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From Demographic Dividend to Demographic Burden?

Regional Trends of Population Aging in Russia

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Abstract

Do regions with higher working age populations grow faster? This paper examines this question using data from Russian regions and finds evidence that demographic trends influence regional growth convergence. In other words, keeping other factors constant, poorer regions grow faster than richer regions, and some of the growth convergence is explained by demographic changes: faster growth in poor regions in the past was related in part to more favorable demographic trends. This finding has important consequences for Russia. If the demographic trends in poorer regions worsen in the future, this could dampen economic convergence. Unless there are significant increases in labor productivity or additions to the labor force through migration, growth in Russian regions will moderate as the Russian population shrinks and ages in the coming decades.

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From Demographic Dividend to Demographic Burden? Regional Trends of Population Aging in Russia

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Summary

Russia benefited from favorable demographic changes until recently. Since the early 1990s, as in many East European countries, Russia experienced three transitions – political, economic and demographic. On the demographic front, Russia entered the transition period with a predominantly young population and a low dependency ratio, and benefited from large cohorts of people entering the labor market. However, with declining fertility rates and longer life expectancy, this has changed in recent years and the population in Russia is projected to shrink and age in the coming decades. Will this affect Russia's longer-term growth prospects?[2]

This paper looks at the impact of demographic trends on regional economic convergence. It asks the question: *do regions with a higher share of working-age population grow faster?* The paper is organized as follows: first, we contrast demographic trends in Russia with those in Europe, and explore the link of demographic change and growth for Russia's regions from 1996 to 2011. Second, we investigate econometrically whether the demographic dividend[3] supported regional convergence over this period. Third, drawing on Rosstat[4] population projections, we simulate the demographic dividend. The fourth and final section draws policy conclusions.

Section I: Demographic and economic trends

We look at demographic changes in Russia to inform the subsequent analysis. First, we compare demographic trends in Russia with Eastern and Western Europe drawing on UN population statistics and projections.[5] Second, we look at the interplay of growth and demography across Russian regions based on data from Rosstat using the national definition of age groups.

Russia and Europe

We compare Russia with the 15 high-income economies of Western Europe and 21 transition economies of Eastern Europe. The UN data track populations in 5-year intervals. We find four interesting trends related to population, working age population, dependency ratios and composition of dependency ratios:

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[2] Existing evidence supports the link between growth and demographic changes. For example, the East Asian and Irish economic miracles are often attributed in part to changes in age structure. However, Bloom and Canning (2004) argue that countries benefit from favorable demographic trends only if their economies are open.

[3] What is a demographic dividend? It refers to an opportunity that opens up when the labor force in a country grows faster than the population dependent(children and elderly) on it – and therefore leads to increases in per capita income (all else equal). As countries develop, they undergo a demographic transition where fertility rates fall. With fewer children due to declining fertility and fewer elderly people because of lower life expectancy, the largest segment of the population is of working age. This lowers the dependency ratios leading to a demographic dividend, where countries experience increases in per capita income if effective public policies are in place. Eventually, this dividend disappears as lower birth rates lead to lower growth in labor force and better health practices lead to an expanding elderly population. This saps additional income and puts to an end the demographic dividend.

[4] Russia's official statistical agency.

[5] We use UN definitions and data to facilitate cross country comparisons. But we switch to using Rosstat data and definitions when analyzing Russian regions. Although the levels may differ slightly, the trends and structures are similar in both sources.

- Russia's *population* declined since 1995, roughly at the same pace as in Eastern Europe (Figure1). The decline is set to continue over the next 40 years. This is in contrast to the rise of the population in Western Europe. Globally, Russia is projected to move from being the ninth most populous nation in 2010 to the 14th most populous nation in 2050.

- In contrast to trends in the total population, the *working age population* (ages 15-64) in Russia increased from 1990-2010, but is projected to drop sharply in the coming decades at a rate similar to Eastern Europe (Figure1). According to UN projections, the working age population in Russia is set to decline from 103 million in 2010 to 76 million in 2050. Western Europe experienced stronger increases from 1990-2010, and is set to experience more moderate declines in the coming decades.

- The trends in working-age population translate into a v-shaped pattern for *dependency ratios*, defined as the share of the population aged less than 15 years or older than 65 as a ratio of population aged 15 to 64 (Figure 2). In Russia, the dependency ratio declined about 12 percentage points from 1995 to 2010 but is projected to increase about 15 percentage points from 2010 to 2030 because the decline in the working-age population is faster than in the total population. In Eastern Europe, the V-shape is flatter than in Russia. In Western Europe, the dependency ratio was constant in the last two decades, and is set to increase about 15 percentage points by 2030, albeit from a higher level.

Figure1: Trends in population and working age population in Russia compared to Western and Eastern Europe, 1990-2050

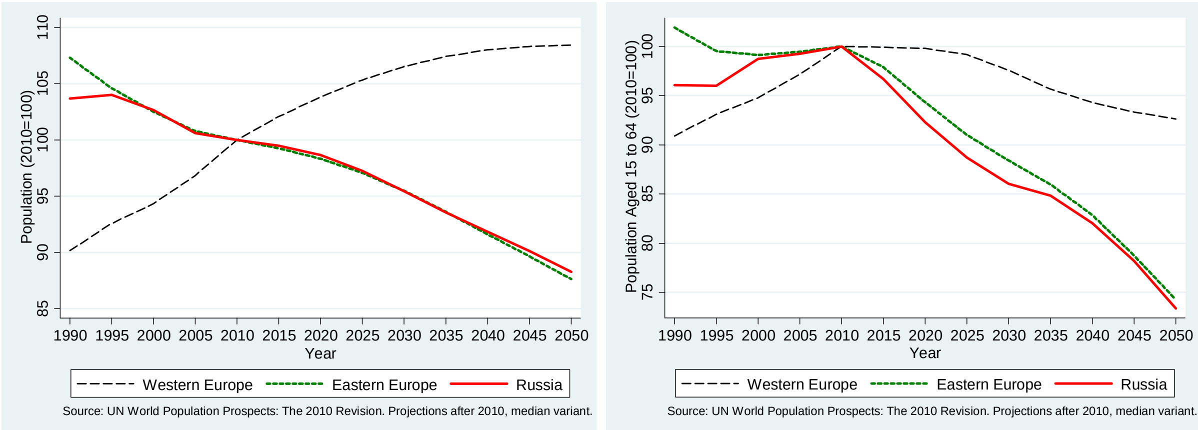
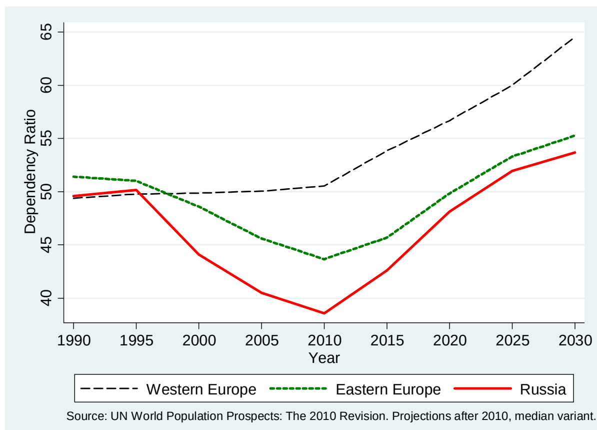
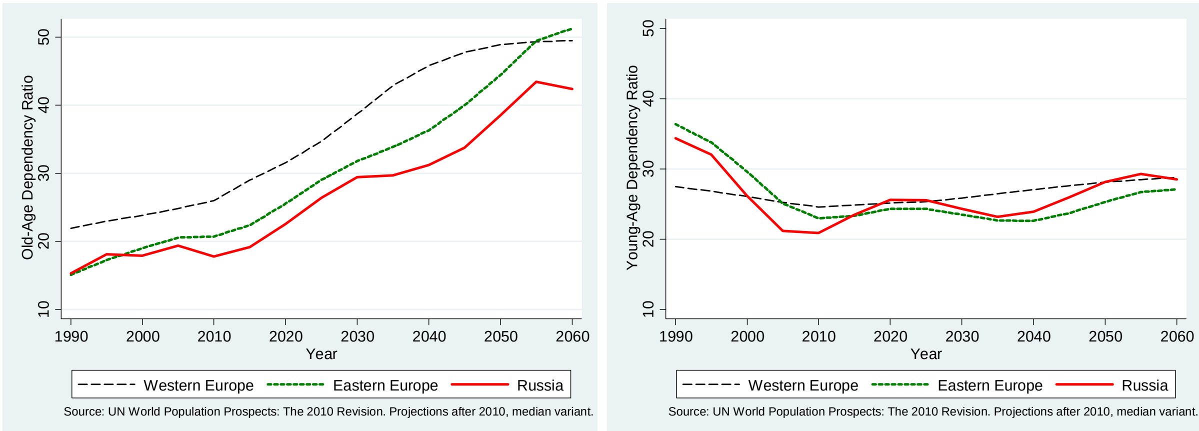


Figure 2: Dependency ratios in Russia compared to Eastern and Western Europe, 1990-2030



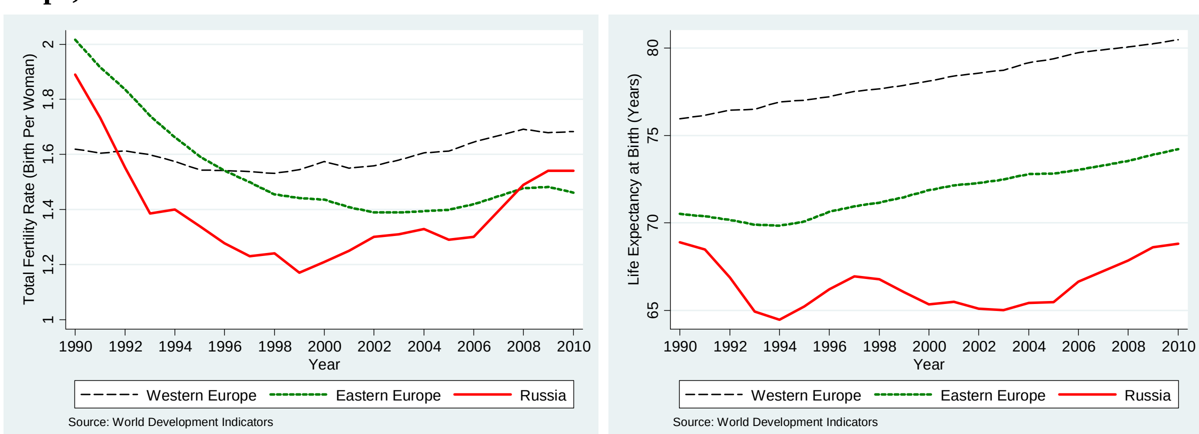
- When we separate the two *components of the dependency ratio*, it becomes clear that the changes in the dependency ratio prior and after 2010 are driven by different factors (**Figure3**). The decline in the dependency ratio prior to 2010 is linked to the drop in the share of the population aged 0 to 14 relative to the population aged 15 to 64 (young-age dependency ratio). By contrast, the rise in the dependency ratio after 2010 is driven by the rise in the share of the population aged 65 or older relative to the population aged 15 to 64 (old-age dependency ratio). The same is true for Eastern Europe. In Western Europe, in the last two decades, the moderate rise in the old-age dependency ratio was compensated by small decreases in the young-age dependency ratio, whereas the future rise in the dependency ratio is driven, as in Eastern Europe and Russia, by the rise in the old-age dependency ratio.

Figure3: Old and young age dependency ratios in Russia compared to Eastern and Western Europe, 1990-2060



Three factors account for the rapid aging of Russia's population in the coming decades (Figure 4). First, fewer people are entering the labor force today due to the sharp decline in fertility rates in the early 1990s. Second, life expectancy, which declined between around 1985 to the 2005 before increasing in recent years, is projected to continue to rise in the future. Third, this decade, the large cohorts born in the mid- and late 1950s are set to retire. In the late 2030s and 2040s, the large cohorts of children born in the 1980s in response to Soviet family policy will retire.

Figure 4: Total fertility rate and life expectancy in Russia compared to Eastern and Western Europe, 1990-2010



Regional trends in Russia

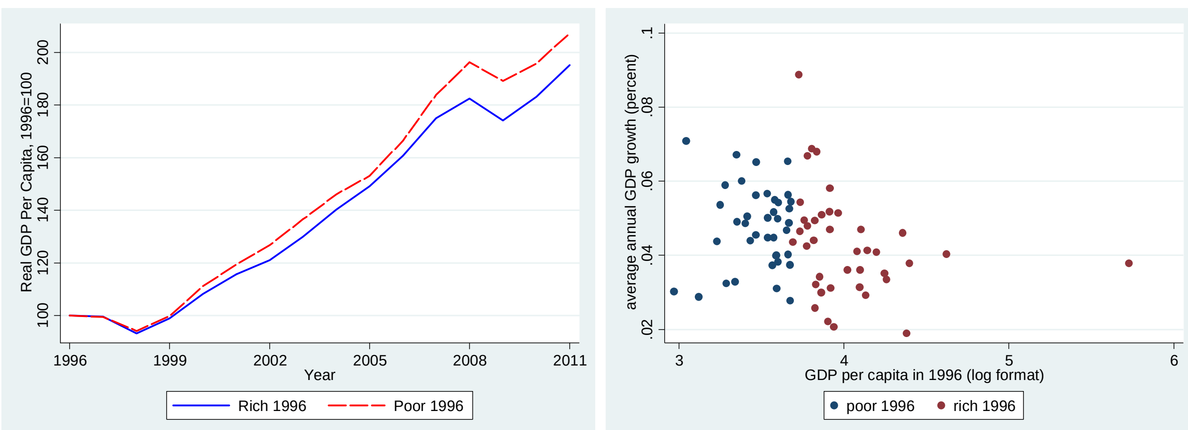
We explore the link between demographic trends and economic growth at the regional level in Russia.[6] This regional focus is motivated by three factors. First, cross-country analyses of growth are often unable to factor in country-specific circumstances. Therefore, we investigate differences within a country, while at the same time exploiting the heterogeneity of demographic trends among regions. For example, the share

[6] For this, we use Rosstat data and Russian definitions – where working age population is from 16-59 years for men and 16-54 for women.

of the population aged 65 or older ranges from 2 percent in Yamalo-Nenetsky AO to over 16 percent in Tulskaya oblast. Second, Russia's shift in demographic changes will affect most regions differently. Third, recent research suggests that the evidence of convergence[7] of output in Russian regions since the mid-1990s is mixed (Guriev and Vakulenko 2012). This evidence contrasts with trends for other countries, including the states in the United States or countries in the European Union. In view of large changes in demographic composition across regions, it is important to investigate how demographic factors influence economic convergence.

Data trends show evidence of economic convergence. Since we are interested in the link of demographic change with economic convergence, we split the regional sample into two using the median real GDP per capita income level for 1996, the first year in our sample. The two groups are labeled "poor" and "rich" regions. Data show some evidence of unconditional convergence. Econometric estimations of the next section confirm the weaker form – conditional convergence. Using control variables for differences in economic, geographic or institutional factors, poor regions grew faster than rich regions since 1999 (Figure 5).

Figure 5: Real GDP Per Capita in Poorer Regions Grew Faster than Richer Regions, 1996-2011



What were the underlying demographic trends in the regions? The decline in total population was similar for poor and rich regions. However, poor regions experienced a stronger increase in working-age population up to 2007 compared to rich regions (Figure 6). Conversely, since the early 2000s, poor regions experienced a faster drop in dependency ratios than richer regions (Figure 7).

[7] B-convergence can be *unconditional* and *conditional*. Unconditional convergence assumes that all countries (or regions) converge to the same steady state point. So based on their initial level of development, countries (or regions) would grow at different rates to reach this steady state point – higher the GDP per capita, the lower its growth rate and vice versa. The implicit assumption here is that countries (or regions) have similar structures. Unconditional convergence, on the other hand, assumes that countries (or regions) converge to different steady state points because they have different structures. Convergence is therefore said to be conditional on the structural factors (for example, geography, culture, natural resources, demographics etc.).

Figure 6: Broad Regional Demographic Trends in Russia, 1996-2011

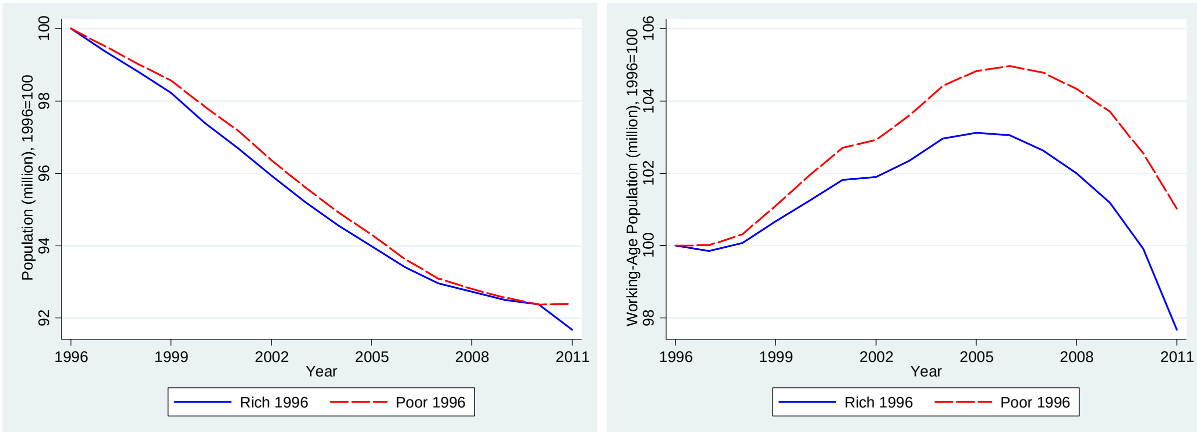
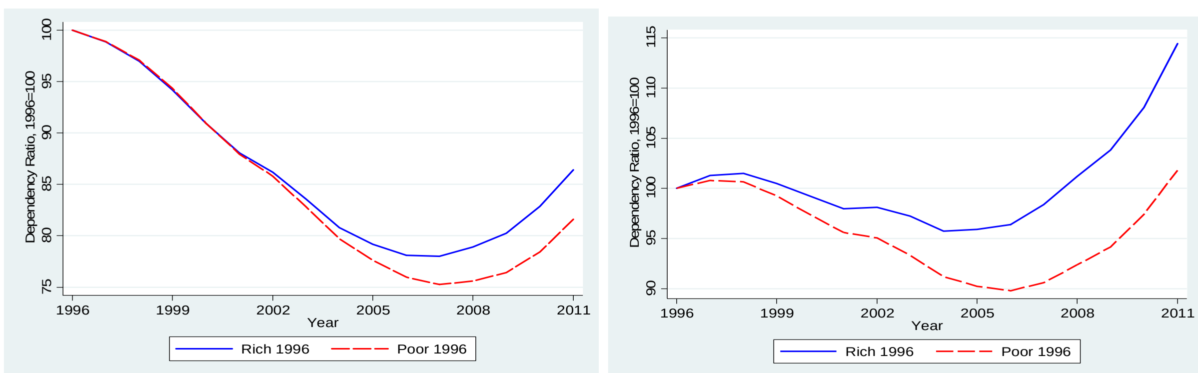


Figure 7: Dependency ratios fell faster in poorer regions compared to richer regions, 1996-2011

A. Total dependency ratio **B. Old-age dependency ratio**



Looking at projected trends, the dependency ratio is expected to be larger in the poorer regions in the future. This bivariate analysis suggests that faster growth in poor regions in the past might be in part related to the more favorable demographic trends. The flipside of this is that the worse demographic trends in poor regions in the future could dampen economic convergence.

Section II: Econometric estimation

Theoretical model

Following Aiyar and Mody (2011), we use a conditional β-convergence equation to study the effect of demographic trends on regional GDP growth per worker[8] in logarithmic form:

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

z – Logarithm of regional GDP per worker,

[8] Here, regional GDP per worker refers to regional GDP per capita of economically active population – employed and unemployed. We considered looking at GDP per employed worker only, but given that conventional definition is per capita of economically active population, we decided to use the former in our analysis. We also checked our results using GDP per employed worker and do not find much of a difference.

g_z - Growth in regional GDP per worker,
z^*- Long-run (steady-state) level of regional GDP per worker, which depends on social, economic, geographical factors,
z_0 – Initial level of regional GDP per worker,
λ - Speed of convergence.

The equation shows that the gap between the steady state level of GDP per worker and the level at the beginning of the period determines the growth in GDP per worker over time. Therefore, the equation posits that growth in labor productivity (GDP per worker) over time in less developed regions will be higher than in more developed regions if they are to reach the long-run conditions z^*. These long-run conditions could depend on a number of factors – time invariant or not ($z^* = \mu + x'\gamma$). Examples of time invariant factors include geographical location, climate, or natural resource endowments, and these are captured by fixed individual effects (μ). Examples of time variant factors include quality of labor (level of education), income inequality, hard and soft infrastructure, etc. These factors (or available proxies) further would be included in the estimated econometric equation as control variables in the panel specification ($x'\gamma$).

Rewriting equation (6) from Annex 4 for each region (*i*) and time period (*t*) and relaxing the relation of coefficients we get the model that could be estimated using various econometric techniques. Description of data used in this study is in Annex 3.

$$(7)\ d(y_{i,t}) = \rho y_{i,0} + \alpha_1 w_{i,0} + \alpha_2 d(w_{i,t}) + \beta_1 p_{i,0} + \beta_2 d(p_{i,t}) + \gamma' X_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t},$$

$y_{i,t}$ – Level of GDP per capita in the region in period t,
$w_{i,t}$ – Working age ratio in the region in period t,
$p_{i,t}$ – Participation in the region in period t,
$d(.)$ – Growth rate (difference in logarithms) of the variable,
$X_{i,t}$ – Matrix of control variables, which are time-varying factors affecting steady-state GDP growth of the region,
μ_i – Individual effects, including all time-invariant characteristics of region,
τ_t – Time effects to control for macroeconomic changes in the Russian economy,
$\varepsilon_{i,t}$ – Shocks (independent and identically distributed with zero mean).

The coefficients in Equation (7) are expected to have the following signs. We posit that initial level of GDP per capita has a negative effect on the growth rate (reflecting regional convergence). Both initial levels and growth rates of the working age ratio and participation rate should have positive signs. The signs of other factors cannot be defined *a priori* and would depend on the set of variables used for controlling the long-run level of real GDP.

We use a panel specification, which is important given the high heterogeneity among Russian regions.[9] This model allows us to use individual fixed effects for each region to capture features that are invariant over time. We also introduced time effects to capture the macroeconomic changes that have taken place at the regional level. A panel model with individual fixed effects and time effects is not flexible enough to

[9] A cross-section approach requires a wide range of control variables to capture all possible factors that influence regional heterogeneity – but we do not have the relevant data.

test for regional conditional convergence. As mentioned before, the idea of conditional convergence is that the steady state point could be different for each region depending on its characteristics. The model with individual effects captures this idea only partially because the individual effects are fixed in time and the only time variation could be through time dummies, which are common for all regions. Therefore, they could reflect only general macroeconomic shocks that affect the whole country, but cannot distinguish between regions. However, it is very likely to be the case that some regions could change their steady stage regime during the period under consideration. For example, a region could accumulate higher stock of social or physical capital and become more productive. Alternatively, a region could start to derive benefits from its geographical location. In this case, the long run level of GDP per worker could change and the model with only time and individual effects cannot deal with this. This effect is partly compensated by a relatively short sample of time-series used in our research. In this situation, not many regions could change fundamental factors that affect the steady state regime. We would like our model to be relevant for forecasting – so we needed the model to be more flexible.

To deal with this, we use control variables that could increase the quality of estimation and allow greater flexibility in the long run. In theory, these variables should reflect social and physical capital stock, some policy implications and other relevant factors. In practice, we include as many relevant factors as we were able to collect for Russian regions in the period of 1997-2011. There are five control variables in our model. Two of them are indicators of social situation in a region – the poverty rate and the Gini coefficient, which is the measure of income inequality. One more control variable used in our estimation is the share of urban population – it is a proxy for industrial development of the region what is important given Russia's economic structure. In the 5-year periods model presented later, we control for human capital (school enrollment ratio) and gender (sex ratio).

We estimate the model in logarithmic form. There could be different approaches to estimating equation (7) for Russian data. In this paper, we present two approaches that supplement each other. The first is direct estimation for the whole sample of regions and time periods. In the second, we aggregate data into 5-year periods. To estimate direct panel model we have to revise equation (7) slightly:

$$(8) \quad d(y_{i,t}) = \rho y_{i,t-1} + \alpha_1 w_{i,t-1} + \alpha_2 d(w_{i,t}) + \\ +\beta_1 p_{i,t-1} + \beta_2 d(p_{i,t}) + \gamma' X_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t},$$

The interpretation of Equation (8) is as follows. It assumes the changes between GDP and working age ratio and participation rate between *t* and initial period *t-1*. In this specification, the initial period is rolling and lagged from current period only for one year. This assumption is debatable and we return to this discussion later when we use the second approach based on aggregating data into 5-year periods. However, for the moment it is important to stay in this specification when we use Arellano-Bond estimator.

The results of direct panel estimation are shown in the first column of Table 1. All the coefficients have expected signs and are significant. Coefficients (α_1 and α_2) are of interest and they have the expected positive signs. It means that regions with higher level of working age ratio have higher growth of GDP per capita (*ceteris paribus*). The elasticity is high – for one percent of working age ratio, real GDP growth

would increase by almost 1.5 percent.[10] The growth rate of the working age population is insignificant in this specification, which could be caused by possible endogeneity. Higher initial level of participation rate as well as higher growth in it also positively contributes to GDP per capita growth. One percentage point of each could add 0.4 percent to GDP growth.

Direct estimation could lead to biased results because of endogeneity. The problem is that working age ratio and participation ratio are contemporaneous with the dependent variable. And in this case they may be affected by the previous level of GDP per capita and as a result by current level of GDP per capita growth (what is simple difference of current and previous level). The main channel of such reverse causality is migration. Internal migration is not very high in Russia (see Guriev and Vakulenko 2012), but could still be significant. There are no strong administrative barriers for migration in Russia and more developed and faster growing regions could attract more immigrants from other regions. And the majority of migrants would likely be working-age and this would increase the working-age ratio. To control for this, we use two methods.

Table 1: Estimation Results (equation 8)

VARIABLES (in logs)	(1) Panel Estimation Growth in GDP per capita	(2) Panel Estimation Growth in GDP per capita (Adjusted for migration)	(3) Arellano-Bond model GDP per capita	(4) Arellano-Bond model GDP per capita (Adjusted for migration)
initial GDP per capita	-0.234***	-0.218***	0.712***	0.739***
	(0.028)	(0.028)	(0.009)	(0.011)
initial working-age ratio	1.497***	1.453***	1.788***	1.640***
	(0.137)	(0.130)	(0.044)	(0.028)
working-age ratio growth	0.745***		0.537***	
	(0.264)		(0.118)	
adjusted working-age ratio growth		1.201***		0.977***
		(0.242)		(0.084)
initial participation rate	0.443***	0.429***	0.636***	0.592***
	(0.061)	(0.057)	(0.025)	(0.027)
participation rate growth	0.449***	0.425***	0.586***	0.547***
	(0.050)	(0.049)	(0.019)	(0.021)
Observations	1,162	1,162	1,083	1,083
R-squared	0.262	0.273		
Number of reg	78	78	78	78
Robust standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

First, we use growth of the migration-adjusted working age ratio. By this we mean the estimated working age ratio (and its growth) which could be without any migration flows (both internal and external). This variable in theory is free of endogeneity and that it why could be used in the estimation. To estimate this, we would need to subtract the net inflow of migrants from the total population of each region by age groups and recalculate the growth of the working age ratio. However, we did not have good information for migration flows in the Russian regions.[11] Instead, we had good demographic information for estimating the

[10] The high elasticity could be driven by annual dynamics. The approach that follows is less sensitive to short-term fluctuations.

[11] The information about the migration flows is collected directly but the quality of these data is poor. In our approach, we do not distinguish between the interregional and external migration.

natural increase of population (the difference between birth and mortality rates). We used these data to estimate the adjusted working age population as working age population minus the net migration inflow, which in turn was estimated as natural increase subtracted from total population increase. This method assumes that all migration inflow is of working age, which is a conservative approach.[12] But using both adjusted and non-adjusted measures of working age ratio allows us to estimate an upper bound for adjustment. The results of estimating the contribution of adjusted working are ration growth to GDP per capita growth are shown in Column (2) of Table 1. We do not find significant differences compared to the unadjusted model except the growth of the working age ratio. The contribution of the growth rate of this factor is significant in the adjusted model. It means that the bias caused by possible migration into faster growing regions could be significant.

To verify this result, we used another approach estimating dynamic panel developed by Arellano and Bond (1991). This method is based on GMM estimation, where current values of contemporaneous or predetermined values of regressors are instrumented by their lagged values.[13] In theory, this method should provide consistent estimations without any systematic bias.

The results of the estimation is presented in column (3) and (4) of the Table 1. We would like to pay attention that coefficient for the growth rate of real GDP per capita ρ+1. To compare the results with first column one should subtract 1 from the value of the coefficient. Column (3) represents the results for not adjusted working age ratio, while column (4) is for adjusted. As we mentioned before, in theory the Arellano-Bond approach should lead to consistent estimates and there is no need for additional adjustment. In practice, we estimated both models – with and without the adjustment of working age ratio growth to be on the safe side because we reduced the number of instruments significantly. The quantitative results of column (3) and (4) are very close to each other and to the general panel regression ((1) and (2)). We conclude that there is negative significant contribution of the former level of GDP per capita showing convergence. The positive effect of working age growth and level in previous period (α_1 and α_2) is still significant for adjusted for migration model that confirms tested hypothesis that demographics have a signification impact on growth.

Following Aiyar and Mody (2011), we split our sample into time periods. In principle, a decade might seem appropriate for demographic changes. However, in view of the small time period, we use 5-year periods. This approach can be justified for the case of Russia, as our sample period coincided with fast demographic changes in Russia. For growth rate within the 5-year period, we use the average of annual growth rates and for initial level – the value in the first year of the period. For control variable, we also calculated the time means. In this case, the equation for estimation is modified slightly. The only difference lies in the initial

[12] This adjustment is relevant only for working age ratio growth. While the initial (previous) level of working age ratio could also be affected by migrants who came earlier, we cannot distinguish between them and natural population of the region. However, this indicator is not contemporaneous with current level of GDP and that is why it bias of the coefficients should be smaller.
[13] The method is based on the property that past value of dependent variable and regressors are not contemporaneous with the error term and can therefore be used as instruments. They correlate with the current levels of regressors and that is why could be strong enough instruments. The idea is to use as many instruments as possible. In our case the contemporaneousness of regressors limit the amount that could be used. We could use only lagged levels of dependent variable as well as regressors, while in standard Arellano-Bond approach all regressors (including future) are used as instruments.

levels of GDP per capita, working age ratio and participation rate. They are noted with the sub-index 0 and relate to the first year of the 5-year period – 1997, 2002 and 2007, respectively. The results are presented in Table 2. Column (1) is for not adjusted working age ratio, column (2) is adjusted.

$$(9) \qquad d(y_{i,t}) = \rho y_{i,0} + \alpha_1 w_{i,0} + \alpha_2 d(w_{i,t}) + \beta_1 p_{i,0} + \beta_2 d(p_{i,t}) + \gamma' X_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t},$$

Table 2: Results Using 5-Year Averages

	VARIABLES (in logs)	(1) Panel Estimation Growth in GDP per capita	(2) Panel Estimation Growth in GDP per capita (Adjusted for migration)
1	initial GDP per capita	-0.056*** (0.019)	-0.048** (0.019)
2	**initial working-age ratio**	**0.190** (0.150)	**0.244*** (0.139)
3	**working-age ratio growth**	**0.993** (0.892)	
4	**adjusted working-age ratio growtl**		**1.627***** (0.601)
5	initial participation rate	0.102 (0.065)	0.099 (0.064)
6	participation rate growth	0.700*** (0.194)	0.620*** (0.171)
	Observations	234	234
	R-squared	0.481	0.494
	Number of reg	78	78
	Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

This model confirms the conclusions from the dynamic panel approach. The coefficients ρ is negative and significant – higher level of GDP per capita in the beginning of the 5-year period leads to lower average growth rate in the period. The elasticity is much smaller than in the dynamic panel model. The impact of working age ratio on to GDP per capita growth is positive. In the specification without the adjusted working age ratio (column (1) of Table 2), the coefficients α_1 and α_2 are insignificant. However, they are insignificant in specification with adjustment for migration (column (2) of Table 2). Again, considering longer periods (five years instead of one) the initial levels of working age ratio is less important for average GDP per capita growth, while the average growth rate of this ratio has coefficient significantly higher than one in both cases – adjusted and not adjusted. It means that one percent of working age ratio growth on average translates to more than two percent of regional GDP per capita real growth. We also note that participation rates also matter for growth.

Robustness check

To be confident that that our results are stable, we conducted robustness checks. We used several modifications of the model to see if our results were stable. As shown above, the results are stable. The main conclusion is that the working age ratio matters for economic growth in Russia at the regional and national levels. Other robustness checks include changing the definition of working age ratio. We tried to use a more commonly used retirement age of 64 for both genders. In this case, the econometric results did

not change dramatically. Most of the coefficients have almost the same values and levels of significance. The most important change is that level of working age ratio has higher elasticity – it matters more, while the growth rate of this modified ratio is insignificant in some models. We interpret this result as evidence of the demographic structure effect. From another point of view the Russian definition of working age looks more relevant, reflecting that people mostly retire close to the official age.

We also made several other modifications. Among them, we changed the length of the period for the second model. We consider a shorter period (3 years instead of 5) and two longer periods (one 7 years and the other 8 years). We also dropped the observations for Moscow and Saint Petersburg, where the labor market and general structure of the economy could be different from other regions. In all cases, the results were stable. Some coefficients became insignificant, but the results do not contradict the baseline specification.

Section III. Simulating the demographic dividend

Sample period

We use the estimated results to calculate the demographic dividend. When dependency ratios are low (either because of falling fertility rates or due to older generations having shorter life expectancy), it produces a demographic dividend (DD). If effective policies are in place to employ the burgeoning working age population, this could produce more rapid economic growth. There are at least three channels that lead to a DD (Bloom et al 2003) – labor force supply, savings and human capital accumulation. First effect is related to the higher share of people in working age translated to lower ratio of dependent categories of people (young-aged and old-aged). As the number of workers increases and the number of dependents declines (relatively), the output per capita of total population goes up. Another effect takes place through savings. Usually people save during the working period when they have the highest income. As the amount of people in the labor force increases, the savings also become bigger. These savings could translate into investment to support economic growth. In addition, the third effect is related to improving people's quality of life and life expectancy. In these conditions, people could invest more in their education and health and become more productive and stay longer in the labor market.

In this paper, we focus only on the first type of demographic dividend – the direct effect of increasing the working age ratio. Since we estimated two models using a dynamic panel approach and 5-year period panel approach, we could use either of them to calculate the demographic dividend. As in Aiyar and Mody (2011), we chose to use 5-year averages to forecast DD because it can smooth out year-to-year variations. Based on equation (7) we have the relation of average annual growth rate and the demographic factors (working-age ratio and its growth rate). To calculate the demographic dividend, we assume that the aging structure is constant for the sample period and equaled the aging structure of 1997 – the first year in our sample. Under this assumption, the working-age ratio for the all years in the sample period was constant and equaled the level of 1997. The growth rate of the working age population in this situation would be zero for all considered years. We assume that other factors are not fixed and take on their actual values in each year. Then equation (7) would be:

$$(10)\ d(y_{i,t}) = \rho y_{i,0} + \alpha_1 w_{i,1997} + \beta_1 p_{i,0} + \beta_2 d(p_{i,t}) + \gamma' X_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t}$$

Subtracting equation (10) from equation (7) yields the formula for calculating the demographic dividend. The formula is quite intuitive. First term reflects the net increase in working age ratio compared to base (1997) year multiplied by the estimated elasticity. The second terms is the growth rate of working age ratio multiplied by its elasticity. We take the total growth rate since under the assumption of constant working age ration at the level of 1997 year the growth rate would be zero.

$$(11) \qquad DD_t = \alpha_1(w_{i,t} - w_{i,1997}) + \alpha_2 d(w_{i,t})$$

We applied formula (11) to calculate the DD for the sample period of our model from 1997 until 2011. The results are presented in the table below. The results are both at the national and Federal Okrugs (district) levels. Federal Okrugs contain 7-12 regions, divided by geographical location. We also reported information for two groups of regions: rich/poor and leaders/laggards. Rich/poor is the division based on the level of GDP per capita in 1996 (the year before sample period). Leaders/laggards – based on average growth rates of first 5-year period. Leaders are 10 regions with highest average annual growth rate in the period of 1997-2001, laggards – with the lowest.

Table 3: Demographic Dividend by Groups

	Demographic dividend (DD), p.p.				GDP per capita annual growth, %				Net of DD GDP per capita annual growth, %			
	1997-2001	2002-06	2007-11	1997-2011	1997-2001	2002-06	2007-11	1997-2011	1997-2001	2002-06	2007-11	1997-2011
Russian Federation	1.1	2.1	1.4	1.5	3.8	7.8	3.3	4.9	2.7	5.7	2.0	3.4
Central Federal Okrug	1.1	2.1	1.4	1.5	5.2	9.1	2.1	5.5	4.1	7.1	0.7	3.9
North-Western Federal Okrug	1.0	1.9	1.0	1.3	3.9	8.5	3.8	5.4	2.9	6.7	2.9	4.1
Southern Federal Okrug	1.0	2.2	1.5	1.6	4.2	7.4	4.6	5.4	3.2	5.2	3.1	3.8
North-Caucas Federal Okrug	1.2	2.8	2.5	2.2	3.3	8.1	5.1	5.5	2.1	5.3	2.6	3.3
Volga Federal Okrug	1.0	2.3	1.5	1.6	3.3	6.2	4.2	4.6	2.3	3.9	2.7	3.0
Ural Federal Okrug	1.1	2.2	1.1	1.5	3.5	7.8	2.7	4.6	2.4	5.6	1.6	3.2
Siberia Federal Okrug	1.2	2.2	1.2	1.5	1.8	6.9	4.0	4.2	0.7	4.7	2.7	2.7
Far East Federal Okrug	0.8	1.3	0.3	0.8	2.5	6.0	6.0	4.8	1.7	4.8	5.6	4.0
10 Leaders	1.0	2.2	1.5	1.6	5.9	10.0	6.3	7.4	4.8	7.8	4.8	5.8
10 Laggards	1.0	1.9	0.9	1.2	3.1	3.4	2.4	3.0	2.2	1.6	1.5	1.8
Rich	1.0	2.0	1.0	1.3	3.2	6.7	3.9	4.6	2.2	4.7	2.9	3.2
Poor	1.1	2.3	1.6	1.7	3.9	7.0	4.6	5.1	2.8	4.7	3.0	3.5

Table 3 shows that DD explains a large part of growth in regional GDP per capita. On average, at the national level, it explained 30 percent of total GDP growth. This contribution is in line with other countries. For example in India the DD explained up to 40% of total GDP per growth (Aiyar and Mody 2011). During 2002-06 the absolute contribution of DD (2.1 percentage points) was highest supported by both channels – fast growth and high initial level of working age ratio, but the relative contribution was the lowest (explained only 27% of total GDP growth) because of high oil prices and other factors driving the growth in Russia. In the first and third five-year periods, the DD was much smaller – 1.1 and 1.4 percentage points, respectively. In 1997-2001, DD was explained by the fast growth of working age ratio, while in the third period by high level of working age ratio. As other factors of economic growth were on average weak in late 1990s (including 1998 crisis) and after the 2008 crisis relative contribution of DD in first and third five-year periods was higher than in the second.

On a regional level, the results are similar. Highest share of DD contribution to the total GDP per capita growth is in North Caucasus Federal Okrug where on average up to 40 percent GDP growth was explained by DD and in Siberian and Volga Federal Okrugs, where share of DD is higher than 35 percent. The smallest share of DD contribution is in Far East Federal Okrug – less than one-sixth of GDP growth was driven by

DD. The relative effect of DD was much higher for regions with low initial growth rates (laggards) comparing to leaders – 41 and 21 percent respectively. The difference in contribution of DD between initially rich and poor regions is 23 percent and 33 percent of total GDP growth.

Forecasting of demographic dividend

We use the estimated model to forecast the demographic dividend. To do this, we used the official demographic forecast provided by Rosstat. It compares the population by regions and divides it into three age groups: before working age, working age and older than working age. Also there are three scenarios – named *high, low and baseline* – but we renamed the scenarios. According to Rosstat, the *high* scenario assumes higher amount of total population and the higher fertility rate what translates to higher young-dependency ratio and therefore corresponds to a lower working is ratio. The low is *vice-a-versa*. Instead, we chose to call them high/low fertility rate scenarios as it reflects they structure better (Figure 8 in the Annex 1). We simulated the DD by three scenarios for all regions (results reported only for the macro regions in table 4) and for the national level assuming that aging structure in Russia would be the same as it was in 2011 – the last year for which we have actual data.

Table 4: Forecasts of Demographic Dividends

Simulation of demograpfic dividend based on official population by age groups forecast												
	Scenario 1 (low fertility)				Scenario 2 (baseline)				Scenario 2 (high fertility)			
	2012-16	2017-21	2022-30	2012-30	2012-16	2017-21	2022-30	2012-30	2012-16	2017-21	2022-30	2012-30
Russian Federation	-1.2	-1.8	-1.5	-1.5	-1.5	-2.3	-2.2	-2.0	-1.6	-2.6	-2.5	-2.3
Central Federal Okrug	-1.3	-1.9	-1.7	-1.7	-1.6	-2.5	-2.4	-2.2	-1.7	-2.7	-2.6	-2.4
North-Western Federal Okrug	-1.3	-1.7	-1.3	-1.4	-1.6	-2.3	-2.1	-2.0	-1.7	-2.4	-2.2	-2.1
Southern Federal Okrug	-1.2	-1.8	-1.5	-1.5	-1.4	-2.2	-2.1	-2.0	-1.6	-2.6	-2.6	-2.3
North-Caucas Federal Okrug	-0.6	-1.5	-1.5	-1.3	-0.8	-2.0	-2.1	-1.8	-1.2	-2.6	-2.8	-2.3
Volga Federal Okrug	-1.2	-1.9	-1.6	-1.6	-1.5	-2.4	-2.3	-2.1	-1.6	-2.7	-2.7	-2.4
Ural Federal Okrug	-1.3	-1.7	-1.3	-1.4	-1.6	-2.3	-1.9	-1.9	-1.7	-2.5	-2.2	-2.2
Siberia Federal Okrug	-1.3	-1.8	-1.3	-1.4	-1.6	-2.3	-2.0	-2.0	-1.8	-2.6	-2.4	-2.3
Far East Federal Okrug	-1.2	-1.6	-1.2	-1.3	-1.5	-2.1	-1.9	-1.8	-1.7	-2.4	-2.2	-2.1
10 Leaders	-1.1	-1.7	-1.5	-1.5	-1.3	-2.2	-2.1	-1.9	-1.5	-2.6	-2.5	-2.3
10 Laggards	-1.2	-1.7	-1.3	-1.4	-1.4	-2.2	-1.9	-1.9	-1.6	-2.5	-2.3	-2.1
Rich	-1.2	-1.7	-1.3	-1.4	-1.5	-2.2	-2.0	-1.9	-1.6	-2.5	-2.3	-2.2
Poor	-1.2	-1.8	-1.5	-1.5	-1.4	-2.3	-2.2	-2.0	-1.6	-2.7	-2.6	-2.4

We see that in all scenarios for all macro regions (and almost all regions) the contribution of the DD would be negative for regional GDP per capita growth. Negative contribution increases after 2017 when the decline of working age ratio becomes faster and reaches low levels. The distribution of DD effect across Federal Okrugs is quite uniform. As we discussed before, the dependency ratio in the scenario with a high fertility rate is higher. Therefore, the negative contribution of DD in the scenario with a high fertility rate would be 1 percentage point higher than in the scenario with a lower fertility rate. It means that government is faced with a tradeoff. Supporting fertility and trying to increase the total population, the policy makers would put additional pressure on regional GDP growth at least in the medium term (until 2030).

We are now in position to simulate the impact of increasing the retirement age. For this, we would need information on the "effective" retirement age – the real age at which people retire which could differ from the official retirement age in practice. Some people are allowed to and prefer to retire earlier because of specific labor conditions or problems with health, while others may choose to work longer. It means that on average people retire "gradually." It is hard to estimate exact retirement age, so we assume that official retirement is a good proxy for this "effective" retirement age. We note in Table 5 that a gradual increase in

the retirement age to 64 for both men and women has a significant impact on the demographic dividend possibly because the share of population ages 60-64 for men and 55-64 for women is fairly large.

Table 5: Demographic Dividend with Higher Retirement Age

Simulation of demograpfic dividend based asuumtion of gradual increase of retirment age and official population by age groups forecast

	Scenario 1 (low fertility)				Scenario 2 (baseline)				Scenario 2 (high fertility)			
	2012-16	2017-21	2022-30	2012-30	2012-16	2017-21	2022-30	2012-30	2012-16	2017-21	2022-30	2012-30
Russian Federation	-0.2	1.0	1.8	1.0	-0.5	0.5	1.2	0.6	-0.6	0.3	0.9	0.3
Central Federal Okrug	-0.2	1.1	1.8	1.0	-0.5	0.6	1.2	0.6	-0.6	0.4	1.0	0.4
North-Western Federal Okrug	-0.2	1.2	2.0	1.2	-0.5	0.7	1.4	0.7	-0.6	0.5	1.2	0.6
Southern Federal Okrug	-0.1	1.1	1.9	1.1	-0.4	0.7	1.3	0.7	-0.5	0.4	1.0	0.4
North-Caucas Federal Okrug	0.0	0.6	1.0	0.7	-0.2	0.1	0.4	0.2	-0.5	-0.5	-0.1	-0.3
Volga Federal Okrug	-0.2	1.0	1.7	1.0	-0.4	0.5	1.2	0.6	-0.6	0.2	0.8	0.3
Ural Federal Okrug	-0.3	1.0	1.9	1.1	-0.6	0.5	1.3	0.6	-0.7	0.3	1.0	0.4
Siberia Federal Okrug	-0.4	0.9	1.8	1.0	-0.6	0.5	1.2	0.5	-0.8	0.2	0.9	0.3
Far East Federal Okrug	-0.3	1.2	2.0	1.2	-0.5	0.7	1.4	0.7	-0.7	0.4	1.1	0.5
10 Leaders	-0.1	1.0	1.7	1.1	-0.3	0.6	1.2	0.6	-0.5	0.3	0.8	0.3
10 Laggards	-0.3	1.0	1.8	1.1	-0.5	0.5	1.3	0.6	-0.6	0.3	1.0	0.4
Rich	-0.2	1.2	2.0	1.2	-0.5	0.7	1.4	0.7	-0.6	0.4	1.1	0.5
Poor	-0.2	1.0	1.7	1.0	-0.4	0.5	1.1	0.6	-0.6	0.2	0.8	0.3

Section IV. Conclusions

Absent policy changes, the aging of the Russian population is likely to have an adverse impact on growth and convergence. Russia's economy benefited from favorable demographic trends from the mid-1990s until the last few years. In the coming decades, however, Russia's population is expected to age, which could dampen prospects for growth and convergence among Russia's regions. This challenge underlines the importance of wide-ranging policy changes to help families, workers, and businesses to adjust to population aging. The paper discusses one crucial reform, the increase in the official retirement age. This policy would need to be complemented by measures to ensure that this translates into a rise of the effective retirement age. Other policies include, among others, the following: increased investment in preventative care to improve health status and thus enable people to work longer; lifelong learning programs and other steps to refresh the skills of an aging workforce; taking legal measures against age discrimination and reducing other constraints on mobility (e.g. making pensions portable); and the provision of quality day care and long term care to facilitate greater labor force participation (which would particularly benefit women, who provide the bulk of such care). By contrast, simply focusing on increasing fertility rates will only address the aging challenge partially. Without supporting policies, mothers might drop out of the labor market to take care of their children, which would further reduce the number of workers. All of these efforts would not only bolster growth and convergence, but also make social security systems more sustainable.

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Annexes

Annex 1. Charts

Figure 8. Dynamics of dependency ratios and their forecast in different sources of data.

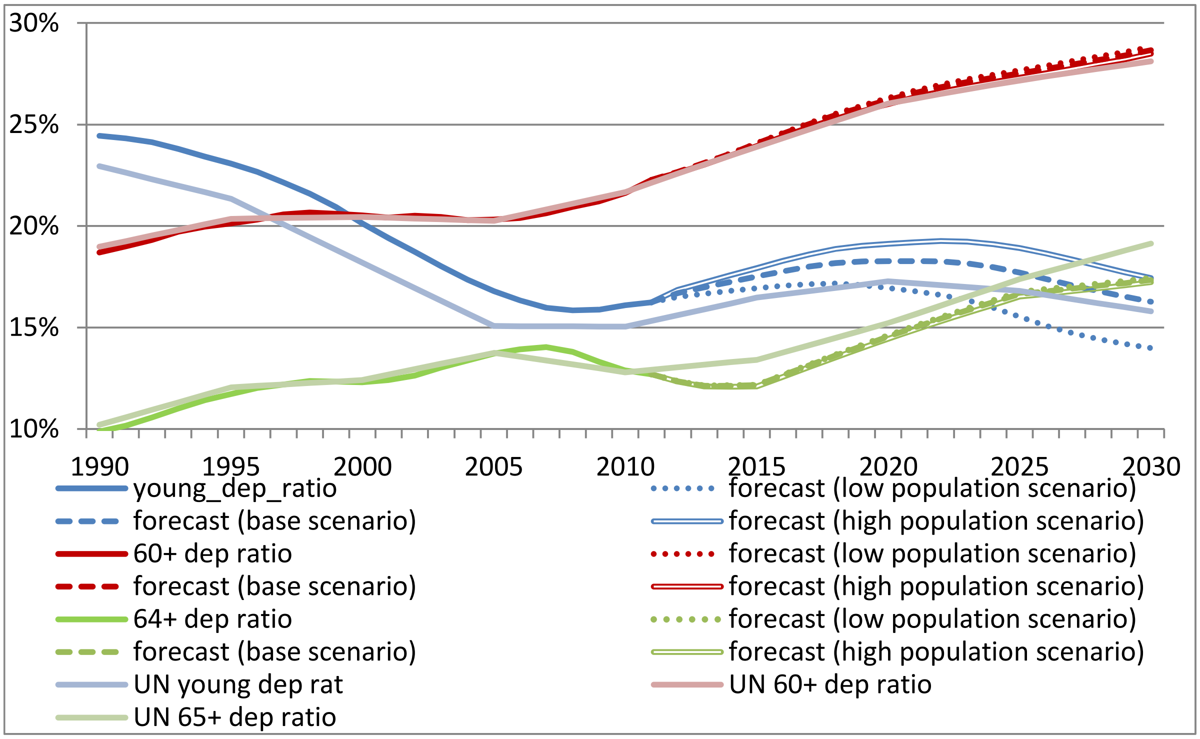
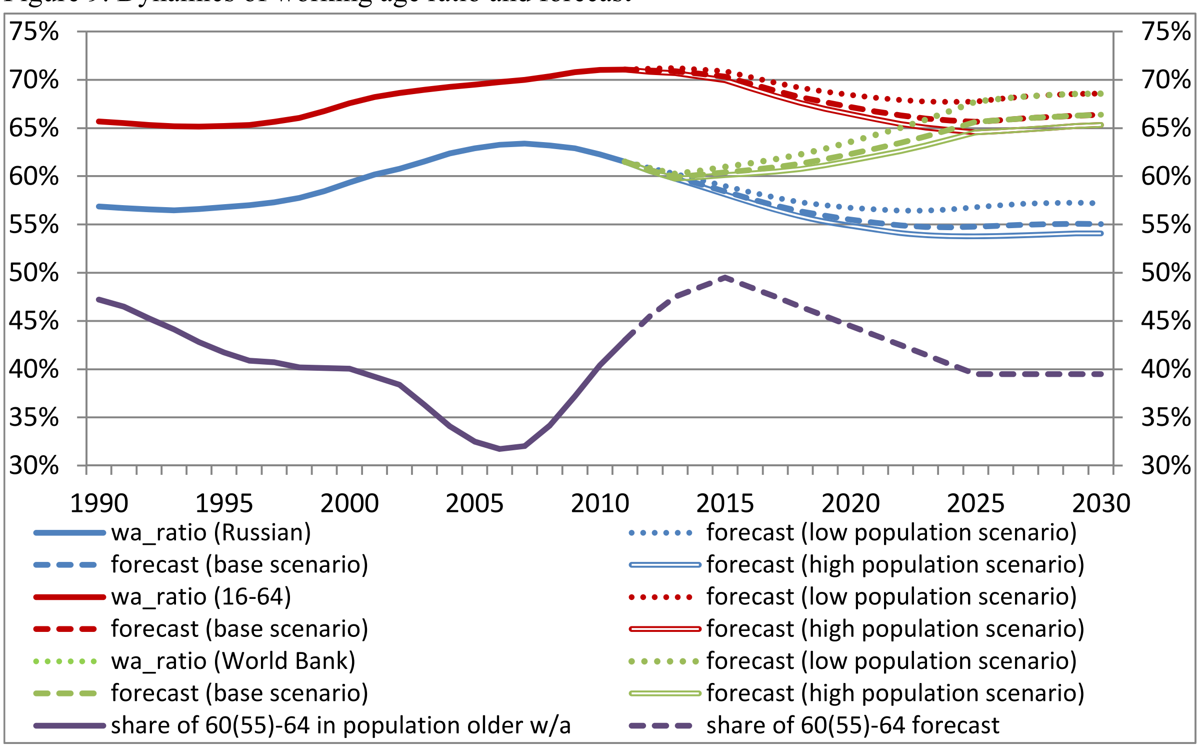


Figure 9. Dynamics of working age ratio and forecast



Annex 2. Data

1. Russia consists of 83 regions (republics, oblasts, krais and so on). Because of regional conflicts, data for some regions is not available and are excluded from this analysis. Using data for 15 years and 78 oblasts means that we have 1170 observations.

2. Estimating the impact of demographic trends on regional growth requires availability of relevant data.

- First, data on all relevant indicators has to be available at the regional level. Regional data – especially demographic data – is available in Russia and are posted on the Rosstat website. Besides, a number of variables are also available at the regional level – some of which were used as control variables in this analysis. There is, however, data on migration is of poor quality at the regional level. As we will see later, this information is necessary for controlling endogeniety in the demographic structure. Therefore, we used birth and mortality rates to calculate natural increases in population and then subtracted it from the regional population to get an approximation of migration statistics.
- In addition, we need long time series because demographic changes are largely inert. Unfortunately, the time series in Russia is not long enough both at the regional and national level because of the relatively short period since the transition. Data are at best available for 15-20 years on a comparable basis. So this study is based on data for 15 years (1997-2011) – which is not long enough for demographic analysis. However, given that this period coincided with important demographic changes, we think that the analysis would still be relevant.

Annex 3. Descriptive Statistics

	GDP per capita (thsd 2003 constant rub)				GDP per capita annual growth, %			
	1997-2001	2002-06	2007-11	1997-2011	1997-2001	2002-06	2007-11	1997-2011
Russian Federation	55	69	102	75	3.5	7.5	3.1	4.7
Central Federal Okrug	67	86	136	96	4.9	8.7	1.8	5.1
North-Western Federal Okrug	54	72	110	79	3.7	8.2	3.7	5.2
Southern Federal Okrug	32	42	63	46	3.9	7.1	4.3	5.1
North-Caucas Federal Okrug	18	23	35	26	3.0	7.7	5.0	5.2
Volga Federal Okrug	46	54	78	59	3.1	6.0	4.0	4.3
Ural Federal Okrug	101	123	181	135	3.3	7.5	2.5	4.4
Siberia Federal Okrug	47	56	80	61	1.6	6.7	3.8	4.0
Far East Federal Okrug	66	79	110	85	2.3	5.9	5.7	4.6
10 Leaders	38	60	84	61	6.8	6.2	3.9	5.6
10 Laggards	49	51	67	56	-0.2	5.5	4.7	3.3
Rich	64	78	110	84	2.9	6.4	3.7	4.3
Poor	31	41	59	43	3.4	6.6	4.3	4.8

	working age ratio, %				working age ratio annual growth, %			
	1997-2001	2002-06	2007-11	1997-2011	1997-2001	2002-06	2007-11	1997-2011
Russian Federation	57	61	63	60	0.6	0.6	-0.4	0.3
Central Federal Okrug	57	60	63	60	0.7	0.6	-0.3	0.3
North-Western Federal Okrug	59	62	64	62	0.6	0.5	-0.4	0.2
Southern Federal Okrug	56	59	62	59	0.6	0.6	-0.3	0.3
North-Caucas Federal Okrug	54	58	62	58	0.7	0.8	-0.1	0.5
Volga Federal Okrug	57	60	63	60	0.6	0.7	-0.3	0.3
Ural Federal Okrug	59	62	65	62	0.7	0.6	-0.5	0.3
Siberia Federal Okrug	58	62	64	61	0.7	0.6	-0.5	0.3
Far East Federal Okrug	62	65	66	64	0.5	0.4	-0.5	0.1
10 Leaders	57	61	64	61	0.6	0.7	-0.4	0.3
10 Laggards	59	62	65	62	0.6	0.6	-0.5	0.2
Rich	59	62	64	62	0.6	0.6	-0.5	0.2
Poor	56	60	63	60	0.6	0.7	-0.3	0.3

	partcipation rate, %				partcipation rate annual growth, %			
	1997-2001	2002-06	2007-11	1997-2011	1997-2001	2002-06	2007-11	1997-2011
Russian Federation	80	82	83	82	-0.2	0.2	0.8	0.3
Central Federal Okrug	80	85	86	84	0.4	0.0	0.2	0.2
North-Western Federal Okrug	84	84	88	86	-0.5	0.5	0.6	0.2
Southern Federal Okrug	77	81	82	80	0.2	0.1	0.6	0.3
North-Caucas Federal Okrug	59	65	75	66	1.2	1.5	0.8	1.2
Volga Federal Okrug	83	83	83	83	-0.3	-0.2	1.1	0.2
Ural Federal Okrug	83	81	82	82	-1.0	0.3	1.4	0.2
Siberia Federal Okrug	81	80	80	80	-0.9	0.2	1.3	0.2
Far East Federal Okrug	83	80	82	82	-0.9	0.2	1.6	0.3
10 Leaders	80	82	83	82	-0.3	0.5	0.4	0.2
10 Laggards	82	81	82	82	-0.5	-0.2	1.8	0.4
Rich	83	83	84	83	-0.6	0.1	1.2	0.2
Poor	80	81	81	81	-0.3	0.1	0.9	0.2

Annex 4. Model

3. We are mostly interested in estimating the effect of demographic changes especially the working age ratio onto the regional GDP growth. To include demographic variables as factors that determine the long-run level of GDP per worker, we considered the following identity.

$$\frac{Y}{N}=\frac{Y}{L}\cdot\frac{L}{W}\cdot\frac{W}{N}, \quad (2)$$

Y – Real regional GDP (in 2003 rubles),

N – Regional population,

L – Labor force (number of employed and unemployed workers),

W – Working age population.

4. According to equation (2), GDP per capita $\left(\frac{Y}{N}\right)$ is the product of GDP per worker $\left(\frac{Y}{L}\right)$ times the participation rate $\left(\frac{L}{W}\right)$ times the working age ratio $\left(\frac{W}{N}\right)$. We are interested in the effect of last term onto the GDP per capita growth to study the demographic dividend. If we denote equation (2) in logarithm with the following notations, we get:

$$z=y-p-w, \quad (3)$$

$$z=\ln\left(\frac{Y}{L}\right), y=\ln\left(\frac{Y}{N}\right), p=\ln\left(\frac{L}{W}\right), \qquad w=\ln\left(\frac{W}{N}\right).$$

5. Equation (3) should be relevant to each period t:

$$y_t=z_t+p_t+w_t. \quad (4)$$

6. If we subtract the previous period (t-1) from equation (4), we get the relation for growth rates, considering, that

$$d(x_t)=\ x_t-\ x_{t-1}=\ln(X_t)-\ln(X_{t-1})\approx\frac{X_t-X_{t-1}}{X_{t-1}}\equiv g_x.$$

$$g_y=g_z+g_p+g_{w.} \quad (5)$$

7. Combining (5) with (1) and considering that $z_0=y_0-p_0-w_0$, we get:

$$g_y=\lambda(\mu+x'\gamma-y_0+p_0+w_0)+g_p+g_{w.} \quad (6)$$

As in Aiyar and Mody (2011), we relax restrictions on the coefficients of demographic variables because in its current form, equation (6) is restrictive. It assumes, for example, that growth rate of participation rate and working-age ratio should be directly translated into growth rate of regional GDP with unit elasticity, which may not be the case. So no restrictions are imposed on the coefficients of demographic variables.