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SPATIAL DEVELOPMENT

Regional Convergence or Polarization: The Case of the Russian Federation

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Abstract—We analyse growth patterns of the Russian federal subjects, and test if all regions converge to a common growth path, or if there are many convergence clubs by using the data on regional GDP per capita for the 1996–2017 period. Our analysis shows that there are four different convergence clubs in the Russian Federation, and there is no geographical concentration of the clubs. The regions with dynamic population movements are likely to be in high-income clubs, and they attract more people. Most of the national republics are included in low-income clubs, and, after controlling for other factors, we find that the North Caucasian republics are likely to be members of low-income clubs, whereas there is not much difference between other republics and regions. The persistence of income differences across convergence clubs is a cause of concern for long term sustainable growth and stability.

Keywords: Russian Federation, convergence, convergence clubs, regional growth, regional inequality

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INTRODUCTION

The Russian Federation is the largest country in the world by total area (about 17 mln km^2), extends across 11 time zones, and includes 85 federal subjects: 22 republics, 9 krais, 46 oblasts, 3 federal cities, 4 autonomous okrugs, and 1 autonomous oblast.[1] It is also ethnically one of the most diverse federations in the world: the republics are historically home to non-Russian nations, and, they have 'the right to establish their own state languages' in addition to the Russian language, the state language of the whole federation.

The Russian Federation has attracted the attention of researchers who analyse regional inequalities and development because of its enormous size, diversity, and global influence. There are numerous studies on regional development, inequalities, and convergence in the Russian Federation. Most of these studies have tested the so-called 'convergence hypothesis' (if there is any regional convergence) and estimated the rate of convergence (how fast regions converge to each other). However, the convergence hypothesis is valid under quite restrictive assumptions, and researchers tend to conclude that countries/regions may have different growth patterns, and may 'converge' towards different growth paths, i.e., there could be many 'convergence clubs', or no convergence at all.

In this paper, we adopt an "empirical approach" to convergence in the Russian Federation because of economic, social, and political implications of regional growth and equality in such a large, diverse, and multi-national country (for the empirics of growth, see (Durlauf and Quah, 1999)). We analyse growth patterns of Russian federal subjects, and test if all regions converge to a common growth path, or if there are many convergence clubs by using the data on regional GDP per capita for the 1996–2017 period. Our analysis shows that the standard convergence hypothesis is not supported by the data, and we can identify four convergence clubs in the Russian Federation. We also analyse if the clubs are concentrated in certain regions, if they have similar migration patterns, and if they differ in terms of national structure by using ordered logit estimation. We found that there is no geographical concentration of the clubs: i.e., all clubs are distributed across the Russian Federation. The regions with dynamic population movements (immigration and emigration) are likely to be in high-income clubs, and they attract more people. Most of the national republics are included in low-income clubs, and, after controlling for other factors, we find that the North Caucasian republics are likely to be in low-income groups, whereas there is not much difference between other republics and regions.

[1] For the federal structure, see the Constitution of the Russian Federation, Chapter 3 (http://www.constitution.ru/en/10003000-04.htm. Accessed July 16, 2021). The Republic of Crimea and Sevastopol (as a federal city) were incorporated into the Russian Federation in 2014. These two regions are not included in our dataset that covers the period from 1996 to 2017.

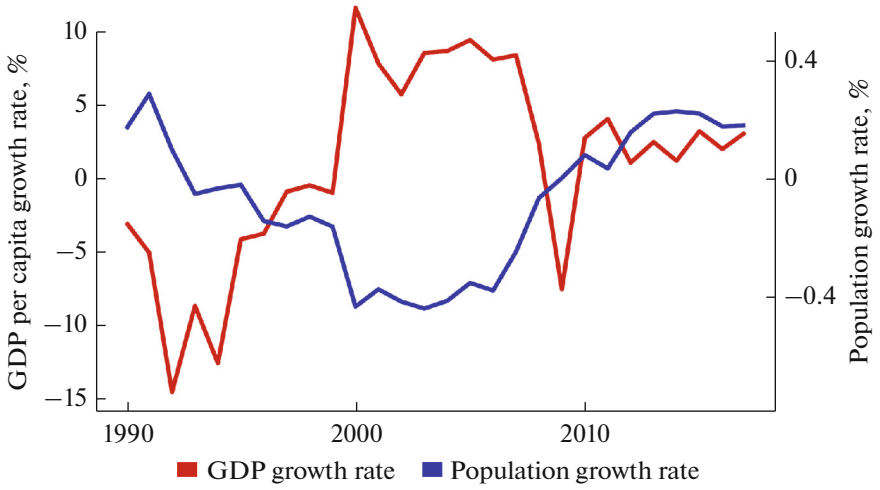

Fig. 1. Growth rates of GDP per capita and population, 1990–2017.

The paper is organized as follows. After the Introduction, section *Economic Growth in Russian Federation* provides information on economic growth in the Russian Federation in the post-1990 period. A short survey of the literature on regional convergence dynamics in the Russian Federation is presented in section *Regional Growth and Convergence in Russian Federation*. Section *Dynamics of Regional Development and the Convergence Clubs* explains the methodology used to identify the convergence clubs, the data sources, and the estimation results. The last chapter summarizes the main findings of our study.

ECONOMIC GROWTH IN RUSSIAN FEDERATION

The Russian Federation experienced a substantial economic crisis after the dissolution of the USSR in 1991. As a result of the collapse of the whole economic system, GDP, after already had declined 3% in 1990, and 5% in 1991, dropped dramatically in 1992 (14.5%). The economy continued to contract until 1999 so that GDP in 1998 was only 55% of its 1989 level (Fig. 1).[2]

Deteriorating economic conditions took its toll on population growth as well. Population declined continuously from 1992 up until 2008 (from 148.5 to 142.7 mln people). The annual population growth rate reached only 0.2% in the mid-2010s.

GDP per capita recovered quickly in the first decade of the post-reform period and achieved 8.5% average annual growth rate in the 1999–2007 period. The world economic crisis in 2008 led to a sharp decline in GDP per capita in 2009 (–7.5%), and GDP per capita increased on average 2.5% each year since 2009.

It is possible to identify three periods of economic growth based on the GDP data: 1992–1998, 1999–2008 and 2009–2020. The first period starts with the collapse of the USSR and ends with the financial crisis of 1998. The second period starts with the recovery following the sharp devaluation of ruble after the crisis and ends with world economic crisis (it coincides with the end of Putin's second term), and the last period covers the post-crisis period until the COVID-19 pandemic in 2020.[3]

Oil and natural gas exports play an important role in the Russian economy as mentioned frequently in studies on regional development. Changes in oil prices followed a pattern similar to the above-mentioned periodisation of the Russian economy. Crude oil prices fluctuated around USD 20 per barrel in the 1990s. After a sharp decline in 1998 (USD 12.7 per barrel), crude oil prices continuously increased until the onset of the world economic crisis and reached almost USD 100 in 2008. After a decline in 2009 (USD 62), oil prices remained within the USD 100–110 band until the end of 2015 and fluctuated extensively around USD 60 until the COVID-19 pandemic. High prices for oil provided additional impetus for economic growth after the financial crisis in 1998 (1999–2008).[4]

[2] Unless otherwise stated, we use the World Bank data (World Development Indicators) for the 1990–1996 period, and the OECD data for the period after 1996.

[3] Berkowitz and DeJong (2011) mention small-scale entrepreneurial activity was the engine of regional growth in the transition period, but the emergence of bank-issued credit has played a dominant role since 2000.

[4] For crude oil prices, see Our World in Data web site (https://ourworldindata.org/grapher/crude-oil-prices?time=1986..latest).

REGIONAL GROWTH AND CONVERGENCE IN RUSSIAN FEDERATION

An extensive literature on economic growth and convergence has surged after the seminal papers by Solow and Swan on growth theory. The neo-classical model suggests that, under certain conditions, all countries will reach to the same long run steady state equilibrium where income per capita differences will not exist. Empirical studies identified two types of convergence: Sigma (σ) convergence implies that the dispersion of real income per capita, measured by the standard deviation of log real income per capita or other inequality measures, would decline over time, whereas Beta (β) convergence is defined as negative partial correlation between initial income per capita and income per capita growth, i.e., those countries with low income per capita would achieve higher growth rates so that their income per capital will catch up with the developed countries' level. However, the steady state level may differ between countries, for example, because of differences in propensity to save. In such a case, each country will converge towards its own steady state level, and the growth rate will be positively related to the distance between the current capital intensity and its steady state level. This is called the 'conditional beta convergence' (for a survey, see (Sala-i-Martin, 1996); for a critical evaluation, see (Gluschenko, 2012)).

Empirical studies on economic growth failed to find convergence across countries and showed that differences in income per capita persist for some countries. It is then suggested by many researchers that there may exist various growth paths leading to different 'convergence clubs' because of the factors such as capital markets imperfections, externalities, and non-convexities or even global divergence is possible under specific conditions (Galor, 1996; Quah, 1997). New methods have also been developed to identify convergence clubs (see, for example, (Beylunioğlu et al., 2018; Phillips and Sul, 2007, 2009)).

There are a large number of papers on regional development, inequalities and convergence in the Russian Federation (for an early literature review, see (Gluschenko, 2011)). These studies differ in terms of the measures used to identify regional inequalities, the methodologies adopted to identify convergence dynamics, and the time period under consideration.

In one of the early studies on regional inequality Fedorov (2002) used Gini coefficient and the Generalized Entropy Index to measure regional inequality and polarization. By using the data on 77 regions for the 'transition decade' of 1990–1999, Fedorov showed that inequality and polarization increased in the first half of the decade but remained almost constant in the second half. Geographical location (west vs east) or ethnicity (ethnic Russian regions vs national republics) did not play an important role in explaining regional differences. Dolinskaya (2002) found similar results while using a different methodology (transition matrix approach). Findings of Carluer and Sharipova (2004), based on the 1985–1999 data and Sigma and Beta measures, provide additional empirical support for weak conditional convergence in the late 1990. Solanko (2008) examined the 1992–2005 period and reached similar results: income levels diverged during the transition period, especially among the initially better-off regions. Differences in the dynamics of richer and poorer regions seem to suggest polarization among Russian regions.

Babetski and Maurel (2003) and Ahrend (2005) analysed the effects of institutions and politics on the dynamics of regional convergence. They found that convergence in the 1995–1999 period was faster in regions that implemented market institutions such as macro-economic stabilization, price liberalization, small-scale privatization, and break-up of state-owned enterprises. Ahrend (2005) found neither the political orientation of regional leaders, nor the political preferences of the population had a significant impact on economic growth whereas structural factors (initial industrial structure, and natural and human resource endowments) were correlated with economic growth.

Drobyshevsky et al. (2005) and Buccellato (2007) demonstrated the importance of natural resources, especially oil and natural gas, for regional growth in the Russian Federation. Moreover, Drobyshevsky et al. (2005) found that federal financial aid and the budget investment policy had no significant impact on regional growth rates.

In one of the rare studies on convergence clubs in the Russian Federation, Carluer (2005) observed a bimodal polarization process during the 1985–1999 period where a large number of regions were lagging behind and a small group of regions (the metropolitan, eastern and northern ones) have moved up the ladder of growth clubs. Carluer draws our attention to the 'the very real threat of an irreversible lock-in' so that the polarization process could further reinforce itself in the future. Tochkov (2021) obtained similar results by using the same methodology (Markov transition matrices) for the 1994–2015 period.

To summarize, studies on the reform (transition) period (1992–2000) obtained similar results: regional inequality increased in the first half, and stabilized later on. Initial endowments and natural resources (especially oil and natural gas) had played an important role in regional growth during the reform decade. However, the findings on the post-reform (consolidation) period (post-2000) are rather mixed and do not lead to a robust conclusion.

Akhmedjonov et al. (2013) studied the 2000–2008 period and did not find any evidence for unconditional convergence. Their findings suggest that there was regional convergence conditional on a number of socioeconomic indicators, most notably physical cap-

ital accumulation. However, Lehmann and Silvagni (2013) found based on Beta convergence regressions that per capita income differences across regions increased at a declining rate during the 1995–2010 period, and their results were robust against the definition of income and the estimation methodology. They also found that 'extractive activities in the Urals and of business services and of the public administration in the Moscow area' were the main factors that explain the lack of convergence.

The paper by Guriev and Vakulenko (2012) suggests that there was no convergence among Russian regions in the second half of the 1990s, but 'the differentials in incomes and wages decreased substantially' in the post-reform period (2000–2010). It is claimed that poor Russian regions were in a poverty trap in the 1990s because workers in poor regions could not afford to migrate to rich regions. The integration of capital and labour markets at the national level in the 2000s eliminated the poverty traps, and capital and labour have become mobile across regions. This process was the main factor behind regional convergence in the first decade of the first millennium.

Durand-Lasserve and Blöchliger (2018) analysed regional growth in the 2004–2015 period and estimated the rate of convergence in regional gross domestic product (GDP) per capita as 2%, in line with the 'iron law of convergence' between countries. Capital investment (public investment in particular) and natural resources are among the main drivers of regional growth.

Analysis of Iwasaki and Suganuma (2015) based on the data for 71 regions for the 1995–2011 shows that foreign direct investment is also another factor that facilitates regional growth. Analysis of Torbenko (2014) suggests unconditional Beta convergence in the 2000s, but federal government expenditures and transfers did not have any effect on the convergence process because the 'federal government's policy was reactive and was not focused on decreasing interregional inequality'.

Perret (2019) analysed the 1994–2013 period by using a variety of tools (panel data regression, Kernel density, Markov transition matrices, and quantile regression), and found absolute convergence up to Putin's second presidential term (2004) and during his third term (2012–2013), and conditional convergence in all time periods.

There are also some studies on the spatial effects on regional convergence. For example, Kholodilin et al. (2012) analysed the impact of spatial effects on regional convergence in the period 1998–2006 and found that the overall rate of convergence becomes lower after controlling for spatial effects. Moreover, their results support spatial dependence: there is a strong regional convergence among high-income regions located near other high-income regions. Danilenko et al. (2018) estimated spatial regression by using the 2005–2012 data, identified three clubs of regions: two clubs with high (low) unemployment surrounded by regions with high (low) unemployment, and the third group of the remaining regions.[5]

Studies on regional convergence on the post-reform period (the period after 2000) did not reveal a strong tendency towards regional convergence in the Russian Federation. However, most of these studies test the hypothesis of convergence of all regions. Given their enormous diversity in terms of capital accumulation, natural resources, geographical conditions, and national composition, the regions in the Russian Federation are likely to experience heterogeneous growth patterns. Therefore, we need to apply a methodology that allows heterogeneity in growth patterns in order to understand the dynamics of regional growth.

DYNAMICS OF REGIONAL DEVELOPMENT AND THE CONVERGENCE CLUBS

In this section, we will analyse the dynamics of regional convergence by using the convergence clubs' approach (see (Phillips and Sul, 2007, 2009)). This approach has three advantages: first, it allows us to identify multiple clubs because we do not impose the condition that all regions will converge to a certain steady state. Second, the transition dynamics could differ across regions even if they belong to the same club so that it is possible to identify empirically different sub-periods. Finally, the convergence clubs, if any, are identified endogenously by the data. We do not impose any *a priori* restriction on neither club membership nor transition paths. Because of its flexibility in modelling the process of regional growth, this approach helps us to unveil complex and heterogeneous dynamics across regions and over time.[6]

Methodology. Consider a variable, for example regional income per capita, y. Its growth path is defined by the following equation:

$$y_{it} = a_{it} + x_{it}t, \quad (1)$$

where y is the log income per capita, and subscripts i and t denote region and time (for details, see (Phillips and Sul, 2007, 2009)); a_{it} embodies transitional dynamics, and $x_{it}t$ captures the idiosyncratic time paths of technological progress. Note that both vari-

[5] Agasisti et al. (2021) estimated that there is a positive effect of higher education institutions efficiency on the regional economic growth, but there are also significant and negative spillover effects, i.e., strong and efficient regional higher education systems may extract resources from neighboring regions.

[6] There are other methods proposed to identify convergence clubs (see, for example, (Beylunioğlu et al., 2020)). We prefer to use the method by Phillips and Sul (2007) because the Beylunioğlu et al. (2020) method is based on the analysis of the mean function, and it does not account for σ–convergence as in Phillips and Sul (2007). Moreover, the Phillips and Sul method works very well for small T values.

ables are permitted to be heterogeneous across regions (i) and over time (t).

Equation (1) can be re-written as follows:

$$y_{it} = b_{it}\mu_t, \quad (2)$$

where $b_{it} = (a_{it} + x_{it}t)/\mu_t$

b_{it} measures the transition path of region i to the common steady state growth path; μ, that is common across regions.

The common component can be eliminated by dividing the transition element for region i by the cross section average of N regions:

$$h_{it} = y_{it}/N^{-1}\Sigma y_{it} = b_{it}/N^{-1}\Sigma b_{it}, \quad (3)$$

If $h_{it} \to 1$ for all i as $t \to \infty$, all regions will converge to a common path. Note that this specification of growth dynamics does not impose any restriction on regions' transition paths. When the regional incomes converge to the common trend, the mean square transition differential

$$H_t = N^{-1}\Sigma(h_{it} - 1)^2, \quad (4)$$

will converge to 0 as $t \to \infty$.

Phillips and Sul (2007, 2009) propose a test statistic, the log t test, that is used to test if $H_t \to 0$ as $t \to \infty$. In the following model,

$$\log(H_1/H_t) - 2\log(\log t) = a + \gamma \log t + u_t, \quad \text{for } t = T_0, \ldots, T \text{ and } T_0 = rT \text{ for some } r > 0 \quad (5)$$

a one-sided test on γ (the log t test) checks if the regions in the sample form a convergence club. The log t test is used to identify converge clubs through an iterative process. For example, if the log t test is not rejected when Eq. (5) is estimated for all regions, there is only one convergence club, i.e., all regions converge to a common path. However, if the log t test is rejected when the data for all regions are included in estimating Eq. (5), then the iterative algorithm allocates each region into a club such that the log t test is not rejected for any one of those clubs. After the identification of the converge clubs, there is another algorithm that checks if two clubs can be merged together. The algorithm simply merges two groups and performs the log t test for the merged group. If the log t test is not rejected, then these groups are merged, and the same step is repeated for the remaining clubs.

Data sources. We obtained the regional data from the OECD database for 83 regions for the 1996–2017 period.[7] Regional GDP per capita in USD at 2015 constant purchasing power parity is used as the income variable.[8] The data includes variables on population, area (km^2), immigration and emigration rates, share of young people, etc.

Table 1 summarizes basic statistics on regional income in the Russian Federation in the 1996–2017 period. As shown in the table, the average regional GDP per capita increased by 1.8 times from 1996 to 2017 (on average, 8.7% per year). However, it is apparent that there are significant differences in growth rates across regions. Simple measures of inequality, such as standard deviation of log GDP per capita and max/min ratio indicate that regional inequality increased substantially, especially in the 1990s, and early 2000s.

Table 2 shows the richest and poorest regions in 1996, 2002, and 2017. There seems to be some changes among the poorest regions, but most of the poor regions are national republics in all years.

Convergence clubs. We identified regional convergence clubs for the Russian Federation by using the data for the 1996–2017 period.[9] Autonomous okrugs (AO) which are parts of other federal subjects are not considered as separate regions, i.e. an oblast/krai that contains (or contained) AO(s) is treated as a single whole. Since the data for the Chechen Republic, Republic of Crimea and Sevastopol are not available for the whole period, they are excluded from the analysis. Thus, the spatial sample consists of 79 regions.

Estimation results suggest that there is no single common convergence path for the regions of the Russian Federation. The algorithm identified 4 difference convergence clubs: the Club 1 includes the richest 5 regions whose average GDP per capita was USD 61.9 thousands in 2017 (see Table 3). The Club 2 includes 17 regions (USD 20.4 thousands). The Club 3 is the most numerous one and includes 45 regions (USD 13.9 thousands). The Club 4 is composed of 12 regions, and the average income is the lowest in that club (USD 7.8 thousands) (see Table 7 for the classification of all regions).

There are three critical parameters in the Phillips and Sul algorithm: r the proportion of initial observations that will be discarded (see Eq. (5)), the sieve criterion, c*, that determines the desired degree of conservativeness, and the calculation of standard errors of regression (that determines the value of the log t test). We experimented with different values of these parameters and found that there are only a few shifts between clubs 2 and 3, and between 3 and 4 when a different parameter set is adopted (see Table 4). Since these changes do not have any qualitative effect on our estimates, we proceed with the parameter values of Model 1 in Table 4.

[7] https://stats.oecd.org/Index.aspx?DataSetCode=REGION_DEMOGR. Accessed May 2, 2021.

[8] We prefer to use regional GDP data because it reflects the extent of economic activity in a region. Note that income per capita is also significantly correlated with GDP per capita at the regional level.

[9] The analysis is conducted by ConvergenceClubs package (Sichera and Pizzuto, 2019). We applied HP filter to GDP per capita series in order to eliminate the effects of annual fluctuations (see (Balcilar, 2019)).

Table 1. Regional GDP per capita in the Russian Federation, USD (constant prices, constant purchasing power parity, base year 2015)

Year	Average	Geometric average	Standard deviation*	Minimum	Maximum	Max/min ratio
1996	9277	8176	0.491	2039	41 138	20
1997	9082	7952	0.496	2427	40085	17
1998	8420	7322	0.510	2116	35898	17
1999	7989	6854	0.535	1922	34748	18
2000	8408	7097	0.550	1984	45682	23
2001	9236	7824	0.539	1789	51487	29
2002	9809	8311	0.541	1504	52863	35
2003	10625	8954	0.548	1706	57446	34
2004	11234	9442	0.556	1920	65439	34
2005	11631	9627	0.571	2004	78919	39
2006	12581	10526	0.556	2201	78777	36
2007	13810	11647	0.537	3694	74559	20
2008	14228	12064	0.530	3572	71001	20
2009	14164	11943	0.526	3440	64206	19
2010	14384	12171	0.531	3149	63563	20
2011	14944	12604	0.536	3636	67813	19
2012	15107	12897	0.514	4478	68897	15
2013	15375	13266	0.494	5063	68987	14
2014	15814	13561	0.502	5216	74081	14
2015	16427	14033	0.518	4583	72777	16
2016	16779	14351	0.520	4556	68592	15
2017	17012	14507	0.526	4534	74766	16

The data includes 79 regions used in the analysis.
* Standard deviation of log GDP per capita.

The evolution of GDP per capita for all regions and clubs are shown in Fig. 2. As seen in the figure, the clubs are not strictly formed by their GDP per capita levels. For example, the Republic of Ingushetia had the lowest income per capita in almost all years, but it is included in Club 3, not Club 4 that has the lowest average income per capita, because of its transition path. Although it is also possible to identify shifts in some regions' ranks over time, the relative positions seem to be quite stable.

The data on average GDP per capita growth rates at the club level are presented in Fig. 3. As may be expected, all clubs experienced an increase in growth rates from the late 1990s until the mid-2000s, but the

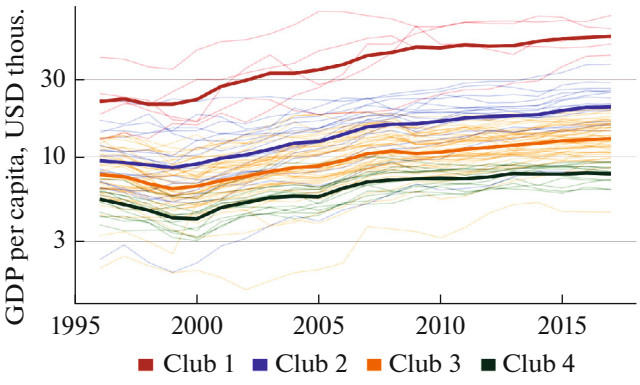

Fig. 2. Growth patterns by region and convergence club.

Table 2. GDP per capita in top and bottom 5 regions, 1996, 2002, and 2017

Top 5 regions		Bottom 5 regions	
Region	GDP per capita, USD	Region	GDP per capita, USD
1996			
Tyumen oblast	41138	Tyva Republic	4258
Chukotka Autonomous Okrug	24557	Republic of North Ossetia-Alania	3800
Sakha Republic (Yakutia)	22633	Republic of Kalmykia	3256
Magadan oblast	21556	Republic of Dagestan	2305
Moscow	18258	Republic of Ingushetia	2039
2002			
Tyumen oblast	52862	Republic of North Ossetia-Alania	4311
Chukotka Autonomous Okrug	35116	Tyva Republic	4291
Moscow	32915	Republic of Adygea	3387
Sakha Republic (Yakutia)	23139	Republic of Dagestan	3125
Magadan oblast	22857	Republic of Ingushetia	1504
2017			
Tyumen oblast	74766	Republic of North Ossetia-Alania	7142
Sakhalin oblast	61988	Ivanovo oblast	7115
Chukotka Autonomous Okrug	54036	Kabardino-Balkarian Republic	6275
Moscow	49751	Karachay-Cherkess Republic	6271
Magadan oblast	42415	Republic of Ingushetia	4534

Table 3. Regional convergence clubs in the Russian Federation

Club	Number of regions	Beta	Standard error	*t*-value	2017 GDP per capita*
1	5	0.296	0.144	2.050	61.93
2	17	0.093	0.026	3.519	20.40
3	45	0.190	0.089	2.132	13.94
4	12	0.119	0.072	1.649	7.75

* Weighted mean of GDP per capita in 2017 (USD thous., constant PPP).

richest clubs (Club 1 and Club 2) had even higher growth rates in the same period. These results indicate that inter-club differences had widened until the mid-2000s. We observe a decline in growth rates since the world economic crisis in 2008, but apparently the richest (Club 1) and the poorest (Club 4) clubs have been affected strongly from this negative trend so that Club 2 is getting closer to Club 1, and Club 4 is falling behind all others in the last decade.[10]

Figure 3 gives an idea about changes in inter-club income differences. In order to analyse intra-club changes, we compared regions' growth rates with their initial income levels for two sub-periods that experienced different dynamics: 1996–2005 and 2005–2017.

Table 4. Robustness tests

Parameters	Model 1	Model 2	Model 3	Model 4
r	1/3	1/4	1/3	1/3
c*	0	0	1	0
HACmethod	FQSB	FQSB	FQSB	AQSB
Number of clubs and regions				
Club 1	5	5	5	5
Club 2	17	15	17	17
Club 3	45	50	44	45
Club 4	12	9	13	12

[10] Alexeev and Chernyavskiy (2018) compared transfers from Russia's federal government to the regions during the two economic crises, 2009 and 2014–2015. They suggest that while federal transfers in 2009 were large and targeted poorer regions, the 2014–2015 transfers were much smaller and not targeted. These policy shifts are likely to increase regional inequalities in income and, more importantly, in public services like education and healthcare.

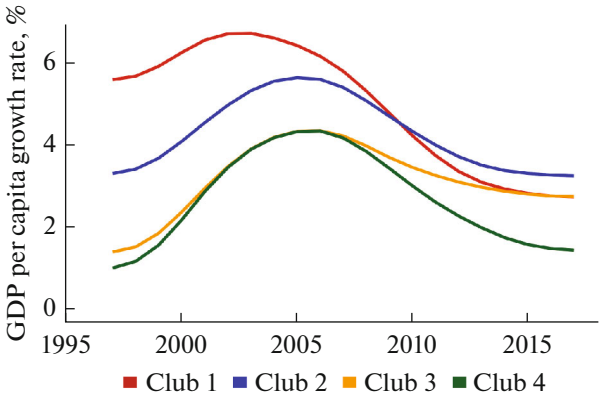

Fig. 3. Average GDP per capita growth rates by convergence clubs.

In Figs. 4a and 4b, the GDP per capita growth rates and initial GDP per capita levels are shown. Each region is represented by a circle, and the size of the circle is proportional to its population. The straight lines are club-specific regression lines that show the correlation between growth rates and initial income levels. A negative correlation between the initial income level and the subsequent growth rate (downward sloping regression line) indicates (Beta) convergence *within* the club.

It seems that there is a mild convergence within clubs 1, 2 and 4, but a divergence within the most numerous Club 3, in the 1996–2005 period (see Fig. 4a). However, we observe strong intra-club convergence since 2005 in all clubs (see Fig. 4b).

The geographical location of the convergence clubs does not reveal a pattern except the fact that Club 1 regions (with the exception of the city of Moscow) are all located in the northern part of the country (Fig. 5).[11] These regions have very low population densities and are rich in natural resources. Regions belonging to other clubs are almost uniformly scattered all around the country without any specific spatial pattern.

Migration and convergence clubs. Migration plays an important role in regional convergence because it is expected that people will move from low-income regions to high-income regions so that labour supply will increase in rich regions and decline in poor regions, and, as a result, wage income will be equalized across regions. Other factors of production (with the exception of land and natural resources) can also move between regions and would have a similar equalizing effect.

In reality, however, migration may have an adverse effect of regional inequality. For example, as

[11] In order to have a complete picture, we classified Nenets, Khanty-Mansi, and Yamalo-Nenets autonomous okrugs in Club 1, and the Chechen Republic in Club 4 in Fig. 5 on the basis of their GDP per capita.

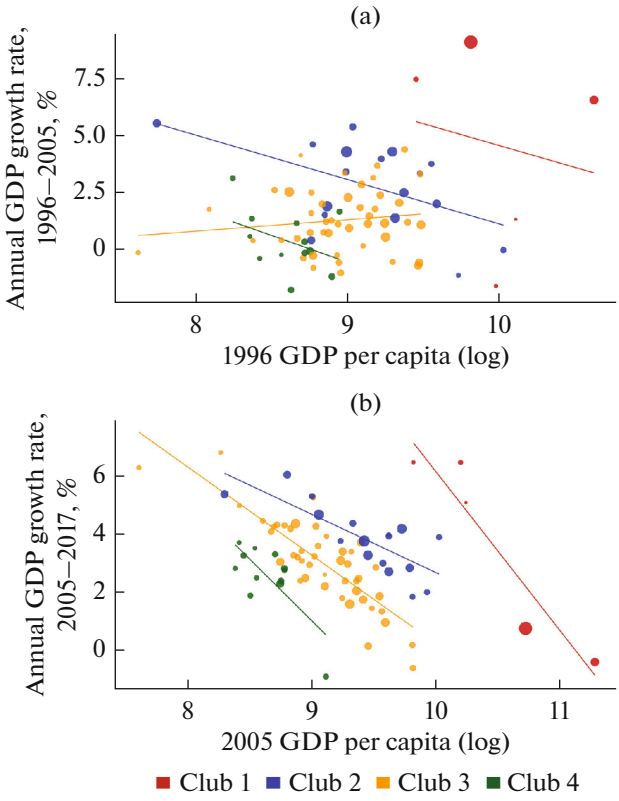

Fig. 4. Intra-club convergence: (a) 1996–2005; (b) 2005–2017.

Andrienko and Guriev (2004) showed in the case of the Russian Federation, there were no emigration from the poorest regions because of liquidity constraint, i.e., the people in these regions were locked in 'poverty traps.' Guriev and Vakulenko (2012) also observed poverty traps in the second half of the 1990s, but they suggest that capital and labour have become mobile across regions in the 2000s. However, even if labour mobility has increased, the age composition of migrants is also important for regional growth and inequality.

We will first look at the relationship between population density and GDP per capita at the club level because, as we have seen above, most of the members of the Club 1 are the regions located in the northern part of the country with low population density.

Figure 6 depicts the relationship between GDP per capita and population density in 2017. There is no strong correlation between these two variables at the national and club level: most of the rich regions have a very low population density but the most densely populated region (Moscow) is among the richest regions. The same observation is valid for all other regional clubs.

The relationship between GDP per capita and net migration rate is shown in Fig. 7. The net migration rate is the ratio between net migration (immigration

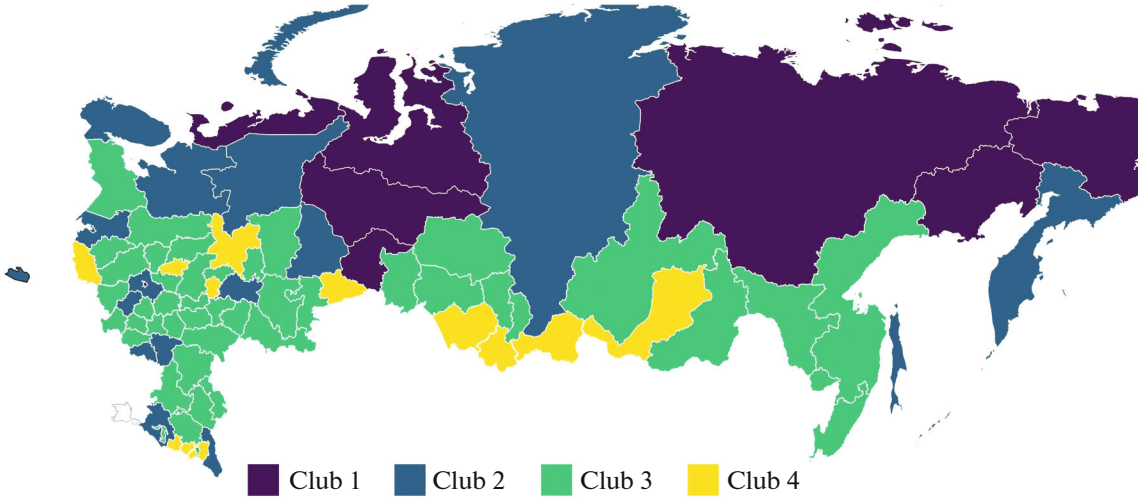

Fig. 5. Location of regions and convergence clubs.

minus emigration) and population in a given year. A region's population will increase more than the natural increase if that region's net migration rate is positive. As shown in Fig. 7, there is no correlation at all between GDP per capita and the net migration rate. In other words, neither the rich regions get net migration, nor the poor regions send people to other regions. The same result is obtained for the young net migration rate as well.

Apparently, population density determines the migration patterns (Fig. 8). Densely populated regions, especially in Club 1 and Club 2, attract people. It seems that people are attracted by the benefits of urbanization/large cities, especially if the average income is sufficiently high. Note that there is no correlation between population density and net migration rate in the poor (Club 4) regions.[12]

National republics and economic growth. The Russian Federation is a multinational state. The Russians account about 80% of the population, and the remaining 20% belongs to almost 200 different nationalities.[13] Russia includes 85 federal subjects, and 22 of them are 'national' republics. Thus, it is important to understand if the convergence patterns of national republics are different from other federal subjects.

A cursory look at the members of the convergence clubs (Table 7) does not reveal any pattern with the exception that republics are over represented in Club 4. There is no republic in Club 1, 4 republics in Club 2 (23% of club members), 9 in Club 3 (20%), and 7 in Club 4 (58%).[14]

Descriptive statistics about the federal subjects of the Russian Federation are presented in Table 5. The table includes the data for 1998, because it's the earliest year in which the data are available for all regions. The first part of the table provides the data for all 79 regions used in our analysis. The second part presents the average values for the North Caucasian republics (republics of Adygea, Dagestan, Ingushetia, Kabardino-Balkaria, Karachay-Cherkessia, and North Ossetia–Alania), other 14 republics ('Republics'), and all other regions ('Regions'). We provide the data on the North Caucasian republics separately because of their geographical location, specific history, and prox-

[12]Vakulenko (2014) analysed the impact of migration on regional wage, income and the unemployment rate by, estimating a dynamic panel data model with spatial effects for the 1995–2010 period, and found no effect of migration on regional convergence.

[13]For the 2010 census results, see Federal State Statistics Service web site: https://gks.ru/free_doc/new_site/perepis2010/croc/perepis_itogi1612.htm.

[14]The dataset does not include the Republic of Crimea and Sevastopol.

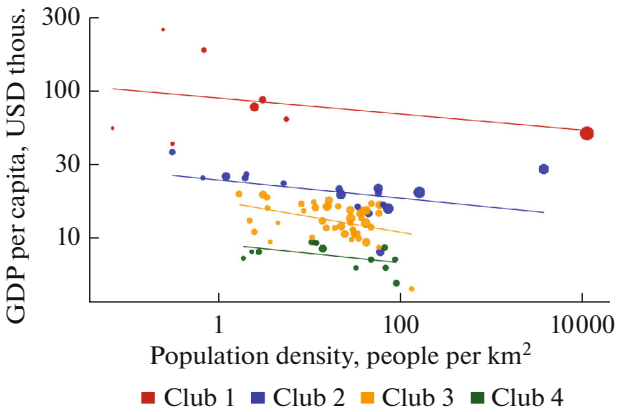

Fig. 6. Relationship between GDP per capita and population density, 2017.

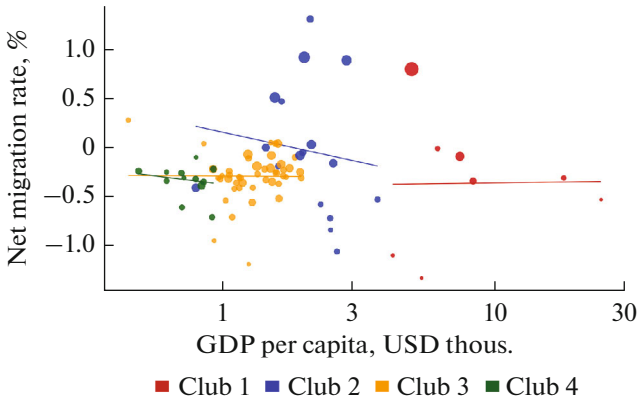

Fig. 7. Relationship between GDP per capita and net migration rate, 2017.

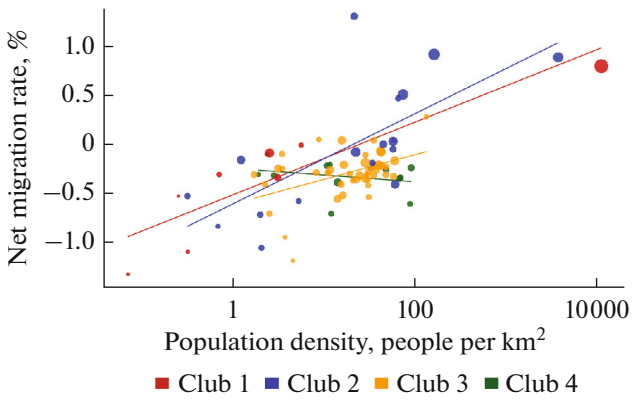

Fig. 8. Relationship between population density and net migration rate, 2017.

imity to the Russian-Chechen Wars in the 1990s, and early-2000s.

There were significant differences between North Caucasian republics, other republics, and other regions in 1998, and as observed in findings about convergence clubs, these differences have persisted to the present. The average GDP per capita was only USD 3.2 thousands (at 2015 PPP) in the North Caucasian republics, whereas it was USD 7.1 thousands in other republics, and USD 8.0 thousands in other regions in 1998. There are differences in terms of population density (much higher in the North Caucasian republics), and youth intensity (higher in the North Caucasian republics). The migration rate (the ratio of immigration *plus* emigration to population) was the lowest in the North Caucasian republics, and lower in other republics than other regions. Moreover, in spite of low levels of GDP per capita, net migration from the North Caucasian republics was also very low. Apparently, inter-regional mobility was low in republics (especially in the North Caucasian republics), that reminds us Andrienko and Guriev (2004) and Guriev and Vakulenko (2012) findings about poverty traps. The share of adults in migrants was also slightly higher in the North Caucasian republics, but lower in other republics.

We estimated an ordered logit model to identify which variables have strong effect in determining club membership. Clubs are ordered from the highest (Club 1) to the lowest (Club 4) GDP per capital, and the explanatory variables[15] are added into the model sequentially.

Table 6 presents estimation results. Initial GDP per capita has a strong effect on club membership (the initial GDP per capita increases the probability of being a member of higher clubs), and population density has a positive coefficient. The dummy variables for the North Caucasian and other republics have negative but insignificant coefficients in Model 3.

When the variable on youth shares is added, the North Caucasian republics dummy becomes significant, implying that there could be omitted variable bias in the first four models.

The migration rate has a positive and significant effect on club membership, but the net migration rate does not. This result shows that what is important for convergence towards higher GDP per capita path is bi-directional mobility of people. The positive and significant coefficient of the adult migration rate variable supports this interpretation because the adults represent economically active part of the population.

When migration variables are included in the model, the statistical significance of the population density variable increases. This result shows that, even if most of the members of Club 1 are the northern regions with low population density, densely populated regions are more likely to be converging towards high growth paths.

We observe a similar effect when the youth share variable is added to the ordered logit model (Model 5). The youth share variable has a positive and significant coefficient: the regions with high share of young people in the mid-1990s were more likely to be classified into higher clubs. This could be an expected result because the share of young people is an indicator for the future productive potential of the region. However, after controlling for the youth share, the North Caucasian republics variable has a negative and significant coefficient, whereas there is no change in the significance level of the coefficient of the other republics variable. These results indicate that the North Caucasian republics increased their probability of being converged towards higher growth

[15]The dependent variable is the club membership. All explanatory variables are the beginning of period (1998) values. The analysis is conducted for 79 regions that are included in the convergence analysis.

Table 5. Descriptive statistics on federal subjects, 1998

	All regions				NC republics	Republics	Regions
	N	Mean	Min	Max	Mean	Mean	Mean
GDP per capita*	79	7324.65	2115.40	35882.32	3216.34	7136.66	8006.43
Population density**	79	17.74	0.10	8734.19	58.44	8.34	18.80
Youth share, %	79	20.83	15.29	33.70	26.88	23.76	19.52
Migration rate, %	79	1.87	0.85	8.47	1.42	1.83	1.92
Net migration rate, %	79	–0.20	–5.04	0.54	–0.07	–0.24	–0.20
Adult migration share, %	79	60.13	51.01	71.25	63.80	56.42	60.64

* Geometric average, USD per capita, constant prices, constant PPP, base year 2015.
** Geometric average, people per km^2.

Table 6. Determinants of club membership (ordered logit model, dependent variable: club category)

	Model 1	Model 2	Model 3	Model 4	Model 5
GDP per capita (log)	3.793***	3.877***	3.558***	4.245***	4.711***
	(0.704)	(0.748)	(0.824)	(0.920)	(1.003)
Population density (log)	0.268*	0.228	0.783***	0.802***	1.159***
	(0.152)	(0.155)	(0.264)	(0.262)	(0.351)
NC Republics		0.398	–0.276	–1.058	–2.863*
		(1.111)	(1.166)	(1.189)	(1.469)
Other republics		–0.773	–0.555	0.729	–0.099
		(0.631)	(0.665)	(0.784)	(0.904)
Migration rate			1.455***	1.169**	1.297**
			(0.512)	(0.517)	(0.534)
Net migration rate			–0.314	0.407	0.278
			(0.799)	(0.806)	(0.868)
Adult migration share				0.308***	0.301***
				(0.093)	(0.095)
Youth share					0.271*
					(0.139)
Observations	79	79	79	79	79
AIC	146.52	146.72	134.89	124.21	122.25

Numbers in parentheses are standard errors of coefficients.
***, **, * means statistically significant at the 1, 5, and 10% level, two tail test.

paths thanks to their young population in the mid-1990s, but they suffered from being national republics in the North Caucasus.[16]

CONCLUSIONS

We analysed growth patterns of regions of the Russian Federation and checked if all regions converge to a common growth path or if there are many convergence clubs by using the data on regional GDP per capita for the 1996–2017 period. Our findings suggest that there is not any common growth path, and the data reveals four distinct convergence clubs. There are sizable differences in average GDP per capita across the convergence clubs. A region in Club 1 had, on average, 8 times higher GDP per capita than a region in Club 4 in 2017.

[16]Limonov and Nesena (2016) analyzed the 2002–2010 period and found 'no relationship between the ethnic heterogeneity of the population in the Russian regions and economic growth and convergence.' Our findings are complementary to their findings, because we analyze the effect of the status and location of regions on economic convergence. For example, the Republic of Dagestan is a national republic located in the North Caucasus, the share of Russian population is low, but it is ethnically heterogeneous.

Table 7. Classification of regions by convergence clubs

Region	Club	GDP per capita	Population	Region	Club	GDP per capita	Population
Tyumen oblast	1	74.6	3306.7	Novgorod oblast	3	11.8	657.6
Moscow	1	54.0	11091.4	Amur oblast	3	11.7	850.5
Sakhalin oblast	1	49.8	513.5	Primorsky krai	3	11.6	1988.6
Chukotka Autonomous Okrug	1	35.4	52.9	Volgograd oblast	3	11.3	2630.0
Magadan oblast	1	18.9	166.9	**Republic of Khakassia**	3	10.7	531.1
Krasnoyarsk oblast	2	23.1	2845.4	Tver oblast	3	10.0	1398.9
Komi Republic	2	22.8	944.8	Kursk oblast	3	9.9	1161.6
Sakha Republic (Yakutia)	2	22.7	956.1	Tula oblast	3	9.7	1600.1
St. Petersburg	2	21.1	4747.6	Rostov oblast	3	9.3	4314.7
Murmansk oblast	2	20.8	824.0	Ryazan oblast	3	9.2	1181.5
Arkhangelsk oblast	2	19.0	1266.7	Astrakhan oblast	3	9.0	1001.3
Republic of Tatarstan	2	18.0	3763.1	Zabaykalsky krai	3	8.9	1115.1
Kamchatka krai	2	17.9	330.8	Vladimir oblast	3	8.9	1475.9
Sverdlovsk oblast	2	16.9	4330.6	Saratov oblast	3	8.8	2572.4
Moscow oblast	2	16.9	6846.8	Kostroma oblast	3	8.5	689.8
Leningrad oblast	2	16.3	1691.1	Oryol oblast	3	8.5	811.4
Belgorod oblast	2	14.0	1514.2	Tambov oblast	3	8.4	1127.0
Kaliningrad oblast	2	13.8	934.3	Ulyanovsk oblast	3	8.4	1325.9
Krasnodar krai	2	11.3	5142.9	Smolensk oblast	3	8.4	1017.9
Kaluga oblast	2	9.8	1020.1	**Republic of Mordovia**	3	8.0	857.9
Voronezh oblast	2	8.5	2353.8	Penza oblast	3	7.5	1411.7
Republic of Dagestan	2	5.1	2735.8	Stavropol krai	3	7.2	2747.1
Tomsk oblast	3	18.7	1023.1	Bryansk oblast	3	7.0	1312.8
Vologda oblast	3	17.7	1225.8	**Republic of Mari El**	3	6.9	708.5
Samara oblast	3	16.2	3223.9	**Republic of Adygea**	3	5.9	438.6
Orenburg oblast	3	16.0	2067.9	**Republic of Kalmykia**	3	5.3	293.0
Perm krai	3	15.9	2691.6	**Republic of Ingushetia**	3	3.7	406.7
Lipetsk oblast	3	15.8	1190.4	**Republic of Buryatia**	4	10.0	964.6
Khabarovsk oblast	3	15.2	1359.9	**Chuvash Republic**	4	8.7	1268.6
Chelyabinsk oblast	3	14.7	3497.0	Altai krai	4	8.1	2473.0
Irkutsk oblast	3	14.6	2467.4	Pskov oblast	4	7.8	708.2
Republic of Karelia	3	14.1	665.0	Kurgan oblast	4	7.7	946.1
Kemerovo oblast	3	14.0	2786.0	Kirov oblast	4	7.6	1396.0
Omsk oblast	3	13.2	2003.3	**Republic of Altai**	4	6.7	201.7
Republic of Bashkorstostan	3	13.0	4053.4	**Republic of North Ossetia-Alania**	4	6.7	708.8
Yaroslavl oblast	3	12.8	1300.0	Ivanovo oblast	4	6.1	1089.8
Nizhny Novgorod oblast	3	12.5	3384.4	**Tyva Republic**	4	5.7	302.4
Novosibirsk oblast	3	12.3	2647.2	**Karachay-Cherkess Republic**	4	5.3	461.7
Udmurt Republic	3	11.9	1538.6	**Kabardino-Balkarian Republic**	4	5.1	858.5
Jewish Autonomous Oblast	3	11.8	179.4				

GDP per capita: USD thous., constant prices, constant purchasing power parity, base year 2015. Population: thousands people.
Regions typed in bold characters are national republics.

The data on the dynamics of growth show that there is a positive correlation between average GDP per capita and growth rates at the club level so that the distance between clubs is widening over time. The only exception is Club 2, that achieved a growth rate higher than Club 1 since 2010, i.e., Club 2 is gradually catching up with Club 1's GDP per capita. The most worrisome case if that of Club 4, that is lagging behind all clubs throughout the period.

An ordered logit model was estimated to identify which variables determine club membership. It is found that the regions with high initial GDP per capita, population density, migration rate, adult migration share, and youth share are more likely to belong to high-income clubs. The North Caucasian republics are more likely to be in low-income groups, whereas there is not much difference between other republics and regions in terms of club membership.

To summarize, income differences across regions in the Russian Federation are quite persistent, and low-income regions are not able to improve their relative positions. These findings provide additional empirical support for the 'poverty trap' hypothesis (Andrienko and Guriev, 2004; Guriev and Vakulenko, 2012). It seems that, in spite of rapid economic growth in the 2000s, the poverty trap was an obstacle for the development of poor regions, especially Club 4 members. The differences in growth rates of club members suggest that the polarization trend, as identified by Carluer (2005) and Tochkov (2021), continues without any indication for a reversal. In spite of substantial income differences, the persistence of the polarization process over a long time period shows that Club 4 (and probably Club 3) members are locked-in into low-income trap. These regions can lock-out from the low-income trap only by a massive and systematic external support. Otherwise, the uneven development of the regions will lead to socially unbearable and unsustainable inequalities.

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CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

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