Analysis of Macroeconomic Development Indicators of the Region

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Abstract

Regional aspect of forecasting in conditions of Russian economic environment plays particular role, since without the consideration of specific character of regions development no long-term national programs can be realized, as well as implementation of any social or economic reforms becomes impossible. The interrelation between economic advancement and social factors in the Republic of Mari El reviewed in this this article creates awareness of specific interrelation of gross regional product with considered factors and their influence on this index value.

Keywords: modelling, capital investments, price index, education level, budget

1. Introduction

Analysis and forecasting of socio-economic development are starting points of regional development management performance. On the basis of sound forecast aims of socio-economic development of region are defined, economic complex development concerned policy events and priorities are specified. And as a consequence of that, efficiency of regional development management largely determined by quality of these forecasts. Regional aspect of forecasting in conditions of Russian economic environment plays particular role, since without the consideration of specific character of regions development no long-term national programs can be realized, as well as implementation of any social or economic reforms becomes impossible.

Considering interrelation between population and economic development, it is necessary to refer to population growth economy, which studies the impact of changes in population size on economic growth dynamics, together with consideration of belonged models, which are founded on one basic equation, which describes the influence of demographic variable on economy. Problem of the relationship of social and economic factors were considered by Russian authors (Dagbaev, 2015; May, 2015; Hohlova 2006; Sharaev, 2006), and and foreign authors (Barro & Sala-i-Martin, 2004; Weber, 2010; Preston, Heuveline, & Guillot, 2000; Miles, 1997).

Models of population growth economy continue being designed and form significant part of researches of this guideline (Ilyin, 2014; Hohlova, 2007). Macro-economic problems of the Republic of Mari El studied in Mary State University (Tsaregorodtsev & Borisov, 2014; Tsaregorodtsev & Bespalov, 2014; Sadovin & Kokotkina, 2014). Development of the approach considering economic progress in conjunction with population variable is solely due to practical reasons: relative simplicity of interpretation of obtained results and possibility of direct use of them in forecasting and development policy design applications. These models include modern single-circuit models, which are used for the rating of influence of population growth dynamics and it's components on different aspects of economic progress.

2. Method

Among models focused on the impact of demographic factors on the "sustained level" of labour productivity separately stand out Barro's models (Barro, & Sala-i-Martin, 2004). Barro's works were reviewed in the Theory economic growth (Sharaev, 2006). Demographic factor in such models is represented by one or two exogenous variables (total fertility rate, life expectancy at birth), according to nature of evaluation expecting the long-term maintenance of existent age fertility and mortality rates. Other factors of "sustained level" of labour productivity included in Barro's model are: government intervention in the economy, social infrastructure facilities, price setting, political stability, social tensions and so on.

Barro substantiated assumptions regarding indexes of model's parameters.   So, the coefficient of the variable of GDP per head is less than zero in accordance with neoclassic hypothesis of tendency of economy to sustained state, the coefficient of the variable of education enrollment coverage is bigger than zero, since these indicators reflect dynamics of human capital value—the key factor of economic growth; coefficient of the variable of government expenses is less than zero, since such expenses decrease rate of savings (education and defense expenditures are excluded from total amount of government expenses, as they are considered as public investments and statistically included in the gross domestic investments); coefficients of the variable of revolutions and willful killing are less than zero, since number of them is considered as indicator of political instability, negatively affecting property rights and private investments; coefficient of the variable of divergence of government investments to the capital assets is less than zero, since public expenditures in GDP can be just slightly changed in each country over a period of time (therefore public and private capital have the same rate of depreciation), which causes deceleration of the capital renewal processes after decreasing (increasing) of public investments ratio (negatively affects the efficiency of private investments).

Broadening of R. Barro's model at the expense of demographic dimensions didn't cause major differences of initial parameters of regression equation, however the precision of estimation was increased (R^2 was increased by 0.15). Meanwhile, two inserted demographic dimensions appeared statistically significant. Generally, the rate of population growth directly reflects the impact of demographic factor; however, this has weak negative impact; both density and size of population reflect the effect of production scale and possibility of new technologies adoption, which causes positive impact.

Design of models, estimating both impact of demographic variables on the "stable level" of labour productivity and features of advancement to this level, is connected with decomposition of demographic factor on the impact of mortality and fertility, past and current. Subsequent Barro's works outlined in the Economic Growth (Barro & Sala-i-Martin, 2004).

On the basis of Barro's ideas it was decided to apply his model in this article, but not for the number of countries, but for certain region of Russia, The Republic of Mari El. It's small republic in the Russian Federation, located in the temperate climate zone. The population of the Republic is approximately 700 thousand people, in the gross regional product main primary economic activities are: manufacturing activities, agriculture, hunting and forestry, wholesale and retail trade, vehicle, motorcycle and consumer goods repairs, construction, public administration and military defense, social insurance, as well as transportation and communications. In the volume of fixed capital investments own funds make slightly more than 25%, remains—obtained funds. The Republic has high proportion of citizens of employable age, and as a result of this structural advantage, the level of economic activity of the Republic's population is comparable to the national average.

3. Results

Data required for the analysis of the Republic characteristics has been taken from past 14 years (2000—2013). The following variables were used as main features of the model:

1) The Gross regional product per head (Y/N);

2) The proportion of people receiving secondary education to population ratio (SecEnr);

3) The proportion of people receiving higher education to population ratio (HighEnr);

4) Expenses ratio of consolidated budget in GRP (Gcons/Y);

5) Consumer price index (Inflatn);

6) Fixed assets investments ratio in GRP (PPIDev);

7) Life expectancy at birth (e0);

8) Number of grave and gravest crimes per head (Assass).

GRP in this model is endogenous variable per head (Y/N), remain indicators—exogenous. STATISTICA 6.0 package was used for the analysis purposes, as this program is one of simplest, but at the same time very efficient for data processing and obtaining results in analytic and graphic representation. Indicators taken for the Barro's model construction are reproduced in the Table 1.

Table 1. Barro's model indicators dynamics

	LnY/N	SecEnr	HighEnr	Gcons/Y	Inflatn	PPIDev	lne_0	Assass
2000	9.62343	0.015057	0.030249	0.178594	1.211	0.151733	4.168833	0.016802
2001	9.928307	0.015965	0.033419	0.214083	1.182	0.128334	4.161847	0.015773
2002	10.1028	0.01774	0.037937	0.27379	1.149	0.164256	4.195697	0.009303
2003	10.36525	0.01899	0.039081	0.238741	1.121	0.189043	4.15638	0.006876
2004	10.64116	0.019255	0.039479	0.24368	1.116	0.194943	4.150252	0.007049
2005	10.75143	0.019808	0.040312	0.244855	1.092	0.230663	4.151512	0.008703
2006	11.02802	0.020661	0.042164	0.242109	1.074	0.244045	4.17408	0.008856
2007	11.26597	0.020518	0.043441	0.248535	1.133	0.311634	4.194793	0.007894
2008	11.44814	0.019198	0.043942	0.253595	1.139	0.324813	4.199305	0.00823
2009	11.50368	0.017569	0.043565	0.254747	1.085	0.238967	4.208566	0.006015
2010	11.67938	0.017	0.043	0.250816	1.115	0.270766	4.20916	0.003895
2011	11.85114	0.0161	0.0401	0.234822	1.06	0.275995	4.22391	0.003501
2012	12.04408	0.016	0.0368	0.208562	1.063	0.269192	4.234107	0.002787
2013	12.09937	0.0145	0.033	0.215686	1.065	0.364507	4.238445	0.002283

Using the data, represented in the Table 1, the regression analysis of the impact of the model's exogenous indicators on the forming process of the endogenous variable has been performed ln(Y/N). Obtained results are shown in the Figures 1 & 2:

Statistic	Summary Statistics; DV: LnY/N (Spreadsheet2)	
	Value	
Multiple R	0,990376542	
Multiple R?	0,980845695	
Adjusted R?	0,958499005	
F(7,6)	43,8922147	
p	0,0000978570679	
Std.Err. of Estimate	0,164155363	

Figure 1. Results of regression analysis

As seen in Figure 1 the coefficient of multiple correlation, defining correlation ratio between dependent variable and independent indicators, is equal to 0.9904 and it is quite high. Obtained model can be called reliable, because coefficient of determination is very close to unity ($R^2 = 0.9808$), at the same time the standard error of the estimation of equation is quite small and equals to 0.1642. Coefficient R^2 represents that drawn regression explains more than 98% of spread of values of variable ln(Y/N) about a mean. If we pay an attention to the value of F- criterion ($F_{tab} = 43.8922 > F_{cr} = 4.2067$), we can see and say, that the regression equation is significant.

N=14	b*	Std.Err. of b*	b	Std.Err. of b	t(6)	p-value	
	Regression Summary for Dependent Variable: LnY/N (Spreadsheet2) R= ,99037654 R?= ,98084569 Adjusted R?= ,95849901 F(7,6)=43,892 p<,00010 Std.Error of estimate: ,16416						
Intercept			2,682	17,50064	0,15327	0,883213	
SecEnr	-0,281323	0,174695	-110,170	68,41292	-1,61037	0,158442	
HighEnr	0,489244	0,156718	90,161	28,88080	3,12182	0,020537	
Gcons/Y	-0,257876	0,116353	-8,599	3,88007	-2,21632	0,068544	
Inflatn	-0,305708	0,125643	-5,277	2,16895	-2,43315	0,050943	
PPIDev	0,385580	0,117342	4,512	1,37305	3,28595	0,016698	
lne0	0,123935	0,150701	3,290	4,00052	0,82239	0,442302	
Assass	-0,131610	0,159399	-24,540	29,72178	-0,82566	0,440582	

Figure 2. Results of regression analysis

According to the data given in the Figure 2, we can write the following regression equation:

$$\ln\frac{Y}{N} = 2.682 - 110.17\,\text{SecEnr} + 90.161\,\text{HighEnr} - 8.599\frac{\text{Gcons}}{Y} - \tag{1}$$
$$- 5.277\,\text{Inflatn} + 4.512\,\text{PPIDev} + 3.29\,\text{lne}_0 - 24.54\,\text{Assass}.$$

Factors HighEnr, PPIDev, lne0 have positive impact on GRP level, i.e. increase of their value will lead to the growth of the gross regional product value per head. Remain independent variables negatively impact the value of variable ln(Y/N), i.e. increase of their values will lead to the reduction of the GRP.

Coefficients of variables of education enrollment coverage in the obtained model are: 90.161 > 0—of the variable of proportion of people receiving higher education; -110.17 < 0—of the variable of proportion of people receiving secondary education (according to Barro these indicators are bigger than zero, as they reflect dynamics of the human capital value - key factor of economic growth). Coefficient of variable of government expenses is equal to-8.599 < 0 (such expenses decrease rate of savings). Coefficient of variable defining crime rate is equal to-24.540 < 0 (approaches as an indicator of political instability having negative impact on property rights and private investments).

In addition to that, according to the data provided by Figure 2, we can write the equation of influence of factor variables on the value of variable ln(Y/N) as follows:

$$t_{\ln\frac{Y}{N}} = -0.281323\,\text{SecEnr} + 0.489244\,\text{HighEnr} - 0.257876\frac{\text{Gcons}}{Y} - 0.305708\,\text{Inflatn} + \tag{2}$$
$$+ 0.38558\,\text{PPIDev} + 0.123935\,\text{lne}_0 - 0.13161\,\text{Assass}.$$

The greatest positive impact on GRP level has the share of people with higher education, the greatest negative impact—level of consumer price index.

According to Student's t-criterion it's possible to check the significance of indicators forming a part of the regression equation (t_{cr} = 2.446912), then only indicators of share of fixed assets investments and share of people receiving higher education remain significant, others do not.

Using stepwise regression with the exception the following data was obtained (Figures 3, 4).

Summary Statistics; DV: LnY/N (Spreadsheet2		
Statistic	Value	
Multiple R	0,988328601	
Multiple R?	0,976793423	
Adjusted R?	0,962289312	
F(5,8)	67,3459708	
p	0,00000254454994	
Std.Err. of Estimate	0,156479717	

Figure 3. Results of regression analysis

The index of multiple determinations defines that 97.68% of value of gross regional product per head depends on factor variables. F_{tab} = 67.346 > F_{cr} = 3.687, from which it can be concluded that regression equation is significant. Standard error of the estimation of equation is quite small and equals to 0.1565. To ensure the confident use of regression analysis results for further operations, you need to check the model's adequacy. Adequacy analysis is based on the analysis of residuals. Residuals correspond the difference between observed values and model ones, i.e. values, evaluated by the model with estimated parameters.

Normal probability of residuals can be also considered as model's adequacy criterion. Histogram of the distribution of residuals is provided in the Figure 4. Drawn model is adequate, since histogram is close to the normal plot.
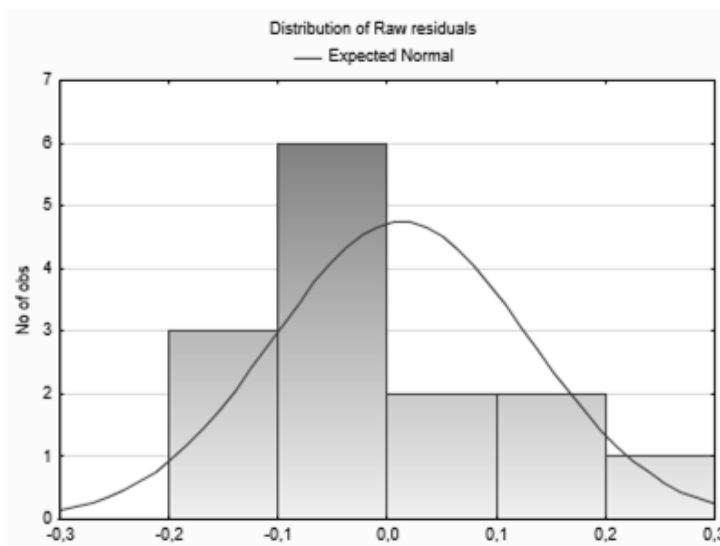

Figure 4. Histogram of the distribution of residuals

N=14	Regression Summary for Dependent Variable: LnY/N (Spreadsheet2) R= ,98832860 R?= ,97679342 Adjusted R?= ,96228931 F(5,8)=67,346 p<,00000 Std.Error of estimate: ,15648					
	b*	Std.Err. of b*	b	Std.Err. of b	t(8)	p-value
Intercept			18,103	1,61805	11,18794	0,000004
SecEnr	-0,438089	0,086770	-171,562	33,98017	-5,04888	0,000991
HighEnr	0,557184	0,136075	102,681	25,07665	4,09469	0,003463
Gcons/Y	-0,214092	0,103834	-7,139	3,46259	-2,06186	0,073148
Inflatn	-0,400866	0,070629	-6,920	1,21926	-5,67566	0,000467
PPIDev	0,480435	0,074856	5,622	0,87590	6,41817	0,000205

Figure 5. Results of regression analysis

According to the data given in the Figure 5, we can write the following regression equation:

$$\ln \frac{Y}{N} = 18.103 - 171.562 \text{Sec Enr} + 102.681 \text{HighEnr} - 7.139 \text{Gcons/Y} - 6.920 \text{Inflatn} + \quad (3)$$
$$+ 5.622 \text{PPIDev} .$$

Factors HighEnr, PPIDev have positive impact on the gross regional product level, thereby increase of their values will lead to the growth of the GRP per head. Factors SecEnr, Gcons/Y and Inflatn negatively impact the value of resultant variable, i.e. increase of their values will lead to the reduction of the GRP.

Equation of an influence of factor variables on the value of resultant variable is written as follows:

$$t_{\ln \frac{Y}{N}} = -0.438089 \text{ SecEnr} + 0.557184 \text{HighEnr} - 0.214092 \text{ Gcons/Y} -$$
$$- 0.400866 \text{ Inflatn} + 0.480435 \text{PPIDev} . \quad (4)$$

Share of the people receiving higher education to population ratio—0.5572, has the greatest impact on the value of gross regional product per head in the Republic of Mari El, share of consolidated budget expenses in GRP—the lowest.

Using Student's t-criterion you can check the significance of indicators forming a part of regression equation (t_{cr} = 2.306), despite that the indicator of the share of consolidated budget expenses in GRP is insignificant.

Using stepwise regression with the exception the following results were obtained (Figure 6-8):

Statistic	Summary Statistics; DV: LnY/N (Spreadsheet2)		
	Value		
Multiple R	0,982069857		
Multiple R?	0,964461204		
Adjusted R?	0,948666184		
F(4,9)	61,0610928		
p	0,00000160586706		
Std.Err. of Estimate	0,182569236		

Figure 6. Results of regression analysis

The 96.44% of value of gross regional product per head depends on factor variables. F_{tab} = 61.061 > F_{cr} = 3.633, from which it can be concluded that regression equation is significant. Standard error of the estimation of equation is quite small and equals to 0.1826. Drawn model is adequate, since histogram is close to the normal plot (Figure 7).
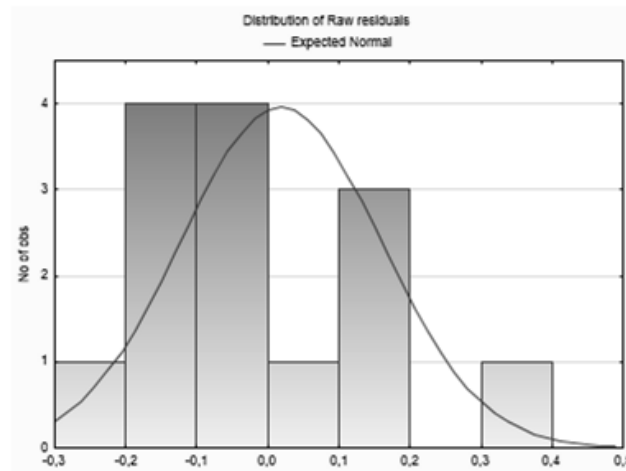
Figure 7. Histogram of the distribution of residuals

	Regression Summary for Dependent Variable: LnY/N (Spreadsheet2) R= ,98206986 R?= ,96446120 Adjusted R?= ,94866618 F(4,9)=61,061 p<,00000 Std.Error of estimate: ,18257						
N=14	b*	Std.Err. of b*	b	Std.Err. of b	t(9)	p-value	
Intercept			17,527	1,85952	9,42561	0,000006	
SecEnr	-0,426706	0,101031	-167,104	39,56528	-4,22350	0,002228	
HighEnr	0,356077	0,110704	65,620	20,40119	3,21648	0,010549	
Inflatn	-0,393372	0,082296	-6,791	1,42066	-4,77999	0,001001	
PPIDev	0,523461	0,083874	6,125	0,98143	6,24105	0,000151	

Figure 8. Results of regression analysis

According to the obtained results we can write the following regression equation:

$$\ln \frac{Y}{N} = 17.527 - 167.104 \mathrm{SecEnr} + 65.62 \mathrm{HighEnr} - 6.791 \mathrm{Inflatn} + 6.125 \mathrm{PPIDev}. \tag{5}$$

Increase of HighEnr, PPIDev factor values will lead to the growth of the GRP per head. Increase of SecEnr, Inflatn factor values will lead to the reduction of the GRP level.

Equation of an influence of factor variables on the value of resultant variable is written as follows:

$$t_{\ln \frac{Y}{N}} = -0.426706 \mathrm{SecEnr} + 0.356077 \mathrm{HighEnr} - 0.393372 \mathrm{Inflatn} + 0.523461 \mathrm{PPIDev}. \tag{6}$$

Share of the fixed assets investment in GRP—0.523461 has the greatest impact on the value of gross regional product per head in the Republic of Mari El, share of people receiving higher education to population ratio—the lowest.

According to the Student's t-test (t_{cr} = 2.262) all indicators of the equation are significant.

4. Conclusion

Thus, the Barro's model was drawn for the Republic of Mari El, which shows that the indicator of share of fixed assets investments in GRP has the greatest impact on the level of the Republic's gross regional product.

Considering all stages of modelling it's easy to see that indicators of share of people receiving higher education to population ratio as well as indicator of share of fixed assets investments in all models had statistical significance and huge positive impact on the Republic's GRP. But factors with the negative sign in front of variable have negative impact on considered indicator, which shouldn't be underestimated. Therefore we can affirm that the assumption of dependence of GRP on these factors is confirmed.

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