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Impact of the demographic dividend on economic growth

Abstract. In the context of the working-age population decline in the Russian Federation, the study of the influence of the dynamics of the share of the working -age population on economic growth is of particular interest. The main purpose of the article is to assess the contribution of the first demographic dividend to the GDP per capita growth rate in Russia between 1997 and 2015. The main methods used by the author of this work are statistical analysis and econometric modeling based on Rosstat data. According to the results obtained in the course of this study, the first demographic dividend provided about 13% growth of real GDP per capita in the Russian Federation in 1997-2015. It has been proved that the age structure of the population is important.

Keywords: demographic dividend, age and sex structure of population, economic development, GDP per capita growth

JEL Codes: J11, J21

Introduction

Demographic issues today are the focus of attention of Russian economists and politicians. In his Address to the Federal Assembly on March 1, 2018, the President of the Russian Federation commented on the results of the population policy of the government, stressing that the demographic problem has an economic dimension and mentioning that the tendency of working-age population decrease may become a serious impediment to the growth of the Russian economy [President's Address..., 2018]. Indeed, demography is very closely linked to the economy, and this relationship is bilateral. It is difficult to separate the processes of interaction because of the interplay of many social, economic, political, demographic and other factors. The study of the impact of demographic factors on the economy was given less attention than the reverse. David Reher demonstrated how demographic transition causes socio-economic changes [Reher, 2011].

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The topic of this article is relevant, since, firstly, the impact of the first demographic dividend on the macroeconomic development of Russia is poorly studied. Secondly, according to three scenarios of the demographic forecast of Rosstat, in the next 7-9 years the share of the working-age population in Russia will decrease [Federal Statistical Service..., 2018].

The main purpose of this work is to assess the contribution of the first demographic dividend to economic growth in Russia in 1997-2015. The hypothesis is that the growth of the share of the labour-age population in Russia has contributed positively to the growth rate of real GDP per capita. The object of research is the first demographic dividend. The subject is the influence of the dynamics of the share of the working -age population on the real GDP per capita growth in the Russian Federation between 1997 and 2015. The main methods used by the author of this work are statistical analysis and econometric modeling.

Concepts of demographic dividends and their impact on macroeconomic development

In terms of influence on the age structure of population, demographic transition can be divided into three stages (Table 1).

Table1. Stages of demographic transition (where α, β, σ are the proportion of children, adults and the elderly, respectively, in the total population)

Phase	Description
1	α↑
2	α↓ β↑ σ↑
3	α↓ β↓ σ↑

Source: [Secretariat U. N., 2005].

During the second phase, the proportion of working-age people increases and the dependency ratio decreases, which, other things being equal, has a positive impact on economic growth. This stage is called the “demographic dividend”, “demographic bonus” or “demographic opportunity window” [Mason, 2005].

The demographic dividend usually lasts for decades [Mason, 2005]. With the third stage, when the proportion of the working -age population begins to decline, the positive effect of the demographic dividend comes to an end. The described demographic dividend is called the first. This paper examines the impact of the first demographic dividend on economic growth.

After the first demographic dividend, the occurrence of the second one is possible [Lee, Mason, 2006]. Andrew Mason describes it as follows. If the population and public authorities anticipate the onset of the third stage of demographic transition (stage of population ageing) and change their behaviour, namely increase the size of savings, in order to maintain a stable level of consumption over the life cycle (life expectancy increases), the rate of accumulation will increase, which will also lead to increased economic growth, other things being equal [Mason, 2005].

The theory of demographic dividends is based on the existence of the economic life cycle of individuals: in any modern society, children and the elderly, on average, consume more than they produce. People in the working age, on the contrary, produce more than they consume [National Transfer Accounts Manual, 2013]. The National Transfer Accounts (NTA) organisation [National Transfer Accounts, 2018] is engaged in the development of age profiles of production and consumption throughout life for different countries. Modeling the age profiles of consumption and production for the population of the country provides a more accurate estimate of the dependency ratio. The use of generally accepted age of economic dependence (under 15 years and over 64 years) is an assumption. In reality, the average age of economic dependence varies from country to country. Thus, according to data obtained by Mason, in 2000 in the United States, citizens under 24 years of age and over 65 years of age could be considered economically dependent [Mason, 2005]. In addition, people of every age are dependent differently: people at the age of 22 are less dependent than people at the age of 5, for example. At the moment in the NTA database age profiles of production and consumption are not presented for Russia. In this work in the construction of econometric models the working age used by Rosstat (16-59 years for men and 16-54 years for women) is adopted.

There are differing views on the reasons for the positive impact of the increase in the proportion of the working-age population on economic growth. First, working-age people tend to be more productive [Mody, Aiyar, 2011]. Therefore, all other things being equal, the reduction of the dependency ratio in the country will lead to an increase in GDP per capita.

Second, the savings rate is highest among people of the working age, and therefore, the increase in the proportion of the working-age population may result in a higher rate of savings and mobilizes opportunities for domestic investment growth [Bloom, Canning, Sevilla, 2003]. In the article “The Demographic Dividend. A New Perspective on the Economic Consequences of Population Change”, the authors note that the highest level of savings is observed among the population aged 40 to 65 [Bloom, Canning, Sevilla, 2003]. According to the authors, this is due to two factors:

- People at this age generally do not need to invest in their children;
- People begin to save more before retirement in order to maintain a usual level of consumption over the next decades of life.

Thirdly, when the large generation born during the first phase of the demographic transition (or the “baby boom”) matures and reaches the working age, the labour supply begins to increase sharply, and if the labour market is able to provide a sufficient number of jobs to employ new workers, per capita output will grow. In addition, fertility decline, which tends to precede changes in the age structure of the population, can increase women's labour supply and employment [Bailey, 2006]. There is empirical evidence that increasing women's employment results in an increase in per capita income [Bloom et al., 2009].

The channels through which the increase in the percentage of the working-age population has a positive impact on economic growth are outlined in Figure 1.

It should be noted that the effect of the demographic dividend is not deterministic [Bloom, Canning, 2004; Mason, 2005; Lee, Mason, 2006]. The transformation of the first demographic dividend into economic growth depends on the ability of the economy to create jobs for the growing working-age population, on the quality of state macroeconomic policies, education policies and other factors [Bloom, Canning, 2004]. In the absence of the correct macroeconomic policy of the state aimed at the implementation of the demographic dividend, growth of the working-age population can lead to growth in unemployment, political instability, rising crime and declining social capital.

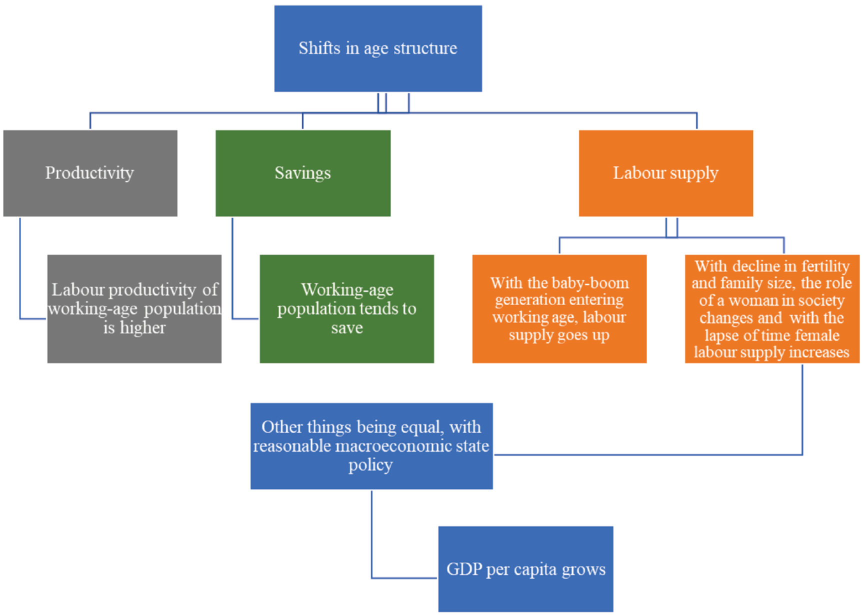

Figure 1. Impact mechanism of the first demographic dividend

Source: scheme developed by the author

Table 2 presents econometric studies of the impact of growth in the proportion of the working-age population on economic growth.

The first work containing econometric modeling of real GDP per capita growth rates depending on the working-age population growth rates is: Bloom, Williamson, 1998. The sample used to build the models in this article includes data for 78 countries from 1965 to 1990. The authors used the least squares method (MLS, OLS) and instrumental variables (DMLS, TSLS) in constructing regressions. In the MLS-model, the share of the working-age population variable is statistically significant, and the authors conclude that, other things being equal, with an increase of the growth rate of the share of the working-age population by 1 percentage point, real GDP per capita increases by 1.46 percentage points. With the introduction of instrumental variables, the statistical significance remains, and the coefficient for variable growth rates of the share of the working-age population slightly reduces from 1.46 to 1.37.

Based on the theoretical model used in the article "Global demographic change: Dimensions and economic significance", Mody and Aiyar built a regression of the GDP per capita growth rate on the share of the working-age population and the rate of growth of the share of the working-age population for India [Mody, Aiyar, 2011]. The authors used a sample of 22 Indian states from 1961 to 2001 and concluded that in India at that time, other things being equal, under growth in the percentage of the working-age population of by 1 per cent, GDP per capita increased by 0.188 percentage points, while as the growth rate of the proportion of the working-age population increased by 1 per cent, GDP per capita grew by 2.478 percentage points. Authors evaluated different specifications, used instrumental variables, and in all cases estimates with interest variables remained significant and were expectedly positive.

Table 2. Econometric studies of influence of working-age population growth on economic growth

Year	Name of study	Authors	Method	Data	Conclusion
1998	Demographic Transitions and Economic Miracles in Emerging Asia	David E. Bloom, Jeffrey G. Williamson	OLS, TSLS	Panel Data: 78 countries, from 1965 to 1990	Positive impact
2001	Cumulative Causality, Economic Growth, and the Demographic Transition	David E. Bloom, David Canning	TSLS	Panel Data: 80 countries, from 1965 to 1990	Positive impact
2003	Contraception and the Celtic Tiger	David E. Bloom, David Canning	OLS, TSLS	Panel Data: five-year intervals from 1965 to 1995 A total of 507 observations. Countries not specified	Positive impact
2004	Global Demographic Change: Dimensions and Economic Significance	David E. Bloom, David Canning	OLS, TSLS	Panel Data: five-year intervals from 1965 to 1995 A total of 507 observations. Countries not specified	Positive impact

End of table 2

Year	Name of study	Authors	Method	Data	Conclusion
2011	The demographic dividend: Evidence from the Indian States	Shekhar Aiyar, Ashoka Mody	FE, TSLS	Panel Data: 10-year intervals from 1961 to 2001 for the states of India. A total of 76 observations.	Positive impact
2018	Swimming against the tide: economic growth and demographic dividend in India	William Joe, Abhishek Kumar, Sunil Rajpal	OLS, TSLS	Panel data for 15 states of India and India as a whole from 1980 to 2010	Positive impact
2018	Age-Structure, Human Capital and Economic Growth in Developing Economies: A Disaggregated Analysis	Munir Ahmad, Rana Ejaz Ali Khan	Diff-GMM	Panel data: 67 developing countries from 1960 to 2014.	Positive impact

Source: compiled by the author.

Thus, a number of studies using econometric methods to assess the first demographic dividend (see table 2) demonstrate the positive impact of increasing the proportion of working-age population on the GDP per capita growth rate.

Dynamics of the dependency ratio and GDP per capita in Russia

Figure 2 shows that since 2010 in Russia the growth rate of the total population has begun to exceed that of the working-age population. Since 2010 the dependency ratio in the Russian Federation began to steadily increase (Figure 3).

Between 1996 and 2009, when the working-age population was mostly increasing and the overall population was declining on average, the dependency ratio declined by approximately 11 percentage points (from 49.31 per cent to 38.78 per cent) (Figure 3).

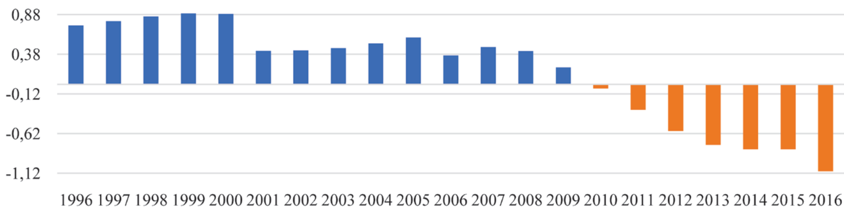

Figure 2. Difference between the growth rate of the population at the age of 15-64 and the total population in the Russian Federation in 1960-2016.

Source: composed by the author on the basis of World Bank data

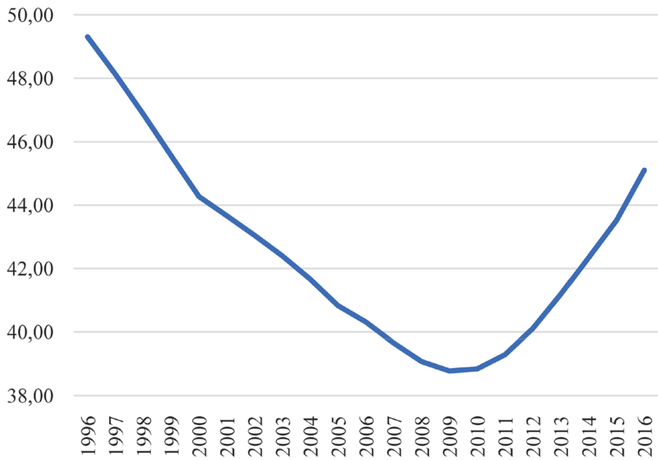

Figure 3. Evolution of the dependency ratio (population under 15 and over 64, per 100 persons aged 15-64)

Source: composed by the author on the basis of World Bank data

Figure 4 shows the real GDP per capita growth rate in 1996-2016. The chart shows that economic dynamics in post-Soviet Russia were quite volatile. Three stages can be distinguished: the stage of transformation recession (1991-1998), when the economy experienced a significant deterioration in the dynamics of GDP; the stage of economic growth (1999-2008), during which the average annual growth rate of the real GDP amounted to about 7%, and the stage of "new normality" (from 2009 to present), called so, due to the unstable nature of economic dynamics, which includes two crises periods [Gudkova et al., 2017].

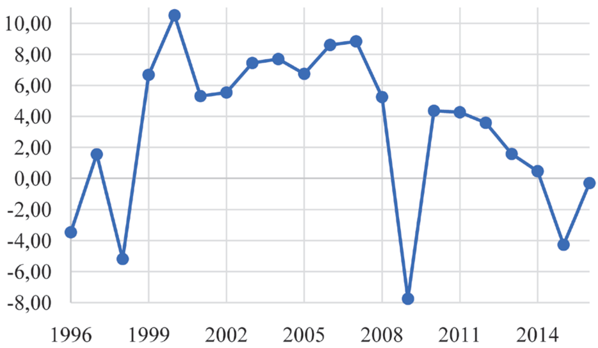

Figure 4. Dynamics of the real GDP per capita growth rate in the Russian Federation in 1996-2016, %

Source: calculated by the author on the basis of Rosstat data

Visually, we observe the convergence of dynamics of the dependency ratio and GDP per capita in Russia. Econometric analysis should be used to check whether this coincidence is based on the impact of the demographic dividend and determine the extent of this impact.

Construction of an econometric model of impact of the first demographic dividend on economic growth

Data

For the construction of econometric models were collected panel data for 78 regions of Russia for 20 years: from 1997 to 2016. The list of regions of the Russian Federation, which were included in the sample, is presented in Annex 1. The sample includes all Russian regions, with the exception of the autonomous districts of the regions and krais, as well as the Republic of Chechnya, due to the lack of data on them for many indicators. The source of all indicators used to build econometric models is the statistical compendium "Regions of Russia. Socio-economic indicators", issued by the Federal Statistical Service [Federal Statistical Service..., 2018]. Table 3 presents the indicators included in the final database.

All growth variables in period t were calculated as the ratio of the corresponding indicator in period t + 1 to its value in period t. The values of the remaining indicators in the final database correspond to the beginning of the year.

Table 4 presents descriptive statistics of interest variables. On average, for the regions of the Russian Federation in the period from 1997 to 2015, the GDP per capita growth rate amounted to 4.19 per cent. The minimum and maximum values of this indicator were achieved in the Republic of Kalmykia and amounted to -22.9 per cent (in 2003) and 78.7 per cent (in 2000) respectively. The average percentage of the working-age population (16-59 years for men and 16-54 years for women) in the total population was 60.54 per cent during the period under review. The minimum was reached in the Republic of Dagestan in 1996, making up 52.5 percent. The maximum value was recorded in the Chukchi Autonomous District in 2005 and amounted to 70.9 per cent. The average growth rate of the proportion of the working-age population was 0.01 per cent. The minimum value of this indicator was achieved in the Republic of Ingushetia in 2011, when the proportion of the working-age population decreased by 4.93 per cent. The maximum was observed in Moscow in 2001, when there was an increase in the share of the working-age population by 8.26 percent.

Table 3. List of variables selected by the author for constructing regressions

Indicator	Units of Measure	Designations in models
GRP per capita (comparable prices)	RUB/person	GDP_real
Growth rate of GRP per capita		Growth_GDP_real
Working-age population,% (men aged 16-59 and women aged 16-54), cleared of migration	%	WA_ratio
Working-age population growth rate		Growth_WA_ratio
Life expectancy at birth	years	Life_exp
Number of hospital beds per 10,000 population		Hosp_beds
Ratio of men to women (number of women per 1,000 men)		Gender_ratio
Investments in fixed assets per capita (in actual prices; rubles; prior to 1998 — thousand rubles)	RUB/person	Inv
Number of students enrolled in the programs of bachelor, specialty or, master's degree per 10000 population		Edu
Cost of fixed assets per capita	million.rub/person	FOND_per_capita
Level of labour force participation	%	WAL
Growth rate of labour force participation		Growth_WAL
Number of organizations carrying out research and development	units.	NIOKR

Source: compiled by the author

Table 4. Descriptive statistics of interest variables

	Mean	Standard Deviation	Minimum	Maximum
Per capita GDP growth rate (percentage)	4.19	6.16	-22.9	78.7
			(Republic of Kalmykia, 2003)	(Republic of Kalmykia, 2000)
Proportion of the labour-age population (%)	60.54	3.32	52.5	70.9
			(Republic of Dagestan, 1996)	(Chukotka Autonomous District, 2005)
Labour-age population growth (%)	0.01	1.22	-4.93	8.26
			(Republic of Ingushetia, 2011)	(Moscow, 2001)

Source: calculated by the author on the basis of Rosstat data

Theoretical model

This paper uses the theoretical model proposed by Bloom and Canning [Bloom, Canning, 2004] and later used in Mody and Aiyar [Mody, Aiyar, 2011]. This model enables associating GDP per capita growth with the demographic factor. Let's proceed to its description.

1) According to the convergence theory [Barro, Sala-I-Martin, 1995], the rate of output growth per employee can be represented as follows:

$$g_z = \lambda(z^* - z_0), \tag{1}$$

where g_z is the growth rate of income (output) per worker, z^* is the steady state level of income (output) per worker, z_0 is the initial level of income (output) per worker, л is the speed of convergence.

According to equation (1), at any point in time, the growth rate of income (output) per worker depends on the difference between the equilibrium level and initial level, as well as on the speed of convergence.

2) The growth rate of income (output) per worker, in turn, depends on a number of factors (health, education and other factors affecting productivity). Therefore, equation (1) can be rewritten as follows:

$$g_z = \lambda(X\beta - z_0), \tag{2}$$

where g_z is the growth rate of income (output) per worker, z_0 is the initial level of income (output) per worker, X is the vector of variables that can affect steady state labour productivity, в is the vector of coefficients, л is the speed of convergence.

3) To associate the growth of per capita output with demographic variables, consider the following equation:

$$\frac{Y}{N} = \frac{Y}{L}\frac{L}{WA}\frac{WA}{N}, \tag{3}$$

where N is total population, Y is (output) income, L is labour (labour force), WA is population of working age, $\frac{Y}{N}$ is income (output) per capita, $\frac{Y}{L}$ is income (output) per worker, $\frac{L}{WA}$ is the level of participation in the labour force, $\frac{WA}{N}$ is the proportion of the population of working age in the total population.

4) Take the logarithms of both parts of equation (3):

$$\ln(\frac{Y}{N}) = \ln(\frac{Y}{L}) + \ln(\frac{L}{WA}) + \ln(\frac{WA}{N}), \tag{4}$$

Introduce the following symbols:

$$\mathrm{y} = \ln(\frac{Y}{N}),\ \mathrm{z} = \ln(\frac{Y}{L}),\ \mathrm{p} = \ln(\frac{L}{WA}),\ \mathrm{w} = \ln(\frac{WA}{N}).$$

Rewrite equation (4) taking into account the introduced symbols:

$$y = z + p + w, \tag{5}$$

Next, moving to the growth rate, rewrite equation (4) in the following form:

$$g_y = g_z + g_p + g_w, \tag{6}$$

where g_y is the per capita income (output) growth rate, g_z is the income (output) per worker growth rate, g_p is the labour force participation rate, g_w is the growth rate of working-age population participation in total population.

Then, taking into account equations (2), (5) and (6), we get the expression of output per capita growth taking into account demographic variables:

$$g_y = \lambda\left(X\beta + p_0 + w_0 - y_0\right) + g_p + g_w, \tag{7}$$

where g_y is the growth rate of income (output) per capita, g_p is the growth rate of the level of participation in the labour force, g_w is the growth rate of the share of the working-age population in the total population, X is the vector of variables explaining the equilibrium output per employee (or productivity), в is the vector of coefficients, p_0 is the level of participation in the labour force, w_0 is the initial value of the proportion of the working-age population in the total population, y_0 is the initial value of income (output) per capita, л is the coefficient reflecting the speed of convergence.

Equation (7) will serve as a basis for further analysis and construction of econometric models. According to it, the growth of per capita income (g_y) should be positively correlated with the share of the working-age population at the initial point of time (w_0) and the increase in the share of the working-age population(g_w).

So the underlying regression model would look as follows:

$$\begin{gathered} Growth\_GDP\_real_{i,t} = \rho lnGDP\_real_{i,t} + \\ +\beta_1 lnWA\_ratio_{i,t} + \beta_2 Growth\_WA\_ratio_{i,t} + \beta_3 lnWAL_{i,t} +, \\ +\beta_4 Growth\_WAL_{i,t} + \gamma X_{i,t} + f_i + \eta_t + \varepsilon_{i,t} \end{gathered} \tag{8}$$

the rate of growth of GRP per capita in region i for year t is the dependent variable ($Growth\_GDP\_real_{i,t}$). The natural logarithm of the percentage of the population of working age in region i at the beginning of period t ($lnWA\_ratio_{i,t}$) and the rate of growth of the proportion of working-age population in region i for year t ($Growth\_WA\_ratio_{i,t}$) are interest variables. Regressors include the logarithm of the level of GRP per capita in region *i* at the beginning of period *t*($lnGDP\_real_{i,t}$), the logarithm of the level of labour force participation in region i at the beginning of period t($lnWAL_{i,t}$) and the rate of growth in the level of participation in labour force in region *i* for year *t*($Growth\_WAL_{i,t}$), $X_{i,t}$ is the vector of control variables that can affect the equilibrium level of labour productivity, f_i is fixed effects, η_t is time effects, ,$\varepsilon_{i,t}$ are random model errors. The use of a model with fixed effects enables taking into account the unobserved individual characteristics of each region that affect the growth of GRP per capita (for example, the presence in the region of extractable resources, natural and climatic factors, cultural features, etc.). Adding time effects to the model enables taking into account the peculiarities of different periods of time that affect GRP per capita.

All explanatory variables, except for growth variables, are taken at the beginning of period t, that is, they are primary to the dependent variable. But the dependent variable and the variable of interest, which reflects the growth of the share of the working-age population ($Growth\_WA\_ratio_{i,t}$), are concurrent. In this regard, we may suspect the presence of a reverse causal link in the model leading to bias estimates.

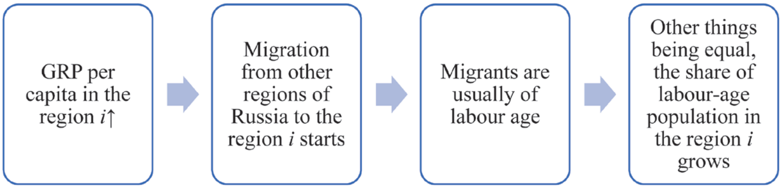

Figure 5. Impact of GRP per capita growth on the proportion of the labour-age population

Source: compiled by the author

While GRP per capita increases in one region, people in other regions are encouraged to migrate to this successful region. And because migrants are mostly people of the working age, an increase in GRP per capita may cause an increase in the proportion of the labour-age population in the region where per capita GRP grows (Figure 5). This is also mentioned by Mody and Aiyar [Mody, Aiyar, 2011]. Thus, changing the dependent variable can change the regressor. In order to eliminate possible causal feedback in the model, the percentage of the working-age population has been cleared of migration. For this purpose data from the Rosstat's compendium "Regions of Russia. Socio-economic indicators" on migration balance was used. Table 5 gives an example of calculation of the percentage of labour-age population cleared of migration.

Table 5. Calculation of the proportion of the working-age population cleared of migration

Percentage of working-age population (men aged 16-59 and women aged 16-54), per cent	X.
Migration balance (migratory growth (decline) per 10,000 persons)	Y
Percentage of working-age population cleared of migration (men aged 16-59, women aged 16-54), per cent	$\frac{X*100-Y}{10000-Y}$

Source: compiled by the author.

Notice: the assumption that all migrants are of working age was used.

Results of econometric modeling

According to the theoretical model described in the previous section, the growth rate of real GRP per capita (Growth_GDP_real) was chosen as the dependent variable. The proportion of the working-age population cleared of migration (WA_ratio) and the rate of growth of the share of the working-age population (Growth_WA_ratio) are interest variables. The initial GRP per capita (GDP_real), labour force participation (WAL) and growth rate of labour force participation (Growth_WAL) have been added to the list of regressors.

The list of control variables includes life expectancy (Life_exp) used in Bloom and Canning [Bloom, Canning, 2004] and the relative number of hospital beds (Hosp_beds), used in Mody and Aiyar [Mody, Aiyar, 2011] as a proxy for the health level of the workforce. It should be noted that the number of hospital beds does not perfectly reflect the level of health of the population, but rather measures the level of expenditure on the health care.

In addition to health, human capital is affected by the level of education. In Mody and Aiyar's article [Mody, Aiyar, 2011], literacy is the variable responsible for the education of Indian workers. Bloom and Canning [Bloom, Canning, 2004] use the average number of years of schooling for the population aged 15 or over. To select a variable characterizing the level of education of workers in the regions of the Russian Federation, indicators contained in the "Education" section in the statistical compedium "Regions of Russia. Socio-economic indicators", published by the Federal Statistical Service, were considered. The final model included the number of students enrolled in Bachelor's, Specialist and Master's programs per 10000 people (Edu). This indicator was included in the list of regressors in modeling the growth rates of GRP per capita in the work of O. S. Balash [Balash, 2012]. It should be noted that this indicator has a disadvantage, as it depends on the territorial location of higher education institutions in the country and does not reflect the level of education of workers directly.

The Gender_ratio variable is used by Mody and Ayar [Mody, Aiyar, 2011] to take into account the social factor. A. Sen in his article "Missing women", notes that gender inequality affects the ratio of economically active men to women in the country [Sen, 1992]. Consequently, the gender ratio can act as a proxy for gender inequality, which in turn affects economic growth [Dollar, Gatti, 1999; Klasen, 2000; Klasen, Lamanna, 2009].

Finally, the following variables were added to the list of regressors: investment in fixed capital per capita (Inv), the value of fixed assets per capita (FOND_per_capita) and the number of research and development performing organizations (NOIKR). These indicators were used as control variables in econometric modeling of GRP per capita in Russian regions in M. A. Latysheva's article "Econometric modeling of social and economic development of the regions of the Russian Federation" [Latysheva, 2009].

Table 6 presents the results of estimating variable growth rate regressions of GRP per capita on all regressors except those excluded due to multicollinearity of fixed asset investments per capita and the per capita value of fixed assets using three approaches: pooled OLS, the fixed effects model (FE) and the random effects model (RE). In all models resistant to heteroscedasticity (robust) standard errors were used.

Table 6. Results of regression estimation (in brackets under coefficients there are robust standard errors; asterisks located to the right of coefficients indicate the significance of variables: * * * p-value < 0.01, * * p-value < 0.05, * p-value < 0.1)

Dependent variable: Growth_GDP_real						
Variables	Model 1 (Joint OLS)		Model 2 (Fixed Effects Model)		Model 3 (Model with random effects)	
const	-2.10 (1,12)	*	-3.84 (3,84)		-1.64 (1,49)	
l_GDP_real	-0.04 (0,01)	***	-0.30 (0,04)	***	-0.03 (0,01)	***
l_WA_ratio	0.70 (0,09)	***	0.87 (0,32)	***	0.51 (0,14)	***
Growth_WA_ratio	1.78 (0,49)	***	1.80 (0,72)	**	1.42 (0,80)	*
l_Life_exp	-0.30 (0,09)	***	-0.18 (0,25)		-0.09 (0,09)	
l_Edu	-0.02 (0,01)		-0.01 (0,02)		-0.02 (0,01)	**
l_Hosp_beds	-0.04 (0,02)		-0.13 (0,04)	***	-0.02 (0,02)	
l_Gender_ratio	0.13 (0,07)	*	0.68 (0,34)	*	0.06 (0,08)	
l_WAL	-0.06 (0,07)		-0.05 (0,11)		-0.05 (0,08)	
l_Growth_WAL	-0.09 (0,10)		0.10 (0,09)		0.09 (0,09)	
l_NIOKR	0.01 (0,002)	***	0.05 (0,02)	**	0.01 (0,003)	**
R^2	R-squared	0.335	LSDV R^2	0.546	-	
	Adj. R-squared	0.329	Within-R^2	0.531	-	
Time effects	none		yes		yes	
Number of observations	1229		1229		1229	

Source: compiled by the author

After conducting the linear restriction test, Breusch-Pagan test and Hausman test (Table 7), we conclude that the model with fixed effects better describes the relationship between variables, and make our choice in its favour.

Table 7. Selection of the best model (Linear Limitation Test, Breusch-Pagan Test, Hausman Test)

Pooled-OLS or fixed effects model	Pooled-OLS or model with random effects	Fixed effect model or random effect model
Test for linear constraint: H_0: $\mu_1 = \mu_2 = ... = \mu_{78} = 0$ (coefficients for individual fixed effects are zero) *No individual effects* H_1 : Otherwise p-value ≈ 0 < 0.01 Output: At a 1% level of significance, the zero hypothesis is H_0 rejected, therefore we emphasize the model with fixed effects	Breusch-Pagan test: $H_0 : \sigma^2_u = 0$ *No individual effects* H_1 : Otherwise p-value = P (Chi-square(1)=0.02)≈ 0.88 > 0.10 Conclusion At a 10% level of significance, the zero hypothesis H_0 on the adequacy of the combined panel data model is not rejected, therefore, we emphasize the pooled-OLS model	Hausman test: H_0 : cov $(u_i;x_{i,t_0}) = 0$ *Individual effects are not correlated with the regressor* H1: Otherwise Test statistics for Hausman: H = 96,0483 p-value = prob(Chi-square(10) > 96,0483) ≈ 0 < 0.01 Conclusion At a 1-% of the significance level, the zero hypothesis H_0 on the adequacy of the model with random effects is rejected, therefore, we emphasize the model with fixed effects
Model with fixed effects	Pooled-OLS	Model with fixed effects

Source: compiled by the author

The study also took into account the temporal effects. The need to include them in the model was confirmed by the result of the Wald test (Table 8).

Table 8. Wald test for temporary effects

H_0 : There are no time effects
H_1 : Otherwise
Asymptotic test statistics: Chi-square (15) = 526.88
p-value ≈ 0 < 0.01 (α (significance level) = 1%)
Conclusion At a 1% level of significance, the hypothesis H_1 is not rejected, therefore, time effects are present in the model

Source: compiled by the author

Thus, based on the final model (see table 6, fixed effects model), we can draw the following conclusions:

1. The logarithm variable of the share of the working-age population (l_WA_ratio) is significant at a 1% level of significance.

2. The variable rate of growth of the share of the working-age population (Growth_WA_ratio) is significant at a 5% level of importance.

Therefore, we can interpret the obtained estimates of coefficients for interest variables:

1. Other things being equal, with an increase in the share of the labour-age population by 1 per cent, the growth rate of GRP per capita on average for 78 regions of Russia increases by 0.87 percentage points.
2. Other things being equal, with an increase in the growth rate of the share of the working-age population by 1 percentage point, the growth rate of GRP per capita on average for 78 regions of Russia increases by 1.8 percentage points.

It is worth noting that the interest variable remained significant in all three models (OLS model, fixed effects model, random effects model).

Calculation of the contribution of the demographic dividend to the growth of real GDP per capita

The methodology used in Mody and Ayar's work was used to estimate the value of the first demographic dividend [Mody, Aiyar, 2011].

The underlying regression model is as follows (see the "Theoretical Model" Section):

$$\begin{gathered} Growth\_GDP\_real_{i,t} = \rho lnGDP\_real_{i,t} + \\ +\beta_1 lnWA\_ratio_{i,t} + \beta_2 Growth\_WA\_ratio_{i,t} + \beta_3 lnWAL_{i,t} +, \\ +\beta_4 Growth\_WAL_{i,t} + \gamma X_{i,t} + f_i + \eta_t + \varepsilon_{i,t} \end{gathered} \quad (8)$$

where $Growth\_GDP\_real_{i,t}$ is the growth rate of GRP per capita in region i for year t, $lnWA\_ratio_{i,t}$ is the natural logarithm of the percentage of the working-age population in region i at the beginning of period t, $Growth\_WA\_ratio_{i,t}$ is the rate of growth of the share of the working-age population in region i for year t, $lnGDP\_real_{i,t}$ is the logarithm of the level of GRP per capita in region i at the beginning of period t, $lnWAL_{i,t}$ is the logarithm of the level of labour force participation in region i at the beginning of period t, $Growth\_WAL_{i,t}$ is the rate of growth in level of participation in the labour force in region i for year t, $X_{i,t}$ is the vector of control variables, f_i is fixed effects, η_t is time effects, and $\varepsilon_{i,t}$ is random model errors.

We assume that the proportion of the working-age population does not change over time. Then

$$lnWA\_ratio_{i,t} = lnWA\_ratio_{i,0} = \text{const, a } Growth\_WA\_ratio_{i,t} = 0,$$

where $lnWA\_ratio_{i,t}$ is the logarithm of the proportion of the population of working age in region i at the beginning of period t, $lnWA\_ratio_{i,0}$ is the logarithm of the proportion of the population of working age in the region i at the beginning of some base year t = 0, $Growth\_WA\_ratio_{i,t}$ is the growth rate of the share of the working-age population in region i in period t.

Equation (8) will be rewritten as follows:

$$Growth\_GDP\_real_{i,t} = \rho lnGDP\_real_{i,t} + \beta_1 lnWA\_ratio_{i,0} + \\ + 0 + \beta_3 lnWAL_{i,t} + \beta_4 Growth\_WAL_{i,t} + \gamma X_{i,t} + f_i + \eta_t + \varepsilon_{i,t}, \quad (9)$$

We received a model of GRP per capita growth on the assumption that the demographic factor is unchanged — the proportion of the working-age population.

The first demographic dividend, which reflects the contribution of the growing share of the working-age population to the growth of per capita output, is calculated as the difference between equations (8) and (9):

$$DD_t = \beta_1 lnWA\_ratio_{i,t} + \beta_2 Growth\_WA\_ratio_{i,t} - \beta_1 lnWA\_ratio_{i,0}, \quad (10)$$

or

$$DD_t = \beta_1 (lnWA\_ratio_{i,t} - lnWA\_ratio_{i,0}) + \beta_2 Growth\_WA\_ratio_{i,t}, \quad (11),$$

where DD_t is the value of the first demographic dividend in period t; $lnWA\_ratio_{i,t}$ is the logarithm of the percentage of the working-age population in region i at the beginning of period t, $lnWA\_ratio_{i,0}$ is the logarithm of the percentage of the working-age population in region i in some base year t = 0, $Growth\_WA\_ratio_{i,t}$ is the growth rate of the share of the working-age population in region i in period t.

Coefficients β_1 and β_2 were previously estimated (see table 6) and are 0.87 and 1.8, respectively. The basic value of the share of the population in working age was the average for the period from 1996 to 2016, which was 70.17 per cent (Annex 1). Table 9presents the calculated values of the first demographic dividend from 1997 to 2015.

Table 9. First demographic dividend, growth rate of real GDP per capita and estimation of growth rate of real GDP per capita if the proportion of people of the working age (15-64 years) remained constant in the Russian Federation in 1997-2015.

Year	FDD	Growth of real GDP per capita	Growth of real GDP per capita (without changes in the percentage of the population of working age, i.e. excluding the FDD)
1997	-0.018	1.015	1.034
1998	-0.010	0.948	0.958
1999	-0.002	1.067	1.069
2000	-0.003	1.105	1.108
2001	0.001	1.053	1.052
2002	0.005	1.055	1.050
2003	0.010	1.074	1.064

End of table 9

Year	FDD	Growth of real GDP per capita	Growth of real GDP per capita (without changes in the percentage of the population of working age, i.e. excluding the FDD)
2004	0.016	1.077	1.061
2005	0.017	1.067	1.051
2006	0.022	1.086	1.064
2007	0.025	1.088	1.063
2008	0.025	1.052	1.027
2009	0.022	0.922	0.900
2010	0.017	1.044	1.027
2011	0.009	1.043	1.033
2012	0.001	1.036	1.035
2013	-0.007	1.016	1.022
2014	-0.014	1.005	1.018
2015	-0.026	0.957	0.983
Mean value	0.005	1.037	1.033

Source: calculated by the author on the basis of World Bank data

The growth rate of real GDP per capita in the Russian Federation was calculated by means of indices of physical volume and population growth rates (Table. 10).

Table 10. Calculation of the real GDP per capita growth rate

Index of physical volume of GDP, in % of the previous year	A
Population growth rate, as a percentage of the previous year	B
Growth rate of real GDP per capita, as a percentage of the previous year	$\frac{A*100}{B}$

Source: compiled by the author

Thus, according to the obtained data, in the period from 1997 to 2015, the contribution of the first demographic dividend to economic growth amounted to approximately 0.47 percentage points (while fixing the value of the share to of working age at the average level for the period from 1996 to 2016). The average growth rate of real GDP per capita over a given period of time is approximately 3.75 per cent (Table 11). Therefore, we can conclude that the first demographic dividend (FDD) provided about 13 percent of real GDP growth per capita in the Russian Federation in 1997-2015. (Figure 6).

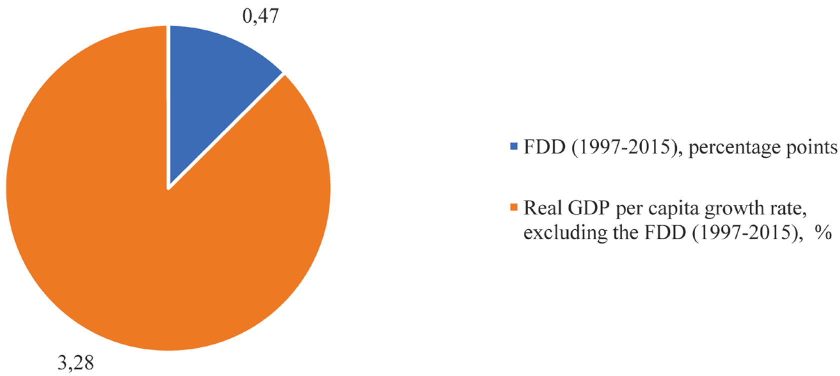

Figure 6. Contribution of the FDD to the real GDP per capita growth rate in the Russian Federation in 1996-2016

Source: calculated by the author on the basis of World Bank data

According to the results obtained, in Russia the contribution of the FDD to economic growth in 1997-2015 was less than in India, where the FDD provided about 39 percent of real GDP per capita growth in 1991-2001. [Mody, Aiyar, 2011].

Mason's FDD estimates for different regions of the world [Mason, 2005] demonstrates that in transition economies, the FDD accounted for about 39 per cent of economic growth in 1970-2000, in industrialized countries - for15 per cent, and in East and South-Eastern Asia - 14 per cent. Due to the use of different time intervals, comparison with the results obtained in this work is not quite correct. It can be noted that the assessment of the FDD in the Russian Federation differs from that of Mason for a group of countries with transition economies, to which Russia belongs. In Mason's work, the size of the FDD is calculated using the growth-accounting method [Sokolova, 2010].

Conclusion

Demography is inextricably linked to the economy: the age structure of the population and its dynamics are significant. This is evidenced by the results obtained in this article, in which the hypothesis about the positive impact of the increase in the share of the working-age population on the growth rate of real GDP per capita in Russia was confirmed.

In the course of this work, an econometric model with fixed effects describing the relationship between the growth rate of real GRP per capita and the demographic factor was constructed: the share of the working-age population and its growth rate. According to the theoretical model, the list of regressors also included the initial level of real GRP per capita, the level of participation in the labour force and the rate of its growth. In addition, control variables were used: life expectancy at birth, relative number of hospital beds, gender ratio, relative number of students, number of R&D performing organizations. The sample is panel data for 78 subjects of the Russian Federation for 1995-2016. Temporary effects were added to the model.

Based on the final model, the following conclusions were drawn:

1. Other things being equal, with an increase in the share of the working-age population by 1 per cent, the growth rate of real GRP per capita on average for 78 regions of Russia increases by 0.87 percentage points.
2. Other things being equal, with an increase in the growth rate of the share of the working-age population by 1 percentage point, the growth rate of real GRP per capita on average for 78 regions of Russia increases by 1.8 percentage points.

With the help of the estimates obtained, the size of the first demographic dividend was calculated with interest variables. On the assumption of immutability of the share of the working-age population and its fixing at the average level for 1996-2016, the contribution of the first demographic dividend to the growth rate of real GDP per capita in Russia in 1997-2015amounted to about 0.5 percentage points, while the average growth rate of real GDP per capita for this period amounting to 3.7 per cent.

Thus, on the basis of the data obtained, we can conclude that the first demographic dividend provided about 13% growth of real GDP per capita in the Russian Federation in 1997-2015.

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Annex 1. Dynamics of the share of the labour-age population (15-64 years), index of physical volume of GDP, population size, population growth rate and growth rate of real GDP per capita in the Russian Federation in 1996-2016

Year	Proportion of the working-age population (%)	Index of physical volume of GDP, as a percentage of the previous year	Population, millions	Population growth rate, as a percentage of the previous year	Growth rate of real GDP per capita, as a percentage of the previous year
	Source: World Bank	Source: Rosstat	Source: Rosstat	Source: Rosstat	Source: author's calculations on the basis of Rosstat data
1996	66.98	96.39	148.16	99.85	96.53
1997	67.51	101.38	147.92	99.83	101.55
1998	68.09	94.66	147.67	99.83	94.81
1999	68.70	106.35	147.21	99.69	106.68
2000	69.31	110.05	146.60	99.58	110.51
2001	69.61	105.09	146.30	99.80	105.30
2002	69.91	104.74	145.20	99.25	105.54
2003	70.23	107.30	145.00	99.86	107.44
2004	70.59	107.18	144.30	99.52	107.70
2005	71.01	106.38	143.80	99.65	106.75
2006	71.27	108.15	143.20	99.58	108.61
2007	71.60	108.54	142.80	99.72	108.84
2008	71.90	105.25	142.80	100.00	105.25
2009	72.06	92.18	142.70	99.93	92.24
2010	72.02	104.50	142.90	100.14	104.36
2011	71.79	104.26	142.90	100.00	104.26

End of Annex 1

Year	Proportion of the working-age population (%)	Index of physical volume of GDP, as a percentage of the previous year	Population, millions	Population growth rate, as a percentage of the previous year	Growth rate of real GDP per capita, as a percentage of the previous year
	Source: World Bank	Source: Rosstat	Source: Rosstat	Source: Rosstat	Source: author's calculations on the basis of Rosstat data
2012	71.37	103.66	143.00	100.07	103.58
2013	70.83	101.79	143.30	100.21	101.57
2014	70.25	100.74	143.70	100.28	100.46
2015	69.68	97.46	146.30	101.81	95.73
2016	68.92	99.83	146.50	100.14	99.69
Mean value	70.17	101.55	146.80	100.20	101.34