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POPULATION GEOGRAPHY

Moving Up: Migration between Levels of the Settlement Hierarchy in Russia in the 2010s

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Abstract—Based on Russian data for 2011–2020, the population flow between seven levels of the settlement hierarchy has been estimated for the first time. Levels of the settlement hierarchy are represented by cities with different population sizes and their suburbs, as well as other urban and rural settlements. Indicators of migration increase (decrease) and demographic efficiency indicators in matrix form are calculated for the hierarchy levels. It is shown that the scale of this flow is affected by changes in the system of migration registration in Russia in the 2010s, namely, the auto return of migrants to their place of permanent residence after the end of the registration period at their temporary place of residence. The beneficiaries of "vertical migration" of population are cities with over 250 000 inhabitants; the biggest winners are the urban agglomerations of Moscow and St. Petersburg. Each next settlement hierarchy level gives the population "up" and receives replenishment from the lower "layers." In contrast to countries where similar studies were conducted (United States, Canada, the Netherlands, etc.), there are no population flows from top to bottom in Russia, and upward flows have a very high efficiency; it is particularly high for Moscow, St. Petersburg, and their suburbs. Despite population movement between neighboring settlement hierarchy levels, its demographic effect is not as great as in jumpwise migrations. The calculations of the study are based on individual depersonalized migrant data, which made it possible to categorize migration flows to individual settlements in Russia. Spatial data referencing was carried out based on Rosstat codes unique for each settlement. This made it possible to analyze migration not between administrative units, but between settlements grouped by population size. It was also possible to identify how the peculiarities of accounting for migration influence population flow between the selected groups of settlements in the 2010s.

Keywords: internal migration, cities, settlements, urban hierarchy, vertical migration, suburbs, migration statistics

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INTRODUCTION

For 2011–2020, 38.9 mln domestic migrations were recorded in Russia, associated with a change of permanent residence or for a more or less long time. Migrants move from one part of the country to another, as a result of which the population is redistributed between certain regions; the population of some regions is decreasing, while others are increasing.

The advent of open access data on internal migration, detailed to the municipal district (urban okrug) level has expanded the possibilities for analyzing migration in Russia. Studies have shown that migration contributes to concentration of population in large cities and their suburbs, while vast peripheral spaces are losing residents. However, even in regions with a steady migration outflow, regional capitals continue to accumulate population (Denisov, 2018), while even in regions attractive to migrants, there are vast areas where migration is depressed (Nefedova, 2020). In addition to population flow between regions and parts of the country, there is an equally powerful transfer between centers and the periphery, between settlements of different size.

This article attempts to assess vertical migration in Russia, which refers to the movement of the population between settlements of different size and positions in the center–periphery system. The authors not only assess the scale of this flow, but also analyze between which levels of the settlement hierarchy this flow occurs: whether it has a strictly upward or somewhere downward direction. This article is the first approach to solving the formulated problem, which will be continued in a study using data for 2011–2020.

REVIEW OF THE LITERATURE

Migration between settlements of different size, or different levels of the settlement (urban) hierarchy, has been studied in developed countries since the second half of the 20th century. Studies that make it possible to estimate upward and downward population flow at a sufficiently detailed spatial level, appeared at the turn of the century and are associated with the availability of statistical data. In (Plane et al., 2005), the flow of the US population is estimated with seven distinguished hierarchical settlement levels, with no sufficiently clear upward or downward direction. As well, megapolises in the United States are losing population, including migration with metropolitan areas at the next level of the hierarchy with populations >1 mln (Plane and Henrie, 2012). A similar study in Canada with five distinguished hierarchical levels of the settlement system (Newbold, 2011) demonstrated that population flows upwards; however, the highest hierarchical level experienced migration loss. Vertical migration in Canada does not occur in leaps and bounds, but in steps, between adjacent levels of the settlement hierarchy.

A similar study (de Jong et al., 2016) analyzes the flow between five levels of the urban hierarchy in the Netherlands and has revealed prevalence of upward flows despite the country's high level of urbanization. However, another study has shown that downward migration became prevalent during economic crisis of 2007 and subsequent years (van Leeuwen and Venhorst, 2021) and that the overall flow is declining. The economic feasibility of migration within the urban hierarchy has also been considered for households in Sweden (Korpi et al., 2011), which notes that migration efficiency is influenced not only and not so much by the possibility of increasing incomes (they increase significantly when moving up), but also by varying housing costs. The examples show the ambiguity of choosing the direction of movement in the settlement system. Small towns can become centers that attract population, like what is taking place in Iceland (Bjarnason et al., 2021).

All the reviewed studies, as well as (Plane and Jurjevich, 2009), show that the upward and downward movement in the hierarchy at different ages is very different and frequently the most migratory groups of the population, primarily young people, establish the trend of overall movement.

In Russia, studies of migration between individual levels of the settlement hierarchy are limited by the lack of statistical data; there are only general ideas on the net migration of the population for groups of settlements of different size (Makhrova and Kirillov, 2014; Nefedova et al., 2016). As well, calculations using migration data for municipalities show that the population is concentrated in large urban agglomerations, and peripheral territories, far from large cities, have a stable and intensive migration population outflow (Karachurina and Mkrtchyan, 2016). The larger the city, the more likely it is to have steady population increase in terms of internal Russian migration (Mkrtchyan, 2011).

The situation in China is similar, but far from complete: research shows that the largest megapolises and large (by Chinese standards) cities are highly attractive to migrants (Liu and Wang, 2020; Yaojun et al., 2019), while migration is deterred by inaccessibility of housing in such cities and the policy of the authorities that restrict access to the social support system (*Hukou*). As a result, the flow of migrants is primarily oriented towards large cities, not megapolises (Song and Zhang, 2020); population outflow from the vast majority of rural areas is noted (Ma et al., 2018). The authors believe that more detailed studies in China are hampered by a lack of detailed statistical data.

MATERIALS AND METHODS

The paper considers migration in Russia between settlements of different size: from the smallest to the largest cities. Grouped by size, these settlements form the levels of the settlement hierarchy. At its very bottom are medium-sized rural settlements; higher are small and medium-sized cities; at the very top, Moscow and St. Petersburg. Large and medium-sized settlements are considered together with their suburbs, which are not only closely interconnected, but are also known to experience an intense increase in migration (Karachurina and Mkrtchyan, 2021). The nature of this increase is associated with cities sprawling beyond the boundaries of their urban okrugs (Karachurina et al., 2022), and the attractiveness of the suburbs of large and major cities to migrants is based on their territorial proximity to a large city. This is also called the agglomeration effect (Plane and Henrie, 2012). The migration balance of population in the suburbs differs fundamentally from peripheral territories: it depends not on the size of settlements making up the suburbs, but also on the size of the city (center) around which they are formed. For the migration balance of a settlement near the core of an urban agglomeration, its own size is not important, while its proximity to a large center is.

Settlements were included in the suburbs of cities based on the indicator of the difference in the coordinates of the center of a given settlement and the center of the nearest city of a certain size; we use straight-line distance. If the suburb under consideration is simultaneously included in two or more suburban zones (e.g., the cities of Sterlitamak and Salavat), then it was attributed to a center of higher order. If the settlement falls into the zone of two centers of the same level, then it was attributed to the one to which the distance is less.

The radii of suburbs is determined depending on the size of the cities that form them (Table 1). This

Table 1. Grouping of settlements (including suburbs) and number of people living in them

Group (level in settlement hierarchy)	Radius of suburbs, km	Population, mln people		
		center and suburbs	center	suburbs
1. Moscow and St. Petersburg		**24.0**	**16.2**	**7.8**
Moscow	100	18.1	11.3	6.8
St. Petersburg	100	5.9	4.9	1.0
2. 750000–1600000 people	**50**	**21.1**	**15–6**	**5.5**
3. 250000–750000 people		**31.3**	**24.6**	**6.7**
500000–750000 people	30	**14–7**	12.1	2.6
250000–500000 people	30	16.6	12.5	4.1
4. 100000–250000 people	**20**	**13.4**	**10.2**	**3.1**
5. 10000–100000 people		**25.8**	**17.3**	**1.6**
50000–10000 people	10	8.4	7.3	1.1
20000–50000 people	5	10.5	10.0	0.5
10000–20000 people	...	5.9	...	...
6. 1000–10000 people		**16.4**	**...**	**...**
3000–10000 people	...	9.5	...	...
1000–3000 people	...	6.9	...	...
7. <1000 people	**...**	**14.3**	**...**	**...**

Source. Census-2010; State catalog of geographical names. https://cgkipd.ru/science/names/reestry-gkgn.php; Yandex Maps.

method of identifying suburbs is formally very simple; naturally, it cannot take into account the characteristics of cities united in one or another group. The main principle on the basis of which we determined the radius of the allocation of suburbs is the approximate distance within which the net migration of suburbs differs significantly from the net migration of the surrounding periphery. The radius was determined empirically for groups of cities; similar calculations have already been carried out using examples of large urban agglomerations (Karachurina et al., 2022). Not all cities are able to have a sharply positive impact on the migration increase of their suburbs, especially in cities with a population of less than 100000 inhabitants. In such cases, when distinguishing suburbs, settlements that are actually merged or close to each other are considered together, which can also affect their migration increase. Examples are the city of Slavyansk-on-Kuban and the Trudobelikovsky farm (Krasnodar krai); Dyurtyuli and the village Ivanaevo (Republic of Bashkortostan).

For Moscow and St. Petersburg, settlements within a 100-km zone were considered suburbs (in (Plane and Henrie, 2012), 100-mile buffer zones were also assigned to US megapolises); the smaller the city, the smaller the radius of the suburbs assigned to it.

To calculate the population of each settlement, the data of the 2010 All-Russian Population Census (Census-2010) were used. The authors are aware that the number of residents of individual settlements, both large (e.g., Krasnodar, Tyumen, etc.) and small (e.g., Magas in the Republic of Ingushetia), could change over the period under review 2011–2020 significantly, but there was no other source of the number of inhabitants of these settlements at the time of the article was prepared.

For analytical purposes of studying migration between individual levels of the spatial hierarchy of settlements, we combined Moscow and St. Petersburg (with their suburbs), designating them as "megapolises." The group of cities with a population of 750000–1600000 includes, in fact, the remaining million-plus cities, since the populations of Voronezh, Perm, and Krasnoyarsk by the date of the Census-2010 did not quite reach this level, and Saratov, together with the satellite city (Engels) already surpassed it. The group of, conditionally, "half-million-plus cities," with populations of 250000–750000, included, e.g., Krasnodar and Tyumen, which showed rapid increase in the 2010s. We also combined groups of settlements with a population of 50000–100000, 20000–50000, and 10000–20000 inhabitants into a single level of "small and medium cities," and settlements with 3000–10000 and 1000–3000 inhabitants into a group of "large rural settlements." This division is very arbitrary; there are rural settlements with populations of more than 10000, there are cities with populations do not reach 10000 inhabitants, and there are urban-type settlements with different populations. Any grouping is always a compromise.

Calculations for 2011–2020 were based on individual depersonalized data of migrants who moved within

Table 2. Number of arrivals by type of registration, Russia, 2011–2020

Year	Total, thous. people	Registered at place of residence		Registered at place of temporary residence		Auto return	
		thous. people	%	thous. people	%	thous. people	%
2011	3057.6	2058.0	67.3	988.8	32.3	10.8	0.4
2012	3774.8	2239.4	59.3	1110.3	29.4	425.1	11.3
2013	3787.3	2042.1	53.9	1166.8	30.8	578.4	15.3
2014	3883.1	1982.1	51.0	1070.7	27.6	830.3	21.4
2015	4128.8	2005.1	48.6	1247.8	30.2	875.9	21.2
2016	4126.8	1895.8	45.9	1212.2	29.4	1018.8	24.7
2017	4179.7	1921.6	46.0	1201.9	28.8	1056.2	25.3
2018	4337.3	2026.4	46.7	1195.3	27.6	1115.7	25.7
2019	4055.3	1895.5	46.7	1053.2	26.0	1106.6	27.3
2020	3521.2	1609.4	45.7	828.8	23.5	1083.0	30.8
Total, 2011–2020	38851.9	19675.4	50.6	11075.9	28.5	8100.6	20.8

Source. Rosstat.

Russia (i.e., internal migrants). Only this type of data makes it possible to analyze migration with an accuracy of individual settlements, which is necessary for their grouping by size. Data were geographically referenced by 15-digit postal codes; it was not possible to reference a very small share of migration recorded by Rosstat, which for the entire period amounted to 0.04% of all resettlements. The data made it possible to single out migration recorded by registration at permanent residence and temporary residence.

HOW THE PECULIARITIES IN STATISTICAL ACCOUNTING OF MIGRATION IN RUSSIA AFFECTS THE RESULTS

It is important that in the period under review, the methodology for recording migration in Russia did not change, but in 2011, the methodology for recording long-term migration in Russia underwent the most serious transformation in the entire post-Soviet period. Until then, only those with registration at permanent residence (similar to *propiska* in the USSR) were counted as long-term migrants, but since 2011, they have been added to those registered at temporary residence for a period of 9 months or more. Thus, Rosstat brought the migration accounting methodology closer to the UN recommendations (Chudinovskikh, 2019) and quite successfully solved the problem of underestimating de facto long-term migration, which was acute in the 2000s. The number of registered in-country migrants more than doubled.

However, the change in the accounting methodology has created a new problem that reduces the quality of observation of migration processes. At the end of the registration period, persons whose registration has ended are automatically considered to have left for their place of permanent residence, but it is not known whether these movements actually occur. In addition, over the period of temporary residence, a number of structural characteristics of migrants (education level, marital status, etc.) could change, but these changes cannot be recorded by statistics (Mkrtchyan, 2020). For this study, such automatic departures (in the terminology of Rosstat "return to the place of permanent residence after a temporary stay in another territory," hereinafter referred to as auto return) represent a problem, which will be discussed below.

Of the 38.9 mln people who moved within Russia in 2011–2020, 19.7 mln were registered at the place of residence (i.e., according to the methodology that was in force until 2011), 11.1 mln were registered at the place of temporary residence for various periods, and 8.1 mln, or almost 21%, were registered as auto return (Table 2). The directions of auto return are always opposite to the dominant directions of migration; it significantly neutralizes the effect of population redistribution between the regions of the country, between settlements of different size. One of the most massive categories of migrants recorded as auto return, are students of secondary vocational and higher professional education institutions for whom registration at the place of temporary residence has ended.

However, the effect of auto return did not appear immediately, which gave rise to the idea of a sharp increase in population flow between parts of the country, concentration of migrants in large cities in the early 2010s, and its subsequent gradual attenuation by the end of the decade. As can be seen (see Table 2), after 2016, the scale of auto return almost equaled the number of those registered at the place of temporary residence and in 2020 even exceeded it. Owing to the individual data used in this article, which make it pos-

Table 3. Redistribution of population between seven levels of settlement hierarchy in Russia as result of internal migration, 2011–2020, mln people

Indicator	Migration within Russia		
	total	intraregional	interregional
Total (including auto return)	6.0	3.0	3.0
Excluding auto return	9.1	4.2	4.9
registered at place of residence	5.2	2.7	2.5
registered at place of temporary residence	3.9	1.5	35.4
Auto return	–3.1	–1.2	–1.9

sible to identify auto return in all the analyzed migrant flows, we were able to track its effect in order to assess the scale of the population flow between settlements of different size.

In the most general form, let us consider the migration increase/decrease (or net migration) between large cities (with populations of 250 000 inhabitants or more) and their suburbs, on the one hand, and smaller settlements, on the other. Figure 1 shows that the migration increase in the populations of both large and smaller settlements as a result of migration accompanied by registration at the place of residence and place of temporary residence was stable until 2019 (the lines "registered at place of residence," "registered at place of temporary residence" and total "within Russia without auto return"). However, the line "within Russia in total," including auto return, has shown a downward trend since 2014. It is this (including auto return) redistribution of the population between settlements of different size that is published by Rosstat and its territorial bodies, e.g., in the Indicators for Municipalities Database (IMDB) or when assessing migration between urban and rural settlements. However, we must understand that increase in flow between settlements of different size in 2011–2013 was due to fixation of an additional volume of movement due to a change in accounting methodology, and the subsequent decrease was due to the appearance of an auto return. Perhaps only in 2019–2020 was there a real decrease when Rosstat recorded a decrease in volumes both registered at the place of permanent and temporary residence.

We do not state that when the registration at the place of temporary residence ends, no one returns to the place of permanent residence, i.e., migratory movements recorded as auto return do not materialize in reality. However, neither can we assert that someone who no longer has registration immediately moves to a new place of permanent or temporary residence. The truth is somewhere in the middle. Therefore, we assume that migration with and without auto return represents a kind of upper and lower limit of possible changes in population redistribution.

This study, which is more of an exploratory nature, assesses the role of migration in population redistribution between separate, rather strongly aggregated levels of the settlement hierarchy in Russia: its absolute scale and "efficiency," according to the methodology used in (Plane et al., 2005; Plane and Henrie, 2012; Plane and Jurjevich, 2009), as well as in studies on other countries (de Jong et al., 2016).

RESULTS

Calculations for the seven levels of the settlement hierarchy, briefly described above (see Table 1), showed the volume of migration redistribution of the population between them (Table 3). Given that the entire flow was directed upwards, from the smallest settlements to larger and largest (including their suburbs), its range can be estimated as 6–9.1 mln people, depending on whether auto return is taken into account. Auto return significantly reduces the role of vertical flow: excluding it, 9.1 mln people redistributed to higher levels of the hierarchy account for 29.8% of all in-country resettlements recorded by Rosstat (see Table 2); if it is taken into account, then it decreases to 15.4%, i.e., almost double. The scale and proportion of vertical migration depend on the number of levels of the spatial hierarchy identified in this study: the more there are, the more people move from level to level. It is like in countries (regions) with less or more fractional administrative divisions: the more administrative units the resettlement between which is counted as migration, the greater its scale. However, calculation for additionally identified levels of the hierarchy (see Table 1) showed that the flow increases slightly, which confirms the sufficiency of the seven levels of the hierarchy of settlements identified in the work.

It is also important to note that the scale of the flow, taking into account auto return, only slightly exceeds the flow of migrants registered at the place of residence (i.e., according to the methodology in force until 2011). The redistribution sharply increased in the early 2010s (see Fig. 1), but returned to its previous values by 2014–2015. Thus, the change in the method of accounting for migration in 2011, which led to an increase in its scale, had little effect on the flow of migrants along the urban hierarchy or their concentra-

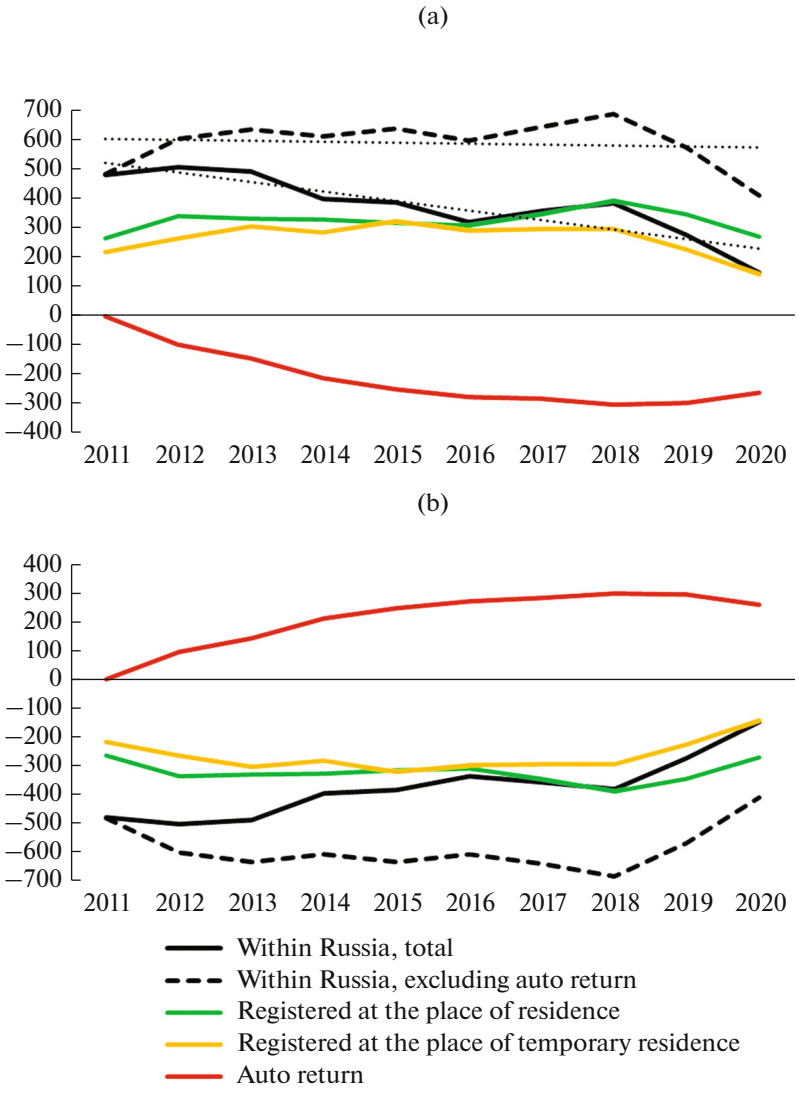

Fig. 1. Net migration of populations of (a) settlements with populations of more than 250 000 people (and their suburbs) and (b) other settlements, 2011–2020, thous. people
Source: Rosstat.

tion in large cities. If we do not take into account auto return, then the effect is significantly greater.

This can be seen in the example of individual levels of the settlement hierarchy (Tables 4 and 5). Within a decade, the flow to Moscow and St. Petersburg, with their suburbs, ranged from 2.1 to 3.3 mln people; to the three upper levels in total, from 3.7 to 5.9 mln people. Accordingly, the four lower levels lost just as much during this period.

A completely correct calculation of the intensity of net migration at individual levels of the settlement hierarchy using data on the population as of Census-2010 is impossible, since this population is at the very beginning of a fairly long time period. Therefore, the intensity indicator for the upper levels will be somewhat overestimated, while for the lower levels, it will be underestimated. Nevertheless, if we neglect the insufficient correctness of the data for calculation, the positive effect of population redistribution increased towards the very top of the settlement hierarchy, and the most negative effect was noted at its very bottom. Moscow and St. Petersburg and their suburbs acquired as a result of migration from below in 2011–2020 8.7–13.9% with respect to the initial number of inhabitants, while small peripheral rural settlements (less than 1000 inhabitants) lost from 11.2–16.6%.

The intensity coefficients of population flow between individual levels of the settlement hierarchy were calculated from the same data (Table 6). Since the population moves between two levels, we correlate the migration gain with their total population. For example, the flow from settlements with populations

Table 4. Migration increase (decrease) of population by individual levels of settlement hierarchy, taking into account auto return 2011–2020*

In exchange of population with level:	Total	Migration increase (decrease) for hierarchy level:						
		Moscow and St. Petersburg	750000–1600000 people	250000–750000 people	100000–250000 people	10000–100000 people	1–10000 people	<1000 people
Total	0.0	2076.2	769.7	902.7	–222.8	–925.7	–1009.3	–1590.8
Moscow and St. Petersburg	–2076.2	0.0	–281.8	–599.8	–286.9	–507.9	–213.2	–186.6
750000–1600000 people	–769.7	281.8	0.0	–67.2	–137.4	–395.8	–238.3	–212.8
250000–750000 people	–902.7	599.8	67.2	0.0	–171.3	–538.3	–471.5	–388.6
100000–250000 people	222.8	286.9	137.4	171.3	0.0	–92.7	–146.3	–133.7
10000–100000 people	925.7	507.9	395.8	538.3	92.7	0.0	–222.4	–386.6
1000–10000 people	1009.3	213.2	238.3	471.5	146.3	222.4	0.0	–282.4
<1000 people	1590.8	186.6	212.8	388.6	133.7	386.6	282.4	0.0

* Settlements of levels 1–5, taking into account suburbs (see Table 1).

Table 5. Migration increase (decrease) of population by individual levels of settlement hierarchy, excluding auto return, 2011–2020*

In exchange of population with level:	Total	Migration increase (decrease) for level of hierarchy:						
		Moscow and St. Petersburg	750000–1600000 people	250000–750000 people	100000–250000 people	10000–100000 people	1–10000 people	<1000 people
Total	0.0	3322.1	1169.6	1397.2	–357.2	–1523.7	–1641.5	–2366.4
Moscow and St. Petersburg	–3322.1	0.0	–443.6	–928.4	–461.3	–815.0	–354.5	–319.3
750000–1600000 people	–1169.6	443.6	0.0	–97.8	–203.0	–595.1	–373.9	–343.3
250000–750000 people	–1397.2	928.4	97.8	0.0	–260.4	–809.2	–725.8	–628.0
100000–250000 people	357.2	461.3	203.0	260.4	0.0	–138.4	–218.9	–210.3
10000–100000 people	1523.7	815.0	595.1	809.2	138.4	0.0	–309.2	–524.8
1000–10000 people	1641.5	354.5	373.9	725.8	218.9	309.2	0.0	–340.8
<1000 people	2366.4	319.3	343.3	628.0	210.3	524.8	340.8	0.0

* Settlements of levels 1–5, taking into account suburbs (see Table 1).

of less than 1000 people to settlements with populations of 1000–10000 people is divided by the population residing as of the Census-2010 in both these groups of settlements.

Taking into account the different population sizes on separate levels of the proposed settlement hierarchy, the most intensive flow occurred in the 2010s in the Moscow and St. Petersburg agglomerations from level 3, represented by cities with populations of 250000–750000 people and their suburbs, and from level 5 (10000–100000 people). The intensity of the flow to cities with populations of 250000–750000 is also high, as well as to their suburbs from levels 5 and 6. Note that the intensity of population flow between neighboring levels (values immediately below the main diagonal of the matrix) of the settlement hierarchy is low, except for the flow from level 7 to level 6, i.e., from small rural settlements to, conditionally, larger ones.

In (Plane et al., 2005) and a number of other studies discussed above on vertical migration, the indicator of the demographic efficiency of migration was calculated as a percentage. Calculation of this indicator is simple and represents the ratio of net migration to gross migration, or migration gain to migration turnover between each level of the settlement hierarchy. The demographic efficiency hypothetically ranges from 0% if the flows in both directions are equal in size, to 100% if there is a migration flow in only one direction. Figure 2 shows the calculation result. The arrows show the direction of the population flow, and their thickness and color intensity indicate the efficiency of migration. The diagram additionally shows the efficiency of population flow between individual parts of the upper level: the Moscow and St. Peters-

Table 6. Intensity of migration flow of population between levels of settlements hierarchy, taking into account auto return, 2011–2020, 1000 people per total population*

In exchange of population with level:	Migration increase (decrease) for level of hierarchy:						
	Moscow and St. Petersburg	750000–1600000 people	250000–750000 people	100000–250000 people	10000–100000 people	1–10000 people	<1000 people
Moscow and St. Petersburg	...	–6.3	–10.9	–7.7	–10.4	–5.3	–4.9
750000–1600000 people	6.3	...	–1.3	–4.0	–8.6	–6.4	–6.0
250000–750000 people	10.9	1.3	...	–3.8	–9.6	–9.9	–8.5
100000–250000 people	7.7	4.0	3.8	...	–2.4	–4.9	–4.8
10000–100000 people	10.4	8.6	9.6	2.4	...	–5.4	–9.9
1000–10000 people	5.3	6.4	9.9	4.9	5.4	...	–9.2
<1000 people	4.9	6.0	8.5	4.8	9.9	9.2	...

* Settlements of levels 1–5, taking into account suburbs (see Table 1).

burg urban agglomerations; it is small: only 11% in favor of the capital.

We also calculated the efficiency for migration without auto return for home; all of its indicators are characterized by even higher values (about 85% and more), but we considered it unnecessary to characterize them in detail due to the similarity of the picture (see Fig. 2).

Unlike the United States and other countries, in Russia in the 2010s, all migration flows redistribute population from the bottom up; there is no flow in the opposite direction. Note also that the efficiency of the flow is high. In (Plane et al., 2005), the highest efficiency of migration between individual levels is determined at 25%, while for Russia, efficiency is near the average.

The most efficient flow from almost all levels occurs to the very top: to the Moscow and St. Petersburg agglomerations, moreover, from agglomerations of large cities of different sizes. This is a distinct specificity of Russia. Conversely, the low efficiency of the flow is between neighboring levels of the settlement hierarchy (excluding the top two and two bottom-most). The efficiency of the flow between the lowest level of the hierarchy and the highest one is also low (by Russian standards).

CONCLUSIONS

For the first time, the authors have assessed the redistribution of the Russian population between individual levels of the settlement hierarchy, of which seven have been identified. The methodological feature of the study is grouping and joint consideration of large and medium-sized settlements with their suburbs. This approach is dictated, first, by the determinism of migration rates in small and medium-sized settlements based on their position in the center–periphery system (Mkrtchyan, 2019); secondly, by the sprawl of many large cities beyond the administrative boundaries of their urban okrugs; and, third, by nearly ubiq-

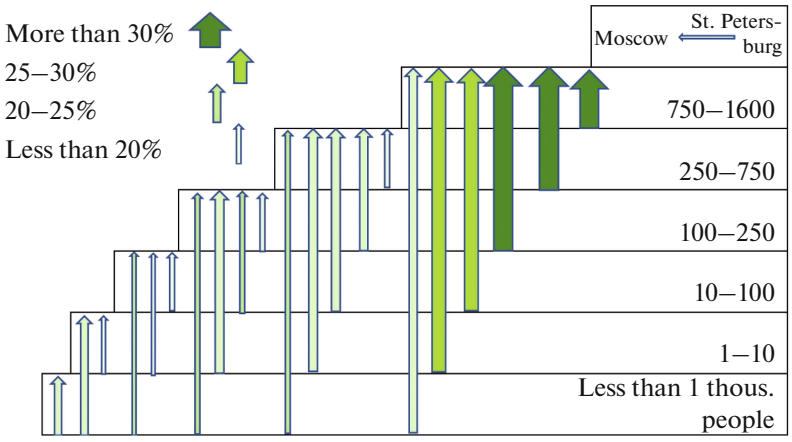

Fig. 2. Efficiency of migration between levels of settlement hierarchy, taking into account auto return, 2011–2020, %.

uitous migration increase of the suburbs, exceeding in intensity the migration increase of the cities around which they are formed.

We believe that it is more correct to analyze migration in Russia not by individual settlements, but by settlement systems, which form, first of all, large cities and their suburbs. At high levels of the settlement hierarchy, these systems are close to large urban agglomerations. This is logical at the ordinary level as well: a person or a household in the suburbs of a large city is strongly involved in its life through labor, educational, household, and recreational ties. People living in the suburbs (e.g., of Moscow, St. Petersburg) frequently associate themselves primarily with a large city, not with a settlement in its suburbs.

The estimates of vertical migration flows carried out in this study and the analysis of their results would not have been possible without the use of data on migration at the level of settlements, without distinguishing migration flows between settlements of different size and their localization in the center–periphery system. This possibility is afforded by depersonalized individual data, which were not previously used in the analysis of migration. Calculations based on them allowed the following conclusions.

(1) ***Estimates of the scale of population flow between individual levels of the settlement hierarchy and its efficiency depend to a large extent on changes in the methodology for accounting for long-term migration***, namely, accounting for those registered at the place of temporary residence and their auto return after it expires. Assuming that accurate estimates of the flow are impossible, we propose characterizing them by an interval value. As a result, population flow to the upper levels of the settlement hierarchy in cities with populations of 250000 or more and their suburbs has been estimated for the 2010s as 3.7–5.9 mln people, while the flow upwards between the seven levels is 6–9.1 mln.

(2) ***The population flow from all levels of the settlement hierarchy occurs only upwards***, which indicates continuation of the mature large-city stage of urbanization in Russia, which marks concentration of the population in large and major cities. Judging by our data, Russia is still far from the counterurbanization stage, long observed by researchers in many Western countries (Fielding, 1982), elements of which are seen from time to time in Russia (Nefedova and Treivish, 2019). The only thing that can cast doubt on this thesis is that the population is concentrated not so much in large cities as in their immediate suburbs (Karachurina and Mkrtchyan, 2021), but this is primarily due to urban sprawl. Thus, the trend towards concentration of the population in large cities and their suburbs, noted in studies for Russia (Karachurina and Mkrtchyan, 2016), is confirmed.

(3) ***The unidirectional redistribution of the population upwards in the settlement hierarchy is a distinct feature of Russia***; nothing of the kind has been observed for a long time, judging from the studies known to us, in the United States, Canada, and a number of European countries. The effect of this spill is achieved not so much by a large volume of upward movement (Russia is generally not distinguished by migration intensity, significantly lagging behind the mentioned countries), but by the extreme weakness of downward movement—with one important caveat: if flow from large cities to their nearest suburbs is not taken into account. In Western countries, this flow is strong, but we cannot say exactly what share it is in the downward movement in individual countries; however, it is not considered in this study for Russia.

What is the reason for the lack of movement down the settlement hierarchy? After moving to a large city or being born in it, Russians are extremely reluctant to agree to move to a small town, village, or settlement on the periphery. Everything works against this, from the weak diversification of the labor market in the periphery, difference in wages (Nefedova, 2020), access to social services and social support (Zubarevich, 2012), risks of premature mortality (Shchur, 2019), to general dissatisfaction with rural life. In addition, even after de facto departure from a large city (e.g., and above all, from Moscow), people do not register at a new place of permanent or temporary residence. This is evidenced, in particular, by overestimation of the number of residents in Moscow and underestimation of the population of Moscow oblast, identified in a study based on cellphone data (Makhrova and Babkin, 2018).

(4) ***The population flow between neighboring levels of the settlement hierarchy is relatively small***. This is apparently explained by the weak motivation for such moves: when moving from a city with a population of 200000 to a city with 300000–400000, living conditions change little or not at all. It is the same when moving from a village of 6000–7000 to a small town. The only exception is an intensive move to the Moscow and St. Petersburg agglomerations from cities with populations of over a million or half-million people. First of all, moving to capitals and megapolises can lead to a strong qualitative breakthrough in living conditions (it is not for nothing that Moscow and St. Petersburg residence permits have always been especially coveted). Second, it is possible that the residents of large and major cities do not experience such strong stress in the differences in housing/rental costs in megapolises. Although a study of the relationship between migration and the housing market (Kurichev and Kuricheva, 2018) shows that residents of the regions surrounding Moscow, as well as residents of St. Petersburg and rich oil and gas regions, stand out among homebuyers in the capital; residents of million-plus cities are not among the active housing buyers in Moscow. Lastly, it may be easier for residents of large cities to adapt to the specific rhythm of life in a metropolis.

This does not mean that people do not move between settlements close in size, but these moves are not unidirectional: flows in both directions are commensurate, almost equal. And this does not indicate nonproliferation of hierarchical migration (in our case, marked by movement between neighboring levels of the settlement hierarchy). Such resettlements exist and are recorded by statistics, but they occur in opposite directions and therefore rarely yield a flow effect in favor of a particular level. Perhaps we are dealing with "background" movements (Plane and Henrie, 2012) associated with moving for education and back, etc. There is a significant flow between the lowest levels of the settlement hierarchy, from small to large rural settlements or to urban-type settlements. In any case, this issue requires a detailed study, taking into account the particular role of suburbs in hierarchical migration.

The study made it possible to consider only the most general patterns of migration in Russia between settlements of different size and positions in the center–periphery system. In future studies, we plan to examine in detail migration between cities of different size and their suburbs, the age characteristics of migration between individual levels of the settlement hierarchy, and a number of other issues.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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