the way for the emergence of endogenous growth theory. The basic premise of endogenous growth models is to provide a satisfactory explanation of the divergences between rich and poor countries across the world. To defend this property, these models assume that capital may not be subject to diminishing returns but rather to constant and even increasing returns due to the inclusion of human capital in the production function that makes it possible to offset the property of diminishing returns or falling marginal product of capital. Furthermore, according to this theory, technological progress is assumed to be a function of the proportion of income devoted to carrying out R & D activities, education and skill formation. Hence growth is endogenous in nature. This provides a plausible justification for the phenomenon of the growing development gap between rich and poor countries and hence a possible divergence rather than Convergence.

The major thrust of this work is twofold. First, it will ascertain whether these different growth theories are mutually exclusive so as to check the validity of the convergence hypothesis in the context of countries of the Commonwealth of Independent States (CIS). Secondly, the study attempts to trace the impact of variables like the role of government, globalization, inflation and capital formation (both physical and human) in explaining the growth performance. This is important because countries of the CIS region emerged during the early 1990s from a single largest socialist state known as the erstwhile Union of Soviet Socialist Republics (USSR). After having remained an integral part of a centrally planned closed economic system for about seven decades, these republics have moved from a socialist economic system to a capitalist market economy. Hence, the present study would be an addition to the existing literature on the subject, as no such attempt has been made so far with respect to growth and Convergence in the CIS region.

The paper is structured as follows, the first part, the "introduction", discusses the background of the theme; the "Literature review" presents both theoretical as well empirical studies related to growth and Convergence; "Commonwealth of

60

Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 32 Issue 4/2022
ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

Independent States" provides about the history and economic performance about CIS region. Empirical studies of absolute and sigma Convergence are given under "Absolute convergence" and "Sigma convergence", respectively. "Conditional convergence" discusses the estimation and empirical results of augmented Solow and extended Solow models. Finally paper summarises the paper under "Conclusion", and finally paper presents the "Policy implication" and "Further suggestions."

2. Literature Review

There has been a concern and debate among economists about why growth rates differ across the countries. From the time of classical economists, the problem of economic growth (its sources, forms and effects) was on the agenda of economists. Adam Smith proposed various fundamentals to classical economics. His book titled '*The inquiry into the nature and cause of the wealth of nations*' (1776) viewed the growth process as strictly exogenous with emphasis on the impact of capital accumulation on capital productivity. The factor determining the growth of labor productivity is the division of labor which in turn depends on capital accumulation. Smith establishes that there is an increasing return based on the division of labor. There are no limits to growth. The growth process itself generates additional required labor forces. The increase in productivity compensates for diminishing returns to natural resources.

Like Smith, David Ricardo, in his book '*Principles of political economy and taxation* (1857), suggested that growth is a function of capital accumulation, which depends on reinvested profits. However, Ricardo predicted that there would be a stationary state in the economy with no growth due to diminishing returns in agriculture. Ricardo was supported by Karl Marx, who predicted the collapse of the capitalist economy in the long run (Thirlwall, 2011).

The modern economic growth theory starts with the paper of Harrod (1939) titled *'An Essay in Dynamic Theory*. The paper highlighted the issues related to steady-state economic growth. The model explains at what rate investment should increase so that steady growth is possible. In this model, the rate of capital accumulation plays an important role in determining economic growth. The model seeks to determine the rate at which investment and income must grow to achieve full employment level in the long run. However, with the assumption of fixed K/L and K/Y, it requires L and K to grow at the same rate to maintain equilibrium. However, the rigid technical coefficient assumption in the Harrod model gave rise to instability, meaning that any divergence from the full employment equilibrium would either lead the economy towards a continuous state of depression or prolonged inflation (Snowdon & Vane, 2005).

Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 32 Issue 4/2022
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Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

61

Neoclassical economist Robert Solow (1956) criticized the assumptions and rigidity of technical coefficients. Solow showed that when prices of factors of production are flexible, and factors are substitutable, countries can achieve a natural growth rate determined by the growth of the labor force and level of technology. However, the growth of the labor force and technology are assumed exogenously given. Therefore, left unexplained the determinants of long-run growth are. Investment does not matter for long-run economic growth because of diminishing returns to capital. Solow's model predicts that poor countries with a low level of capital will grow faster than rich countries with abundant capital. Therefore, Convergence in the per capita income of countries across the world (Thirlwall, 2011). In this model, the economy will grow for a while but not forever. Over time growth declines as the country approaches a steady state and eventually stops altogether at a steady state (Jones & Vollerath, 2013). However, in a greater sample of countries with large heterogeneity, each country will have different steady-state levels of income and hence no convergence.

The endogenous growth model relaxes the assumption of diminishing returns to capital. They redefined capital by including human capital and R&D expenditure. This board capital either has constant returns (Romer, 1986) or increasing returns. With no diminishing returns to capital, investment becomes important in determining the long-run growth of the economy. With the constant or increasing return, countries' per capita income will not converge.

Barro and Salal-i-Martin (1990) examined the data for U.S. states from 1960 to 85. The authors found clear evidence of poor states growing faster than rich states indicating a case of unconditional Convergence. The authors found no such convergence by comparing U.S. states with a cross-country sample of 98 countries from 1960-1985. However, after controlling additional regressors like school enrollment, government consumption, and the difference in steady-state value and technology, the estimated results conform to the Convergence similar to that found in U.S. states. Thus providing proof of conditional Convergence.

Dobson and Ramlogan (2002) examine Convergence in Latin America from 1960 to 1990. During this time, Latin America experienced impressive economic and social changes. Between the period 1960 and 1990, there is proof of absolute Convergence. However, there is no proof of sigma convergence for the whole sample. There is additional proof of conditional Convergence in the reported time at a rate lower than in many developed nations. However, the development programs presented by the poor countries and the availability of external finance to support the unutilized resources served to support Convergence among poor nations.

Urmas Varblane and Priit Vahter (2005) examined the economic Convergence of transition economies during 1995-2004. The authors found absolute Convergence and sigma convergence across transition economies during the said period.

Comparing new member states (NMS) with existing member states of E.U. reveal that new member states (NMS) have been more successful in Convergence than existing states. While introducing additional factors in terms of variables like human capital and infrastructure, NMS is performing better. Therefore, NMS face an opportunity to obtain a rapid convergence process.

Menbere (2005) examined the degree to which transition economies of Central and Eastern Europe have brought down per capita gaps with the existing members of the European Union during the 1990s. The author used different regression tests to find the empirical results of the given hypothesis. The first was a cross-sectional regression that incorporates the time 1990 – 2000. The outcomes demonstrate no significant convergence in GDP per capita among the transition economies of Central and Eastern Europe and the EU15. However, after controlling various macroeconomic variables like human capital, physical capital, and initial level of capital, there was proof of conditional Convergence among transition economies and the EU15. The results are in line with the predictions of the augmented Solow model. Further, the regression results propose that nations with sound macroeconomic indicators, FDI, financial development, and better structural adjustment will generally have sound economic growth compared to those lacking these indicators.

Madhusudan Ghosh (2006) examines regional disparities in agricultural development over 15 states in India during 1960-2002. The author examined the σ and β Convergence (Absolute and Conditional) in land productivity and per capita agricultural output over the states, especially after adopting new HYV technology and various large-scale economic reforms. The author found no significant convergence in land productivity and per capita agricultural output after the initiation of economic reforms during the 1990s. Sigma convergence shows a decrease in land productivity variation while increasing variation in per capita output after the introduction of HYV technology. The author, however, observes a case of conditional Convergence positively impacted by physical capital, human capital and infrastructure.

Wana (2008) examines the growth and Convergence in the ASEAN countries by utilizing a dynamic, heterogeneous group approach, namely Pool Mean Group Estimation, from 1960 to 2004. The author found evidence of absolute and conditional Convergence in ASEAN countries during the said period. The speed of Convergence ranges from 1.6% to 16.6% per annum. The formation of ASEAN was positively associated with growth.

Djennas and Ferouani (2014) conducted a cross-country analysis in Africa incorporating a decomposition approach for absolute Convergence, sigma convergence and conditional Convergence of GDP growth and its dynamics, using data from 52 African countries from the period 1980 to 2011. Baring a few cases, all

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ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

63

nations demonstrate weak proof of absolute Convergence, sigma convergence and conditional Convergence in Africa.

Umut Unal (2014) finds proof of conditional Convergence among 31 OIC countries from 1980-2009. The coefficient of absolute Convergence, although negative but is statistically insignificant. By including human capital, 50 percent cross-country variation in per capita income is explained. However, by employing additional variables, 70 percent of the total variation is explained. The coefficient of conditional Convergence calculated is 1.3 percent per annum, implying that it would take OIC economies almost 55 years to reach half of the study state.

Gömleksiz, Şahbaz, and Mercan (2017) examined the growth and Convergence of GDP per capita income between German states following the German reunification. The authors apply the neoclassical growth model in a panel approach. The panel regression is modified by including technological progress and a dummy variable to capture the financial crisis. To this basic panel equation, the authors also have labor migration, investment subsidies and fiscal policies as determinants of economic growth. Authors discover proof of moderate Convergence when technological progress and financial development are included in the model. The coefficients of explanatory variables to explain economic growth are significant, and the marginal impact of variables depends on economic prosperity. Net migration is found to have negatively affected the economic growth of poor economies and positively affected the growth of advanced economies.

Michal, Havrlant, Kuenzel and Monks (2018) examined economic Convergence in the Czech Republic and Slovakia from the period 1998 -2016 while concentrating on the growth of Gross National Income (GNI) per capita. The empirics show that the Czech Republic and Slovakia saw significant Convergence concerning the E.U. average during the period between 2003 and 2008. Various policy and economic variables like FDI, industrial legacies and labour market reforms affect the speed of Convergence. Further global crisis adversely affected the speed of Convergence in the Czech Republic and Slovakia.

3. Commonwealth of Independent States

The creation of the Commonwealth of Independent States (CIS) was directly related to the dissolution of the Union of Soviet Socialist Republics (USSR). Fifteen states which emerged due to the disintegration of the USSR had to define their position in the region, outlining the directions of their economic development and specifying the scope of foreign economic policy they were to pursue. Initially, eleven former Soviet republics - Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Turkmenistan, Tajikistan, Ukraine, and Uzbekistan signed an agreement of membership in the Commonwealth of Independent States (CIS). Georgia joined CIS two years later, in December 1993. Thus, except for three Baltic States - Estonia,

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"Vasile Goldiş" Western University of Arad

Shah, I.A, Haq, I. (2022)
Convergence or divergence in economic growth of Commonwealth of Independent States (CIS)

Latvia, and Lithuania, all former Soviet republics were members of CIS. Among the 12 states of CIS, four are in Europe: Ukraine, Russia, Moldova and Belarus. Russia is an important country in terms of the area not only in Europe but also in Asia. Three countries, Armenia, Georgia and Azerbaijan, are in the Caucasus, i.e., between Asia and Europe. The rest remaining five countries: Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan, are in Central Asia.

The political and economic reforms that countries undertook and external factors played an important role in shaping GDP growth rates in early periods. Immediately after the disintegration of the USSR, all the countries experienced a heavy contraction of output associated with hyperinflation due to the breakdown of old linkages and sudden liberalization of prices. However, the number of output losses and time of recovery varied across countries. It was only in 1995 when the majority of countries somehow recorded a positive growth rate in GDP, along with some control in managing hyperinflation. On the whole, the period between 1991 to 2017 can be divided into three distinct phases viz, the period of transitional recession (1991-1995); the period of recovery (1996-2008) and the period of stability (2010-2017).

Despite strong similarities in economic structure, culture and history, their initial conditions like geographical advantages/ disadvantages (like being a landlocked country, powerful neighbors, or ownership of natural resources) were different. Also, the transitional development strategies in a bid to move from a centrally administrated socialist system to free market-oriented economies varied across the region's countries in terms of pace and sequence.

4. Absolute Convergence

Absolute Convergence based on cross-sectional regression is estimated using the following equation

$$GR = \alpha_0 + \alpha_1 log y_{i0} + \varepsilon_{it} \tag{1}$$

Where GR represents the growth rate of a country, $log y_{i0}$ is the initial level of income and ε_{it} is the error term. Convergence requires α_1 (coefficient of the initial level of income) to be significantly negative. The results of absolute Convergence are presented in table 1 by using OLS econometric technique. The Regression results (using 1991-2017 data) show that the coefficient of the initial level of GDP per capita is negative but insignificant. Hence, no absolute convergence. The lack of absolute Convergence within the CIS region indicates that the steady-state level of income is not the same across such regions. This may be because not all countries have the same investment rates, and population growth rates and technology levels vary

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ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

65

across the countries in the region. As such, they are not generally expected to converge towards the same steady state target.

Table 1 Absolute Convergence based on cross-sectional regression analysis: CIS Region

Dependent variable: GDP per capita growth rate.			
Variable	Coef. Interval]	Std. Err.	t	[95% Conf.
α_1	-.2917429 3.178824	1.557608	-0.19	-3.76231
α_0	5.736523 16.67482	4.909165	1.17	-5.201778
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity *Ho: Constant variance* chi2(1) = 0.01 Prob > chi2 = 0.9027			

α_0 is the intercept while as α_1 is the coefficient of the initial level of per capita income.
Source: Own processing

The scatter diagram of the GDP per capita of CIS countries is shown in figure 1. The figures depict an insignificant negative relationship between GDP growth rate and the initial level of GDP.
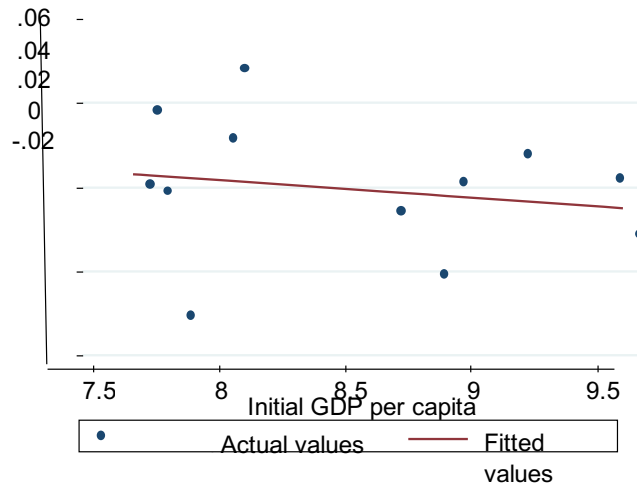
Figure 1 Absolute Convergence: CIS (1991-2017)
Source: Own processing

5. σ (sigma) convergence

Grier and Grier (2007) and Streissler (1979) adopted linear regression of a country's cross-sectional variances to study sigma convergence. Following their methodology, sigma convergence is evaluated through the following linear trend equation as;

$$\sigma_t^S = \gamma_0 + \gamma_1 t + u_t \qquad\qquad (2)$$

Where σ_t^S is dispersion is based on a standard deviation of the log of income. A negative sign of γ_1 indicates the presence of sigma convergence. The results of sigma convergence are shown in table 2. The t-statistics are based on the Newly-West (HAC) consistent standard errors. The table shows that the time series coefficient of standard deviation is positive and statistically significant. Hence no sigma convergence. Therefore, dispersion in GDP per capita income of CIS countries has increased over the period of time.

Table 2 Sigma convergence regression with Newey-West standard errors: CIS Region

	Dependent variable: Standard Deviation of GDP per Capita.			
Variable	Coef.	Std. Err.	t	[95% Conf. Interval] (Newey-West)
γ_1	.0029354***	.0011281	2.60	.0005894 .0052814
γ_0	-5.191304**	2.264081	-2.29	-9.899718 - .4828909

***, ** *indicates significance at the 1 % and 5% levels of significance, respectively.*
γ_0 *is the intercept and* γ_1 *is the time coefficient.*
Source: Own processing

Graphical presentation of sigma convergence is shown in Fig. 2. The slope of the predicted regression line is upward sloping, showing sigma divergence. Supports the earlier results as of absolute Convergence.
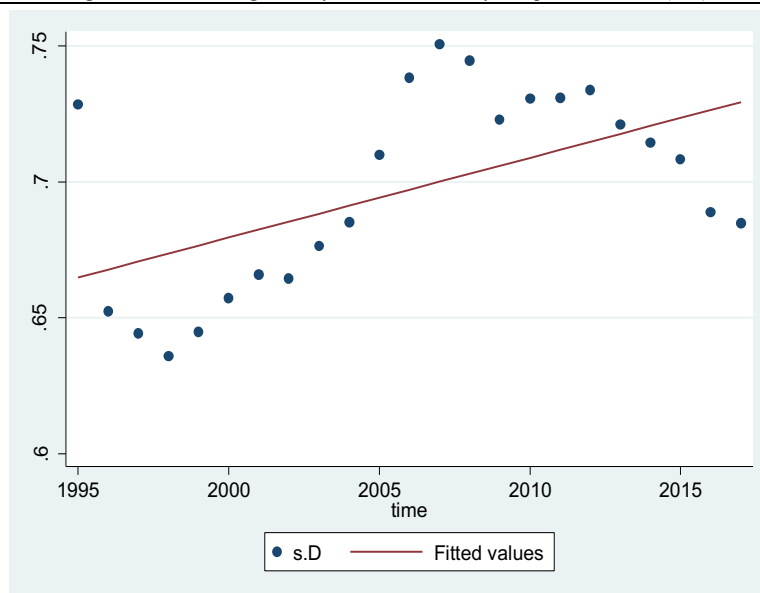
Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 32 Issue 4/2022
ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

67

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"Vasile Goldiş" Western University of Arad

Shah, I.A, Haq, I. (2022)
Convergence or divergence in economic growth of Commonwealth of Independent States (CIS)

Figure 2 Sigma Convergence: CIS (1991-2017)
Source: Own processing

6. Conditional β Convergence

The heterogeneous nature of the Commonwealth of Independent States (CIS) in terms of geographic, demographic and socio-economic attributes makes it a case implausible for absolute Convergence. The absolute Convergence is rejected in terms of a cross-sectional analysis of the CIS region. In order to capture cross-country differences in steady state, Barro and Salal-i-Martin (1992) revised the concept of absolute Convergence. They derived the convergence equation of the neoclassical growth model (NSGM) by incorporating the different steady-state incomes of countries. Hence the idea of conditional Convergence originated in growth literature. Conditional Convergence shows a negative relationship between the growth rate and initial level of income after controlling the steady-state differences of countries (Salali-i-Martin, 1996). Therefore, differences in GDP per capita across countries are due to the varying nature of various underlying parameters of GDP of a country like population, stock of capital, human capital formation, exports, government consumption, inflation, etc.

Bassanini, Scarpetta, and Hemmings (2001) presented the following dynamic growth model equation of conditional Convergence:

68
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ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

STUDIA UNIVERSITATIS ECONOMICS SERIES
"Vasile Goldiş" Western University of Arad

Shah, I.A, Haq, I. (2022)
Convergence or divergence in economic growth of Commonwealth of Independent States (CIS)

$$\Delta log y_{it} = \beta_{0i} - \phi_i \log y_{i,t-1} + \beta_{1,i} \log s\, k_{i,t} - \beta_{1,i} \log n_{i,t} + \beta_{m+1,i} t +$$
$$\Delta \log s\, k_{i,t} + \alpha_{2,i} \Delta \log n_{i,t} + \epsilon_{i,t} \tag{3}$$

Where y_{t-1} is the lagged dependent variable, ϕ is a convergence parameter, $s\,k$ is the share of investment in GDP, n is population growth, and t is the time trend. α captures short-term dynamics, and ϵ is a country-specific error term.

Barro (1991) introduced additional macroeconomic, socio-economic and demographic indicators determining the growth of the economy in the study of conditional Convergence and is usually known as the '*extended version of the Solow growth model'*.

The Extended Barro equation is obtained by adding various additional repressors to the equation (5.22). For estimating the extended Solow equation, the GDP per capita growth rate, gross capital formation, human capital, the growth rate of population (plus 0.5 percent of depreciation), life expectancy, exports, government consumption, and inflation are used.

$$\log y_t - \log y_0 = \upsilon_i - \beta_1 log y_0 + \beta_2 \log s_k + \beta_3 \log h_k - \beta_4 log(n + \delta + g) +$$
$$\beta_5 \log In + \beta_6 log G_C + \beta_7 log X + \beta_8 log LE + \theta_t \tag{4}$$

Where In is the rate of inflation, G_C is the government consumption as a percentage of GDP, X are the exports of a country, and LE is the life expectancy at birth. Other terms in the equation are the same as defined previously.

According to Pereira and Xu (2000), the ratio of exports to the GDP of the economy shows the openness of the economy. An increase in exports will lead to larger economies of scale and increased productivity (Grossman and Helpman, 1990). A long-run relationship exists between exports and GDP growth of the economy, and exports cause the growth of the economy (Suleiman & Hemed, 2018).

Government consumption has both a negative impact of taxes on the marginal product of capital and a positive effect on a marginal product due to government services and spending. At a low level of public spending, the positive effect of an increase in the marginal product is more than its negative impact and hence growth rate increases. However, after some level, negative impact dominates (Robert Barrow, 1990). Connolly & Cheng (2016) and Grier and Tullock (1989) find a negative and statistically significant relationship between the GDP growth rate of the economy and the growth rate of government consumption.

The impact of money on the economic growth of the economy is determined through the impact of inflation on the steady-state equilibrium level of the economy's output. The impact can be neutral, positive (also called Tobin's), or negative (anti-Tobin's). Sidrauski (1967) found a neutral impact of money, while Tobin (1965) considers it as a substitute for capital and hence has a positive impact on economic growth.

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ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

69

STUDIA UNIVERSITATIS ECONOMICS SERIES
"Vasile Goldiş" Western University of Arad

Shah, I.A, Haq, I. (2022)
Convergence or divergence in economic growth of Commonwealth of Independent States (CIS)

Stockman considers money as complementary to capital and hence has a negative impact on the growth of the economy.

According to Cervellati and Sunde (2009), life expectancy positively and negatively impacts economic growth. Lower mortality increases the productivity of available resources on the one hand and decreases per capita output on another. Lorentzen, McMillan, and Wacziarg (2008) find a strong and positive relationship between GDP growth and life expectancy.

6.1 Data Sources

All the variables used in the model have been gathered from World Development Indicators (2011), also known as WDI. A description is given in table 3.

Table 3 Description of Variables and Data Sources.

S.NO.	Variables	Indicators	Symbols	Data Source
01.	Economic Growth	GDP per capita growth (Annual)	$y_{i,t} - y_{i,t-1}$	www.worldbank.org
02.	The initial level of income	Lag of GDP per capita	$y_{i,t-1}$	www.worldbank.org
03.	Population	Population annual growth rate	$(n + \delta)$	www.worldbank.org
04.	Physical capital	Capital Formation	s_k	www.worldbank.org
05.	Human Capital	percentage of GDP spent on education.	h_k	www.worldbank.org
06.	Tarde	Exports as a percentage of GDP	X	www.worldbank.org
07.	Inflation	GDP Deflator (Annual)	In	www.worldbank.org
08.	Health	Life expectancy	LE	www.worldbank.org
09.	Government Consumption	Government Consumption as a percentage of GDP	Gc	www.worldbank.org

Source: Authors view

6.2 Estimation of Conditional Convergence

Barro and Sala-i-Martin (1992) and MRW (1992) adopted a cross-sectional approach to estimating the convergence hypothesis. However, cross-sectional estimation ignores the effect of time series variation. Also, cross-section analysis cannot explain heterogeneity among different cross-section units. To overcome these problems, panel data estimation is used.

70

Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 32 Issue 4/2022
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Shah, I.A, Haq, I. (2022)
Convergence or divergence in economic growth of Commonwealth of Independent States (CIS)

Panel data estimation allows the inclusion of a set of data for various cross sections over a period of time. In other words, it has both cross-sectional and time series dimensions. Panel data has more advantages than time series and cross-sectional analysis. Therefore, provides more information about data. It has more variability, less colinearity among variables, more degree of freedom, and is more efficient (Gujarati, 1995). One can better assess the impact of economic, political, institutional, and social policies and programs because the same cross-sectional units are observed in each time period. (Wooldridge, 2011).

Panel data can be estimated by using different methods. The pooling method (PM) presents results under the assumption that countries are homogenous and estimates a common constant for all countries. The fixed effect (F.E.) method allows different dummies for each country. In other words, F.E. provides a different constant for each country, while as Random effect (RE) method assumes each country differs in its error term. The fixed effect estimator is consistent even when the estimator is correlated with individual effects

The growth regression (or equation of Convergence) in the dynamic panel takes the form shown below:

$$y_{it} = \alpha_1 y_{t-1} + \sum_{i=1}^{n} \gamma_i x_{it} + \delta_t + v_i + u_{it} \tag{5}$$

y_{t-1} is a lag of the dependent variable (GDP per capita),$\sum_{i=1}^{n} \gamma_i x_{it}$ is the sum of regressors. δ_t and v_i are time effect and country-specific effect, respectively. u_{it} is the error term.

However, the panel data also suffer from various problems like serial correlation, correlated individual effects, inaccurate standard errors and the problem of endogeneity. Dynamicity causes error terms to be correlated with the regressor y_{t-1}. Therefore a bias is introduced, and the convergence coefficient is underestimated. Random effect regression is thus ineligible for estimation because it assumes exogenity of variables; that is, there is no correlation between the error term and regressors.

To come out of these above problems, Arellanoand Bond (1991) developed the first-differenced generalized method of moments. The difference GMM approach uses lagged levels of series as instruments on the assumption of specific moment conditions and absence of serial correlation in error term before differencing the regression equation. However, this method has its own shortcomings, in as much as it behaves poorly when the time series are persistent because of the lagged values of the variables, which are used as a weak instrument for subsequent first differences. Therefore, correlates with the error term (Sabbaghpoor-Fard, 2013).

Blundell and Bond (1998, 2000) developed a dynamic system generalized method of moments to avoid the problems of the first-differenced generalized method of

moments (system). The sysGMM estimates a system of equations both in levels and first differences, where first differences are used as instruments. Therefore, avoids the problem of both omitted variable bias as well as endogeneity problem.

In dynamic system GMM, the Sargen test is used to check the correlation between the error term and instruments. The null hypothesis is that instruments are valid and not correlated with the error term. If the null hypothesis is rejected, the instruments are not valid. AR(1) and AR (2) are used to check the residual serial correlation, where the null hypothesis is that test should reject the null hypothesis of first-order serial correlation, but it should not reject second-order serial correlation (Roodman, 2006).

6.3 Results and Discussions

The convergence hypothesis is said to occur if the coefficient of the initial level of GDP per capita of a country is negative and statistically significant. All variables are transformed into a natural log form to capture heteroscedasticity and nonlinear trends (Iyoboyi, 2014).

The regression results of the first Augmented Solow Model and Extended Solow Model are shown in Table 4. For authentic estimation, the endogeneity of variables, the validity of instruments, no problem of autocorrelation AR (2) and individual significance of all coefficients are essential. The Sargent test is insignificant; therefore, the instruments are valid. Also, the model shows the presence of first-order autocorrelation but the absence of second-order autocorrelation. Therefore, a model shows no autocorrelation

The model suggests that the coefficient of log of initial GDP per capita, 0.028 is negatively and significantly related to the country's real GDP per capita growth, which implies there is conditional Convergence across the CIS region while controlling investment, human capital and population growth of given countries. Hence poor countries in CIS are growing faster than rich ones in the region.

Focussing on the impact of regressors of economic growth in the augmented Solow model, it is clear that physical capital stock is having a positive and significant impact on the economic growth of CIS countries. The coefficient of physical capital is 0.011, statistically significant at 10%. The second variable of the augmented Solow model is human capital. The size elasticity of the human capital variable is 0.19, statistically significant at 1% signifying the conduciveness of human capital to economic growth. The contribution of population growth is positive and significant. Therefore, population growth in the CIS region enhances the region's economic growth. This is pertinent to mention here that the majority of the countries in the CIS region have experienced negative growth rates in the population. As such, these countries need to formulate policies to incentivize married couples to increase fertility rates to reap the benefits of the demographic dividend.

In our study, we extended the augmented Solow model by controlling more variables like (a) government final consumption (% of GDP), (b) general exports of goods and services (% of GDP), (c) inflation rate (annual %) and (d) life expectancy (number of years). For authentic estimation, the endogeneity of variables, the validity of instruments, no problem of autocorrelation AR (2) and individual significance of all coefficients are essential. The Sargent test is insignificant; therefore, the instruments are valid. Also, the model shows the presence of first-order autocorrelation but the absence of second-order autocorrelation. Therefore, there is no problem with autocorrelation in the overall model.

Table 4 Testing Conditional Convergence: CIS (1991-2017)

Variable	Dependent Variable $(y_{i,t} - y_{i,t-1})$	
	Augmented Solow Model	Extended Solow Model
$\Delta Ln(y_{i,t-1})$	0.3181*** (0.0257)	0.463642*** (0.004025)
$Ln(y_{i,t-1})$	-0.028278***` (0.035662)	-0.333943*** (0.001376)
$Ln(s_k)$	0.011701* (0.006860)	0.035307*** (0.000994)
$Ln(h_k)$	0.199266*** 0.026594	0.022421*** (0.000971)
$Ln(n + \delta)$	0.092358* (0.048311)	0.123874*** (0.001937)
$Ln(Gc)$		-0.054954*** (0.000824)
$Ln(X)$		0.098292*** (0.004755)
$Ln(IN)$		-2.90E-05*** (4.43E-07)
$Ln(LE)$		1.041384*** (0.011963)
AR(1) p-value	0.09211	0.0701
AR(2) p-value	0.2261	0.1201
Sargan test (p-value)	0.543	0.324

*, *** *shows significance level at 10% &1% respectively.*

Source: Own processing

$y_{i,t-1}$ is lag of GDP per capita, s_k is physical capital, h_k is the human capital. $n + \delta$ is population growth plus 0.5% depreciation. It is the rate of inflation, G_C is the

Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 32 Issue 4/2022
ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

73

government consumption as a percentage of GDP, X are the exports of a country, and LE is the life expectancy at birth.

AR (1) is significant hence the rejection of first-order correlation, but AR (2) is insignificant.

Sargan test is insignificant and confirms instruments are valid.

After controlling other macroeconomic indicators like government consumption, exports, inflation and life expectancy, the coefficient of the initial level of per capita income becomes negative and is significant. It, therefore, provides proof of conditional Convergence. The convergence coefficients (coefficient of the initial level of income) for CIS in the augmented Solow model, as discussed in the previous section, are lower than the coefficient in the Solow extended growth model, thus emphasizing the role of additional variables in explaining the economic growth across CIS region. The results imply that the extended Solow type income growth framework better explains the phenomena of growth and Convergence than the augmented Solow model. The marginal impact of different macroeconomic variables is different.

The study by MRW (1992) proposes a significant role for physical capital in explaining differences in cross-country differences in output per capita. Growth theory regarded the accumulation of physical capital as the engine of growth. In fact, the notion that raising the investment rate is a key to increasing long-run growth has been at the heart of growth economists since the times of David Ricardo. In the case of CIS, we too found a positive and significant relationship between economic growth and physical investment

The second variable in the regression equation is human capital. There is a large body of literature that has revealed that one of the most important factors of economic growth is human capital with regard to both the effect of level (so-called level effect) by its strong influence on production through labor productivity; and the rate effect by contributing to increased competitive advantage through innovation and transfer of technology. Like Elena Pelinescu (2014), we found a positive and strong relationship between economic growth and human capital. Life expectancy with a coefficient size of 1.04 has the greatest positive and significant effect. This shows that health plays an important role in determining economic growth rates.

The relationship between population growth and economic output growth has been studied extensively in growth literature (Headey & Hodge, 2009). Many analysts believe that economic growth in transition economies in general and CIS countries, in particular, is likely to be relatively slow in the coming years because population growth in these countries is predicted to be slow considerably (Baker, Delong & Kurgman, 2005). Others argued that population growth has been and will continue to be problematic as more people inevitably use more of the finite resources available on earth, reducing potential long-term growth (Linden, 2017). In our study, we found

STUDIA UNIVERSITATIS ECONOMICS SERIES
"Vasile Goldiş" Western University of Arad

Shah, I.A, Haq, I. (2022)
Convergence or divergence in economic growth of Commonwealth of Independent States (CIS)

that population growth positively and significantly affects the CIS region's economic growth.

The theoretical literature supported by empirical findings has confirmed a negative relationship between the inflation rate and economic growth through the adverse effects of the former on investment, exports and income distribution (Li and Zous, 2002). Nevertheless, the presence of unusually large inflation figures in a majority of CIS has possibly resulted in the adverse effect of this variable in the income growth framework during the earlier years of transition. Therefore, inflation has a negative and significant impact on the income growth of these countries, as evidenced by a statistically negative coefficient.

Trade has always been considered an engine of growth through its static and dynamic gains for the countries in the form of efficient resource allocation, knowledge transfers and increases in productivity (Thirlwall, 2000). In our study, economic growth within CIS is positively affected by trade openness, and this coefficient is also significant.

Another policy variable, namely the government consumption ratio, has been a frequently utilized regressor for the analysis of long-run income growth (Barro, 1999). On the theoretical front, two famous but opposing arguments are the *crowdings out hypothesis* and the *government expenditure multiplier*. As shown in Table 5.4, the government consumption ratio is negatively and significantly related to the economic growth of the CIS region. A negative impact of government spending on the economic growth of developing countries was also validated by Guseh (1997).

7. Conclusions

In this study, the issue of economic growth and Convergence in 12 countries of the CIS region has been investigated thoroughly for a time of 27 years ranging from 1991-2017. During the study period, no significant negative correlation existed between the initial ratio of the countries per capita GDP and the average yearly growth rate. Thus, indicating the absence of absolute β convergence across the CIS economies during 1991–2017. Also, the results of the sigma convergence are consistent with the results derived from the absolute convergence model.

To capture the heterogeneity of CIS countries, both augmented Solow model and extended Solow growth regression frameworks are applied for estimation. The Augmented Solow model is obtained by controlling the effect of physical capital, human capital and population growth rate (Variables used by MRW) in the convergence equation. Solow extended regression is obtained by controlling more variables like exports as a percentage of GDP, inflation, life expectancy, and government consumption as a percentage of GDP to capture the heterogeneity of

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ISSN: 1584-2339; (online) ISSN: 2285 – 3065
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75

CIS countries. Both these models are estimated with Dynamic System Generalized Method of Moments (DSGGM)

Referring to the augmented Solow model estimations, we found the rate of conditional β-convergence (coefficient of initial GDP per capita) of value 0.028 among members of the CIS region. This implies that besides the initial level of GDP per capita, physical and human capital and population growth have important contributions to make to the growth and Convergence of countries.

In Solow extended growth regression, the coefficient of initial GDP per capita is 0.33. Therefore, besides the initial level of per capita income, physical and human capital and population growth, other factors have important contributions to make to the growth and Convergence of countries of CIS.

8. Policy Implications

Like many transition economies, the primary focus of policies in CIS is to have high and sustainable growth. However, to achieve and maintain a high growth rate, policymakers need to understand the determinants of growth as well as how policies affect economic growth. Since the independence of CIS member countries, the growth of real GDP has become a key policy objective in almost all countries.

In consonance with the results, this research work comes to the conclusion that growth shall be positively affected by growth in the labor force, investment in both physical and human capital, coupled with controlled inflation and open trade policies, minimum government consumption, while prioritizing spending on social sectors like health and education.

Open economies are generally in a better position to import new technologies and new ideas from the rest of the world. In addition, they are likely to have a greater division of labor and production processes that are more consistent with their comparative advantages, which enable them to grow faster.

The central government savings rate is an important policy indicator. Higher government saving is likely to support aggregate economic growth in two ways: (1) countries which have higher saving rates also tend to have higher investment levels and therefore grow faster; and (2) higher government savings indicate overall sound macroeconomic management.

A positive and significant relationship between government spending on education and health (measured as the percentage share of GDP) and the growth of per capita income of CIS countries has been observed in this study during the stipulated time period. A direct implication is that governments must increase the spending on human capital formation to achieve higher growth performance. On the other hand, the coefficient of government consumption (as a percentage of GDP) shares a negative and statistically significant relation with per capita income growth. Thus,

76

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ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

the government needs to formulate prudent budgetary policies to efficiently allocate resources.

Life expectancy has a positive and statistically significant effect on the economic growth rate among CIS members. Theoretically, productivity growth should be positively correlated with the level of health, in particular with the average life expectancy representing the proxy variable for health. For this reason, it is incumbent on the governments to increase the budgetary allocations toward the health sector of the economy.

The contribution of population growth is positive and significant. Therefore, population growth in the CIS region enhances the region's economic growth. This is pertinent to mention that most countries in the CIS region have experienced negative growth rates in the population. As such, these countries need to formulate policies to incentivize married couples to increase fertility rates to reap the benefits of the demographic dividend.

Another important result of this study is reflected in a significant inverse relationship between inflation and income growth. This is a direct consequence of hyperinflation and the collapse of the production system during the early years of transition, although inflation subdued and production recovered from initial shocks in subsequent years. Hence inflation management through an effective monetary policy mechanism is crucial for stability and growth.

9. Suggestions for Further Research

Studying economic growth and Convergence is a very dynamic issue. Many researchers have attempted to find the effects of different determinants of economic growth by applying different econometric techniques that could also consider the unobserved effects. In this research, we applied the dynamic system GMM. However, one suggestion for further research is to extend the time series by focusing on other determinants of economic growth for which data is available and use Mean group estimators (MGE) or pooled mean group estimators (PMGE) to gain more robust results.

The second suggestion for further research is to test the convergence hypothesis by examining multiple independent variables that represent different aspects of economic growth such as labor productivity and institutional factors.

The third suggestion for further research is to classify countries based on the distance to the leader, like Russia can be chosen as a leader within CIS based on the high GDP and per capita income and then test the convergence hypothesis with other explanatory variables to see whether the results are the same as we classify the countries based on their GDP per capita.

Finally, for more meaningful research on the convergence hypothesis, the number of countries in the sample must be large. The study is based on just 12 countries in CIS

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ISSN: 1584-2339; (online) ISSN: 2285 – 3065
Web: publicatii.uvvg.ro/index.php/studiaeconomia. Pages 58–80

77

regions. Also, comparison between different groups of countries can be a further research topic.

Author Contributions
This study is the independent work of the two authors, from the conception of the topic to the literature review, data collection, and analysis. The authors equally participated in the making of this paper.

Disclosure Statement
The authors declare no conflict of interest. The authors have not any competing financial, professional, or personal interests from other parties.

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78

Studia Universitatis "Vasile Goldis" Arad. Economics Series Vol 32 Issue 4/2022
ISSN: 1584-2339; (online) ISSN: 2285 – 3065
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79

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