Research on Inter-Regional Population Migration as a Labor Supply Chain

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Abstract— This article explores the determinants of interregional labour migration in southern Russian regions. Using a basic gravity model with very specialized variables (working-age population, the nearest distance between the administrative regional centres) we partially confirmed hypotheses concerning the presence of a gravitational link between separate regions in southern Russia. The relevance of the topic is determined by the increasing imbalance in the labour force, the partial territorial desertification and the lack of adequate authority measures to regulate migration processes by preserving the integrity of out-migration areas. During the research period (1995-2018), the gravity between regions was both centripetal and centrifugal depending on its centre. In turn, prioritized attraction points are urban settlements within the Southern Federal District. During our regression analysis, we identified four significant variables having the most significant impact on the number of working-age drop-out population: share of the urban population, the average per capita monetary income of the population, length of paved roads, and unemployment rate. The obtained results of calculations allow us to assume that the migration movement of the working-age part of the population is a supply chain of labor in the direction of favorable territories

Keywords— *regional economy, labor, favorable, working population, socio-economic asymmetry*.

1. Introduction

Migration is an indicator of divergent processes [9]. On the one hand, the selection of immigration direction indicates the greater socio-economic well-being of the territory. On the other hand, for the out-migration territories this process is depressed causing negative spatial phenomena (territorial desertification, labour force depletion) [15].

Review in the retrospective studies on this topic, one should mention the considerable efforts of Russian and foreign authors in the elaboration of the decisive factors of labour migration. For example, Daniela Bunea identified two forms of labour migration: speculative and contract. Both processes depend on several micro and macro factors, most of which are non-formalized [6]. However, John Hicks claimed that wages are the decisive factor in labour migration as the guarantor of financial sustainability [3].

According to the study by Raul Ramos and Jordi Suriñach, it is initially poor living conditions in a place of regular residence that provokes massive labour migration. That means a low standard of living generates workforce spillover more intensely than career opportunities and higher salaries with an initially stable and prosperous standard of living. However, a group of authors from Indonesia claims that the developed urban environment attracts the population and the urbanization of the territories is the determining factor of migration [25].

In our research, we are conceptually close to the position of socio-economic inequality as a general and decisive factor of labour migration, particularly within a single country or macro-region.

Southern Russia is a densely populated territory without a pronounced settlement structure (urban or rural). The issue of interregional labour migration is being actively studied by the Russian scientific community as there is the growing all-Russian

trend of labour migration to the metropolitan regions (Moscow, Moscow region and Leningrad region).The southern regions maintain the tradition of border spillovers [7],[2].

The analyzed territories are characterized by a high population density and a high standard of living for the local population. However, these statements are correct when regions are viewed as a whole, whereas analyzing the regional indicators separately reveals a significant asymmetry and differentiation of basic socio-economic indicators [23].

Is it worth to consider interregional migration processes (specifically labour migration) as a negative or positive factor for the economy, or is it a natural process balancing the regional economy? Are neighboring territories always to be priority directions for labour migration? What is the determining factor for labour migration? Can the migration movement of the working-age population be considered as a labor supply chain on an interregional scale?

2. Literature Review

Gravity models are widely used to simulate the attraction between territories in analyzing foreign trade turnovers [21], [12], air transportation volumes [14], spillovers of various resources [19].

In our case, the application of the gravity model for estimating the level of migration relations between the regions of southern Russia is justified by the borderline position of these territories suggesting that there are strong interregional links in the labour market. We assume that regional proximity is an important factor for the population movement within the administrative units and, above all, people seek to improve the quality of life in the regions closest to the place of their permanent residence. On that issue, we relied on the study by the IMAGE studio that emphasized the uniqueness of migration processes in a given territorial unit (sometimes the distance factor has a major impact, sometimes it becomes irrelevant due to the improved transportation) [22]. The classical gravity model is as follows:

$$M_i = k\frac{x_i}{d} \quad (1),$$

Where k is an empirical coefficient used as a measure of convergence for an intended indicator for different territories;

xi,xj is the factor determining gravity;

d2 is the distance between territories.

A review of migration studies based on the gravity model enabled identifying the most frequently included determinants for its subsequent enhancement and accuracy improvement.

A group of Russian authors traced the evolution of the gravity model of human migration. "…During the 1950s and 60s, several American geographers researched the impact of four factors on migration concluding that its scale was connected to the size of the employed labour force. They also introduced three complementary indicators: employment growth in the manufacturing industry, average family income and share of professional classes and engineering and technical personnel in overall employment [5]. At the same time, Walter Isard (1960) introduced complementarity into a regular gravity model where the gravitational pull is inversely proportional to the distance:

$$Mij = (Pj/dij)f(Z) \quad (2),$$

where Pi and Pj are population sizes of two migration centres (two masses); wi, wj are the weight coefficients of these masses that characterize their various peculiarities (socio-economic, etc.); dij is the distance between masses; G, b, αand β are coefficients of the model..." [4], [5]. Thus, complementary indicators became part of the gravity model of migration.

Modern authors also use an integrated approach and include groups of deterministic indicators in the gravitational model: for example, Raul Ramos and Jordi Suriñach analyzed gravity between countries using demographic, geographic, social/historical and economic factors resultingin identifying high levels of migration between some countries due to their geographical proximity or strong political, economic or colonial ties [17]. Other researchers specificated the role of the distance between the analyzed locationsas well as the significance of small settlements (urban and rural ones) as interim objects of migration [16].

We drew on the results of the above-mentioned studies and applied on the gravity model (1), which consists of the following determinants: k is the coefficient of territorial convergence, for which we use the share of the drop-out population calculated from the average annual population migrated to other Russian regions; xi,xj is the number of the working-age population; d2is the distance between the territories, we used the nearest distance between the objects along the roads (not a straight line). The role of each indicator in the gravity model is important and will answer a number of questions, including whether migration should be identified with the labor supply chain.

3. Methodology

All the data used in the research have been selected at the regional level. The aggregate statistical information at one level would avoid data comparability conflict and allow for adequate comparisons of the socio-economic situation in regions of southern Russia (the Krasnodar region, the Rostov region, the Astrakhan region, the Republic of Kalmykia, the Stavropol region, and the Volgograd region). The analyzed regions were selected based on the borders proximity and long-lasting historical socio-economic ties and similar agro-industrial sectoral specialization [8],[18].

Sources of information include official data from the Russian Statistics Service, the data from the Ministry of Economic Development of the Russian Federation and municipal statistics. The sampling period for statistical analysis is from 2000 to 2018 and for calculating the gravity model it is from 1995 to 2018.

The first analytical stage of the study involves the comparison of the main socio-economic indicators for a group of southern Russian regions to obtain general information about regions. Furthermore, the gravity model calculation will indicate the presence or absence of the interregional attraction for migrationspillovers of the population. The final stage is aimed at identifying the factors impacting the outflow of the working population using a regression analysis for the group of factors. To implement the regression analysis, we use aggregate average data for southern Russian regions from 2000 to 2018. List of indicators for regression analysis:

1. Number of working-age drop-outs (Y)-people (dependent variable);

Independent variables:

1. Population (P) – thousand people;
2. GRP per capita (GDP)-rubles;
3. Share of urban population (CP)-%;
4. Average per capita monetary income (V) - rubles;
5. Number of unemployed (U) – thousand people;
6. Mortality of working-age population (D) - per 100,000 people;
7. Number of reported crimes (T) Units.
8. Length of paved roads (R) kilometres.

Table 1. Russian migration by inflow and outflow territories, people (2019)

Inflow Territory	Russia	To Federal Districts							
Outflow Territory		Central	North-Western	Southern	North-Caucasus	Privolzhsky	Ural	Siberian	Far Eastern
from urban settlements to urban ones									
Southern FD	1644 89	3951 9	15214	74567	8163	8077	7129	6322	5498
from rural settlements to urban ones									
Southern FD	1000 24	1346	5258	66140	3293	3302	3482	2750	2452
from urban settlements to rural ones									
Southern FD	7572 8	6408	2587	56192	5197	2347	933	1207	857
from rural settlements to rural ones									
Southern FD	5051 4	3649	1137	38771	3499	1393	584	858	623

Source: Rosstat

Table 1 shows the migration data from the Southern Federal District as of 2019 (5 out of the 6 analyzed regions are part of the Southern Federal District), and the population is indicated without taking into account the age groups of those who depart but enabling to describe the overall movement trends. Urban settlements within the Southern District dominate as target destinations. We should also note the popularity of reverse movement (from cities to villages) within the district only. The local population does not seek to fundamentally change their territory of residence being content with an intraregional movement.

Figure 1 presents the information on the changes in GRP. We note the overall positive dynamics for all regions of southern Russia with the highest growth in the Astrakhan region and the Krasnodar region.

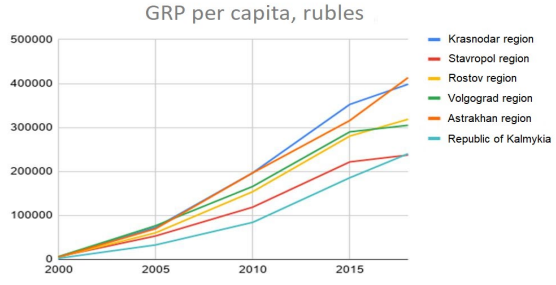

Figure 1. Dynamics in GRP per capita

GRP generally reflects the viability of an economic subject. Does the GRP level impact migration processes?[11]. As a result, migration influences the overall population of the territories along with other demographic factors. Figure 2 shows the population dynamics reflecting the differences between the analyzed territories. So only two regions of southern Russia (the Krasnodar region and the Rostov region) demonstrate positive trends, whereas the remaining regions have difficulties in retaining the number of permanent residents.

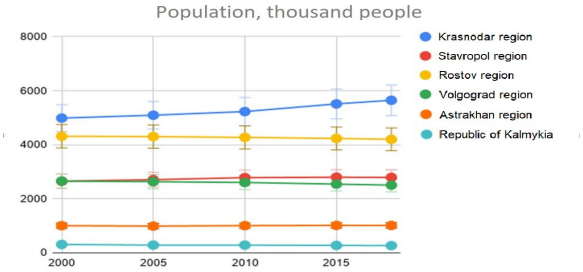

Figure 2. Population dynamics by region

The calculation of the coefficient of variation for the three indicators shown in Figure 3 demonstrates a significant gap in the number of unemployed (on average 0.631). The volatility in the number of unemployed has internal and external factors that can also be associated with migration processes [24]. The higher it is, the greater the probability of activation of migration processes, and in this case, we can designate the migration process as one of the components of the labor supply chain [1] .

The convergence of average per capita monetary income and GRP per capita is not high with an average variation for the analyzed regions is 0.0225 and 0,241. This fact preliminary rejects the assumption regarding high differentials of income among the population of southern Russian regions as the main factor of interregional movement.

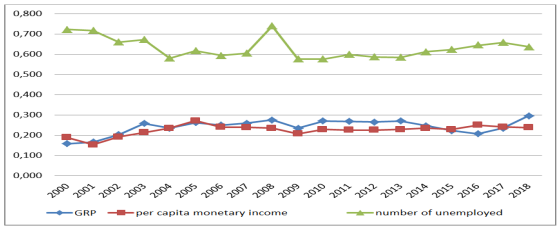

Figure 3 . σ-convergence of GRP per capita, unemployment rate and average per capita monetary income

Turning to the official annual rating of the Russian regions for quality of life, the Krasnodar region is traditionally among the top 10 regions (6th place in 2019), the Rostov region took 19th place in 2018 and 2019. In 2019, the Stavropol region was on the 23rd place, where as the Volgograd region, the Astrakhan region and the Republic of Kalmykia did not enter the top 40. This rating is a comprehensive indicator of the population well-being in the regions representing the annual trends [20].

The correlation of migration spillovers of the population aiming to improve the quality of life was analyzed at different scales with significant asymmetries in the socio-economic development of regions and countries [10]. In our case, it is important to identify the potential directions of the internal movement of the working population in the regions of the southern group and their causes.

3.1. Results of gravity model calculation and regression analysis

To calculate the gravity model we have identified three attraction centres that are regional administrative centres and sub-millionaires (Krasnodar), as well as millionaires (Rostov-on-Don, Volgograd) in terms of population. In table 1 there is the data on gravitational coefficients in the selected centres. The resulting values of the gravity model are moderate, but with considerable variation. The minimum value is less than 1, the maximum value is more than 54. The stronger the gravitational link, the higher the coefficient.

Table 2. Calculation of gravitational pull (gravitational coefficient) for migration of working population

	1995	2005	2010	2011	2013	2014	2015	2016	2017	2018
Model 1 (Centre –Krasnodar city of Krasnodar region)										
Stavropol region	23,25	23,74	27,90	28,38	29,33	28,26	28,81	29,38	29,86	28,44
Republic of Kalmykia	0,77	0,89	0,94	0,90	1,00	0,96	0,88	0,81	0,87	0,90
Astrakhan region	0,78	1,19	1,37	1,40	1,23	1,08	1,04	1,18	1,15	1,13
Volgograd region	2,82	4,04	4,52	4,90	4,82	4,54	4,27	3,80	3,71	3,48
Rostov region	31,15	47,21	46,68	46,43	46,64	43,21	43,04	40,61	40,36	40,45
Model 2 (Centre –Rostov-on-Don city of Rostov region)										
Stavropol region	15,57	15,07	14,43	14,57	15,52	16,15	17,18	17,18	17,02	16,51
Republic of Kalmykia	0,91	1,00	1,01	1,10	1,09	1,04	1,03	0,96	1,00	0,99
Rostov region	37,47	43,69	43,95	43,92	44,76	46,25	47,11	47,07	54,23	52,36
Astrakhan region	0,86	1,24	1,34	1,30	1,29	1,24	1,38	1,39	1,13	1,03
Volgograd region	6,25	8,52	8,90	8,85	8,41	8,71	9,23	9,83	10,05	8,80
Model 3 (Centre –Volgograd city of Volgograd region)										
Stavropol region	3,53	3,41	3,26	3,29	3,50	3,64	3,85	3,85	3,82	3,64
Republic of Kalmykia	1,36	1,49	1,50	1,64	1,62	1,55	1,52	1,42	1,52	1,44

Krasnodar region	3,04	3,54	3,56	3,56	3,62	3,74	3,79	3,78	4,00	4,14
Astrakhan region	1,69	2,45	2,65	2,57	2,54	2,45	2,70	2,71	2,29	1,99
Rostov region	5,62	8,07	7,85	8,32	7,85	7,62	7,66	7,49	7,23	6,62

Model 1 describes the processes of active gravity tothe city of Krasnodar from the Stavropol region and the Rostov region (to a greater extent) (Figure 4). Model 2 reflects the opposite trend as the centre shifts to Rostov-on-Don with the highest gravitational flow from the Krasnodar region and the Stavropol region (figure 5). Model 3 is not viable as the calculated gravitational coefficient values are insufficient (less than 10 units). Volgograd is not the centre of attraction for migration flows for the productive segment of the population from border territories.

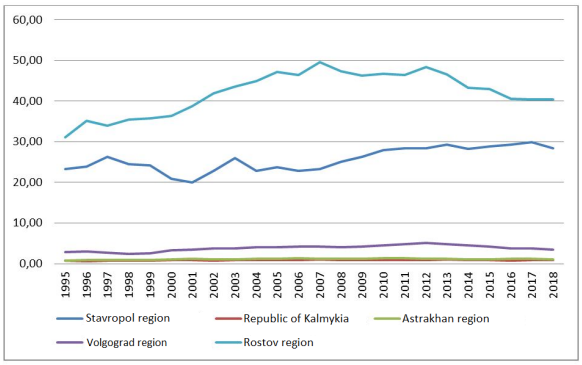

Figure 4. Dynamics of migration gravitational pull for working population (centre in Krasnodar)

Analyzing specifics of gravitational pull, it is worth noting the centripetal migration movement in the direction of Krasnodar from the Stavropol and the Rostov regions. The gravity slowed somewhat since 2007 (within 40-50 units), but the direction remains constant (figure 4).

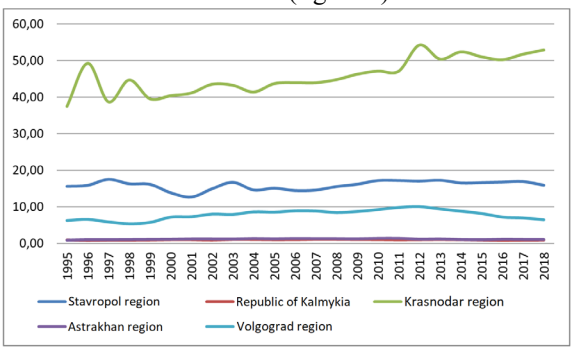

Figure 5. Dynamics of migration gravitational pull for working population (centre in Rostov-on-Don)

The most intensive centripetal movement is from Krasnodar towards Rostov-on-Don (more than 50 units), while in other regions there is a static trend with a gradual centrifugal character since 2014 (the Stavropol region, the Volgograd region).

To determine the causes for migration it is efficient to apply regression analysis and identify by calculation the fact and specifics of the relations between dependent and independent variables.

Table 3 presents the descriptive statistics of variables. In our case, the data is very different having various measurement units. So to exclude the impact of severe effects and time abnormalities, the data for regression analysis is to be normalized.

Table 3. Descriptive statistics of variables from 2000 to 2018.

Variables	Starting data			
	Mean	SD	Min	Max
Number of working-age drop-outs (Y)	37222	13621	22974	55105
GRP (GDP)	152921	108000	22942	361405
Population(P)	1601	47	1511	1654
Share of urban population (CP)	61	0,58	60	61,9
Average per capita monetary income of population (V)	12475	8357	1492	25073
Number of unemployed(U)	109	24	74	170
Mortality of working-age population (D)	528	52	419	579
Number of reported crimes	28227	3598	22083	33543
Length of paved roads (R)	12553	3391	7810	17628

The significance of several variables decreased due to the application of multiple regressions. As a result of the step-by-step models' selection, we have the outcome shown in the table. Models include several social and economic variables describing the behavior of the drop-out population with a high probability (table 4).

Table 4. Results for regression modelling of migration processes

Independent variables	Dependent variable: Number of working-age drop-outs		
	Model 1	Model2	Model3
GRP (GDP)	-1.27 (0,87)	-	-
Mortality of working-age population (D)	-0,40 (0,42)	-0,04 (0,35)	-
Population(P)	-0,01 (0,16)	0,10 (0,14)	0,09 (0,11)
Share of urban population (CP)	0,93** (0,28)	1,01** (0,29)	1,01** (0,28)
Average per capita monetary income of population (V)	-0,69 (0,82)	-1,60* (0,54)	-1,62** (0,51)
Number of unemployed(U)	0,17 (0,17)	0,29 (0,16)	0,28* (0,13)
Number of reported crimes	0,14 (0,21)	0,14 (0,22)	0,13 (0,17)
Length of paved roads (R)	1,86* (0,60)	1,95* (0,62)	1,97** (0,56)
Normalized *R*-squared	0,95	0,94	0,95
Standard error	0,23	0,24	0,23

Note: * p < 0,05; ** p < 0,01; *** p < 0,001

When all variables were included in the regression analysis, only two were relevant: the share of urban population (with the significance value of 0.01) and the length of paved roads (with the significance value of 0.05). By excluding several variables step by step, we concluded that the level of GRP did not influence the number of

drop-outs. Model 2 shows the increasing influence of the two abovementioned factors (CP, R) with the addition of acomplemental factor –the average per capita monetary income of the population (the significance value is0.05).

Further modelling excluded the mortality of the working-age population (statistically insignificant) from model 2. That resulted in forming model 3 with four significant variables: the urban population that remained consistently positive (the significance value is0.01); average per capita monetary income that increased to -1.62 (the significance is 0.01); length of roads that increased its influence to 1.97 (the significance is 0.01); and the number of unemployed is at 0.28 (with the value of 0.05). The remaining variables are not significant and have no tangible impact on the dependent variable.

4. Conclusion and discussion

Earlier studies of interregional labour migration revealed signs of profitableness in the regions of southern Russia and for many other Russian regions [13].

In our research, we used the basic gravity model though with the inclusion of special indicators characterizing the outflow of the working population. The data sampling for the gravity model represents the period from 1995 to 2018 in terms of 6 southern Russian regions.

Our intention was not only to identify the fact of a gravitational link between regions but also to reveal the factors impacting the drop-out process. Using the regression analysis, we defined four factors that have a significant effect on the washing-off processes in relation to the working population. Among these factors, the urban environment is of particular importance, which was confirmed by the results of the research by Wajdi and others [25]. Being more economically developed, the urban area is more attractive to the residents of the peripheral regions.

Also, the level of monetary income is a serious disincentive as interregional movement involves the search for higher wages without leaving the area of permanent residence. In confirmation of the hypothesis [17], it is worth noting the low significance of the crime rate for migration. Low-income regions demonstrate the equally low number of reported crimes (for example, in the Republic of Kalmykia). Given circumstances in Russia, the low level of socio-economic development in the region causes the population to seek more favourable conditions excluding the life of crime.

The gravity model showed that not all regions of southern Russia are equally attractive for the migration of the working population. Strong interdependent links were identified between the Krasnodar region and the Rostov region, the Krasnodar and the Stavropol regions. Other regions dismiss the assumption of the significant and permanent attraction between all regions of southern Russia.

The calculation of the gravity model and the regression model allow us to conclude that there are strong links in the interregional economic system between regions with low and high levels of monetary income of the population. This fact confirms the author's assumption that migration processes are an integral part of the labor supply chain to neighboring regions. Migration processes are part of the logistics supply chain of labor, and it is promising to study the dynamic features of the direction and structure of movement of the able-bodied part of the population.

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