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MODELLING MIGRATION AND LABOUR MARKETS IN RUSSIA

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Motivation

Labour market issues, where the interests of employers, workers and the state merge, occupy a central position in economic analysis. The functioning of key macroeconomic mechanisms and, consequently, economic policy recommendations are determined by specific features of the labour market. When studying the labour market, researchers apply macroeconomic and microeconomic theories, institutional analysis, demography, and econometric analysis, among others.

The Russian labour market is an attractive object of research, since it has a number of features that distinguish it from those in other countries. According to the hypothesis proposed in (Layard, Richter, 1995), the Russian labour market adjusts to economic shocks mainly through changes in wages, not employment. Later research lent additional support to this concept (Gimpelson, Lippoldt, 2000; Kapeliushnikov, 2001; Gimpelson, Kapeliushnikov, 2011), primarily based on the analysis of the Russian labour market's reactions to downturns in production during two crises, 1992–1994 and 2008–2009. These observations do not provide a comprehensive account of the specifics of the Russian labour market, as they do not have answers to many principal questions, such as what mechanisms drive the observed market adjustments to shocks, and whether the reactions constitute a short or long-term relationship, that is, whether there is a shift in the equilibrium or a temporary fluctuation. Answers to such questions could only be obtained from the macro modelling of the regular functioning of the Russian labour market. This problem poses several methodological difficulties, such as the need to identify a causal relationship between labour market indicators, to model spatial dependence in the analysis of its regional performance, to account for structural shifts caused by macroeconomic shocks, and to model asymmetries in labour market reactions to positive and negative shocks in the economy.

Another specificity of the Russian labour market is the growth in the share of wages in GDP over the 2000s (excluding crisis periods). The prevailing trend in most countries during these years was the downward. One more feature of the Russian labour market is the growing deficit of labour resources caused by the decline in the number of working-age population, which results in relatively strong demand for foreign labour (Zaionchkovskaya, 2013).

Worldwide, the analysis of the labour market centres around the most important feature: mobility, e.g., professional, intracompany, intercompany, intersectoral and interterritorial. Labour performance in the economy, the speed of economic adjustment to shocks and the response to government actions are largely determined by labour mobility. This dissertation focuses on the macro aspects of the latter, and consequently, addresses intersectoral and primarily interterritorial mobility, i.e., migration. Russia is characterised by strong regional differentiation in labour market indicators (Zubarevich, 2014), which may create incentives for migration; interregional migration might either exacerbate or smooth out this differentiation.

Internal migration transforms the demographic structure, which directly affects regional labour potential. Therefore, studying interregional and intraregional migration is of theoretical and practical relevance. While undertaking such research, it is important to consider not only the scale and directions of spatial movements within the country, but also the structure of migration flows and their underlying factors. Without understanding the macroeconomic mechanisms of labour markets, their reactions to crises and the spatial relationships between regional markets, it is hardly possible to provide explanations, or projections, for internal migration flows. This justifies the need to approach internal migration research in conjunction with labour market studies.

Internal migration in former socialist countries represents a unique research subject. In the early 1990s, the widely adopted administrative means of restriction of movement (a system of propiska) were replaced by socioeconomic constraints and incentives which opened the way for studying the directions and factors of internal migration. Russia's vast and varied territory, strong regional differentiation by socioeconomic, natural, climatic and other factors open up a potential for developing multifactor models of migration and applying spatial econometric methods to account for spatial dependence. However, the empirical modelling of internal migration in Russia has several methodological difficulties, usually disregarded in studies:

1) accounting for intraregional flows in internal migration models, which requires the correction of coefficients in gravity models (LeSage, Fisher, 2016);

2) accounting for the spatial dependence of migration factors;

3) the problem of the endogeneity of labour market factors;

4) accounting for the heterogeneity of regions and the identification of homogeneous groups by the sensitivity of migration to different factors;

5) the identification and modelling of structural shifts caused by either methodological changes in migration statistics or crisis shocks in the economy.

In this dissertation research, these methodological difficulties in labour market and migration studies are resolved by means of econometric methods for model verification and robustness checks. Linear, nonlinear and nonparametric methods are used to estimate model parameters; the relationships between labour market variables are analysed through the development of a system of equations and the method of instrumental variables; the unobservable heterogeneity of regions is taken into account using the analysis of panel data; the aspects of labour market adjustment to different shocks are analysed. The analysis includes many potential mechanisms that are disregarded in most studies but are important in many cases. In particular, the asymmetry of the reaction of the labor market to positive and negative shocks in the economy is checked; models based on regional data take into account spatial dependence using spatial econometrics.

Objectives of the research

The aim of this dissertation is to propose methodological approaches that substantiate specific features of the macroeconomic mechanisms of the Russian labour market, by modelling the indicators of the labour market and migration while taking into account their relationship.

To achieve this aim, the following **objectives** are addressed:

1. To develop macroeconomic models of the labour market functioning in Russia, explaining the relationship between real wages, labour productivity and the unemployment rate.
2. To propose and describe the functional mechanisms of the Russian labour market based on classical macroeconomic models: the relationship between GDP unemployment rate (Okun's law), real wage flexibility to unemployment rate, real wage elasticity to productivity.
3. To substantiate the existence and assess the degree of the spatial dependence between regional labour markets in Russia by means of spatial econometric modelling.
4. To develop approaches to interpreting the results of spatial econometric models.
5. To formulate an approach for identifying the dominant directions of age-specific migration associated with life-course stages.
6. To develop econometric models, explaining the directions of internal and age-specific migration in Russia and to test the poverty trap hypotheses, opposite directions of migration flows composed of different dominant age groups, spatial dependence, and competition/cooperation between regions.
7. To develop theoretical and econometric models for testing the impact of changes in global resource demand on internal migration flows in Russia.
8. To develop a model of demand for foreign labour and to test the hypothesis about competition between foreign and local workers.
9. To assess the degree of wage discrimination against foreign vs. local workers.

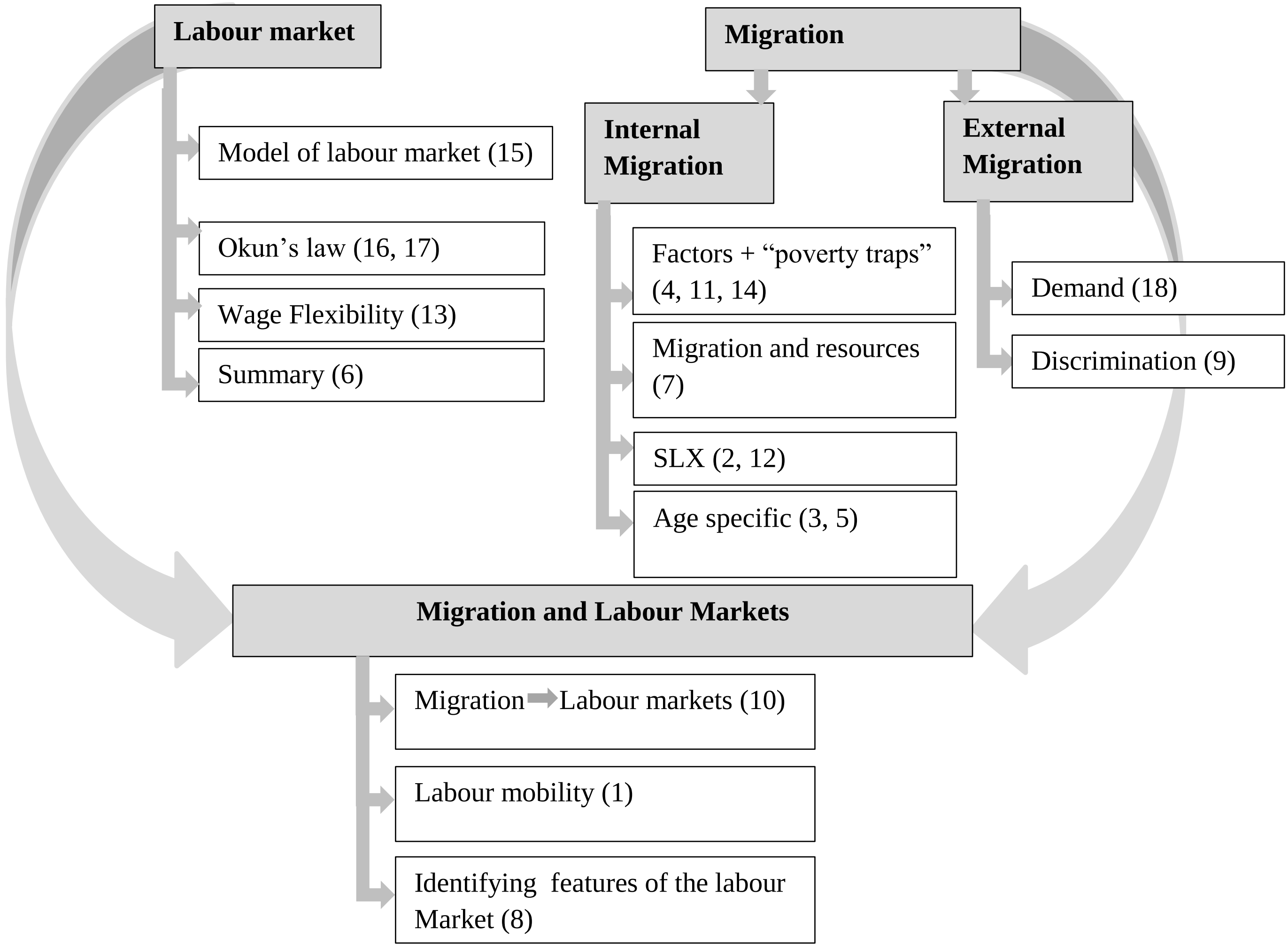
10. To evaluate the impact of migration on regional differentiation in terms of the unemployment rate, income and wages, taking into account their relationships and spatial dependence.
11. To develop an approach for a comparative analysis of the intensity of the interregional migration and the intersectoral mobility of workers in the labour market in Russia and other countries.
12. To define the features of the functioning of the Russian labour market and internal mobility based on the estimations of the models developed and cross-country comparisons of their parameters.

These objectives are addressed in the 18 papers constituting this dissertation. The studies were conducted across four areas (Figure 1):

1) the macroeconomic analysis of the mechanisms of the labour market (objectives 1–4);
2) the analysis of internal migration in Russia (objectives 5–7);
3) the analysis of international (external) labour migration into Russia (objectives 8-9);
4) the relationship between migration and labour markets (objectives 10–12).

The first area concerns the (national and regional) analysis of the relationship between the key macroeconomic indicators of the Russian labour market: economic growth rates, labour productivity, wages and the unemployment rate. The second area explores the strength of the relationship between regional labour markets, as measured by the intensity of interregional migration flows. Under this pillar, the analysis addressed: a) the directions of internal migration flows and age-specific migration in Russia with a focus on working-age migrant flows; b) the factors driving or constraining internal migration; c) the impact of external economic conditions on internal migration in Russia; d) the competition/cooperation between regions in migration factors. The third area explores the factors of demand for foreign migrant workers' as a potential source for closing the deficit in labour resources and addresses wage discrimination against foreign workers and competition with locals. The fourth area aggregates the research findings on the labour markets and migration exploring their relationship, identifying the macroeconomic patterns of the Russian labour market based on cross-country comparisons.

The data used for the research on the Russian labour market and migration included national and regional population statistics of the Russian Federal State Statistics Service (Rosstat). Interregional migration by age groups was analysed using the data of the Russia population census of 2010. International labour migration papers relied on data on applications for foreign migrant quotas submitted by Russian employers for 2009–2013 reported by the Russian Federal Service for Labour and Employment. The analysis of discrimination against foreign workers integrated the findings of the micro surveys of the Russia Longitudinal Monitoring Survey - HSE (RLMS-HSE). The analysis in each paper addressed different time periods. The time period covered by the papers is 1995–2016. Data constraints and methodological limitations are discussed in the papers constituting this dissertation.



Note: references in brackets appear in accordance with the author’s list of published works (see below). SLX refers to models of migration with spatial lags of factors.

Fig. 1. Structure of the papers: four areas research.

Brief literature review

Many aspects of the Russian labour market have been studied. The most detailed analysis and descriptions refer to its structural and institutional characteristics. In this regard, it's worth mentioning the scientific contribution of the HSE Centre for Labour Market Studies, particulary, the collective monographs edited by V. E. Gimpelson and R. I. Kapeliushnikov (2006, 2008, 2011, 2014, 2017). A substantial contribution to Russian labour market research (specifically its macroeconomic characteristics and migration processes) was made by the Laboratory for Labour Force Forecasting, Institute of Economic Forecasting, RAS, led by A. G. Korovkin.

However, there has been very little research on the macroeconomic mechanisms of the Russian labour market. To some extent, this can be explained by the fact that these mechanisms emerged and became established only in the early 2000s (Gurvich et al., 2016). (Akhundova et al., 2005) assessed the relationship between unemployment rate and GDP growth (Okun's law) for the Russian economy and found no statistically significant relationship. New estimations of Okun's law have arrived recently (Kazakova, 2017). A new wave of interest in Okun's law, globally, occurred during the crisis of 2007–2008 when cross-country differences in labour market reactions to shocks were analysed (IMF, 2010). For some countries, there exist estimations of Okun's Law based on regional data: these estimations take into account spatial dependence and underline its significance (Oberst, Oelgemöller, 2013; Kangasharju et al., 2012 and others). No similar analysis based on regional data has been done for Russia. There are papers modelling the unemployment rate, employment or real wages using regional data (or city-level data (Ivanova, 2018)) with spatial dependence but without reference to classical labour market models (Demidova et al., 2013; Demidova, 2015; Semerikova, Demidova, 2015; 2016a; 2016b; Danilenko et al, 2018; Demidova et al., 2018).

Russian researchers appeared primarily interested in the Phillips curve (showing the relationship between the unemployment rate and inflation). This concept was applied in: Belyavskiy et al., (2000); Korovkin et al., (2003); Korovkin et al., (2005); Gafarov, (2011); Zubarev, (2018) and Averina et al., (2018). These papers did not attempt to assess the degree of wage flexibility to the unemployment rate. Other notable works include analysis of the non-accelerating inflation rate of unemployment (NAIRU) based on the Phillips curve (Bragin, Osakovsky, 2004; Akhundova and Korovkin, 2006) and the estimation of the wage equation with employment on panel data for Russian regions by Shilov, Möller (2008). However, even these few studies produced quantitative rather than qualitative findings about the Russian labour market. The papers making use of regional data (Shilov, Möller, 2008) did not include the impact of spatial dependence; its importance for the Russian economy has since been highlighted by other authors (Kolomak, 2011; Demidova et al., 2013; Demidova, 2015; Semerikova, Demidova, 2016b; Kolomak, 2019).

At the time the papers included in this dissertation were published, there were no estimations of the parameters of classical macroeconomic models for the Russian labour market (Okun's coefficient, real wage flexibility to the unemployment rate, real wage elasticity to productivity), which could be compared with estimates for other countries. This dissertation research fills this gap.

Additionally most earlier studies addressing internal migration in Russia were descriptive and did not use econometric modelling to explain migration flows. Papers with estimations of migration models based on data for the early 1990s found no meaningful relationship between migration and economic indicators (Denisenko, 1994). However, (Brown, 1997) using data for 1993, showed that labour market indicators and housing market indicators, in particular, higher wages and a higher rate of apartment privatisation, affected both the outflow and inflow of migrants in the regions. According to Brown (1997), migration would not smooth out cross-regional differences, since primarily successful regions participated in migration exchange. This conclusion was confirmed in other papers for more recent periods (Korel, Korel, 1999; Andrienko, Guriev, 2004; Kumo, 2017). The important role of labour market indicators (wages and/or the unemployment rate) for internal migrants in Russia is cited in nearly all works concerned with modelling internal migration (Brown, 1997; Gerber, 2000; Korovkin, 2001; Kumo, 2003; Andrienko, Guriev, 2004; Gerber, 2006; Aleshkovski, 2007; Kumo, 2007; Oshchepkov, 2008; Vakulenko et al., 2011a; Vakulenko et al., 2011b; Vakulenko, 2012; Korovkin et al., 2013; Kumo, 2017). (Brown, 1997; Korel, Korel, 1999; Andrienko, Guriev, 2004; Vakulenko et al., 2011; Korovkin et al., 2013) point out a significant impact of housing market indicators. The attractiveness of resource-rich regions is emphasised in (Kumo, 2017). Not all of these papers make use of interregional migration data which would make it possible to estimate gravity models of migration, taking into account the factors of both the region of origin and destination. Socioeconomic indicators included in the model do not always have predictable signs. According to research in Russia and in other countries migrant outflows from poorer regions can be lower because residents cannot afford to move (Guriev, Andrienko, 2004; Gerber, 2006 for Russia; McKenzie and Rapoport, 2007; Angelucci, 2015 for Mexico; Phan and Coxhead, 2010 for Vietnam; Michálek and Podolák, 2010 for Slovakia; Horváth, 2007 for the Czech Republic; Golgher et al., 2008; Golgher, 2012 for Brazil; Bazzi, 2013 for Indonesia and others). This phenomenon is known as “poverty traps” (Banerjee, Kanbur,1981). In the model, this corresponds to the positive coefficient of the logarithm of per capita income in the region of origin. The actual relationship between migration and per capita income in the region of origin is non-linear; it was first estimated for Russia by (Andrienko, Guriev, 2004) in a quadratic function. Further works on modelling migration also used this specification, which, in some cases, failed to yield significant results. More flexible and also nonparametric specifications were proposed in (Guriev, Vakulenko, 2015).

None of the studies on modelling internal migration in Russia took into account the factors of neighbouring regions and did not apply spatial econometric approaches. (LeSage, Pace, 2008, LeSage, Fisher, 2016) proposed gravity models of migration with spatial lags of factors (SLX) and with spatial lag of the dependent variable (SAR) and provided case studies for spatial samples describing the migration of teachers between school districts in Florida (LeSage, Fisher, 2016). Maintaining largely a technical focus, these papers did not provide any definitive interpretation of the results of the complex model construct. Some comments concerning the interpretation of gravity SAR models can be found in (LeSage, Thomas-Agnan, 2015). (Sardadvar, Vakulenko, 2020), which is also a constituent paper for this dissertation research, provides explanations on the interpretation of the gravity SLX model and describes the rules of determining competition or cooperation between regions.

The papers applying gravity models of migration (Brown 1997, Andrienko, Guriev, 2004; Aleshkovski, 2007; Oshchepkov, 2008; Kumo, 2017) did not specifically account for intraregional migration flows (the diagonal of the interregional migration matrix) as proposed in (LeSage, Pace, 2008), or such flows were excluded from consideration. (LeSage, Pace, 2008; LeSage, Fisher, 2016) included intraregional migration flows as separate variables of the model, and showed that its coefficients should be corrected; however, they did not clarify when such corrections could be omitted. (Sardadvar, Vakulenko, 2020), in this dissertation research, fills this gap.

The relationship between migration and migrant age in Russia was analysed without reference to the directions of migration (Karachurina, Mkrtchyan 2018), or such analysis only concerned specific age groups (Kashnitsky et al., 2016; Karachurina, Ivanova, 2017; Ivanova, 2017); moreover, these papers did not estimate migration models to explain the directions and underlying reasons. Such analyses do exist for other countries, e. g., the UK (Fielding, 1992; Millington, 2000), Germany (Goetzke, Rave, 2011), the US (Plane and Heins, 2003) and others. However, these papers operate with empirical models referring to specific migrant profiles and age groups in the respective countries, which excludes their applicability to Russia. The models proposed in this dissertation were further used in Russian graduate studies of migration (Antosik, Ivashina, 2019; Moskvina, 2019).

Demand for foreign labour force in Russia was studied in (Commander, Denisova, 2012) with a focus on highly skilled migrants. (Lokshin, Chernina, 2013; Kumo, 2012) analyse data on migrants from Tajikistan working in Russia. Discrimination against foreign workers, using survey data and without modelling, was studied in (Zaionchkovskaya, Tyuryukanova, 2010; Grigorieva, Mukomel, 2014; Mukomel, 2017). (Lokshin, Chernina, 2013; Denisenko, Chernina, 2017) assess the discriminatory gap in wages between foreign and Russian workers based on the Blinder–Oaxaca method, but only Tajik migrants were considered. (Smirnykh, Polyakova, 2015, 2016, Polyakova, 2019) estimated a wage gap for immigrants born in the former Soviet republics who later resettled in Russia. The competition between local and foreign workers in the Russian labour market using survey data and without modelling is analysed in (Ryazantsev, Krasinets, 2015).

Empirical studies on the impact of migration on cross-regional convergence in terms of labour market and income indicators have been conducted in many countries. The earliest paper was devoted to the US economy (Barro, Sala-i-Martin, 1991) and applied a conditional β-convergence model with migration as one of the factors. A review of papers analysing the speed of cross-regional convergence and the underlying impact of migration can be found in (Vakulenko, 2016a). (Niebuhr et al., 2012) proposed including the spatial lag of the dependent variable in the conditional β-convergence model of the unemployment rate and wages to account for spatial dependence. (Florinskaya et al., 2015) explored labour migration in Russia and its effects on national and regional labour markets, but without model calculations. One of the most recent works exploring the impact of internal migration and migrant human capital on the speed of regional convergence in terms of wages in Russia (Smirnykh, Buranshina, 2018), estimated a conditional β-convergence model with spatial effects as in (Vakulenko, 2016a). Neither paper provided any methodology for estimating σ-convergence indicative of narrowing cross-regional inequality (Glushchenko, 2012). The paper of this dissertation (Vakulenko, 2016a) filled this gap and proposed an approach to analyse the impact of migration on cross-regional inequality.

Contribution

The contribution of this dissertation includes the development of theoretical models explaining internal migration in Russia, the substantiation of models providing quantitative estimates, and the macroeconomic mechanisms of the Russian labour market. The research also contributes through the adaption of existing econometric approaches to resolving economic tasks with available data, through overcoming existing methodological challenges in empirical analysis, and through improving the interpretation of advanced econometric models applied in a different context. The key scientific results are the following:

1) The **theoretical model** of migration proposed by Crozet (2004) was modified by including an additional sector – the mining industry. Based on this modification, an econometric specification was derived for testing the formulated hypotheses. This made it possible to explain migration flows to resource-producing regions and to assess the impact of changes in global demand for natural resources on internal migration in Russia (Sardadvar, Vakulenko, 2017).
2) **Methodological approaches included**:
    a) identifying the macroeconomic peculiarities of the Russian labour market, applying classical macroeconomic models and comparing the models' parameters for comparable countries (Gurvich, Vakulenko, 2017; Gurvich, Vakulenko, 2018);
    b) clustering interregional migration flows in Russia by prevailing age groups. Such an approach allowed to the determination of age-specific directions of migration, while all age groups are represented in each interregional migration flow (Mkrtchyan, Vakulenko, 2019);
    c) determining the degree of intersectoral and interregional labour mobility in the Russian labour market (Vakulenko, 2020).
3) **Econometric models** have been developed for testing hypotheses concerning:
    a) the opposite direction of migration flows associated with different life course events (education, work, retirement). For the first time, for Russia, models of interregional migration were developed for certain age groups (Vakulenko, Mkrtchyan, 2020);
    b) competition/cooperation between Russian regions attracting internal migrants. For this purpose, gravity models of migration were developed with spatial effects of migration factors (Sardadvar, Vakulenko, 2020);
    c) competition between local and foreign workers in the Russian labour market based on the developed model of demand for foreign labour (regardless of the country of origin) and an assessment of wage discrimination (Vakulenko, Leukhin, 2015; Vakulenko, Leukhin, 2017).
4) Approaches to the **interpretation of spatial econometric models** have been offered:
    a) two new coefficients were developed for the interpretation of spatial econometrics models: coefficients of independence and influence (Vakulenko, 2015). These coefficients single out the effects of each region in the spatial interactions and rank them according to the degree of influence on other regions. Previously, the coefficients of SAR model (with a spatial lag of the dependent variable) were

interpreted on the basis of three aggregated values that were common for all regions: total, direct and indirect effects;
   b) previous approaches (LeSage, Fischer 2014) to the interpretation of gravity-type econometric models with spatial lags for factors were improved through developing a scheme for the identification of competition/cooperation between regions based on the estimated coefficients (Sardadvar, Vakulenko, 2020).

5) **Methodological challenges** in the models of migration and labour markets have been resolved:
   a) the **corrections** for the coefficients of the gravity model of migration proposed by (LeSage, Fischer, 2016) were transformed because factors for intraregional migration were included, and the conditions for the use of coefficients without corrections were explained (Sardadvar, Vakulenko, 2020);
   b) to prevent bias in the coefficients and to increase the explanatory power of the models, migration models were developed taking into account the **spatial dependence** of factors (Sardadvar, Vakulenko, 2016; Sardadvar, Vakulenko, 2020);
   c) **causality** in the developed macro model of the labour market was identified for: real wages, the unemployment rate and labour productivity (Vakulenko, Gurvich, 2015a). Such an approach explains the macroeconomic mechanisms of the Russian labour market;
   d) the **asymmetry of the adjustment** of real wages, the unemployment rate and productivity to long-term equilibrium for positive and negative economic shocks was considered (Vakulenko, Gurvich, 2015a, Vakulenko, Gurvich, 2015b);
   e) the necessity of taking into account **spatial effects** in Okun's models for Russian regions has been substantiated. In particular, the shift of coefficients and the levelling of the asymmetry of the adjustment to positive and negative shocks were shown (Vakulenko, 2015).

6) New qualitative and quantitative results have been obtained:
   a) the macroeconomic peculiarities of the Russian labour market were identified based on the assessment of the parameters of classical macroeconomic models and their cross-country comparisons (Gurvich, Vakulenko, 2017; Gurvich, Vakulenko, 2018):
      i. Okun's coefficient (Vakulenko, Gurvich, 2015b);
      ii. The degree of wage flexibility to unemployment rate (Vakulenko, Gurvich, 2016);
      iii. The elasticity of wages to labour productivity (Vakulenko, Gurvich, 2015a; Vakulenko, Gurvich, 2016).
   b) using the developed gravity models of migration, migration factors relating to both the region of origin and the region of destination were identified and ranked by importance for long-term migration for 1995–2016 (Vakulenko, 2016b; Vakulenko, 2019);
   c) the poverty traps hypothesis was tested using the data for 1995-2016 to construct nonlinear and nonparametric models of the relationship between migration and average per capita income in the region of origin, which allowed the testing of the robustness of the obtained results. The threshold values of average per capita income were estimated, which allowed to determine the regions of departure for migrants in "poverty traps" (Guriev, Vakulenko, 2015; Vakulenko, 2019).
   d) the impact of migration flows on interregional differentiation with regard to the unemployment rate, wages and income was assessed (Vakulenko, 2016a).

Methodology

1. Labour market models

a. Okun's law

(Vakulenko, Gurvich, 2015b) analyses models describing short-term and long-term relationships between GDP and the unemployment rate (and employment numbers). This relationship shows unemployment responsiveness to the deviation of production from a long-term trend over the business cycle, therefore it plays a key role both for macroeconomic policy (e.g., for assessment of the "cost" of employment support programs) and for social policies. This relationship is commonly described by Okun's law in labour market research (Okun, 1962):

$$u_t - u_{t-1} = a + bg_t + \varepsilon_t,$$

where u_t, g_t are the unemployment rate and GDP growth rate at time *t* respectively, b is Okun's coefficient. The negative sign is principal: accelerating growth is accompanied by declining unemployment; slowing growth or declining GDP lead to higher unemployment.

Along with the estimate of Okun's coefficient, (Vakulenko, Gurvich, 2015b) also addresses the direction of the causal relationship between the unemployment rate and GDP growth, asymmetries in labour market reactions to shocks, and shifts in labour market mechanisms occurring during crises. The vector error correction model (VECM) is used as the main tool, which enables studying both short-term and long-term relationships between the analysed variables. The short-term relationship was analysed in the standard form of Okun's law equation and, further, with lags in the GDP growth rates, and with asymmetries (with separate coefficients for GDP growth and decline). The rolling window method was used to test coefficient stability. To allow for potential asymmetries in the adjustment following deviations from the long-term trend, threshold VECMs, the TAR and MTAR models, were analysed (Hansen, 1996). In these models, adjustments to positive and negative shocks are differentiated and analysed separately (in contrast to the VECM approach addressing shocks uniformly). The cointegration relationship is $e_t = \beta' X_t$ where X_t is the vector of analysed variables; accordingly, the TAR specification for a vector error correction model is:

$$\Delta X_t = \alpha_1 I_t e_{t-1} + \alpha_2 \left(1 - I_t\right) e_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + \varepsilon_t,\ t = 1, \ldots, T \tag{1}$$

where $I_t = \begin{cases} 1, & if \quad e_{t-1} \geq 0 \\ 0, & if \quad e_{t-1} < 0 \end{cases}$, D_t is the time effect (a set of dummy variables).

This assumes different speeds of adjustments to the long-term equilibrium (which is determined by the cointegration relationship) after positive and negative deviations from it. For the system to restore its long-term relationship, the coefficients α_1 and α_2 have to be negative but may be different. Coefficient equality is tested to verify the hypothesis of asymmetric adjustments. A similar specification for labour market modelling was used in Pascalau (2007).

The MTAR vector error correction model is also discussed in the paper. The model specification is:

$$\Delta X_t = \alpha_1 M_t e_{t-1} + \alpha_2 \left(1 - M_t\right) e_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + \varepsilon_t,\ t = 1, \ldots, T\ , \tag{2}$$

where $M_t = \begin{cases} 1, & if \quad \Delta e_{t-1} \geq 0 \\ 0, & if \quad \Delta e_{t-1} < 0 \end{cases}$.

The cointegration between series was tested in various procedures for a single equation (Engle-Granger (Engle, Granger, 1987), Phillips-Ouliaris (Phillips, Ouliaris, 1990), Hansen procedures (Hansen, 1992), asymmetric cointegration (Enders, Siklos, 2001)) and systems of equations (the Johansen procedure).

(Vakulenko, 2015) analysed the relationship between GRP growth and change in unemployment rate (Okun's law) at the regional level in Russia. The specifics in addressing the relationship between output and unemployment rate at the regional level means that the movements of workers between territories have to be taken into account. To analyse this relationship, for the first time in Russia, Okun's model with spatial autoregressive lag (SAR) was used, assuming that the unemployment rate in each region is explained by unemployment rates in other regions:

$$\Delta u_{i,t} = \alpha_i + \rho \sum_{j=1}^{N} \omega_{i,j} \Delta u_{j,t} + b g_{i,t} + \varepsilon_{i,t} \tag{3}$$

where $\Delta u_{i,t} = u_{i,t} - u_{i,t-1}$ is change in the unemployment rate, $g_{i,t}$ is GRP growth; α_i is the fixed regional effect showing the change in the unemployment rate in a region with zero GRP growth; *i* is the region's index, *t* is the time index. The sum $\sum_{j=1}^{N} \omega_{i,j} \Delta u_{j,t}$ represents the weighted average change in the unemployment rate in all regions with weights $\omega_{i,j}$ and is described as the spatial lag. Robustness checks were conducted with various weighting matrices: inverse distance; inverse distance squared; the neighbour matrix in which the elements are equal to 1 where the regions share a border or zero otherwise; gravity weights; matrices of 5, 10 and 39 (half of the regions) closest neighbours. Spatial interactions were also evaluated using other models, including a model with spatial error (SEM), a model with spatial autocorrelation lag and with spatial correlation in regression error (SAC), and the Durbin model (SDM).

The interpretation of model (3) is nontrivial. If the spatial lag is moved over to the left side of the equation, the marginal effects of the change in the unemployment rate for an increase in the GRP growth rate are not merely Okun's coefficient b but its product with the inverse matrix $(I - \rho W)^{-1}$, where I is an identity matrix of size N (the number of regions), and W is the weight matrix. In contrast to simple linear models, spatial models assume that the expected level of change in the unemployment rate is affected by GRP growth not only in the respective region (the direct effect), but other regions as well (the indirect effect). An important element in the analysis of spatial econometric models consists in estimating the direct and indirect effects averaged for all regions (LeSage, Pace, 2009). (Vakulenko, 2015) proposes a **new way of interpreting the results** and two types of coefficients reflecting *autonomy and influence* and calculated individually for each region as the share of the direct effect of each region in the total effect (the total of direct and indirect effects) W. The matrix W is normalised to 1 by rows for the coefficient of independence and by columns for the coefficient of influence. In other words, to calculate the proposed coefficients for each region, the diagonal elements of the matrix $(I - \rho W)^{-1} b$ should be divided by the total for the row. The coefficient of independence reflects the influence on the region's labour market exerted by its own production stimulation policies. The coefficient of influence shows the influence of the region's growing output over unemployment in other regions.

b. Real wage flexibility analysis

(Vakulenko, Gurvich, 2016) provided an assessment of real wage flexibility in Russia and specifically the elasticity of realwages to the unemployment rate. The findings were used for cross-country comparisons. The classical model describing the relationship between changes in wages (reflecting inflation) and the unemployment rate (indicative of a labour market imbalance) is the wage Phillips curve. In order to draw cross-country comparisons, the research focused on papers and models for which there were available estimates of wage flexibility to the unemployment rate for other countries (Poeck, Veiner, 2007; Arpaia, Pichelmann, 2007; Huber, 2004). Econometric specifications from the first two papers were analysed for country-wide

Russian data, while the third applied to the regional level. In all cases, the dependence of real wages on the unemployment rate was described using error correction models. Labour productivity and price indices based on both consumer and producer prices were added to the models. No custom changes were made to these models for comparability, so the models are not addressed here, however, all relevant tests were conducted to ensure their adequacy for Russia. Note that labour market flexibility studies may also operate with other definitions, e.g., employment flexibility (Varshavskaya, 2009). This aspect is beyond the scope of this dissertation.

c. Analysis of the Russian labour market mechanisms

(Vakulenko, Gurvich, 2015a) modelled the relationship between the main indicators of the Russian labour market such as labour productivity, real wages and the unemployment rate. Many studies analysing the relationship between these three main labour market indicators are based on the paper of Blanchard and Katz (1999), who note that most theories of wage determination (including search and matching models) imply a negative relation between the level of wages and the unemployment rate, and the classical Phillips curve (with wages serving as an approximation of inflation). This can be interpreted as a negative relationship between the expected change of real wages and the unemployment rate. (Blanchard, Katz, 1999) showed that both relationships, with reasonable assumptions, can be represented as:

$$w_t - p_t^e = \alpha + \beta(w_{t-1} - p_{t-1}) + (1-\beta)y_t - \gamma u_t + \varepsilon_t \qquad (4)$$

where w_t is the nominal wage, $p_t\left(p_t^e\right)$ is the actual (expected) price level, y_t is labour productivity, u_t is the unemployment rate at moment t. With $\beta = 1$, this equation is represented as a “wage curve” which may be approached as a case of the Phillips curve with wages instead of prices, this classical concept represents a specific case of relationship (4). The analysis focused on the interaction between the three key variables of the labour market (real wages, labour productivity and the unemployment rate), proposing VECM, TAR and MTAR models with asymmetric adjustment to the long-term equilibrium based on quarterly data. Robustness checks were conducted for various time periods (including or excluding crises), various numbers of time lags, and various specifications of cointegration relationships.

2. Models of internal migration in Russia

a. Migration and “poverty traps”

(Guriev, Vakulenko, 2015) developed a model of interregional migration in Russia in 1996-2010, identified pull and push factors of regional migration, offered a theoretical model explaining “poverty traps” phenomenon and tested the hypothesis of “poverty traps” for the Russian case.

To identify the determinants of interregional migration in Russia, a gravity model of migration was constructed, which allowed to estimate pull and push factors. Econometric specification of the migration model is the following:

$$\begin{aligned} \ln M_{i,j,t} = \alpha_{i,j} + \phi \ln income_{i,t} + \varphi \ln income_{j,t} + \sum_{k \in K} \gamma_k \ln X_{k,i,t} + \sum_{k \in K} \delta_k \ln X_{k,j,t} + \\ + \sum_{t \in T} \theta_t year_t + \varepsilon_{i,j,t} \end{aligned} \qquad (5)$$

Where $\ln M_{i,j,t}$ is a log of migration flow from region *i* to region *j* in year *t*, $\ln X_{k,i,t}$ *is* a log of indicator k of region *i* (the region of origin) in year *t*, $\alpha_{i,j}$ is a fixed effect which is different for pairs of regions *i*, *j* (i.e., which incorporates an individual effect of a pair of regions), $year_t$ is a dummy for year t (equals 1 for the year t, 0 is otherwise), θ_t are the coefficients for dummy variables, γ_k and δ_k are vectors of the coefficients for the explanatory variables (the characteristics of the regions of origin and destination), and $\varepsilon_{i,j,t}$ is a random error. All $\varepsilon_{i,j,t}$ are independent and identically distributed, $\varepsilon_{i,j,t} \sim iid\left(0;\sigma_u^2\right)$. It is supposed that all $X_{k,i,t}$, $X_{k,j,t}$ are independent of $\varepsilon_{i,j,t}$.

Model (5) is a log linear model based on panel data with a fixed individual effect for a pair of regions. The following factors were included in the model: demographic structure (population size, the share of young people, the share of the elderly, the share of women), the unemployment rate, per capita income, housing market characteristics (price of housing, new apartment construction, the supply of housing), the supply of social goods, for example, the density of roads, health care services (the number of doctors per individual, and the number of hospital beds per individual), public transport (the number of buses per individual), education (the number of students per individual). These variables cover all time-varying factors, which can influence migration decisions. The Gini coefficient was used to control changes in the income distribution in the regions. To account for the potential endogeneity problem, several factors were included in the model with a lag of one year. Key factors of model (5) are $\ln income_{i,t}$ and $\ln income_{j,t}$, the natural log of per capita income in the region of origin i and the region of destination j.

It is assumed that the coefficient for per capita income in the region of destination is positive, meaning that migrants move to the regions with a higher per capita income. If a positive correlation is also observed between migration outflows and per capita income in the region of origin, i.e. an increase of income leads to an increase of the outflow of people, it implies that the poverty trap exists. This means that those who wish to leave have the opportunity to finance their move. The actual relation between the number of migrants from the region of origin and the per capita income is non-linear: there exists a threshold level of income, below which the migration flow increases with higher incomes and then it either flattens or declines as income rises above the threshold. This is explained in our theoretical model of migration by the poverty trap. The present research proposes three methods to estimate the non-linear relationship between migration and per capita income to determine the threshold levels of the poverty trap:

1) *Squared specification*. Model (5) additionally includes a squared log of per capita income in both regions, and the FE model is estimated. It is supposed that the relationship between the number of emigrants and per capita income in the region of origin has an inverted U-shape, i.e. until some threshold, the increase of income level corresponds to the increase of those who emigrate, and after that point, the outflow of migrants decreases with a further increase of income. This is a method widely used in similar works.

   Below, two new approaches are proposed for testing the poverty trap hypothesis.

2) *Model with a structural break.*

$$
\begin{aligned}
&\ln M_{i,j,t} = \alpha_{i,j} + a\left(\ln income_{i,t} - \gamma\right) I\left(\ln income_{i,t} \le \gamma\right) + \\
&+ b\left(\ln income_{i,t} I - \gamma\right)\left(\ln income_{i,t} > \gamma\right) + \\
&+ \sum_{k \in K} \gamma_k \ln X_{k,i,t} + \sum_{k \in K} \delta_k \ln X_{k,j,t} + \sum_{t \in T} \theta_t year_t + \varepsilon_{i,j,t}
\end{aligned}
\tag{6}
$$

This model can be also written in the following way:

$$
\ln M_{i,j,t} = \begin{cases} \alpha_{i,j} + a\left(\ln income_{i,t} - \gamma\right) + controls_{i,j,t} + \varepsilon_{i,j,t}, & \ln income_{i,t} \le \gamma, \\ \alpha_{i,j} + b\left(\ln income_{i,t} - \gamma\right) + controls_{i,j,t} + \varepsilon_{i,j,t}, & \ln income_{i,t} > \gamma, \end{cases}
$$

where $controls_{i,j,t} = \sum_{k \in K} \gamma_k \ln X_{k,i,t} + \sum_{k \in K} \delta_k \ln X_{k,j,t} + \sum_{t \in T} \theta_t year_t$.

In model (6), a threshold value of per capita income in the region of origin is γ. If logs for per capita income are below γ, then an increase of income leads to an outflow of migrants, i.e. the coefficient is $a > 0$. On the other hand, if per capita income is above γ, then an increase of income leads to a decrease of migrant outflow, i.e. coefficient is $b < 0$. Model (6) was assessed using FE method for the given values of γ. Transformation of the variable $\ln income_{i,t}$ was made separately before and after the threshold value, as suggested by Hansen (1999). The parameter γ had an estimated value at which the model had the least value for the sum of the squared residuals.

3) *Semiparametric specification.*

$$\ln M_{i,j,t} = \alpha_{i,j} + f\left(\ln income_{i,t}\right) + \varphi \ln income_{j,t} + \sum_{k \in K} \gamma_k \ln X_{k,i,t} + \sum_{k \in K} \delta_k \ln X_{k,j,t} + \\ + \sum_{t \in T} \theta_t year_t + \varepsilon_{i,j,t} \qquad (7)$$

In model (7), the relationship between migration flow and per capita income in the region of origin has a nonparametric form. To assess the semiparametric model with fixed effect (7) an approach suggested by Baltagi Li (2002) was used, based on interpolation according to the method of local polynomial or splines.

The evaluation of these three models defined the turning points of per capita income, which allowed for the estimation of which regions, and at what point in time, were in the poverty trap, i.e. when an increase of per capita income led to an outflow of migrants from the region. For each turning point, intervals were identified using a bootstrap procedure.

For robustness checks, the models were estimated for different time periods, for different sets of regions (including those located relatively close and far from each other, both poor and rich), for factors of financial development, for the difference in per capita income between the region of origin and the region of destination, and for the non-linear character of per capita income in the region of destination.

(Vakulenko, 2016b; Vakulenko, 2019) estimated squared specification of model (5). In particular, the multicollinearity of migration factors was addressed (Vakulenko, 2016b). Using principal component analysis, aggregated indices for groups of factors were constructed (Ayvazyan, 2012). The factors were ranked according to the degree of their significance for migrants based on the calculated standardized coefficients. (Vakulenko, 2019) studied directions and motives of migration using the data on internal migration in Russia, for 2011–2016, a period which characterizes migration in Russia following significant changes in data collection methods. The chi-square (χ^2) test was used to test migration matrices for various years for homogeneity, i.e. for statistically significant changes in migration directions.

b. Migration and the industry specificity of the regions

Sardadvar and Vakulenko (2017) explored the relationship between interregional migration in Russia and industry specificity of the regions, including the number of people employed in the mining sector. A correlation analysis showed that the net migration rate was positively associated with the number employed in the industrial sector and negatively associated with the number employed in the mining sector. This phenomenon is explained both at the theoretical and empirical levels. For this purpose, a theoretical migration model by Crozet (2004) was adapted to the Russian context: the mining sector was added since it plays a vital role in the economy of the Russian regions. Such an approach takes into account external market factors: energy prices and geographic limitations for this type of production. It was suggested that demand for labour in the mining sector positively correlates with changes in global energy prices. While extracted raw materials were partially exported, the corresponding effect was that change in demand for resources changed the demand for labour in this sector, stimulating the inflow of internal migrants. The second important difference in our model was the inclusion of consumer prices in the regions (minimum subsistence level, CPI or fixed basket price index were used as a proxy), which also included imported goods instead of the value of the internal market potential of industrial goods as in Crozet (2004), because the share of imported goods in consumption was 50%. The theoretical model could be directly transformed into an econometric specification of migration model which was evaluated using the panel data on 78 Russian regions for 2004–2010:

$$\begin{aligned} &\ln M_{ij,t} - \ln \sum_{j=1}^{N} M_{ij,t} = \alpha_i + \beta_1 \ln w_{j,t-1} + \beta_2 \ln L_{B,j,t-1} + \beta_3 \ln L_{D,j,t-1} + \\ &\beta_4 \ln P_{C,j,t-1} + \beta_5 \ln u_{j,t-1} + \beta_6 \ln S_{j,t-1} + \beta_7 \ln \delta_{ij} + \beta_8 \ln \xi_{ij} + \beta_9 \ln \pi_{t-1} + \varepsilon_i \end{aligned} \tag{8}$$

Where the dependent variable is the share of migrants from region i who choose the region j as migration destination $\left(M_{ij}\right)$, while regressors are population size $\left(S_j\right)$, nominal wage $\left(w_j\right)$, number of employed in the mining sector $\left(L_B\right)$ and in the service sector $\left(L_D\right)$, change of global energy prices $\left(\pi\right)$, consumer prices $\left(P_{C,j}\right)$, the unemployment rate $\left(u_j\right)$, the distance between the region of origin and the region of destination $\left(\delta_{ij}\right)$, the existence of common border $\left(\xi_{ij}\right)$. A model specification including the number of employed in other sectors was also evaluated.

c. Accounting for spatial effects in the migration models

(Sardadvar, Vakulenko, 2016) studied spatial effects for migration factors in the eastern and western regions of Russia. For this purpose, a model was estimated using the panel data of 78 regions of Russia for 2001–2010 with time and fixed effects. The explanatory variables used in the analysis were: logs of real per capita income, real GRP per capita growth, logs of the unemployment rate, the shares of the population younger and older than working age, and the Gini coefficient. To consider human capital in the region, the model included the share of the population with higher education, and the number of students per capita. A distinctive feature of the analysis was that it assessed a model also covering factors related to neighbouring regions. For this purpose, the spatial lags for regressors were incorporated into the model:

$$\begin{aligned} &m_{i,t} = \alpha_i + \delta_t + \beta_1 \sum_{l=1}^{3} x_{1,i,t-l}/3 + \ldots + \beta_k \sum_{l=1}^{3} x_{k,i,t-l}/3 + \\ &\gamma_1 \sum_{i\neq j}^{N} \sum_{l=1}^{3} w_{ij} x_{1,i,t-l}/3 + \ldots + \gamma_k \sum_{i\neq j}^{N} \sum_{l=1}^{3} w_{ij} x_{k,i,t-l}/3 + \ldots + \varepsilon_{i,t} \end{aligned} \tag{9}$$

where $m_{i,t}$ is the inflow or outflow of migrants per capita, or net migration rate. Two variations were considered: internal migration only and both internal and international migration. The values of the explanatory variables were averaged over the past three years $\sum_{i\neq j}^{N} \sum_{l=1}^{3} w_{ij} x_{1,i,t-l}/3$, because it is assumed that migration decision is made based on the indicators for the previous years, $\beta_1, \ldots, \beta_k$ are the corresponding coefficients. $\sum_{i\neq j}^{N} \sum_{l=1}^{3} w_{ij} x_{1,i,t-l}/3$ denotes values of neighbouring regions averaged over the past three years and used with weights w_{ij}, and $\varepsilon_{i,t}$ is an error term. The weights used are inverse distances (d_{ij}) between pairs of regions for k (5 or 10) neighbouring regions, the weights have a zero value for the rest of the regions.

$$\begin{cases} w_{ij} = d_{ij} \Big/ \sum_{j=1}^{n} d_{ij} \;\; if \;\; d_{ij} \le d_j^*(k) \forall i, j = 1, 2, ..., n; i \ne j \\ w_{ij} = 0 \; if \;\; d_{ij} > d_j^*(k) \forall i = j \end{cases}$$

The higher the weight w_{ij}, the closer region j is to region i. This specification is called a spatial lag of X model (SLX). The time effect δ_t is considered using a set of dummy variables for years, α_i is a fixed effect of the regions. Model (9) was estimated for Russia as a whole and separately for the western and eastern regions because significant differences between these groups of regions have been repeatedly identified in region-level modelling (Kolomak, 2011; Demidova et al., 2013; Demidova, 2015; Kolomak, 2019).

(Sardadvar, Vakulenko, 2020) estimated a gravity model of migration in Russia considering spatial interactions of migration factors both for regions of origin and regions of destination and suggested an interpretation of such models. It was assumed that a migration flow from one region to another can be explained not only by factors of the region of origin or destination, but also by the socio-economic situation in neighbouring regions. To test this hypothesis, a *gravity model with exogeneous spatial regression lag* (LeSage, Pace, 2008; LeSage, Fischer, 2014) was estimated using panel data on the regions of Russia. Such models were applied for the first time to study migration in Russia. The estimated model specification was:

$$M = \alpha_0 \otimes i_T + i_{n^2} \otimes \alpha_t + \tilde{X}_o \beta_o + \tilde{X}_d \beta_d + X_i \beta_i + W_o \tilde{X}_o \theta_o + W_d \tilde{X}_d \theta_d + \varepsilon \qquad (10)$$

where M is the natural log of the migration flow from the region of origin, *o*, to the region of destination, *d*, in year t. M is a vector $n^2T \times 1$, T is the number of years. A destination-centric organization matrix of the migration flows M was constructed. X_o is a matrix of the explanatory variables for the region of origin. $X_o = i_n \otimes X$, where X is $nT \times k$ matrix with k explanatory variables for each region and each year. Similarly, X_d is a matrix of explanatory variables for the region of destination. $X_d = X \otimes i_n$. X_i is $n^2T \times k$ matrix of explanatory variables for intraregional migration flows. Explanatory variables in the matrix X included: population size, per capita income, GRP growth rate, the unemployment rate, housing availability, infant mortality rate, and the number of students per capita. Vectors β_O, β_d and β_i include coefficients for factors related to origin regions, destination regions and intraregional factors respectively. α_0 is the fixed effect of a pair of regions ($n^2 \times 1$); α_t is a time effect (dummy variables for years); ε is a random error. The assumptions $\tilde{X}_o = X_o - X_i$ and $\tilde{X}_d = X_d - X_i$ imply that the values of the explanatory variables for intraregional migration flows are zero (i.e. where the region of origin and the region of destination coincide). Matrix X_i contains non-zero values for cases of intraregional migration. $W_o = I_{nT} \otimes W$ and $W_d = W \otimes I_{nT}$, W is an $n \times n$ spatial matrix of weights. The bigger the component w_{od} of matrix W, the closer the region of origin is to the region of destination. The same weights based on the distances between regions (Sardadvar, Vakulenko, 2016), are applied. Vectors θ_O and θ_d of the dimension $k \times 1$ include coefficients that reflect the spatial effects of the region of origin and the region of destination respectively. When checking for robustness, a fixed effect was incorporated into the model for a pair of regions and separately for the region of origin or the region of destination.

For the interpretation of the gravity model with intraregional effects (variables of the matrix X_i) the model coefficients are corrected (LeSage, Fischer, 2016). (Sardadvar, Vakulenko, 2020) shows that the coefficients β_o, β_d, θ_o and θ_d can be corrected if multiplied by $(n-1)/n$, where n is a number of regions. In this case: $76/77 = 0.987$. To make corrections of the coefficients of the intraregional effect β_i, a multiplier value is $1/n$ or approximately 0.013. Thus, if $n \to \infty$, then coefficients β_o, β_d, θ_o and θ_d need not be corrected, and the intraregional effect can be disregarded, since it tends to zero. Standard errors for coefficient correction were calculated using a bootstrap procedure (LeSage, Pace, 2009).

Since the application of the gravity models with spatial lag is a relatively new area of research, the model interpretation is still developing. In the dissertation research, an *improved interpretation* of network effects is introduced (spatial lags for factors related to the region of origin and the region of destination). According to the developed scheme of interpretation, depending on the combination of the signs of the coefficients that reflect factors of the regions of origin/destination and the corresponding spatial lags, there emerges either *a spillover effect or a competition effect* in the regions of origin or destination. If the signs of coefficients related to the factors of the regions of origin/destination coincide with the signs of their spatial lags, then a spillover effect between the regions of origin/destination is observed. Alternatively, competition effects emerge. LeSage and Pace (2009) demonstrated that the total effect of the impact of each explanatory variable on the migration flow is the sum of effects of the region of origin, the region of destination and an intraregional effect. Effects of the regions of origin/destination comprise the effects of a given region and network effects (spillover or competition). Thus, the following equation can be written:

Total effect = effect of origin region + network effect of origin region + effect of destination region + network effect of destination region + intraregional effect

A bootstrap procedure was applied to determine the statistical significance of the total effects for each coefficient.

d. Age-specific migration models

Interregional migration in Russia considering the age composition of migration flows was studied by (Vakulenko, Mkrtchyan, 2018). The analysis relied on age-specific migration data obtained from Russia's population census of 2010 (information about the change of the place of residence within the year preceding the census date). Interregional migration flows were clustered by prevailing age groups, analysed in terms of direction and consistency, and described by socio-economic parameters. The paper, for the first time, explored age-specific migration directions considering associated life-cycle events, using Russian data.

To study age-specific interregional migration patterns, 82-by-82 matrices were used without diagonal elements, i.e. without intraregional migration, 8.5% of 6,075 interregional migration were excluded from the analysis due to zero migration exchange between the regions. Clustering was conducted using k-median and k-mean methods and allowed the grouping of migration flows by age. The clustering of directed interregional flows disaggregated by age was conducted using five variables: the deviation of the student share (aged 17–19), the youth share (aged 21–24), the economically active migrant share (aged 25–39), the pensioner share (aged 50 and over) and the family migrant share (adults aged 25–39 and children aged 0–4) in migration flow from Russian averages for each of these age groups. The age groups were identified based on the sequence of key life-course events (graduation, entering the labour market, having a family and children, extension of the family, retirement) that could impact a migration decision (Courgeau 1985; Geist and McManus 2008; Bell and Muhidin 2009).

Using the same dataset, (Valulenko, Mkrtchyan, 2019) studied the determinants of interregional migration by age group. For this purpose, negative binominal regression models were estimated for the total and age-disaggregated migration flows, with socio-economic, demographic, spatial-geographical factors of both the region of origin and the region of destination. The paper justifies the choice of a negative binomial model, rather than a lognormal model (5), as in (Guriev, Vakulenko, 2015; Vakulenko, 2016b; Vakulenko, 2019) and not a Poisson regression, as in (Flowerden, Aitkin, 1982; Millington, 2000; Moskvina, 2019). *To test the hypothesis about the opposite direction of migration flows associated with different life-course events*, it was proposed that a model describing the interregional migration of young people going from region i to region j also includes the flow of students going in the opposite direction. Similarly, a model for the interregional migration of pensioners was supplemented with a flow of the economically active and families' groups of migrants going in the opposite direction. Instead of absolute values of the number of migrants, relative indicators were also included, i.e. the share of students or economically active in the total return flow.

3. Foreign labour migration

(Vakulenko, Leukhin, 2015) analysed the factors driving demand for foreign migrant workers in Russia. Five groups of variables were analysed as demand factors characterizing enterprises (wages, fixed capital, the share of foreign capital), industry specifics (OKVED, the national Classifier of Types of Economic Activity), occupations, migrant qualifications (work experience and education) and the macroeconomic situation in Russia (GRP, the unemployment rate, the net internal migration rate). The model was estimated on 2012 data of applications for foreign migrant quotas published by the Russian Federal Service for Labour and Employment. The input on enterprises requesting the right to hire foreign workers within the Government's annually approved foreign migrant quotas was retrieved from the Ruslana database provided by Bureau van Dijk. TINs of enterprises were used to align the two databases. An important technical highlight relates to the decomposition of the explained variance of the model $\left(R^2\right)$ by groups of factors. This helped to identify the highest contributing factors affecting the variance of demand for foreign migrant labour.

(Vakulenko, Leukhin, 2017) addressed wage discrimination against foreign workers in the Russian labour market. For this purpose, the Blinder–Oaxaca decomposition was used to evaluate wage differences. The estimates of the degree of discrimination were based on the data of applications for foreign migrant quotas filed by Russian employers according to the Russian Federal Service for Labour and Employment and data of the Russia Longitudinal Monitoring Survey - HSE (RLMS-HSE) for 2009–2013. The following factors were considered as influences affecting wage levels: work experience, education, occupational group, region of Russia, industry specifics (OKVED). The detailed decomposition (Fortin et al., 2011) was calculated to find the contribution of specific factors included in the model. The purpose of this was to decompose each analysed component into elements separately for each group of factors. As long as the analysed variables are categorical variables, adjustments were applied to ensure invariance to the choice of base references (Jann, 2008).

4. Analysis of interregional and intersectoral mobility in Russia

(Vakulenko, 2020) analysed the degree and dynamics of regional and sectoral mobility in the Russian labour market compared to other countries based on earlier research and new

evidence obtained by the author. The term “mobility” is approached in two aspects: movements of labour between types of economic activities (sectors of economy) and change of residence, in this case, between regions of Russia, i.e., the analysis concerns interregional migration. The paper did not address other types of mobility, particularly relating to employment status (employed, unemployed, inactive), intra-company and inter-company mobility without a change of sector. This approach employed both direct (mobility costs, transition matrices, Shorrocks indices (Shorrocks, 1978)) and indirect indicators (structural unemployment, wage differentiation, unemployment differentiation). The initial information was the data of the RLMS-HSE and the data of Rosstat for the 2000s. Estimates of intersectoral mobility in other countries were taken from Artuç, et al. (2013) and Artuç, McLaren (2012). In Russia, such assessments were carried out only for mobility between the enlarged sectors: public and private (Klepikova, 2016). Interregional mobility estimates for different countries can be found in Gurvich, Vakulenko et al. (2016), Karachurina, Mkrtchyan (2017), Bell et al. (2015).

5. The impact of migration on the Russian labour market

(Vakulenko, 2016a) analysed the impact of migration on the level and differentiation of wages, the unemployment rate and per capita income in Russian regions. To address the issue, first a dynamic model with spatial effects was analysed based on data from Rosstat for 1995–2010. To account for spatial effects, the spatial lag of the dependent variable was included (SAR) (Niebuhr et al., 2012):

$$\ln\left(y_{i,t}\right) = \alpha_i + \delta_t + \beta \ln\left(y_{i,t-1}\right) + \rho \sum_{j=1}^{J} \omega_{i,j} \ln\left(y_{j,t}\right) + \gamma \text{Migration}_{i,t-1} + \sum_{k=1}^{K} \theta_k \mathrm{X}_{k,i,t} + \varepsilon_{i,t} \quad (11)$$

where $y_{i,t}$ is the dependent variable for region i in year t. The models were estimated separately for three different dependent variables: real wages, real per capita income, and the unemployment rate. The value α_i is regional fixed effect, δ_t is the time effect described by a set of dummy variables by year. $\mathrm{X}_{k,i,t}$ is a set of explanatory variables which are different for each of the dependent variables; k is the factor index, i is the region's index, t is the year index. β, γ and θ_j are the set of parameters to be estimated. The sum $\sum_{j=1}^{J} \omega_{i,j} \ln\left(y_{j,t}\right)$ represents the weighted average of the dependent variable for all regions with weights $\omega_{i,j}$. Weights represent inverse distances between pairs of regions. The econometric specification (11) represents a modified conditional β-convergence model (Barro, Sala-i-Martin, 1991).

To estimate the migration effect on the discussed variables, model (11) was built to include net migration rates for internal and international migration separately and internal and international migration jointly. Migrant inflows and outflows were analysed separately (Østbye, Westerlund, 2007). All migration indicators were included with a year's lag to account for the endogeneity problem. The generalized method of moments for systems of equations was used to estimate model (11) (Blundell, Bond, 1998).

To test the hypothesis concerning the impact of migration on interregional differentiation by labour market indicators (σ-convergence), an approach was developed based on comparisons of the dynamics of the Gini coefficients calculated for observed per capita income, wages and unemployment rates versus the estimates derived from model (11) under the hypothesis assuming no migration to/from the region. The statistical comparison of the Gini coefficients was based on the estimated confidence intervals.

Main findings

Research findings on the Russian labour market:

1) The unemployment rate and Russia's GDP have a stable long-term relationship: Okun's law works for Russia similarly to other countries with similar characteristics (Vakulenko, Gurvich, 2015a, 2015b). The results of the model evaluation showed that the unemployment rate reacts more strongly to a drop in production than to its growth. As in other countries, the short-term relationship between GDP and the unemployment rate is stronger during crisis periods and weaker (to the point that it may become insignificant) during periods of economic growth (Vakulenko, Gurvich, 2015b).
2) The estimation of the macroeconomic model for labour market indicators showed that in the 2000s, an increase in labour productivity and a decrease in the unemployment rate contributed equally to the growth of real wages in Russia (Vakulenko, Gurvich, 2015a). As a result, real wages grew faster than labour productivity and hence, the share of wages in GDP increased (in contrast to most other countries). Meanwhile, the share of gross profit in GDP was falling, which negatively affected investment in the economy and the supply of goods and services, inhibiting economic growth. The strong dependence of real wages on the unemployment rate implies that the economic growth model based on expanding demand observed in Russia in the 2000s is severely constrained. A further increase in production requires the development of a new growth model based on technological progress and an increase in labour productivity (Gurvich, Vakulenko, 2018).
3) The causal relationship between productivity and wages is one-sided, meaning that the concept of “effective wages” (the positive impact of wages on labour productivity) is not applicable (Vakulenko, Gurvich, 2015a).
4) From a macroeconomic point of view, the key distinctive feature of the Russian labour market is its flexibility of real wages to the unemployment rate, compared to other countries (Vakulenko, Gurvich, 2016). The Russian labour market is not distinguished by either an increased response of wages, or a decreased response of employment to productivity or output shocks. The Russian labour market is generally characterized by reactions typical of an emerging market (Vakulenko, Gurvich, 2015a; Gurvich, Vakulenko, 2017).
5) The relevance of considering spatial interaction effects when modelling indicators of labour markets at the regional level has been substantiated. Without spatial effects, estimates of Okun's coefficient on regional data are underestimated (Vakulenko, 2015). After the incorporation of spatial interactions into the model, the effects of the asymmetric adjustment of the unemployment rate on the growth and decline in the growth rate of GRP disappear. This means that effects of the regional “buffer” or “absorption” are observed in the regional labour markets in Russia: during crises, more prosperous regions can improve the situation in neighbouring regions through spatial interactions (Vakulenko, 2015). Due to the high spatial dependence, labour market policies implemented at the regional level are less effective than those at the federal level.
6) The values obtained for the author's coefficients of the *autonomy* and *influence* of regions showed that these are associated with the level of economic development and geographic location. Regions with a higher GRP (represented by large agglomerations, and oil and gas producing regions) are the most independent and have the highest impact on other regions, while most of the regions of the Far East, distanced from the European part of the country and experiencing an outflow of the population, have the lowest values for the coefficients of autonomy and influence (Vakulenko, 2015).

Research findings on Russia’s internal migration:

7) The econometric models developed for testing the hypothesis of the poverty trap made it possible to obtain stable estimates of the threshold values of average per capita income and determine that by 2010 most Russian regions had escaped the poverty trap (Guriev, Vakulenko, 2015). However, the estimates of migration models based on data for 2011–2016, showed that the intensity of migration from poor regions of Russia is much lower (Vakulenko, 2019).
8) The ranking of migration factors showed that until 2010, internal migration in Russia was mostly driven by demographic and economic factors (housing provision, per capita income and the unemployment rate). The role of other factors (ecology, infrastructure, public goods, etc.) was far less significant. Migrants were more focused on factors of the region of destination than factors of the region of origin (Vakulenko, 2016b). In 2011–2016, the unemployment rate becomes less meaningful as a determinant of internal migration. Beside demographic factors, the poverty rate and the availability of housing, other factors start gaining significance—regional infrastructure (road density, the development of internet connections) and the environment. Factors of the region of origin became more relevant for migrants. The highest migration intensity in Russia was mainly observed between regions which were more similar to each other in terms of the quality of life and standard of living (Vakulenko, 2019).
9) According to the estimates, when the global demand for natural resources grows, the outflow of people from sparsely populated regions of Russia reduces, because migrants go to the Far East and Siberia mainly to earn money in mining sector (Sardadvar, Vakulenko, 2017).
10) The application of the spatial econometric methods to migration models allowed us to obtain evidence indicating that migrants consider socio-economic factors related to origin/destination regions and to neighbouring regions when making a migration decision (Sardadvar, Vakulenko, 2016; Sardadvar, Vakulenko, 2020). In the models incorporating the factors of the region of origin, the factors of the region of destination, network effects of the regions of origin and destination (effects of neighbouring regions) and intraregional effects, the total effect is positive for real GDP growth rate, the availability of housing and student numbers, while the unemployment rate has negative total effect on migration (Sardadvar, Vakulenko, 2020). When aiming to increase the inflow of migrants to a region, the migration policies of the neighbouring regions should be considered, because competition/cooperation effects between the regions emerge. Regions with a labour force deficit should consider what their competitive advantages are compared to the nearest alternative destinations (Sardadvar, Vakulenko, 2020).
11) Modelling internal migration in Russia should be carried out separately for people of different age groups. Such an approach would help identify age-specific migration determinants and improve the explanatory power of the models. Alternatively, the model would yield results only for the dominant age group in the migration flow (i.e. economically active and families) (Vakulenko, Mkrtchyan, 2020).
12) The research findings confirmed the hypothesis that migration movements associated with specific life-course events take opposite directions. In other words, in Russia, as in other countries, the flows of migrants returning after graduation go in the opposite direction to the flows of students, and the flows of the economically active population are opposite to the flows of pensioners (Mkrtchyan, Vakulenko, 2018).
13) The determinants of migration differ across age groups. For example, labour market conditions are important for working-age migrants, while students and young people are more concerned with the opportunities for human capital accumulation for their careers. The affordability of housing plays a role in the migration decisions of families with children. Pensioners prefer destinations with a warmer climate and more comfortable

living conditions, therefore, at this age people leave resource-extracting regions with an unfavourable environment. Young people, economically active and family migrants choose to move to natural resource-rich regions to earn money (Vakulenko, Mkrtchyan, 2020).

Research findings on foreign labour migration in Russia

14) Modelling the demand for foreign migrant labour using the data on quota applications showed that most Russian employers hire low-skilled foreign migrants with secondary education and work experience of up to one year (Vakulenko, Leukhin, 2015), and pay them much less than Russian workers: the wage gap between natives and migrants with similar labour productivity exceeds 40% (Vakulenko, Leukhin, 2017). Moreover, wage discrimination is largely due to the difference in employment sectors. The analysis of the wage gap dynamics found that natives and migrant workers do not compete in the labour market because the lower wages of foreign workers do not lead to the reduction of wages of Russian workers in related positions.

Research findings on the relationship between migration and labour market indicators

15) Migration in Russia does not reduce interregional inequality in income, wages and unemployment rates (Vakulenko, 2016b).
16) Compared to other countries, Russia has relatively low intersectoral and interregional labour mobility (Vakulenko, 2020). Cross-sectoral transitions are mainly made between related industries, requiring similar knowledge from workers.

The outlined findings across different areas of this dissertation research can be summarized as follows. In Russia, long-term interregional migration is mainly determined by economic factors, i.e. by labour market conditions. The poverty trap appears a key obstacle for interregional mobility: while economic growth in the 2000s eliminated the poverty trap, the most recent economic crises saw its re-emergence. High interregional differences in economic performance does not have a positive impact on internal long-term migration, which remains relatively low. This could explain why Russian regions continue to differ significantly in terms of wages and unemployment rates. The results also showed relatively low intersectoral mobility. Low labour mobility is one of the reasons for the high flexibility of real wages to the unemployment rate, considered a distinctive feature of the Russian labour market. High wage flexibility ensures full employment, i.e. the proximity of the unemployment rate to its "natural" level, which creates a demand for foreign labour during periods of production growth. In other words, all key research findings obtained are largely determined by the low labour mobility and justify the conclusion about the high flexibility of real wages to the unemployment rate.

The empirical results of the dissertation research are supported by econometric models and answer previously unanswered questions or those not confirmed by model calculations. The findings of the dissertation do not contradict the conventional view of "the Russian model of the labour market", but describe it in an accurate and concrete manner and substantiate it using a set of macroeconomic models.

There are still many questions that need to be investigated. A new industrial era (Industry 4.0) is coming, where many people will work remotely. It is hard to predict how this will transform labour market relations. It is possible that the boundaries between office work and remote work, between regions and, perhaps, between countries will become blurred. Future research, building on the findings of this dissertation, will help analyse the scale of population mobility, and the emergence of new labour market mechanisms or the adaptation to former ones.

List of author's original articles

1. Vakulenko E.S. (2020). Analysis of the level of interregional and intersectoral labor mobility in Russia. *Economy of region*, 4. (in press) [In Russian]
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