LIFE QUALITY AND HUMAN POTENTIAL OF TERRITORIES

THE IMPACT OF IMPROVED HOUSING CONDITIONS ON THE CONVERGENCE FOR URBAN AND RURAL FERTILITY IN POST-SOVIET RUSSIA

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Housing conditions, or housing availability, is considered in modern research as an important but controversial factor in fertility changes in modern research. In a study using an ordinal logistic model, quantitative estimates of the impact of housing conditions on fertility convergence in post-Soviet society were obtained, separately for urban and rural populations. We have been established that housing availability has a statistically significant impact on the formation of regional convergence clubs of age-related fertility, and this influence varies significantly in importance and intensity depending on the age group of women and their place of residence. The total living area available to the average Russian resident in 1989 had a significant impact over the next 30 years on the formation and disintegration of regional age-specific fertility convergence clubs only in the younger age groups (15–19 and 20–24 years old) of urban and rural populations, as well as in the group of 25–29-year-old rural population. On the contrary, the growth rate of the total area per inhabitant in 2020/1989 manifested itself as a factor in the formation and disintegration of such clubs only in the middle age groups: 25–29 years for the urban population and 30–34 years for the rural population.

Fertility, housing conditions, marginal effects, age-related fertility rate, urban population, rural population, convergence, ordinal logistic model, convergence clubs, regions of Russia, post-Soviet period.

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Introduction

According to the 1989 Soviet Census, at the end of the Soviet era, the average resident of the RSFSR had approximately 15 sq. m of total floor area and 10 sq. m of living space per capita. In rural areas, these figures were 16 sq. m and 11 sq. m, respectively[1]. Individual houses or separate apartments were occupied by 78.1% of the urban and 89.8% of the rural population[2]. Centralized hot water supply was available to 68.5% of urban residents and only 10.8% of rural residents[3]. Nearly 4 million Russians lived in houses made of adobe or clay, and over 34 million lived in wooden houses (out of a total of 139.6 million individuals who reported their housing conditions and a total population of 147 million)[4]. Over the more than 30 years of post-Soviet transformations, the housing conditions of the country's residents have improved somewhat. According to the 2020 Russian Census, by the end of 2021, the average Russian had 18 sq. m of total floor area in cities and 23 sq. m in rural areas, with 95–97% of the population living in individual houses or separate apartments. The number of citizens living in houses with wooden exterior walls halved to 17.3 million people[5].

It is evident that the changes in the quantity and quality of housing in the post-Soviet period have closely interacted with the transformation of many social and demographic processes, including fertility. The most general outcome of this process in post-Soviet Russia has been the decline in the total fertility rate (TFR) of the urban population from 1.7 in 1990 to 1.4 children per woman over a lifetime in 2023, and that of the rural population from 2.6 to 1.6 children[6]. At the same time, the fundamental logic of housing construction and purchase subsidies is based on stimulating fertility, which underlines the relevance of studying the link between housing availability (accessibility, cost) and fertility in the country (Zhuravleva, Gavrilova, 2017; Isupova, 2018; Osipova, 2020; Trynov et al., 2020; Vakulenko et al., 2023; Kolbina, 2023).

Another important trend in contemporary demographic development is convergence, i.e., the narrowing of demographic differences between territories as they approach a common long-term equilibrium (O'Connell, 1981; Gabrielli et al., 2021; Stadnik, 2023; Domnich, 2024). This complex and prolonged process involves overcoming numerous obstacles that are difficult to quantify: socio-cultural, economic, organizational, and institutional (Papagni, 2023). The convergence of fertility levels is initially observed within small "clubs" of countries or regions possessing certain similarities, allowing them to reach a local equilibrium relatively quickly (O'Connell, 1981; Dorius, 2008; Strulik, Vollmer, 2013; Nakagaki, 2019). Studies of age-specific fertility rates in Russian regions confirm the formation of such regional convergence clubs for both urban and rural populations in post-Soviet Russia (Domnich, 2025). However, analysis of fertility convergence across the country's regions, while common in itself, has not yet been conducted in relation to housing conditions (Sinitsa, 2017; Shubat, 2019; Rodina, 2023; Domnich, 2024).

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[1]   Brief Socio-Demographic Characteristics of the Population of the RSFSR (Based on the 1989 All-Union Population Census). Part 3: Family, Housing Conditions. Moscow: Republican Information and Publishing Center of the RSFSR State Committee on Statistics, 1991. P. 111. Available at: https://www.statmuseum.ru/ru/results/1989/?section=1989&PAGEN_1=1 (accessed: 07.07.2025).

[2]   Ibidem. Pp. 130–131.

[3]   Ibidem. Pp.140–141.

[4]   Ibidem. Pp. 202–203.

[5]   Results of the 2020 All-Russian Population Census. Vol. 11: Housing Conditions of the Population. Available at: https://rosstat.gov.ru/vpn/2020/Tom11_ZHilishchnye_usloviya_naseleniya (accessed: 07.07.2025).

[6]   Total Fertility Rate. Available at: https://www.fedstat.ru/indicator/31517 (accessed: 07.07.2025).

Questions of fertility convergence (divergence) are closely linked to issues of territorial development. If regions tend to form multiple fertility convergence clubs, such local equilibria may hinder the achievement of a global (nationwide) equilibrium. Deepening interregional inequality in population reproduction in the long term leads to radical social, cultural, and economic changes and is therefore acutely perceived by society, exacerbating accumulated internal contradictions. A key problem becomes the possibility of a region transitioning from a high-fertility convergence club to a club with lower fertility, and a central question is the comparative significance of factors facilitating (or hindering) such a transition. This study focuses on the role of housing conditions, considered a significant factor influencing fertility itself, in the formation and dissolution of regional convergence clubs for age-specific fertility.

The aim of the study is to assess the marginal effects of housing provision as a factor in the formation and dissolution of regional convergence clubs for age-specific fertility in the regions of post-Soviet Russia. The research objectives are: to synthesize global experience in assessing the demographic effects of housing provision; to justify a relevant methodology for evaluating the link between improved housing conditions and the formation (dissolution) of regional fertility convergence clubs; and to implement this methodology using the example of regional convergence clubs for age-specific fertility of the urban and rural population in post-Soviet Russia. The subject of the study is the marginal effects of housing provision on the formation and dissolution of regional convergence clubs for age-specific

fertility among urban and rural populations. The object of the study comprises 79 regions of the Russian Federation from 1990 to 2023[7].

Theoretical foundations of the research

The relationship between housing provision and fertility is ambiguous and nuanced, leading to active discussion in the literature (Mulder, 2013; Pinnelli, 1995). On one hand, the basic logic linking improved housing conditions to increased fertility is supported by several studies in developed countries. Homeowners are more likely to have children than renters (Lin et al., 2016; Mulder, Wagner, 2001), and couples often purchase housing before becoming parents (Mulder, Wagner, 2001). However, purchasing a home is typically expensive, potentially creating a negative income effect – housing and having children may compete for limited resources, reducing the likelihood that parents who have improved their housing will have additional children (Flynn, 2017; Chudnovskaya, 2019). In a tight housing market (i.e., with high prices or low supply), it is more difficult for young people to obtain separate housing (Haurin et al., 1997; Hughes, 2003; Lauster, 2006), and more expensive housing generally correlates with later and lower fertility (Simon, Tamura, 2009; Yi, Zhang, 2010; Clark, 2012).

Research using diverse Russian data also yields contradictory results.

A study based on data from the HSE Russian Longitudinal Monitoring Survey (RLMS-HSE) for 1994–2014 (over 33,000 observations) found that housing area has a significant, albeit weak, negative influence on the probability of a woman without a partner deciding to have a child within a year, and a significant weak positive influence for women with a partner but no children. If a woman

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[7] The cities of Moscow, Saint Petersburg, and Sevastopol, as well as the republics of Ingushetia, Crimea, and Chechnya, are excluded from the sample.

with a partner already has children, housing area does not influence the decision to have a child within a year (Zhuravleva, Gavrilova, 2017, p. 161). Furthermore, housing area statistically significantly increases the age of a woman at childbirth if she has a partner, but does not affect the age at childbirth for single women (Zhuravleva, Gavrilova, 2017, p. 163). An analysis of factors affecting the total fertility rate (TFR), as well as fertility rates for the first, second, third, and fourth child across 85 regions of the country from 2005 to 2017, showed that housing provision (living area) had no statistically significant effect on any of these indicators (Trynov et al., 2020, p. 814).

Research on the effectiveness of regional maternity capital programs, using factor analysis of the TFR on a sample of 80 regions for 1996–2020, established that the cost per square meter on the secondary housing market had a statistically significant negative effect in regions with a TFR below 1.7 children, as well as in regions with a predominance of Orthodox Christianity (Vakulenko et al., 2023, p. 1088). This underscores the relevance of directing maternity capital programs towards improving housing conditions. At the same time, an analysis of the institutional framework of state pronatalist policy suggests that subsidizing housing improvements through maternity capital primarily stimulates the construction industry (Kolbina, 2023).

In the subjective perception of the population, housing provision as an incentive for childbearing and state support measures for improving housing conditions traditionally retain high importance. For instance, according to the 2015 Russian Microcensus, the most popular fertility incentive among all women, regardless of their reproductive plans (one, two, or three children), was an interest-free housing loan (Isupova, 2018). A survey by the Public Opinion Foundation also showed that mortgage repayment assistance for large families remains a sought-after measure in demographic policy (Osipova, 2020).

The dynamics of age-specific fertility indicators (for age groups 15–19, 20–24, 25–29, and 30–34) among the urban and rural populations of Russian regions allow for grouping the latter into convergence clubs (local equilibria), where fertility indicators tend towards a common asymptote (Domnich, 2025). It was found that the number of such clubs increases for younger maternal ages and decreases for older ages. A dependency on the type of settlement was also discovered: there are more convergence clubs in rural areas than in urban ones. For young age groups of both urban and rural populations (15–19 and 20–24 years), as well as for the rural population aged 25–29, regions were identified that demonstrate divergence and do not belong to any convergence club (which is strictly proven mathematically within the applied method). The number of regions in individual clubs varies from small (starting from 2) to substantial (up to 79). The composition of the clubs differs for various age groups and for urban versus rural populations[8].

Regional convergence clubs (*C1, …, CN*) are ordered in descending order of the mean age-specific fertility rate in 2023. The number of clubs varies depending on the age group, and their composition is largely determined by the type of settlement. Specifically, in the younger age groups (15–19 and 20–24 years), regional clubs with the highest average fertility rates (*C1*) are formed differently in urban and rural areas. For the rural population, these clubs include regions that initially (in 1990) had high fertility and demonstrate convergence

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[8] For the composition of regional convergence clubs for age-specific fertility, see the Appendix.

exclusively among themselves. For the urban population, such clubs include regions with varying initial fertility levels, from very high to extremely low. This indicates that in the post-Soviet period, the decline in fertility among the urban population in traditionally high-fertility regions occurred faster than in regions with medium and low fertility, leading to their convergence.

In the 25–29 age group for the urban population, two major regional convergence clubs are identified, comprising 28 and 51 regions, respectively. For the rural population in this age group, five convergence clubs are identified. Notably, club C1, which in younger age groups of the rural population united exclusively regions with initially high fertility, now consists half of regions that had medium fertility in 1990. In the 30–34 age group for the urban population, a single common convergence club is identified, indicating the achievement of a nationwide fertility equilibrium at this age. For the rural population in this age group, two major regional convergence clubs are identified, uniting 34 and 45 regions, respectively. Fertility dynamics in older age

groups (35–39 and 40–44 years) indicate they have reached a common equilibrium and formed a single club of regions in each case, which holds true for both urban and rural populations.

Research methodology
Assessing changes in housing conditions for the urban and rural population in the regions of post-Soviet Russia can be based on the indicator of total floor area per capita in urban and rural areas, according to the 1989 and 2020 population censuses. Other census indicators describing the quantity and quality of available housing are not comparable due to methodological changes, which imposes significant limitations on the interpretation of results. Based on a comparison of the mean values of the indicator, it can be concluded that housing provision in 1989, as well as the increase in total area by 2020, was higher for the rural population compared to the urban population *(Table 1)*. However, regional differentiation in housing conditions is also consistently higher for the rural population, as evidenced by a greater dispersion between the minimum and maximum values of the indicator compared to the urban population.

Table 1. Descriptive statistics of total floor area per capita in urban and rural areas across 79 regions of Russia in 1989 and 2020, sq. m

Indicator	Urban		Rural	
	1989	2020	1989	2020
Mean	13.9	19.9	15.4	22.5
Median	14	20	15	23
Mode	14	21	14	24
Standard deviation	1.1	2.3	2.6	2.5
Minimum	11	14	10	13
Maximum	16	23	21	27
Number of observations	79	79	79	79
Source: own calculations.				

The formation of regional convergence clubs for age-specific fertility can be interpreted as the result of the influence of numerous factors, including improved housing conditions. The latter act as one of the incentives and/or obstacles in the formation of such clubs. Regions belonging to clubs with the highest average fertility (*C1*) face the greatest difficulties in reducing their fertility, i.e., when attempting to exit this club and join clubs *C2,…,CN* (Papagni, 2023, p. 443). As the average fertility decreases in clubs *C2,…,CN*, the barriers for regions to enter and exit these clubs also diminish.

When modeling barriers to entry and exit of regions from convergence clubs (Bartkowska, Riedl, 2009; Barrios et al., 2019; Matysiak, Olszewski, 2019; Zhang et al., 2019; Jimenez-Moro et al., 2023; Papagni, 2023), the ordinal numbers of regional convergence clubs *C1,…,CN* within each age group are considered as ordinal nominal variables to be modeled using an ordinal logistic model. The model posits the existence of a continuous latent variable y_i^* for each region *i*, which has a linear dependence on a vector of independent variables X_i:

$$y_i^* = X_i\beta + \varepsilon_i.$$

The variable y_i^* can be interpreted as a certain equilibrium level of fertility that determines a region's propensity to belong to one of the convergence clubs. In a situation where y_i^* falls within the range of specific threshold values τ, the equilibrium fertility level in region *i* determines its membership in convergence club *j*:

$$y_i = j, \quad \text{if} \quad \tau_{j-1} \le y_i^* < \tau_j, j = 1, …, N.$$

The threshold values $\tau_1, …, \tau_{N-1}$ are to be estimated, while $\tau_0 = -\infty$, and $\tau_N = \infty$. When the variable y_i^* crosses the threshold value τ_j, region *i* ends up in club *j+1*.

The ordinal logistic model is defined as a probabilistic model:

$$\ln\left(\frac{\Pr(y \le j|X)}{\Pr(y > j|X)}\right) = \tau_j - X\beta, j = 1, … N-1.$$

The probabilities of belonging to a specific club are estimated using the mean values of the variables *X* and are determined as follows:

$$\Pr(y = 1|X) = \frac{e^{\tau_1 - X\beta}}{1+e^{\tau_1 - X\beta}}, \text{for } j = 1;$$

$$\Pr(y = j|X) = \frac{e^{\tau_1 - X\beta}}{1+e^{\tau_1 - X\beta}} - \frac{e^{\tau_{j-1} - X\beta}}{1+e^{\tau_{j-1} - X\beta}}, \text{for } j = 2, … N-1;$$

$$\Pr(y = N|X) = 1 - \frac{e^{\tau_{N-1} - X\beta}}{1+e^{\tau_{N-1} - X\beta}}, \text{for } j = N.$$

Significant positive values of the coefficients β in this model indicate that a region with a larger value of X_i is, on average, located in a club with a higher ordinal number *j* (i.e., with lower average fertility). If a significant coefficient has a negative sign, an increase in X_i statistically significantly reduces *j*, and the region falls into a club with higher average fertility.

To assess how strongly certain variables determine regional membership in a specific club, the marginal values of predicted probabilities (marginal effects) are also estimated. Marginal effects estimate how the probability of belonging to a club changes when an independent variable changes by one unit, while all other variables are fixed at their sample mean values. Thus, positive marginal effects help a region "consolidate" its position in a particular club, while negative ones help it leave. In accordance with the research objectives, we are primarily interested in the marginal effects of variables assessing housing conditions.

The vector of independent variables X_i for modeling convergence clubs is constructed to reflect both initial conditions and the direction (pace) of development of the vector y_i (Bartkowska, Riedl, 2009; Matysiak, Olszewski,

2019; Zhang et al., 2019). Therefore, the housing conditions factor in the model is represented by two variables: the total floor area per capita in 1989 and its growth rate by 2020[9]. Control variables were also estimated based on data from the 1989 and 2020 population censuses. These include the share of persons aged 16 and over who have never been married (in 1989[10] and its growth rate by 2020)[11], the share of Eastern Slavs (Russians, Ukrainians, Belarusians) in the total population in 1989[12] and its growth rate by 2020[13], as well as the share of women in the corresponding age group in the total population in 1990 and its growth rate by 2020[14]. Due to possible heteroskedasticity of the regression residuals, robust variance estimates obtained using the Huber – White method were employed (Huber, 1967; White, 1980).

The research strategy involved estimating the coefficients β for ordinal logistic regression with only housing condition variables (1) and the full model with control variables (2), as well as calculating the marginal effects of housing condition variables for the model with the full set of variables.

The working hypotheses of the study suggest a differentiation in the effects of housing conditions depending on the population's age group and type of settlement.

Regarding age differences, it is hypothesized that for the processes of formation and dissolution of regional convergence clubs in younger age groups, the initial living area (total area in 1989) is of paramount importance, as it pertains to the birth of first children (Hypothesis *H-1.1*). In contrast, for middle age groups, where second and subsequent children are born, the improvement of housing conditions (the growth rate of total area in 2020/1989) is more relevant (Hypothesis *H-1.2*).

Regarding urban-rural differences, based on the analysis of the composition of regional age-specific convergence clubs (see above), a hypothesis can reasonably be put forward that in cities, the effects of housing conditions equally contribute to regions exiting high-fertility clubs and consolidating their position in low-fertility clubs (Hypothesis *H-2.1*). In contrast, in rural areas, the most significant effects are expected to be associated only with regions exiting high-fertility clubs (Hypothesis *H-2.2*).

The calculation results for the urban population are presented in *Tables 2* and *3*, and for the rural population in *Tables 4* and *5*.

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[9] All variables are calculated separately for urban and rural populations.

[10] Calculated based on: Brief Socio-Demographic Characteristics of the Population of the RSFSR (Based on the 1989 All-Union Population Census). Part 1: Population Size, Sex, Age, Nationalities, Marital Status, Education Level. Moscow: Republican Information and Publishing Center of the RSFSR State Committee on Statistics, 1991. 210 p. Available at: https://www.statmuseum.ru/ru/results/1989/?section=1989&PAGEN_1=1 (accessed: 07.07.2025).

[11] Calculated based on: Results of the 2020 All-Russian Population Census. Vol. 2: Age-Sex Composition and Marital Status. Available at: https://rosstat.gov.ru/vpn/2020/Tom2_Vozrastno_polovoj_sostav_i_sostoyanie_v_brake (accessed: 07.07.2025).

[12] Calculated based on: National Composition of the Population of the RSFSR. According to the 1989 All-Union Population Census. Moscow: Republican Information and Publishing Center of the RSFSR State Committee on Statistics, 1990. 747 p. Available at: https://www.statmuseum.ru/ru/results/1989/?section=1989&PAGEN_1=1 (accessed: 07.07.2025).

[13] Calculated based on: Results of the 2020 All-Russian Population Census. Vol. 5: National Composition and Language Proficiency. Available at: https://rosstat.gov.ru/vpn/2020/Tom5_Nacionalnyj_sostav_i_vladenie_yazykami (accessed: 07.07.2025).

[14] Calculated based on: Resident Female Population by Age as of January 1. Available at: https://www.fedstat.ru/indicator/33459 (accessed: 01.07.2025).

Research results

The obtained system of econometric estimates is characterized by pronounced differentiation across economic (age groups and settlement types) and econometric (type of equation and indicator) features. Housing conditions, as well as their improvement, have a positive effect on the variable y_i^*, promoting a region's transition to a club with lower average fertility.

In the younger age groups of both urban and rural populations (15–19 years and 20–24 years), as well as in the 25–29 age group of the rural population, the most important factor was the initial housing conditions, i.e., the total floor area available to the average urban or rural resident in 1989. Thus, demographic transformations in post-Soviet Russia, despite their rapid pace, are closely linked to the initial conditions in which the urban and rural population of a specific region found themselves at the end of the Soviet era, especially when it comes to younger ages. At the same time, the growth rate of total area per capita in 2020 relative to 1989 as a factor in the formation of regional fertility convergence clubs begins to manifest in the 25–29 age group for the urban population and in the 30–34 age group for the rural population. Moreover, in both cases, the influence of changes in housing conditions prevails over the initial housing provision: the influence of the latter factor becomes insignificant for the urban population aged 25–29, and for the rural population aged 30–34, it is noticeably weaker than the influence of the growth rate of living area. The process of formation and dissolution of regional fertility convergence clubs in middle age groups is sensitive to the extent to which housing conditions have been improved in the post-Soviet period.

Table 2. Influence of housing conditions on the formation and dissolution of regional fertility convergence clubs for the urban population of post-Soviet Russia

Age	15–19		20–24		25–29	
Specifications	(1)	(2)	(1)	(2)	(1)	(2)
Total area per resident in 1989	0.691***	1.356***	0.925***	1.302***	0.133	-0.251
Growth rate of total area per resident in 2020/1989	1.369	2.362	2.637	3.584	3.140*	4.776**
Control variables	-	+	-	+	-	+
τ_1	10.497***	12.799	15.790***	39.180***	5.727	13.562
τ_2	11.734***	14.317	18.304***	41.859***	-	-
τ_3	12.195***	14.842	19.460***	43.057***	-	-
τ_4	13.298***	16.074	20.621***	44.263***	-	-
τ_5	14.736***	17.650	-	-	-	-
τ_6	15.459***	18.417	-	-	-	-
Number of observations	77	77	77	77	79	79
Wald χ^2	8.06**	31.17***	16.73***	12.62	3.15	15.14*
Pseudo R^2	0.044	0.122	0.084	0.131	0.035	0.205

*** – significant at 1% level;
** – significant at 5% level;
* – significant at 10% level.
Source: own calculations.

Table 3. Marginal effects of housing conditions on the formation and dissolution of regional fertility convergence clubs for the urban population of post-Soviet Russia

Age	15–19		20–24		25–29	
Club number	Total area per resident in 1989	Growth rate of total area per resident in 2020/1989	Total area per resident in 1989	Growth rate of total area per resident in 2020/1989	Total area per resident in 1989	Growth rate of total area per resident in 2020/1989
1	-0.193***	-0.336	-0.198***	-0.545	0.043	-0.825**
2	-0.061***	-0.107	0.005	0.014	-0.043	0.825**
3	0.008	0.013	0.103***	0.284	-	-
4	0.075***	0.131	0.058	0.159	-	-
5	0.109***	0.189	0.032	0.087	-	-
6	0.030	0.052	-	-	-	-
7	0.033	0.057	-	-	-	-
*** – significant at 1% level; ** – significant at 5% level; * – significant at 10% level. Source: own calculations.						

A comparative analysis of the quality of equations (1) and (2) based on the Wald χ^2 and pseudo-R^2 criteria shows that middle age groups are also noticeably more sensitive to the inclusion of control variables in the specification. The proportion of explained variance of the variable y_i^* (pseudo-R^2) is significantly higher in type (2) equations precisely in the middle age groups. For the urban population, equation (1) in the 25–29 age group is not significant at all according to the Wald χ^2 criterion.

The formation of regional fertility convergence clubs in younger age groups is primarily determined by the fertility of first children, while in middle age groups it is determined by second and subsequent children. Therefore, if initial living area is important for fertility in younger age groups, fertility in middle age groups is more dependent on its expansion (growth rate), as well as on control variables such as ethnic and sex-age composition and the matrimonial behavior of the population. These results, reproducible in both urban and rural areas, confirm hypotheses *H-1.1* and *H-1.2*.

Both the initial size of total living area per capita in 1989 and the rate of its increase by 2020 contribute to regions exiting clubs with relatively high fertility and their subsequent consolidation in clubs with relatively low fertility. However, there are age-related and urban-rural nuances.

For the urban population aged 15–19 and 20–24 years, significant marginal effects facilitating inter-club transitions were established only for total housing area per capita in 1989. In the 15–19 age group, improved initial housing conditions help regions leave high-fertility clubs *C1* and *C2* and consolidate in low-fertility clubs *C4* and *C5*. In the 20–24 age group, they help regions leave club *C1* and consolidate in club *C3*. For the urban population aged 25–29 years, only the marginal effects of the growth rate of living area in 2020/1989 are important: they facilitate regions' transition from club *C1* to club *C2* and consolidation within it.

Table 4. Influence of housing conditions on the formation and dissolution of regional fertility convergence clubs for the rural population of post-Soviet Russia

Age, years	15–19		20–24		25–29		30–34	
Specifications	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Total area per resident in 1989	0.752***	0.575**	0.990***	1.001***	0.584***	0.739***	0.501***	1.677***
Growth rate of total area per resident in 2020/1989	5.425***	2.868	2.508	1.754	-1.084	1.040	-0.512	9.849**
Control variables	-	+	-	+	-	+	-	+
τ_1	17.698***	-14.808	13.340***	22.809***	4.053	27.793***	6.534	57.789***
τ_2	17.942***	-14.511	15.328***	24.971***	6.939	31.274***	-	-
τ_3	19.412***	-12.686	18.127***	27.912***	8.603	33.168***	-	-
τ_4	21.289***	-10.436	19.652***	29.539***	8.784	33.349***	-	-
τ_5	23.930***	-7.479	24.335***	34.630***	-	-	-	-
Number of observations	77	77	77	77	77	77	79	79
Wald χ^2	26.32***	38.73***	31.16***	29.97***	29.68***	43.61***	13.61***	18.9**
Pseudo R^2	0.139	0.234	0.273	0.307	0.211	0.285	0.221	0.563

*** – significant at 1% level;
** – significant at 5% level;
* – significant at 10% level.
Source: own calculations.

Table 5. Marginal effects of housing conditions on the formation and dissolution of regional fertility convergence clubs for the rural population of post-Soviet Russia

Age, years	15–19		20–24		25–29		30–34	
Club number	Total area per resident in 1989	Growth rate of total area per resident in 2020/1989	Total area per resident in 1989	Growth rate of total area per resident in 2020/1989	Total area per resident in 1989	Growth rate of total area per resident in 2020/1989	Total area per resident in 1989	Growth rate of total area per resident in 2020/1989
1	-0.053**	-0.266	-0.019***	-0.034	-0.043***	-0.061	-0.157***	-0.920***
2	-0.005	-0.024	-0.043***	-0.075	-0.056***	-0.078	0.157***	0.920***
3	-0.023*	-0.114	-0.063***	-0.110	0.011	0.015	-	-
4	0.008	0.041	0.007	0.012	0.003	0.004	-	-
5	0.058	0.290	0.095***	0.166	0.085***	0.120	-	-
6	0.015	0.073	0.023	0.040	-	-	-	-

*** – significant at 1% level;
** – significant at 5% level;
* – significant at 10% level.
Source: own calculations.

For the rural population, the size of the initial total area is important primarily from the perspective of overcoming barriers to exiting regional clubs with relatively high fertility. In the 15–19 age group, this means exiting clubs *C1* and *C3*; in the 20–24 group, exiting clubs *C1, C2,* and *C3*; and in the 25–29 group, exiting clubs *C1* and *C2*. Furthermore, in the 20–24 and 25–29 age groups, improved initial housing conditions help regions consolidate in club *C5*. For the population aged 30–34 years, both the initial size of total area per capita in 1989 and its growth rate by 2020 are important for exiting club *C1* and consolidating in club *C2*.

Thus, hypotheses *H-2.1* and *H-2.2* were broadly confirmed but required qualification across age groups.

Conclusion

In contemporary literature, housing conditions are considered an ambiguous factor in terms of their influence on fertility. Under certain conditions, improved housing can either stimulate or suppress additional childbearing. The role of housing conditions in the regional convergence of demographic indicators had not been quantitatively measured until now. This study, using an ordinal logistic model, provides quantitative estimates of the influence of housing conditions on the formation and dissolution of regional convergence clubs for age-specific fertility, separately for urban and rural populations. It examines initial housing provision at the end of the Soviet period (1989) and its growth rate by 2020. Prior to this, identification of regional convergence clubs for age-specific fertility of the urban and rural population in post-Soviet Russia was conducted *(see Appendix)*.

The study establishes that the indicator of housing provision has a statistically significant influence on both the formation and dissolution of regional convergence clubs for age-specific fertility. This influence differs substantially in significance and intensity depending on the population's age group and place of residence.

The total living area available to the average Russian resident in 1989 exerted a significant effect on the formation and dissolution of regional convergence clubs for age-specific fertility only in the younger age groups (15–19 and 20–24 years) of both urban and rural populations, as well as in the 25–29 age group of the rural population. Conversely, the growth rate of total area per capita in 2020 relative to 1989 manifested as a factor in the formation and dissolution of such clubs only in the middle age groups: 25–29 years for the urban population and 30–34 years for the rural population.

An assessment of the marginal effects of housing provision indicators allows us to conclude that their role in the formation and dissolution of regional convergence clubs for age-specific fertility differs qualitatively depending on the type of settlement and age group. By influencing the reproductive behavior of the urban population, both housing provision indicators facilitate both the exit of regions from high-fertility clubs and their consolidation in low-fertility clubs, regardless of age group. In contrast, the influence on the reproductive behavior of the rural population is differentiated across age groups. In the 15–19 age group, an increase in the total living area available to the average rural Russian resident in 1989 helped regions exit high-fertility clubs but did not contribute to their consolidation in low-fertility clubs. A dual effect of housing provision indicators (exit from high-fertility clubs and consolidation in low-fertility clubs) in rural areas is observed only starting from the 20–24 age group.

This is a qualitatively new scientific result, which not only characterizes the dependence of fertility on certain socio-economic factors but also explains the joint dynamics of population reproduction processes in the regions throughout the post-Soviet period. It provides the scientific community and government authorities with both new knowledge about long-term demographic trends and a new experimental toolkit that allows working not only with ontological criteria (the level of fertility in specific regions) but also with epistemological criteria (trajectories of local equilibrium) of the demographic development of territories.

The research results can be applied for more accurate modeling of demographic processes in Russian regions. The scientific significance of the study lies in obtaining robust estimates of the influence of improved housing conditions on the convergence of demographic development indicators in the country's regions, with a breakdown into urban and rural segments. The methodological significance of the study consists in advancing the toolkit of ordinal logistic regression for the quantitative analysis of long-term patterns of social and demographic development under conditions of limited and incomplete data.

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Appendix

The composition of regional clubs for the convergence of age-related fertility of urban and rural populations in the regions of Russia 1990–2023

Region	Urban			Rural			
	15–19	20–24	25–29	15–19	20–24	25–29	30–34
Belgorod Region	C5	C3	C2	C5	C5	C5	C2
Bryansk Region	C4	C2	C2	C4	C6	C5	C2
Vladimir Region	C3	C2	C2	C4	C5	C5	C2
Voronezh Region	C5	C3	C2	C4	C5	C5	C2
Ivanovo Region	C3	C2	C2	C4	C5	C5	C2
Kaluga Region	C2	C1	C1	C5	C5	C5	C2
Kostroma Region	C6	C2	C1	C5	C5	C2	C1
Kursk Region	C3	C2	C2	C4	C4	C3	C2
Lipetsk Region	C4	C2	C2	C4	C5	C5	C2
Moscow Region	C2	C1	C1	-	-	-	C2
Oryol Region	C5	-	C2	C3	C4	C3	C1
Ryazan Region	C4	C3	C2	C5	C5	C5	C2
Smolensk Region	C5	C4	C2	C5	C6	C5	C2
Tambov Region	C2	C2	C2	C4	C5	C5	C2
Tver Region	C4	C2	C2	C4	C5	C3	C2
Tula Region	C3	C2	C2	C4	C5	C5	C2
Yaroslavl Region	C6	C3	C1	C5	C5	C5	C2
Republic of Karelia	C5	C4	C1	C5	C4	C2	C1
Komi Republic	C3	C2	C2	C3	C3	C1	C1
Nenets Autonomous Area	C1	C1	C1	C1	C2	C1	C1
Arkhangelsk Region	C5	C4	C2	C4	C3	C1	C1
Vologda Region	C4	C2	C1	C5	C5	C4	C1
Kaliningrad Region	C5	C3	C1	C4	C5	C5	C2
Leningrad Region	C4	C4	C2	-	-	-	C2
Murmansk Region	C4	C2	C1	C5	C5	C3	C2
Novgorod Region	C2	C2	C2	C4	C5	C5	C2
Pskov Region	C2	C2	C1	C4	C5	C3	C2
Republic of Adygea	C4	C1	C2	C4	C4	C5	C2
Republic of Kalmykia	C4	C2	C1	C5	C5	C5	C2
Krasnodar Territory	-	C1	C1	C5	C5	C3	C2
Astrakhan Region	C1	C1	C1	C3	C4	C3	C2
Volgograd Region	C2	C3	C2	C3	C5	C5	C2

Region	Urban			Rural			
	15–19	20–24	25–29	15–19	20–24	25–29	30–34
Rostov Region	C2	C2	C2	C4	C4	C3	C2
Republic of Dagestan	C1	C1	C2	C1	C2	C2	C2
Kabardino-Balkarian Republic	C1	C1	C1	C4	C3	C3	C2
Karachay-Cherkess Republic	C2	C2	C2	C5	C5	C5	C2
Republic of North Ossetia-Alania	C4	C1	C1	C5	C5	C3	C2
Stavropol Territory	C1	C2	C2	C3	C3	C4	C2
Republic of Bashkortostan	C7	C3	C2	C4	C4	C2	C1
Republic of Mari El	C2	C2	C2	C4	C4	C3	C2
Republic of Mordovia	C7	C5	C2	C6	C5	C5	C2
Republic of Tatarstan	C5	C2	C1	C6	C5	C3	C2
Udmurt Republic	C5	C3	C2	C4	C3	C2	C1
Chuvash Republic	C4	C2	C2	C5	C4	C2	C1
Perm Territory	C2	C2	C2	C3	C3	C2	C1
Kirov Region	C4	C3	C2	C4	C3	C1	C1
Nizhny Novgorod Region	C5	C2	C1	C5	C5	C3	C2
Orenburg Region	C3	C2	C2	C4	C3	C2	C1
Penza Region	C4	C3	C2	C5	C5	C3	C2
Samara Region	C4	C2	C2	C4	C5	C3	C2
Saratov Region	C3	C2	C2	C4	C5	C5	C2
Ulyanovsk Region	C2	C2	C1	C4	C5	C5	C2
Kurgan Region	C2	C1	C1	C3	C3	C2	C1
Sverdlovsk Region	C2	C2	C1	C3	C3	C2	C1
Khanty-Mansi Autonomous Area	C2	C1	C1	C4	C4	C3	C1
Yamal-Nenets Autonomous Area	C4	C1	C1	C2	C2	C2	C1
Tyumen Region	C1	C1	C1	C4	C4	C2	C1
Chelyabinsk Region	C2	C2	C2	C3	C4	C3	C1
Republic of Altai	C2	C2	C2	C1	C2	C1	C1
Republic of Tyva	-	-	C1	C1	C1	C1	C1
Republic of Khakassia	C2	C1	C1	C1	C3	C3	C2
Altai Territory	C3	C2	C2	C3	C4	C2	C1
Krasnoyarsk Region	C2	C2	C2	C2	C3	C2	C1
Irkutsk Region	C1	C1	C1	C1	C3	C2	C1
Kemerovo Region	C1	C1	C2	C1	C4	C5	C2
Novosibirsk Region	C1	C2	C2	C3	C3	C2	C1
Omsk Region	C2	C2	C2	C3	C3	C2	C1
Tomsk Region	C4	C5	C2	C3	C3	C2	C1
Republic of Buryatia	C1	C1	C2	C1	C3	C2	C1
Republic of Sakha (Yakutia)	C1	C1	C2	C3	C3	C2	C1
Trans-Baikal Territory	C1	C1	C2	C1	C2	C2	C1
Kamchatka Region	C1	C1	C1	C3	C3	C2	C2
Primorye Territory	C1	C2	C2	C1	C4	C2	C1
Khabarovsk Territory	C1	C2	C2	C1	C3	C2	C1
Amur Region	C1	C1	C2	C1	C3	C2	C1
Magadan Region	C1	C2	C2	C5	C4	C2	C2
Sakhalin Region	C1	C1	C1	C3	C3	C2	C1
Jewish Autonomous Region	C1	C1	C2	C1	C3	C3	C2
Chukotka Autonomous Area	C1	C2	C2	C1	C1	C1	C2
Source: compiled according to (Domnich, 2025, pp. 27–32).							

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