

## REGIONAL ECONOMIES

## ECONOMIC GROWTH IN THE CENTRAL CAUCASO-ASIAN COUNTRIES ADJUSTED FOR THE CATCH-UP EFFECT

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### *Introduction*

One of the main problems of economic development is to ensure stable economic growth. This article examines some issues relating to the measurement of economic growth in the context of Central Caucaso-Asia, a geopolitical region which includes the countries of the Central Caucasus (Azerbaijan, Armenia and Georgia) and Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan).<sup>1</sup>

<sup>1</sup> See: V. Papava, "Central Caucasia Instead of Central Eurasia," *Central Asia and the Caucasus*, No. 2 (50), 2008; V. Papava, "Central Caucaso-Asia: Toward a Redefinition of Post-Soviet Central Eurasia," *Azerbaijan in the World*, The Electronic Publication of Azerbaijan Diplomatic Academy, Vol. 1, No. 17, 1 October, 2008, available at

It should be emphasized that this problem has been analyzed in a number of significant publications.<sup>2</sup> In order to measure economic growth,

[<http://www.ada.edu.az/biweekly/issues/156/20090328041927833.html>], 7 September, 2012; V. Papava, "Eurasia Versus Central Caucaso-Asia: On the Geopolitics of Central Caucaso-Asia," *CICERO Foundation Great Debate Paper* No. 09/8, December 2009, available at [[http://www.cicerofoundation.org/lectures/Vladimer\\_Papava\\_On\\_the\\_Geopolitics\\_of\\_Central\\_Caucaso\\_Asia.pdf](http://www.cicerofoundation.org/lectures/Vladimer_Papava_On_the_Geopolitics_of_Central_Caucaso_Asia.pdf)], 7 September, 2012; V. Papava, "Central Caucaso-Asia: From Imperial to Democratic Geopolitics," *Bulletin of the Georgian National Academy of Sciences*, Vol. 4, No. 1, 2010.

<sup>2</sup> See, for example: J.E. Stiglitz, A. Sen, J.-P. Fitoussi, *Mismeasuring Our Lives: Why GDP Doesn't Add Up*, The Report by the Commission of the Measurement of

it is particularly important to use a more or less adequate method allowing a spatial comparison

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Economic Performance and Social Progress, The New Press, New York, 2010; R.J. Barro, X. Sala-i-Martin, *Economic Growth*, Massachusetts Institute of Technology, 2004; M. Fleurbaey, "Beyond GDP: The Quest for a Measure of Social Welfare," *Journal of Economic Literature*, Vol. 47, No. 4, 2009, pp. 1029-1075.

of countries and regions. But at present such a comparison is complicated by the existence of the so-called "catch-up effect."

The approach proposed below makes it possible to remove this effect and make a more adequate comparison of economic growth in countries and regions (with a case study of the Central Caucaso-Asian countries).

## On the Catch-Up Effect

As we know, economic growth is measured using two indicators: gross domestic product (GDP) growth rate ( $R$ ), and rate of increase of GDP ( $r$ ). The first indicator is calculated by dividing real GDP in the reporting period ( $Y^1$ ) by real GDP in the base period ( $Y^0$ ):

$$R = \frac{Y^1}{Y^0}. \quad (1)$$

To calculate the rate of increase in GDP, the amount of increase in real GDP ( $\Delta Y = Y^1 - Y^0$ ) should be divided by the amount of base-period real GDP ( $Y^0$ ):

$$r = \frac{\Delta Y}{Y^0}. \quad (2)$$

This results, as we know, in the following relation:

$$R = 1 + r.$$

In practice, economic growth is usually measured in terms of the second indicator: the rate of increase in real GDP (conventionally, in terms of percentage change).

It is common knowledge that one of the problems in measuring economic growth is a comparison of indicators for countries and regions. The essence of the problem is that due to diminishing returns on capital, all other things being equal, it is easier to achieve higher rates of economic growth in countries with relatively low levels of economic development than in those with a more advanced economy. In economics, this phenomenon is known as the **catch-up effect**.<sup>3</sup>

To illustrate this effect, let us consider the relationship between the indicators of economic growth in the Central Caucaso-Asian countries and the United States for 2010 (annual percentage change from 2009) as provided by the World Bank<sup>4</sup> (see Table 1).

In 2010, economic growth data for all countries listed in Table 1 (except Armenia and especially Kyrgyzstan, which experienced an actual economic decline) were higher than those for the United States; the "best performers" here were Turkmenistan (3.1 times the U.S. indicator), Uzbekistan (2.8 times), Kazakhstan (2.4 times), and Georgia (2.1 times).

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<sup>3</sup> N.G. Mankiw, *Principles of Economics*, Thomson South-Western, Mason, 2004, pp. 546-547.

<sup>4</sup> See: *GDP Growth (Annual %)*, The World Bank, 2012, available at [<http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG>], 7 September, 2012.

Table 1

**Economic Growth and  
Economic Development Level  
in the Central Caucaso-Asian Countries and the U.S.**

Countries	Indicators of Economic Growth in 2010 Compared to 2009 (Annual Percentage Growth Rate of GDP)	GDP Per Capita (in U.S.\$) in 2009	Ratio of Actual Economic Growth to Similar U.S. Indicator	Coefficient of Proportional Offset of the Catch-up Effect (Ratio of GDP Per Capita in the U.S. in 2009 to Similar Indicators of Individual Countries)	Indicators of Adjusted Economic Growth	Ratio of Adjusted Economic Growth in Individual Countries to Actual Economic Growth in the U.S.	Ratio of Actual Economic Growth in the U.S. to Adjusted Economic Growth in the Respective Countries
<b>Countries of Central Caucasus</b>							
Armenia	2.1	2,803	0.7	16.1	0.13	0.04	23.08
Azerbaijan	5.0	4,950	1.7	9.1	0.55	0.18	5.45
Georgia	6.3	2,441	2.1	18.5	0.34	0.11	8.82
<b>Countries of Central Asia</b>							
Kazakhstan	7.3	7,165	2.4	6.3	1.16	0.39	2.59
Kyrgyzstan	-1.4	871	-0.5	51.9	-0.03	-0.01	-100
Tajikistan	6.5	734	2.2	61.6	0.11	0.04	27.3
Turkmenistan	9.2	3,745	3.1	12.1	0.76	0.25	3.95
Uzbekistan	8.5	1,182	2.8	38.2	0.22	0.07	13.6
U.S.	3.0	45,192	1.0	1.0	3.00	1.00	1.00

Naturally, a direct comparison of economic growth indicators does not give a true estimate of the real situation because the "starting conditions" (i.e. the initial level of economic development) differ significantly from country to country.

A comparison of countries with different economic development levels is only possible by removing the catch-up effect from economic growth rates. For this it is necessary to find a coefficient that would enable us to make an appropriate adjustment of economic growth rates for countries and regions.

As we know, the aggregate indicator of a country's economic development is GDP per capita ( $y$ ), whose amount is determined by dividing GDP ( $Y$ ) by the population ( $N$ ):

$$y = \frac{Y}{N}. \quad (3)$$

It should be noted that in comparing countries and regions, GDP is usually measured in U.S.\$. The figures for GDP per capita given in Table 1 are also provided by the World Bank.<sup>5</sup>

For example, according to Table 1, the U.S. economy is 12.1 times the economy of Turkmenistan (in terms of GDP per capita), 38.2 times the economy of Uzbekistan, 6.3 times the economy of Kazakhstan, 18.5 times the economy of Georgia, etc. Due to the catch-up effect, all other things being equal, it is much more difficult for the U.S. to achieve economic growth of 1% than for each of these countries.

It is logical to assume that since the U.S. economy in 2009, for example, was 61.6 times larger in GDP per capita terms than the economy of Tajikistan, it would be 61.6 times more difficult for the U.S., all else being equal, to achieve the same economic growth as in Tajikistan. This reasoning is based on the following **hypothesis**:

*If the level of economic development of one country is times higher than the level of economic development of another country, achieving the same economic growth in the former will be times more difficult than in the latter.*

Let us call this assumption the **hypothesis of proportional offset of the catch-up effect**, or briefly the **proportional offset hypothesis**. For its mathematical description, let us divide GDP per capita of the  $i$ -th country ( $y_i$ ) by that of the  $j$ -th country ( $y_j$ ):

$$\alpha_{ij} = \frac{y_i}{y_j}. \quad (4)$$

Based on the essence of the above hypothesis,  $\alpha_{ij}$  is the coefficient of proportional offset by the  $i$ -th country of the catch-up effect of the  $j$ -th country. Briefly, let us call  $\alpha_{ij}$  the *proportional offset coefficient*.

If actual economic growth in the  $j$ -th country is  $r_j$ , then economic growth in this  $j$ -th country corresponding to that in the  $i$ -th country, given the hypothesis of proportional offset of the catch-up effect, will be:

$$r_{ij}^* = \frac{r_i}{\alpha_{ij}}. \quad (5)$$

Consequently,  $r_{ij}^*$  is the adjusted economic growth of the  $j$ -th country that can be regarded as corresponding to economic growth in the  $i$ -th country. Briefly, let us call  $r_{ij}^*$  the *adjusted economic growth of the  $j$ -th country*.

If the actual economic growth of the  $i$ -th country ( $r_i$ ) is divided by the adjusted economic growth of the  $j$ -th country ( $r_{ij}^*$ ), we will get a value that shows how many times economic growth in the  $i$ -th country is really faster than economic growth in the  $j$ -th country. In particular, taking into account (3), we obtain:

$$\beta_{ij} = \frac{r_i}{r_{ij}^*} = \frac{r_i}{r_j} \alpha_{ij}. \quad (6)$$

<sup>5</sup> See: *GDP Per Capita (Current U.S.\$)*, The World Bank, 2012, available at [<http://data.worldbank.org/indicator/NY.GDP.PCAP.CD>], 7 September, 2012.

Based on (2)-(5), (6) can also be written as:

$$\beta_{ij} = \frac{\frac{\Delta Y_i}{N_i}}{\frac{\Delta Y_j}{N_j}} = \frac{y_i}{y_j},$$

where  $y_i$  and  $y_j$  are the increases in GDP per capita in the  $i$ -th and  $j$ -th countries, respectively.

As is evident from Table 1, actual economic growth, for example, in Tajikistan in 2010 compared to 2009 was 6.5%, and in the United States 3%, while the American economy was 61.6 times larger in GDP per capita terms than the Tajik economy. Consequently, 6.5% growth of the Tajik economy corresponds to U.S. economic growth of 0.11% (6.5:61.6). Similarly adjusted indicators of economic growth in other countries are also given in Table 1.

As noted above, actual economic growth in a number of countries listed in the Table was faster than in the United States: for example, it was 3.1 times faster in Turkmenistan, 2.8 times in Uzbekistan, 2.4 times in Kazakhstan, and 2.1 times in Georgia. But in reality the picture is quite different. In particular, given the hypothesis of proportional offset of the catch-up effect (see Table 1), the ratio of properly adjusted economic growth in Turkmenistan to actual economic growth in the U.S. is equal to 0.25 (0.76:3.0); the ratio for Uzbekistan is 0.07 (0.22:3.0), for Kazakhstan it is 0.39 (1.16:3.0), and for Georgia, 0.11 (0.34:3.0). In other words, economic growth in Turkmenistan is by no means almost 3.1 times faster than economic growth in the U.S.; on the contrary, economic growth in the U.S. is almost 3.95 times (3.0:0.76) faster than that in Turkmenistan; in Uzbekistan, the ratio is 13.6 (3.0:0.22), in Kazakhstan it is 2.59 (3.0:0.16), and in Georgia, 8.82 (3.0:0.34).

In 2010, Kyrgyzstan went into an economic decline: compared to 2009, actual economic growth was -1.4%. At the same time, the country's adjusted economic growth was -0.03% (see Table 1). Evidently, the 47-fold reduction (1.4:0.03) in the adjusted rate of economic decline was due to the fact that the American economy was many times (more precisely, 51.9 times) larger in GDP per capita terms than the Kyrgyz economy.

## Invariance Principle

The indicators presented in Table 1 are constructed on the principle of choosing the economy of a so-called "reference country," which in our case is the United States. The country with the world's highest GDP per capita can be used in this capacity. In this case, its economic growth indicator will serve to rank similar indicators of other countries.

This approach has one purely technical flaw. In 2009, for example, Luxembourg reached a very high GDP per capita of \$104,354 (in some countries, the figure in 2009 was even higher). That same year, GDP per capita in Burundi was only \$222 (not the lowest in the world).<sup>6</sup> Thus, for Luxembourg the coefficient of proportional offset of the catch-up effect of the Burundian economy is 470.1 (104,354:222). It is so high that, given actual economic growth in Burundi of 3.8% in 2010,<sup>7</sup> the adjusted figure will be 0.008% (3.8:470.1). The figure is so small that it can be rounded down to zero. This problem will arise for many countries in the world with a relatively low level of GDP per capita and modest rates of economic growth.

<sup>6</sup> See: *GDP Per Capita (Current U.S.\$)*.

<sup>7</sup> See: *GDP Growth (Annual %)*.

In order to avoid such difficulties, it is better to use average GDP per capita for the group of countries in question. For this it is necessary to divide the total GDP of these countries by their total population. The economic growth indicators of any country will then be ranked based on this average indicator. Such an approach to the solution of the problem of removing the catch-up effect obviously implies the use of an average indicator of economic growth.

If the given group consists of  $m$  ( $i = 1, 2, \dots, m$ ) countries, average GDP per capita ( $\bar{y}$ ) is calculated as follows:

$$\bar{y} = \frac{\sum_i^m y_i N_i}{\sum_i^m N_i} = \frac{\sum_i^m Y_i}{\sum_i^m N_i}, \quad (7)$$

where  $Y_i$  is the amount of GDP in the  $i$ -th country, and  $N_i$  is the population of the  $i$ -th country.

Such an approach implies that the question associated with an adequate assessment of the economic growth rate is studied based on the example of a group of countries whose composition may change. Hence, it is better to use global GDP per capita and global economic growth data as appropriate average indicators. In this case, the basis for comparing the respective indicators will not change regardless of any changes in the composition of the group of countries being compared.

Consequently, if  $m$  is the number of countries in the world, (7) can be used to determine global GDP per capita. In 2009, it was \$8,588.3.<sup>8</sup>

Taking into account (4), for the average level of global economic development the coefficient of proportional offset of the catch-up effect of the  $j$ -th country ( $\bar{\alpha}_j$ ) can be calculated according to the formula:

$$\bar{\alpha}_j = \frac{\bar{y}}{y_j}. \quad (8)$$

As in (5), the adjusted economic growth of the  $j$ -th country ( $\bar{r}_j^*$ ), i.e. economic growth in the  $j$ -th country corresponding to the growth of the world economy, given the hypothesis of proportional offset of the catch-up effect, is determined as follows:

$$\bar{r}_j^* = \frac{r_j}{\bar{\alpha}_j}. \quad (9)$$

If the growth of the world economy is denoted by  $\bar{r}$ , then, taking into account (2), we obtain:

$$\bar{r} = \frac{\sum_i^m \Delta Y_i}{\sum_i^m Y_i}.$$

It should be noted that in 2010 the world economy grew by 4.2%.<sup>9</sup>

Based on (6), the value of indicator  $\bar{\beta}_j$  shows the difference between the growth of the world economy and the economic growth of the  $j$ -th country expressed in times:

$$\bar{\beta}_j = \frac{\bar{r}}{\bar{r}_j^*} = \frac{\bar{r}}{r_j} \bar{\alpha}_j.$$

<sup>8</sup> See: *GDP Per Capita (Current U.S.\$)*.

<sup>9</sup> See: *GDP Growth (Annual %)*.

Table 2

**Economic Growth and Economic Development Level  
in the Central Caucaso-Asian Countries, the U.S. and the World as a Whole**

Countries	Indicators of Economic Growth in 2010 Compared to 2009 (Annual Percentage Growth Rate of GDP)	GDP Per Capita (in U.S.\$) in 2009	Ratio of Actual Economic Growth to Similar Global Indicator	Coefficient of Proportional Offset of the Catch-up Effect (Ratio of Global GDP Per Capita in 2009 to Similar Indicators of Individual Countries)	Indicators of Adjusted Economic Growth	Ratio of Adjusted Economic Growth in Individual Countries to Actual Global Economic Growth	Ratio of Actual Global Economic Growth to Adjusted Economic Growth in the Respective Countries
<b>Countries of Central Caucasus</b>							
Armenia	2.1	2,803.0	0.50	3.06	0.69	0.16	6.08
Azerbaijan	5.0	4,950.0	1.19	1.74	2.87	0.68	1.46
Georgia	6.3	2,441.0	1.50	3.52	1.79	0.43	2.35
<b>Countries of Central Asia</b>							
Kazakhstan	7.3	7,165	1.74	1.20	6.08	1.45	0.69
Kyrgyzstan	-1.4	871	-0.33	9.86	-0.14	-0.03	-30.00
Tajikistan	6.5	734	1.55	11.70	0.56	0.13	7.5
Turkmenistan	9.2	3,745	2.19	2.29	4.02	0.96	1.04
Uzbekistan	8.5	1,182	2.02	7.27	1.17	0.28	3.59
U.S.	3.0	45,192.0	0.7	0.19	15.79	3.76	0.27
World	4.2	8,588.3	1.0	1.00	4.20	1.00	1.00

Table 2 presents indicators of economic growth and economic development level in the Central Caucaso-Asian countries and the United States. In order to eliminate the influence of the catch-up effect, they are adjusted according to the respective global indicators.

Whereas the highest actual economic growth among the countries of the Central Caucasus was recorded in Georgia (6.3%), the highest adjusted rate of economic growth was in Azerbaijan (2.87%).

At the same time, whereas the highest rate of actual economic growth among the Central Asian countries was achieved by Turkmenistan (9.2%), the highest adjusted economic growth (after removal of the catch-up effect) was observed in Kazakhstan (6.08%).

When comparing the data in Tables 1 and 2, one will naturally ask how identical they are, i.e. whether the magnitude of the ratio of adjusted economic growth rates (after the influence of the catch-up effect has been removed) depends on changes in the base indicator of economic development (its initial level) that is used to calculate the coefficients of proportional offset of the catch-up effect.

It is easy to show that *the ratio of economic growth rates adjusted to remove the catch-up effect does not change regardless of how they were calculated* (based on economic development and economic growth indicators for some particular country or globally averaged).

To support this proposition, let us consider the ratio of adjusted economic growth rates separately. They are calculated based on a particular country or on global averages.

Inserting (4) in (5), we obtain:

$$r_{ij}^* = \frac{r_i y_j}{y_i}. \quad (10)$$

Based on (10), the ratio between the adjusted economic growth of the  $j$ -th country corresponding to the economic growth of the  $i$ -th country and the actual economic growth of the latter is as follows:

$$\frac{r_{ij}^*}{r_i} = \frac{r_j}{r_i} \cdot \frac{y_j}{y_i}. \quad (11)$$

Similarly, inserting (8) in (9), for the  $j$ -th and  $i$ -th countries, respectively, we obtain:

$$\bar{r}_j^* = \frac{r_j y_j}{\bar{y}}, \quad (12)$$

$$\bar{r}_i^* = \frac{r_i y_i}{\bar{y}}. \quad (13)$$

A comparison of (12) and (13), i.e. the ratio of the adjusted economic growth rates of the  $j$ -th and  $i$ -th countries corresponding to the growth of the world economy, is equal to:

$$\frac{\bar{r}_j^*}{\bar{r}_i^*} = \frac{r_j}{r_i} \cdot \frac{y_j}{y_i}. \quad (14)$$

Comparing (11) and (14), we get:

$$\frac{r_{ij}^*}{r_i} = \frac{\bar{r}_j^*}{\bar{r}_i^*}. \quad (15)$$

Based on (15), we can formulate the so-called *invariance principle*.

**Invariance principle.** *The ratio of economic growth rates adjusted to remove the influence of the catch-up effect does not depend on the choice of the base indicators of economic growth and development level that are used to calculate the coefficients of proportional offset of the catch-up effect.*

As an illustration of (15), let us compare the ratios of economic growth rates adjusted for the catch-up effect as presented in Tables 1 and 2, taking Tajikistan and the U.S. as an example. As we see from Table 1, this ratio is equal to 0.04; a similar ratio can be easily calculated from Table 2, and it is also equal to 0.04 (0.56:15.79).



### *Conclusion*

One of the main problems that arise in comparing economic growth in individual countries and regions is the existence of the catch-up effect. The most adequate picture can be obtained only after removal of this effect, while a direct comparison of the respective indicators of economic growth is incorrect.

The adjusted rates of economic growth derived from the hypothesis of proportional offset of the catch-up effect satisfy the invariance principle. According to this principle, the ratio between economic growth rates adjusted for the catch-up effect does not depend on the choice of the base indicators of economic growth and development level.

Observance of the invariance principle shows that the proposed approach to removing the catch-up effect from economic growth indicators for the purpose of their spatial comparison is consistent and can be used for practical purposes without much difficulty.

Further research to remove the catch-up effect from economic growth indicators should evidently be conducted so as to “complicate” the hypothesis of offset of the catch-up effect, primarily by abandoning the assumption of the proportionality of this offset.