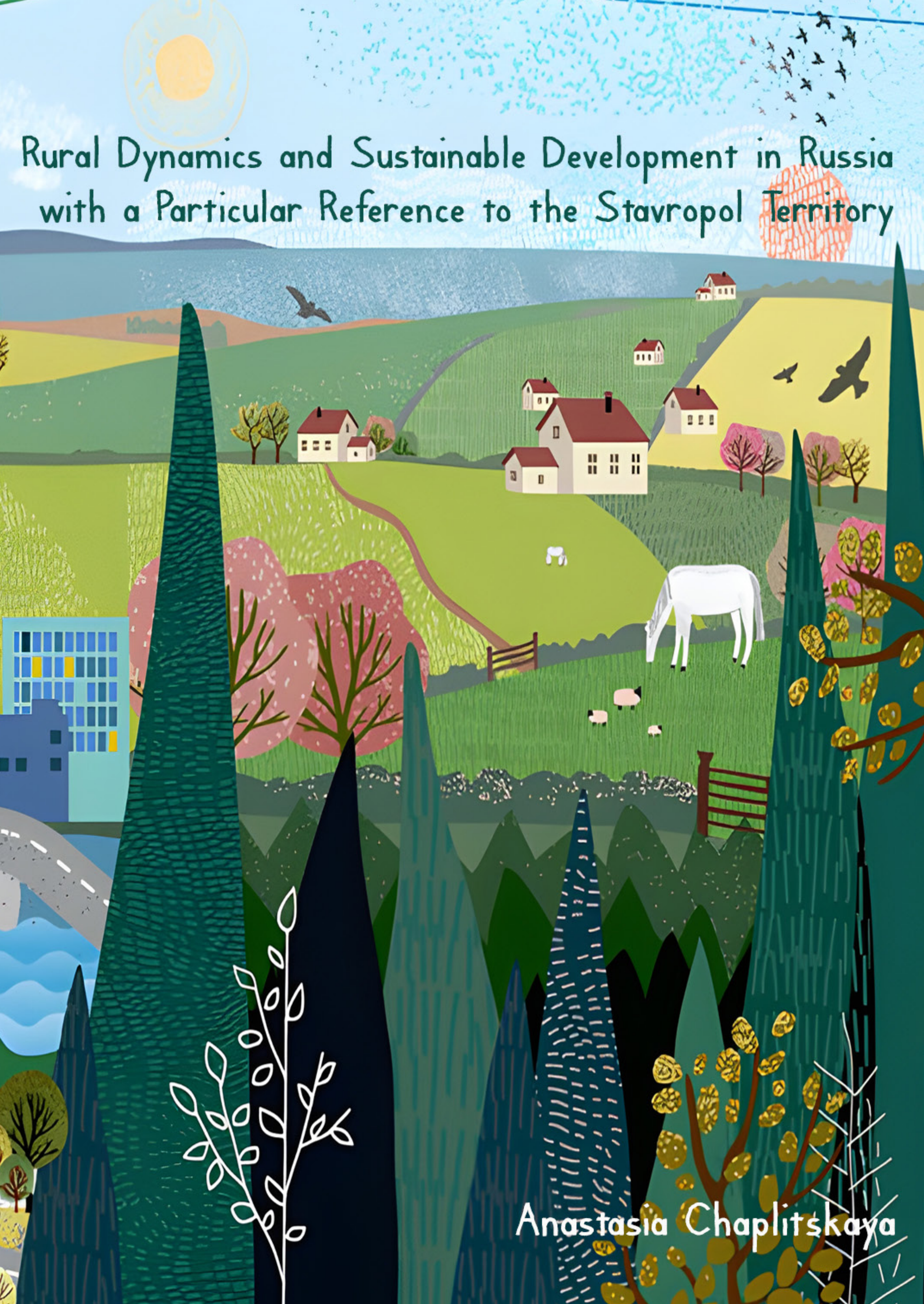
Rural Dynamics and Sustainable Development in Russia with a Particular Reference to the Stavropol Territory



Anastasia Chaplitskaya

Propositions

1. There is a wide gap between a centrally developed strategy for sustainable rural development and its local implementation.
   (this thesis)

2. The decision of an individual to migrate is motivated by material benefits.
   (this thesis)

3. Technical innovation alone is insufficient to solve environmental problems.

4. A centralized hierarchical university management system hinders the educational process.

5. All media are biased.

6. Wages will be lower for jobs that artificial intelligence is incapable of doing.

Propositions belonging to the thesis, entitled

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Anastasia Chaplitskaya
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Anastasia Chaplitskaya

Thesis committee

Promotor:
Prof. Dr J.H.H. Wesseler
Professor of Agricultural Economics and Rural Policy
Wageningen University & Research

Prof. Dr W.J.M. Heijman
Professor, Department of Economics
Czech University of Life Sciences, Prague, Czech Republic

Co-promotor:
Dr J. van Ophem
Associate professor, Urban Economics Group
Wageningen University & Research

Other members:
Prof. Dr E.H.P. Frankema, Wageningen University & Research
Prof. Dr A. Nábrádi, University of Debrecen, Hungary
Prof. Dr M.P.M. Meuwissen, Wageningen University & Research
Prof. Dr M.A.E. Wagemakers, Wageningen University & Research

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Anastasia Chaplitskaya

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"The best stories might stop but they never end"

Contents

Chapter 1

General Introduction

1.1 Context and Problem Statement

As stated in the 1996 Declaration on World Food Security, rural areas in any country play a crucial role in securing national and global food supplies, making their sustainable development a priority for all. Achieving sustainable rural development is not an easy task; it relies on the inherent development of many different factors, such as efficient resource management, increased job opportunities, supporting favorable demographic trends, and improving infrastructure, and quality of life (Masot and Gascon, 2021). Closely related to these socioeconomic traits, then, are environmental factors, such as the value and allocation of natural resources and land, which influence the positioning of key agroeconomic activities and additional anthropogenic features that shape rural lifestyles.

With about 80 million hectares for agriculture, the Russian Federation is a significant player in the global food market (FAO, 2022). In 2022, Russia harvested 153.8 million tons of grain, including 104.4 million metric tons of wheat. 72 million tons were exported, primarily to China, Turkey, EU nations, Kazakhstan, Belarus, South Korea, Egypt, and Saudi Arabia (AGROEXPORT, 2023). Between 2018 and 2022, Russia accounted for 5.4% of the global output of barley, wheat, and maize, making Russia the world's largest exporter of wheat (FAO, 2022). Its agricultural revenues, which grew to $91 billion in 2019, further underscore the importance of Russian agriculture (ITA, 2023). However, rural areas in Russia are compromised by constant depopulation (Leksin, 2021).

70% of Russia's land area is covered by rural settlements (The World Bank, 2022), home to about one-quarter of Russia's population (147 million people). Despite their significant contribution to the country's resources, the total number of rural settlements is experiencing a gradual decline at an annual rate of 1.5-3% (Nefedova and Mkrtchyan, 2017). In addition, according to the 2021 population census of the country, 16.2% of the total Russian rural settlements (153.2) have no permanent population. These conditions demonstrate how important it is for policymakers to gain a better understanding of the livelihood needs of rural communities and the vulnerabilities they face, take appropriate actions to reverse these negative trends and encourage sustainable growth and progress in rural areas. This requires a more inclusive, diligent, and effective use of the country's rural resources, with the global of protecting a higher level of well-being and quality of life for rural residents (Nigmatullina et al., 2022).

At the policy level, steps have already been taken in this regard. In 1996, the FAO session in Rome established the main objectives for sustainable development in agriculture and rural areas. These encompassed guarantees of food security, the integration of innovative food production technologies, the alleviation of unemployment and poverty, and the advocacy for rational use of natural resources alongside environmental protection (FAO, 2001). After the Rome session, Russia attempted to implement several programs with the same goals, including the 'Concept of Sustainable Rural Development' and the

‘Social Development of Rural Areas’. Unfortunately, due to low state resources, the areas touched by these programs were limited (Gorohov et al., 2021). Afterward, the development of rural territories fell under the Federal Target Program Sustainable Rural Development (one for the 2014-2017 period and one for the period to 2020) (Federal Targeted Program, 2012), along with it, rural areas were supported by the Federal Law “On the Development of Agriculture” (Federal Law, 2015). In this timeframe, the primary focus was promoting sustainable rural development through agricultural policies by addressing interconnected issues related to rural employment, equitable remuneration, and improved living conditions aimed at the establishment of a resilient agricultural sector, ensuring the production of superior-quality food and the efficient use of natural resources. As a result, these programs increased the appeal for investment and the profitability of agricultural commodity producers but only for specific rural areas where extensive investment projects in agricultural production were being implemented (Ministry of Agriculture of the Russian Federation, 2015).

As the latest action, the Russian government approved the ‘Strategy for Achieving Sustainable Rural Growth by 2030’. This document outlined a set of specific measures to achieve sustainable rural development goals, such as a stable socio-economic progression, amplified agricultural yields and efficiency, full employment for rural residents, improved standard of living, and sensible land use (FAOLEX, 2015).

The focus of governmental policies in the past decades has been on creating an enabling environment to foster a consistent enhancement in the quality of life and well-being of the rural population. The main primary objectives of sustainable rural development in Russia include stabilization of the rural population; reduction of the migration outflow of the rural population; ensuring an average annual growth rate of agricultural production; increase in rural employment; increase in the ratio of wages in agriculture to the average value of the country’s economy. However, permanent issues related to poverty, social inequality, unemployment, and depletion of natural resources (FAO, 2016) are posing a constant pressure on rural depopulation caused by environmental degradation and climate change impacts.

In contemporary times, the Russian rural population is affected by several issues, such as the non-diversified structure of the rural economy, high unemployment, insufficient improvement and development of the social environment, and the attractive image of urban life (Chugunova et al., 2023). Moreover, there is a significant outflow of people from rural areas, resulting in a decrease in population (Mkrtchyan, 2019). This migration exacerbates the demographic aging of rural regions as the majority of individuals relocating to urban areas generally belong to a younger age group (Kovanova and Badmaeva, 2018). Additionally, the disintegration of the collective farming infrastructure and the inefficiency of Soviet agriculture have further compounded the difficulties faced by rural communities (Karachurina and Mkrtchyan, 2018). Low pay, a high level of concealed unemployment, and a scarcity of adequately compensated employment opportunities, which has resulted in a significant income disparity between rural and urban populations (Ibragimov, 2022), characterize the socioeconomic situation of rural Russians. These factors collectively contribute to the complex and multifaceted challenges impacting the Russian rural population.

The present Chapter 1 comprises a brief introduction to the overall conceptual framework, the main case study area and the four core chapters (Chapters 2-5), each featuring an independent research question (RQ). We combined specific studies on sustainable rural development in the case of the Stavropol Territory (Chapters 2 to 4) as well as in Russia as a whole (Chapter 5). Finally, the concluding Chapter 6 remarks and compares the key findings collected in this dissertation, highlighting their importance for understanding and promoting better sustainable rural development.

1.2 Conceptual framework

The thesis employs the nexus approach to sustainable rural development, highlighting the connections between sustainable rural and agricultural development, well-being, and migration. To facilitate a nuanced understanding, this section defines these concepts and illustrates the interrelationships within the scope of the thesis.

The concept of sustainable development has gained widespread international recognition in recent years. First introduced in the 1987 report of the World Commission on Environment and Development (WCED), the concept gained prominence after the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. Sustainable development is defined as the pursuit of meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. It encompasses socio-economic development, human and cultural fulfilment, and reasonable use of natural resources, emphasizing integration among people, society, and nature.

Sustainable rural development is a specific application of the broader principles of sustainable development, tailored to the unique challenges and opportunities of rural areas [1]. It focuses on improving the quality of life in rural communities while preserving the ecological integrity of the surrounding environment. In 2009, the Commission on Sustainable Development (CSD) emphasized that the foundation of rural development is a healthy and dynamic agricultural sector.

[1]Rural areas in Russia are self-governing political divisions composed of one or more contiguous rural settlements, such as towns, villages, hamlets, farmsteads, and other types of settlements. A rural settlement typically comprises either a single rural community with a population of 1,000 or more, or multiple rural communities, each with a population of less than 1,000. Exceptions are made for areas with low population density and for remote and inaccessible areas (FAO, 2024; Russian Federal Assembly, 2003)

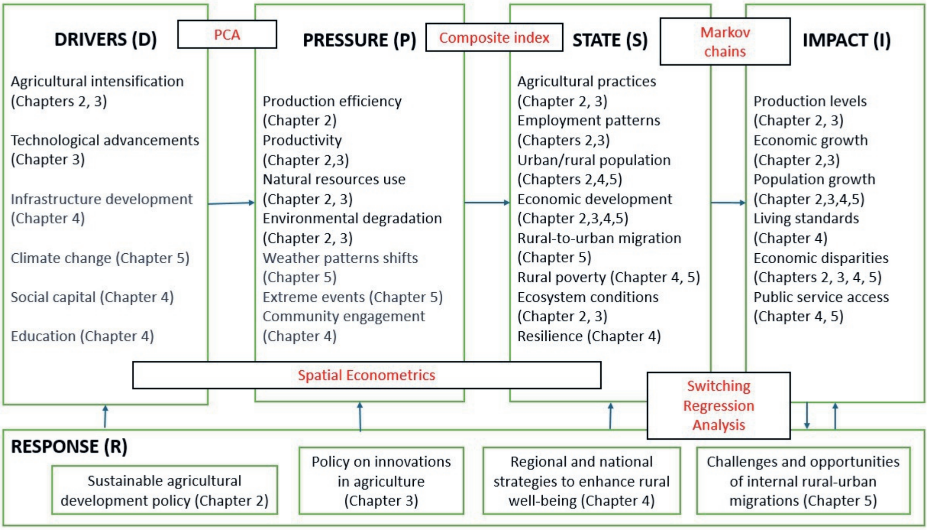
Agriculture plays a pivotal role in sustaining humanity by serving as the cornerstone of global food production. Beyond its fundamental role in food security, agriculture contributes significantly to economic development, employment, and the overall well-being of rural communities. Thus, sustainable agricultural development refers to a holistic approach that seeks to meet current food needs while ensuring the long-term viability of agricultural systems and their surrounding ecosystems. Additionally, it encompasses considerations for social equity, rural livelihoods, and community well-being, acknowledging the interconnectedness of ecological, economic, and social factors in fostering a balanced and enduring agricultural sector (Webb et al., 2022; UN, 2008; CSD, 2009).

Achieving sustainable (rural or agricultural) development is strongly correlated with the measure of well-being (De Neve and Sachs, 2000). This central objective encompasses various dimensions of human life and refers to the overall quality of life and happiness experienced by individuals and communities, extending beyond economic indicators to include social, environmental, freedom, and health considerations (Ronen and Kerret, 2020). The success of sustainable (rural) development depends on strategies that enhance the well-being of people and address basic needs, thus contributing to poverty eradication and the economic, social, and environmental viability of nations (SDG2, 11).

Finally, the lack of well-being in rural areas can have significant implications for migration. When individuals do not achieve well-being, they may seek better economic opportunities and improved living conditions in urban areas, contributing to out-migration and rural depopulation, a major issue in Russia. Out-migration from rural areas can have adverse impacts on agricultural labor availability, affecting productivity and household production. This can potentially also stifle economic growth and exacerbate rural poverty, undermine food security, and influence the sustainable management of natural resources.

In the evaluation of sustainable rural development, a robust analysis demands therefore a comprehensive and integrative approach that considers all these multifaceted concepts and interplay of economic, social, environmental, and cultural factors. To explain how we addressed this challenge in the thesis, Figure 1.1 illustrates the interaction between factors and concepts analyzed through different methodologies. The diagram is based on a Driver-Pressure-State-Impact-Response (DPSIR) framework (Fried, 1970; Kristensen, 2004). The DPSIR framework is a systematic approach to illustrate and analyze the linkages between Drivers (needs that initiate a chain of causal links), Pressures (activities that generate change), States (current conditions), Impacts (consequences of change), and Responses (policy or management actions) for a given issue (Kristensen, 2004). In the context of sustainable rural development, the DPSIR framework serves to elucidate the complex interplay among factors such as agricultural labor, urbanization, productivity, economic growth, rural poverty, and natural resource management. This framework unveils a dynamic landscape of interconnected economic, societal and environmental phe-

Figure 1.1: DPSIR framework of the thesis



Source: own elaboration based on Xu et al. (2022)

nomena, providing a comprehensive understanding of the multifaceted challenges and opportunities within rural areas addressed in this thesis.

Technological advancements and agricultural intensification act as driving forces, pressuring the system to meet escalating demands for efficiency and productivity. The resultant state manifests in shifts in agricultural labor practices and employment patterns, as well as the expansion and transformation of urban areas due to economic development and rural-to-urban migration. These changes exert impacts that reverberate through the socioeconomic fabric, influencing production levels, economic growth, and living standards. However, the flip side of this progress emerges in the form of heightened pressure on natural resources and environmental degradation. From a social perspective, as rural poverty persists, economic disparities and limited access to essential services become pronounced impacts. The role of social capital and community engagement is also acknowledged as pivotal, shaping resilient communities and shared resource management. On the environmental side, climate change, with its shifting weather patterns and extreme events, introduces uncertainties affecting agricultural practices. In addition, the altered conditions of ecosystems and natural resources, stemming from increased demand and intensive resource use, introduce complexities in ecosystem services.

Acknowledging all these diverse elements enriches our understanding of the intricate relationships shaping sustainable rural development in the Stavropol Territory and informs the formulation of targeted responses and policies for a resilient and balanced rural development. The responses included in this thesis involve promotion environmentally friendly farming practices. This response aims to enhance agricultural sustainability and rural resilience, promoting research and development, and providing incentives for the adoption of innovative technologies. This ensures a more effective and sustainable approach to agricultural innovation. In response to the impact of well-being conditions on overall development, regional and national strategies can be developed. This might involve investing in healthcare infrastructure, improving education systems, enhancing security measures, and upgrading rural infrastructure to create an environment conducive to sustainable development. To manage the impact of migration on rural sustainable development, policies should be formulated to address both challenges and opportunities associated with internal rural-urban migrations. This may involve measures to retain talent in rural areas, creating job opportunities, and ensuring that migration does not lead to depopulation and the loss of rural vitality.

Each of the DPSIR contents required specific approaches, indicators and methods to be systematically investigated throughout the thesis. The choice of indicators is based on several key criteria, including usefulness, consistency, adaptability, and data availability. Primarily, our selection of indicators generate data that are needed, useful to the specific research question of each chapter, and consistent with prevailing choices in academic literature. This is essential to ensure that the information and findings are stored and used at multiple instances. Next, we addressed at least one indicator for each sustainability dimension to be consistent also with our overall framework. Each selected metric is also versatile, able to adapt to the different research objectives and analytical approaches, as we applied different methods along the thesis. Finally, indicators are selected based on the availability of a comprehensive and reliable dataset.

Methodologically, we integrate Principal Component Analysis (PCA) with three different approaches: Composite Index Formulation, Switching Regression Analysis (SRA), and Regression Analysis. This integration allows us to assess agricultural sustainability, policy implementation for agricultural innovation, and the well-being of urban and rural populations. We demonstrated the adaptability of PCA in the consolidation of indicators into composite measures, which provides a better understanding of the trends in sustainability and well-being, as well as on possible structural changes in the relationship with the SRA. In addition, we used Markov chains and spatial econometric regression to analyze rural-urban migration patterns and drivers. This provided valuable insights into migration dynamics and the spatial interdependencies and factors influencing internal population movements.

Through this multidimensional assessment framework, involving driving forces, pressures, states, impacts and responses, we gathered unique empirical evidence on the economic, social, and environmental sustainability in Russia. Using the Stavropol Territory as a case study, as described in detail in the next section, we emphasized via this empirical evidence how rural development, well-being, and intra-country migration are interrelated and crucial for achieving a structural transformation in the sustainable rural development in the country. This approach provides a publicly (international) available information for informed decision-making and the development of targeted strategies to enhance the sustainability and well-being of rural communities.

1.3 The Case Study: Stavropol Territory

The Stavropol Territory is located at the northern end of the Caucasus, more than 1,600 km south of Moscow. The area of this region, covering 62.2 thousand km2, is predominantly rural with 736 rural settlements in which 1.75 million residents live (in 2022). Most of the population (98%), on the other hand, is concentrated in only seven urban settlements. In economic terms, the Gross Regional Product (GRP) of the Stavropol Territory in 2020 amounted to 863 billion rubles (29th place among the subjects of Russia [2]), accounting for about 1.5% of the Gross Domestic Product (GDP) of the entire nation and 36% of the GRP of the North Caucasus Federal District. The share of rural areas in the GRP of Russia in 2020 was 12.4%.

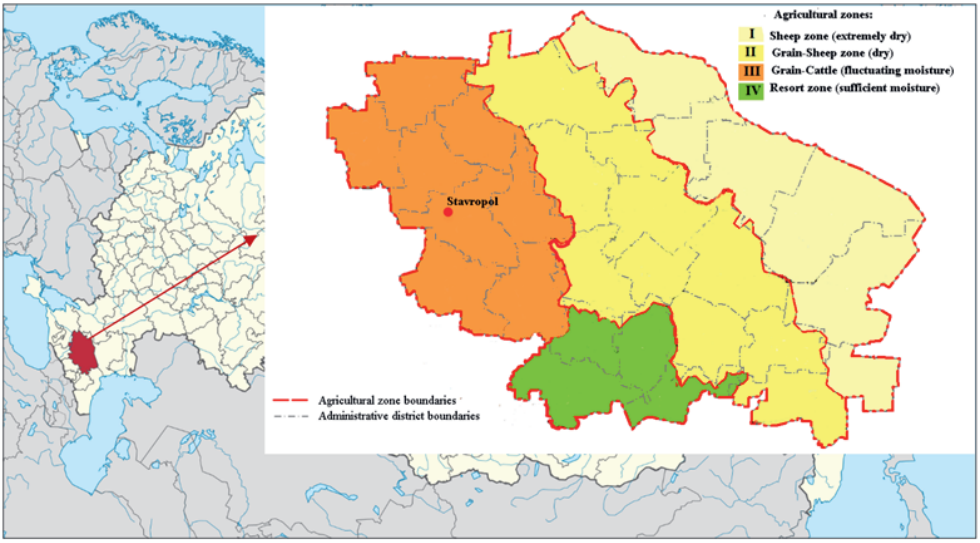
The area of 2.4 million hectares includes cereals (third nationwide in terms of production), vegetables, fruits, and livestock (Stavstat, 2022). In 2022, Stavropol Territory produced 9.2 million metric tons of grain and leguminous crops, of which 36.2% were exported. Meat products hold the secondary position in Stavropol's export (35.4%). Exports are directed mainly to the Middle East and Transcaucasia, as well as to Asia (Azerbaijan, Saudi Arabia, China, Georgia, and the United Arab Emirates) (AGROEXPORT, 2023). Specifically, at the national level, Stavropol territory ranks first in grain sorghum exports, second for poultry meat, and fourth for milling products.

Owing in part to a temperate climate (in the Atlantic continental zone), Stavropol Territory is one of the most important regions in Russia from an agro-industrial perspective, with agriculture as the leading economic activity. The agricultural land of Stavropol is among the most agro-diverse in the nation given distinct climatic conditions, from extremely dry in the east to sufficient moisture in the southwest, soil, and environmental factors. As presented by Pismennaja et al. (2015) four distinct agricultural zones can be presented in the Stavropol Territory (Figure 1.2).

Various ecological zones are present, influenced by differences in precipitation levels The first zone, - 'Sheep' in Figure 1.2, is an extremely dry climate zone, covering an

[2]The Russian Federation comprises equal subjects - republics, krais, oblasts, federal cities, autonomous okrugs, and autonomous oblasts - and functions as a federal state. The constituent entities of Russia, are also commonly known as the regions of the Russian Federation and its constituent political subdivisions. (Constitution of the Russian Federation, 2023)

Figure 1.2: Agricultural specialization and climate zones of the Stavropol territory



Source: Adapted from the Federal State Statistics Service in the North Caucasus Federal District, 2023

area of more than 1.7 million hectares; it is made up of light chestnut soils with a light mechanical composition. Approximately 47.4% of the agricultural land within the zone consists of natural hayfields and pastures. The second zone, – 'Grain and Sheep', - a dry climate zone, occupies an area of about 2.4 million hectares and features chestnut and dark chestnut soils; it specializes in the production of grain, technical crops, fruits and grapes, and sheep and cattle breeding products. The third zone, 'Grain and Cattle', is a climate zone with fluctuating humidity and covers 1.7 million hectares, of which 0.88 are cultivated with winter wheat taking the lead among the grain crops, accompanied by beetroot, sunflower, maize, and other cereals. The soil composition is largely comprised of ordinary chernozems, natural hayfields, and pastures account for 26.6% of the total agricultural land. The fourth zone is the resort area (a climate zone with sufficient humidity), which comprises foothills and hilly areas, with typical chernozems; this area is home to a range of highly specialized intensive enterprises including sheep farming, fruit cultivation, viticulture, livestock rearing, and the production of poultry and pork.

The agricultural sector depends on the available agro-climatic conditions and natural resources, as well as on the human capital, the quality of infrastructure, and the socio-economic conditions prevailing in rural areas (NRC, 2002). The Stavropol Territory benefits from favorable pedo-climatic factors, but the region lacks the socio-economic conditions necessary for the efficient and sustainable use, as well as for attracting and retaining a rural population, on which a significant development of the economic well-being of the entire region may depend (Ministry of Agriculture of the Stavropol Territory, 2020).

In line with the average trends in Russia, the rural population in the Stavropol Territory is decreasing. Since 2011, the territory has been witnessing a massive shift of residents from rural to urban areas, losing more than half a million rural residents in ten years. This trend has been also, exacerbated by a birth rate deficit; in 2022, there were 11,942 births versus 18,516 deaths (Stavstat, 2023).

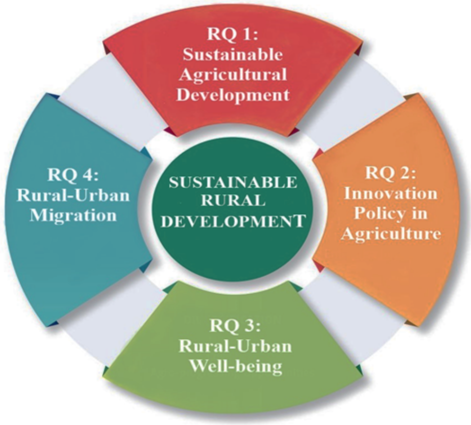
For these reasons as well as to address sustainable rural development, the Government of the Russian Federation adopted Resolution No. 696 of May 31, 2019 ”On the State Program for the Comprehensive Development of Rural Areas for 2020-2025” (North Caucasus Statistical Agency, 2020). The main objectives of the program: to maintain the share of the rural population in the total population of the Russian Federation at a level of at least 25.3%; to increase the share of the total area of improved housing in rural settlements to 50%; to achieve a ratio of average monthly disposable resources of rural and urban households to 80% (Ministry of Agriculture, 2022). However, strategic plans and executed programs tend to be overly theoretical, leading to discrepancies between theoretical advances and their actual empirical implementation (Gromov, 2020). This is demonstrated in the prolonged discomfort endured by the territory's residents, as evidenced by the results of the annual quality of life assessment conducted by the Agency for Strategic Initiatives (Asi, 2021). Nevertheless, there is a lack of empirical evidence that distinguishes the difference in life satisfaction and well-being between rural and urban residents.

The research in this thesis on the Stavropol Territory, therefore, makes a key contribution to clarifying the economic, social, and environmental challenges and perspectives supporting sustainable rural development in local rural areas. In addition, the thesis defines priority directions for the integrated development of rural territories and agrarian economy in similar contexts, bridging the gap between theoretical insights and practical implementation of sustainable rural development. The Stavropol Territory is an ideal case study because of the diversity of its agricultural production, pedoclimatic conditions and economic contexts. Consequently, the empirical collected evidence can be more easily generalized to other rural areas in similar conditions across Russia. The next section describes the main RQs answered in the four core chapters and the main features of the empirical research conducted to answer them.

1.4 Research questions, objectives, and methods

The primary objective of this thesis is to study sustainable rural development in Russia by analyzing the agricultural, migratory, and well-being linkages in at both local (the

Figure 1.3: Outline of the Research subjects



Source: own elaboration

Stavropol Territory) and national levels. The thesis contains four empirical investigations that employ systematic approaches and complementary methodologies: Principal Component Analysis (PCA), Switching Regression Modelling (SRM), Markov Chains trend analysis, and spatial econometric regression. Data collection is based on the use of both qualitative and quantitative data from primary and secondary sources. Primary sources include surveys as explained in more detail in Chapter 4, section 4.3.1, while secondary sources mainly consist of officially published statistical publications from the Federal State Statistical Service[3], the governmental statistics agency in Russia. With the exception of Chapter 4, which required specific information relevant to the research objectives that was not publicly available, most of the chapters in this thesis rely on secondary data sources.

Figure 1.3 illustrates a schematic diagram summarizing the topics explored, corresponding to chapters 2-5 of the thesis. These chapters are the core chapters of the thesis, each of which answers a specific research question.

Research Question 1: What are the core elements of sustainable regional agricultural development in the Stavropol Territory (Russia), and how can they be integrated into a composite indicator to guide policies for social welfare and sectoral improvement?

The second chapter adressing RQ1 aims to better understand the economic, social,

[3]FederalState statistical Service https://rosstat.gov.ru/

and environmental sustainability of agricultural activity in the Stavropol Territory of Russia by proposing a composite sustainable indicator (CSI) that measures these three dimensions together to get more robust results. This has been proposed by Nicoletti at al.(2000) and Gomez-Limona and Riesgo (2000). The chapter addresses this topic by considering the needs of current and future generations, the potential of natural resources, and the surrounding environment (WCED, 1987) following the well-established methodological literature (Stockl et al, 1994; Adreoli and Tellarini, 2000; Sands, and Podmore, 2000; Riesto and Gomes-Limon, 2009), and providing new empirical evidence for Russian regions alike. Previous studies in Russia have primarily focused on improving economic and productivity aspects, with limited attention to the broader sustainability context (Zagaytov, 1999; Granberg, 2007). To bridge this gap, we follow the well-established methodological literature (Nicoletti et al., 2000; Riesto and Gomes-Limon, 2009; Emelynova et al., 2015). The chosen indicators are selected for their usefulness, versatility, consistency, and availability of data time series.They cover environmental (air pollutant emissions, organic fertilization, and soil cover), economic (agricultural GDP, land productivity, and labor productivity), and social (proportion of rural population and income distribution between rural and urban residents) dimensions. The data for each indicator for the period of 2005-2014 are obtained from the official annual publications of the Federal State Statistics Service such as the 'Socio-Economic Indicators of Russian Regions Statistical[4]' and 'Russia in figures[5]' annual digests. To construct the CSI and reduce the number of explanatory variables while considering their intercorrelations, we choose Principal Component Analysis (PCA) as aggregation method for our multidimensional data. This method provides a clear and informative representation of the complex multidimensional dataset, facilitating a nuanced understanding of the sustainability of the agricultural sector in the Stavropol Territory and the main trends and implications from a policy-making process perspective.

Building upon this evidence, Chapter 3 expands the analysis of sustainable rural development in Russia by integrating and measuring, with a stylezed composite index, the effectiveness of innovation in regional agriculture. This includes further investigation into the impact of local policies designed to promote innovation.

Research Question 2: What are the impacts of a local policy aimed at agricultural innovation in Russia for sustainable rural development?

According to academic literature (Porter, 1998; Triomphe et al., 2013; Chupryakova, 2015), we consider innovation as one of the key factors for sustainable rural development.

[4]Socio-Economic Indicators of Russian Regions Statistical Digest: / Federal State Statistics Service (Rosstat). https://rosstat.gov.ru/folder/210/document/13204

[5]Russia in figures/ Federal State Statistics Service (Rosstat): https://rosstat.gov.ru/folder/210/document/12993

In Chapter 3, we discuss the concept and types of this innovation in agriculture activities in Russia. We investigate the relative benefits and challenges for regional sustainability, the role of the state policy in promoting it, and whether the implementation of the policy increases sustainable agricultural growth locally. In particular, we examine the hypothesis that the implementation of a government innovation policy (machine technological complex) affects the composite indicator positively and, thereby, the sustainable development of agriculture. To address these issues, we utilize the CSI introduces in Chapter 2 within a switching regression modeling (SRM) framework. This model accommodates the possibility of structural changes in parameter regimes, reflecting the assumption that state policies may induce shifts in the CSI, thereby stimulating sustainable agricultural development in the region. The data for each indicator from 2000 to 2016 for each indicator are sourced as from official annual publications of the Federal State Statistics Service, such as 'Socio-Economic Indicators of Russian Regions Statistical' and 'Russia in Figures' annual digests, as in Chapter 2.

Chapters 2 and 3 complement each other; Chapter 2 provides the theoretical framework and measurement approach necessary to evaluate the results of a policy aimed at improving agricultural sustainability through innovation, as is demonstrated in Chapter 3 to show its empirical application.

In Chapter 4, we expand the analysis of sustainable development by integrating well-being notions and acknowledging differences between rural and urban regions. Using the case of Stavropol Territory, we investigate these concepts to comprehend the socio-economic and environmental obstacles prevalent in the region, along with their impact on rural sustainable development and urbanization, and address the following research question.

Research Question 3: What are the differences and related key factors affecting well-being and quality of life between rural and urban residents in Russia?

Given the depopulation and socioeconomic challenges in the Russian rural areas, Chapter 4 aims to measure and compare differences in well-being and quality of life between rural and urban residents in Russia, as well as uncover the drivers of these divergences. To this end, we make use of a survey among Stavropol Territory residents. Primary data collection is facilitated through a survey based on the European Social Survey (ESS) framework, which is renowned for its scientifically valid methodology and ethical research practices. The survey is adapted to suit the national context of Russia and includes questions from Rounds 3 and 4 of the ESS Well-being section. Since Russia is one of the participating countries in the ESS, the study benefits from a comprehensive set of questions that are relevant to its research aims. We constructed the composite regional Well-being Index (WBI) using these questions. At the beginning of the study, we perform a Principal Component Analysis (PCA) (Nicoletti et al., 2000) on the survey responses to examine if there is a correlation between well-being and living standards in urban versus rural areas, and if the quality of life is affected by the spatial conditions of the residents' living environment. We identified key indicators to assess the satisfaction of urban and rural populations regarding their social, economic, and environmental needs. It is important to note that these indicators differ for the different spatial groups analyzed. The study employs a robust methodology that combines the ESS framework, PCA analysis, and targeted survey questions to provide valuable insights into the well-being of rural and urban residents. Based on our results and a better understanding of regional specificity, we suggest policy recommendations for improving sustainable rural development in Russia.

By developing and using composite indicators as well as exploring the interconnected economic, social, and environmental dimensions of sustainability, this thesis captures valuable empirical insights in the process of shaping initiatives and policies to address the challenges and opportunities for sustainable rural development. Chapter 5 further extends the analysis by examining rural-urban migration flows within Russia.

Research Question 4: What are the prospects and drivers of migration flows within Russia, considering the rural or urban nature of the areas?

Rural-urban migration is a prevalent contemporary phenomenon in many regions of Russia, including the Stavropol Territory. It is influenced by socioeconomic factors that particularly affect rural depopulation, posing challenges to agricultural sustainability and rural development. Chapter 5 explains where people move to and what might cause it. We make use of the most recent publicly available data from Rosstat (the Federal Statistical Service of the Russian Federation) on intra-country migration flows between rural and urban origins and destinations across each Federal District between 2011 and 2020 [6]. As explanatory variables, we employ the panel dataset that includes key indicators that capture the economic, social, and environmental conditions of each region, representing both attractive and/or hindering forces. These socioeconomic factors encompass the primary determinants of migration choices recognized in academic literature (Margolies, 1978; Zhang, 2003; Tacoli et al., 2015; Jia et al., 2017; Rodríguez-Pose and von Berlepsch, 2018; Vakulenko, 2019), including population, average wage (adjusted for constant 2020 prices), unemployment rate, and housing availability (measured as residential building area in square meters per capita). Regarding potential environmental effects, we followed the approach proposed by Dell et al. (2014) to incorporate population weights into climate data to provide a more accurate understanding of how climate variations

[6] Intra-Russian migration by territories of arrival and departure (checkerboard by federal districts). Federal State Statistics Service `http://www.gks.ru/free`$_{doc}/new_{s}ite/population/demo/migr3.xls$

affect people within a specific region. The data are collected from Rosstat's Annual Statistical Digest 'Socio-Economic Indicators of Russian Regions[7]', with the exception of wages for urban areas, which are available from Rosstat's annual collection 'Regions of Russia. Main Socio-Economic Indicators of Cities [8]. The dataset is enriched with information on the physical, economic, and social characteristics of each urban and rural area, creating a comprehensive panel dataset. This study employs and integrates two methods: a Markov chain analysis and a spatial interaction regression model. The former is used to present an overview of current trends and prospects of migration flows within the Russian Federal Districts, based on the probabilities of transition from one location to another (Bertsekas et al., 1996). The latter is applied to explore and clarify the underlying drivers explaining the dynamics of migration flows as described by the Markov chains, considering the spillover effects that one region may have on the surrounding or nearby regions by mean of a spatial regression model (LeSage and Fisher, 2016; Sardadvar and Vakulenko, 2020). This chapter explores how migration from rural to urban regions in Russia is causing depopulation pressures in most of the country's rural areas and leading to increased urbanization.

Finally, Chapter 6 summarizes and compares the key findings of the previous chapters, highlighting limitations and providing suggestions for further research, contribution, and policy recommendations.

[7]Socio-Economic Indicators of Russian Regions Statistical Digest: Federal State Statistics Service (Rosstat). https://rosstat.gov.ru/folder/210/document/13204

[8]Regions of Russia. Main socio-economic indicators of cities https://rosstat.gov.ru/folder/210/document/13206

Chapter 2

Sustainable Agricultural Development in the Stavropol Territory, Russia

Abstract

The purpose of this chapter is to evaluate the sustainability performance of agriculture in the Stavropol Territory, Russia. This research employs a principal component analysis to compute a composite sustainability index that integrates selected economic, social, and environmental indicators. On a multi-year basis, the results demonstrate a trend and dynamics towards sustainable agricultural development. Nevertheless, such development is mainly driven by economic and productivity factors; instead, regional agricultural development policies need to better address the social needs of rural communities and environmental externalities.

Keywords: sustainability; composite indicators; principal component analysis; agricultural policy

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2.1 Introduction

The concept of sustainable development has gained widespread international recognition in recent years. First introduced in the 1987 report of the World Commission on Environment and Development (WCED), the concept gained prominence after the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. Sustainable development is defined as the pursuit of meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. It encompasses socio-economic development, human and cultural fulfilment, and reasonable use of natural resources, emphasizing integration among people, society, and nature.

Agriculture plays a pivotal role in sustaining humanity by serving as the cornerstone of global food production. Beyond its fundamental role in food security, agriculture contributes significantly to economic development, employment, and the overall well-being of rural communities. Thus, sustainable agricultural development refers to a holistic approach that seeks to meet current food needs while ensuring the long-term viability of agricultural systems and their surrounding ecosystems. Additionally, it encompasses considerations for social equity, rural livelihoods, and community well-being, acknowledging the interconnectedness of ecological, economic, and social factors in fostering a balanced and enduring agricultural sector.

In this study, we assess the state of sustainable agricultural development in Stavropol Territory, Russia. Among all sectors, agriculture is particularly susceptible to the dynamic interplay of socio-economic and environmental factors, which requires special attention. Designing regulations with a local focus proves to be more effective in discerning specific needs and priorities essential for ensuring greater sustainability. Collecting empirical evidence, therefore, on sustainable agricultural development in specific regions of a nation is crucial for informed, context-specific policymaking, efficient resource allocation, and ongoing assessment and adaptation of strategies to address the unique challenges and opportunities present in each place.

The Stavropol Territory is a region in the south of Russia, 1621 km far from Moscow. In 2015, its population was 2799.5 thousand people. About 60% of them (1627.5 thousand people) live in cities. The significance and prominence of its agriculture grew due to its crucial role in fulfilling the state's agricultural production needs, both for domestic consumption and export. In 2015, the Stavropol Territory was ranked among the first ten regions with the highest agricultural production turnover, which amounted to 175.7 billion rubles (RUB) (Table 2.1).

In the Stavropol Territory, there are about 300 large and medium-sized farms, 15 thousand farming households and over 400 thousand individual (subsidiary) farms (Ministry of Agriculture of the Stavropol Territory, 2016). The heterogeneous local development of agricultural production is favored by the climate, which is Atlantic continental

Table 2.1: The top 10 regions in Russia for the period 2001-2015, ranked by agricultural production in billion rubles.

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Krasnodar	60.1	63.4	66.8	88.1	97.1	111.0	142.4	185.0	175.0	202.0	239.0	235.0	254.7	287.0	334.0
Rostov	34.8	36.6	41.3	56.9	61.5	67.6	79.7	116.0	102.0	118.0	149.0	155.0	161.3	191.0	229.0
Belgorod	19.5	19.6	22.9	26.4	32.7	39.1	56.3	75.7	86.5	98.1	135.0	149.0	115.4	188.0	218.0
Republic of Tatarstan	39.4	39.0	44.9	53.7	61.6	71.6	93.5	117.0	1117.0	101.0	150.0	150.0	160.2	186.0	214.0
Voroneg	22.1	23.2	28.8	29.3	31.7	35.9	52.9	69.0	75.3	68.2	111.0	126.0	143.9	159.0	200.0
Stavropol	24.5	26.6	30.8	41.5	44.5	50.6	69.1	76.4	67.7	84.3	104.0	101.0	122.8	149.0	176.0
Republic of Bashkortostan	35.8	42.9	49.1	55.3	60.4	70.9	81.6	105.0	104.0	88.6	109.0	107.0	126.4	137.0	152.0
Altai Territory	30.8	30.5	35.2	41.5	39.8	46.4	57.1	69.2	76.4	83.3	93.8	94.3	114.7	113.9	140.4
Volgograd	22.3	23.7	28.7	33.1	33.0	39.4	53.3	70.7	65.7	64.3	76.1	83.9	89.9	107.8	125.2
Tambov	12.5	13.2	15.7	16.3	18.5	21.3	28.3	35.6	37.4	36.6	52.0	60.0	72.3	93.5	124.2

Data Source: Federal State Statistics Service (Rosstat) - 2017

in the north and more rigid in the south (Erokhin et al., 2014). The main crops include maize (Ministry of Agriculture of Stavropol Territory, 2016), with a gross yield of 1049.6. tons per hectare[1] under favorable weather conditions, and wheat, which accounts for 80% of the grain production in the region. Livestock also plays an important social and economic role within the territory, which ranked at the national level second in the number of poultry and tenth in the number of dairy cows. One of the historical specialties of the regions includes the breeding of sheep for the production of fine wool, producing 7.2 thousand tons of wool in 2016 (Rosstat)[2]. It is exported to India, China, European countries, and meets the needs of the domestic textile industry.

Currently, the Stavropol region is facing severe challenges, including reduced profitability of agricultural enterprises and insufficient rural resources. Despite the presence of regulatory frameworks such as the Federal Law 'On the Development of Agriculture' (Federal Law, 2015) and the Federal Target Program 'Sustainable Rural Development for 2014-2017 and for the period up to 2020' (Federal Target Program, 2012), it is necessary to strengthen sectoral policies to meet specific needs and priorities for the sustainable agricultural development in the Stavropol Territory. Given its significance relevance at both the regional and national levels, this enhancement is crucial for the social well-being of the rural population and country's national security.

Crafting policies to promote sustainable agricultural development requires systematic monitoring frameworks. The research question is then how to assess agricultural sustainable development at the regional level. This study aims to analyze the sustainability of agricultural developments in the Stavropol Territory by means of a Principal Component

[1] Bulletin Gross yields and yields of agricultural crops in the Russian Federation in 2016: Federal State Statistics Service `https://rosstat.gov.ru/compendium/document/13277`

[2] Bulletin Livestock production in farms of all categories in 2016: Federal State Statistics Service `https://rosstat.gov.ru/compendium/document/13277`

Analysis (PCA), integrating the economic, social, and environmental dimensions together (von Hauff et al., 2009) with a composite indicator that can be used to monitor sustainable development on time and support development of regional policies.

Indicators and composite indicators are recognized as valuable tools for policy-making and public communication, providing comprehensive information on environmental, economic, social, and technological performance across regions (Singh et al., 2007). The use of such indicators makes it possible to explore important trends in the sustainable development of the socio-economic system as a whole. Currently, Russia lacks standardized approaches to assess sustainable agricultural development on a regional scale. Progress in this area of research is essential to effectively address regional challenges without excluding any social, environmental, or economic dimensions of truly sustainable development.

2.2 Literature review

Sustainable development requires a complex interplay of technological, environmental, economic, and social factors. This concept is well established in international academic literature, especially in agricultural sustainability studies (German Science and Humanities Council, 2023; Singhet al.,2023; Trigo et al., 2023; Nicoletti et al., 2000; Gomez-Limona and Riesgo, 2000). However, when it comes to Russia, there is a lack of comprehensive assessments of its agricultural production systems, which are defined primarily by the relationship between economic and productivity elements, such as labor, technology, and production organization. Previous research on the sustainability of agriculture in Russia has mainly focused on improving these aspects alone (Afanasev and Uzbashev, 1996; Boyko, 1986; Zagaytov, 1999; Granberg, 2007). To our knowledge, only one study (Emelynova et al., 2015) has examined sustainable development in Russian agriculture and rural areas using our same definition of sustainable (rural) development.

Emelynova et al. (2015) assessed the sustainable development of the border rural areas of the Kaliningrad region for the study period 2007–2012 by analyzing agropotential, social, economic, and environmental indicators. The environmental dimension includes indicators on water quality, area of damaged land, amount of hazardous waste, and emissions of air pollutants. The economic aspects includes pesticide consumption, availability of public services for sewage collection, investments, and share of actually used agricultural land. Finally, the social dimension includes regional unemployment, poverty rate, average living space per capita, and number of registered crimes. These indicators were selected by 15 experts and used to construct a composite sustainability index after normalization.

Our study is based on this framework (Emelynova et al., 2015). Due to issues with data availability, it was not possible to collect all the same exact indicators for

Table 2.2: Selected indicators for assessing agricultural sustainability

Type of dimension	Indicators	Metric
Economic	Agricultural Gross Domestic Product (AGRGDP)	RUB per year
	Land productivity (LANDPROD)	RUB/ha
	Labor productivity (LABOURPR)	RUB per capita
Environmental	Organic fertilization (LABOURPR)	tons/ha
	Soil cover for agriculture (SOIL)	ha per year
	Emissions of most air pollutants from stationary sources (EMAIRPOLL)	tons of CO2 per year
Social	Proportion of rural population (RURALPOP)	%
	Share of rural and residents' income (WAGESHARE)	%

Data Source: Adapted from Emelynova et al. (2015)

the Stavropol Territory. Thus, we selected different indicators based on their usefulness, versatility, consistency, and sufficiency in data time series. Firstly, we ensured the inclusion of at least one indicator per sustainability dimension and that data are available for 10 years of observations (2005-2014). Based on Emelynova et al. (2015), we selected the same environmental indicators as emissions of air pollutants, organic fertilization, and soil cover for agriculture, offering valuable insights into the ecological impact and promoting the development of more sustainable farming systems, as stocks and annual growth of organic substances characterize the stability of natural ecosystems. Next, we included the main economic factors based on the case study of Gomez-Limona and Riesgo (2000, 2008), which include economic agricultural gross domestic product, land productivity, and labor productivity. These economic aspects emphasize the most the principles of sustainable agriculture mentioned in the federal law "On the development of agriculture" (Federal law, 2015) and the federal target programme "Sustainable development of rural areas for 2014-2017 and for the period up to 2020" (Federal target programme, 2012). Then, as social indicators, we included the proportion of rural population and share of rural and residents' income, as main concerns in the Stavropol Territory given the rural depopulation and migration to urban areas. Table 2.2 presents the final set of indicators.

Our study improves the global understanding of sustainable agricultural development in Russia by introducing new indicators and empirical evidence. We bridge a gap in international literature and offer fresh perspectives on regional progress by presenting new metrics for computing composite indicators. In a methodological leap, we integrate the approach of Emelynova et al. (2015) with a PCA to compute the composite indicator, providing a more sophisticated and data-driven approach. This combination of techniques converts correlated variables into uncorrelated ones, simplifying the evaluation of complex systems such as sustainable agricultural development by reducing dimensionality and facilitating a clearer interpretation of regional trends.

2.3 Materials and methods

The main principle of the CSI is the aggregation of a combination of multidimensional indicators to form a composite indicator for ease of interpretation and comparison (Rigby et al., 2001). The construction of a composite indicator using PCA involves several steps. PCA is a statistical technique that simplifies data by transforming it into a set of indicators, called principal components. We followed the approach of Gomez-Limona and Riesgo (2000, 2008), based on few methodological steps:

- selection of indicators to be used for the CSI;
- data collection and normalization;
- explore relationships among indicators;
- assigning weights to each indicator, which reflect the variable's contribution to a specific sustainability dimension;
- aggregation of these normalized values to create the multi-dimensional CSI;
- presentation of the CSI.

In the initial phase of the analysis, we identified the indicators to capture the sustainable agricultural development of the Stavropol Territory. We selected these indicators based on the literature and according to their relevance, measurability, and comparability for the specific case of Stavropol.

Once the set of initial indicators was defined, we gathered the data for each indicator for 10 years of observations (2005-2014). Table 2.3 reports the descriptive statistics.

As PCA is sensitive to differences in variable magnitudes, we then normalize the data to ensure that all variables are on the same scale. There are several methods in this regard; we opted for re-scaling to a range of [0, 1] (Freudenberg, 2003) according to Eq.1:

$$Min - Max\ I_{ki} = \frac{x_{ki} - \min(x_k)}{\max(x_k) - \min(x_k)}\ [0;1] \tag{1}$$

where I_{ki} is normalized indicator for variable k and year i.

After normalization, indicators range between 0 (i.e., the least sustainable option) to 1 (i.e., the most sustainable option) (Gomez-Limon and Riesgo, 2009).

Table 2.3: Data for each indicator selected for the Composite Agricultural Sustainability Index

YEAR	AGRGDP	RURALPOP	LANDPROD	LABOURPR	WAGESHARE	FORGANIS	SOIL	EMAIRPOLL
2005	40638.3	43.6	17250.3	200.8	0.6	1.6	5284.7	75.0
2006	46695.6	43.5	19024.5	232.6	0.6	1.6	6610.6	73.0
2007	63303.5	43.2	24616.4	324.4	0.7	1.9	5659.3	69.0
2008	68410.9	43.1	25694.2	355.9	0.8	2.4	5659.0	77.0
2009	60610.6	43.0	22425.9	317.1	0.8	3.0	5659.5	64.0
2010	75436.9	42.8	28854.4	392.8	0.8	2.9	4850.1	66.0
2011	92632.1	42.6	34790.1	480.6	0.8	2.9	4875.7	68.0
2012	90612.4	42.4	34355.4	464.5	0.8	3.1	5657.9	69.0
2013	109915.0	42.1	38923.1	564.2	0.8	2.6	6108.5	75.0
2014	133393.9	41.9	47892.1	705.5	0.8	3.2	6108,5	79.0

Data Source: Federal State Statistics Service
Indicators: AGRGDP – agricultural GDP of the region), RURAPPOP - share of rural population in total population, LANDPROD – land productivity, LABOURPR – labour productivity, WAGESHARE - share of rural and residents' income, FORGANIS – organic fertilization, SOIL - soil cover for agriculture, EMAIRPOLL - emissions of most air pollutants from stationary sources

2.3.1 Multivariate analysis

Conducting multivariate analysis before constructing composite indicators enables the best methodological decision-making for standardization processes, weighting, and aggregation on the indicators (OECD, 2008). Multivariate analysis involves verifying relationships between variables to prevent the selection of random variables without links among them, which could compromise research results. For this purpose, once the data are standardized, a correlation matrix is calculated. This matrix shows the pairwise correlations between all variables in the dataset. The correlation coefficient between two variables ranges from -1 to 1, where -1 indicates a perfect negative linear relationship, 0 indicates no linear relationship, and 1 indicates a perfect positive linear relationship.

2.3.2 Performing PCA

We then performed a standard PCA on the correlation matrix. This involves calculating the eigenvalues and eigenvectors of the matrix. The eigenvalues represent the variance explained by each principal component and the eigenvectors determine the weights of the original indicators in each principal component. Kaiser-Meyer-Olkin (KMO) statistic was adopted as measure of sampling adequacy for the PCA; the KMO measure ranges from 0 to 1, with values closer to 1 indicating better suitability for PCA. Kaiser's varimax rotation is then implemented to help interpret these components. (Kaiser's) Varimax rotation is also applied to make the interpretation of components clearer by maximizing the variance of the factor loadings within each principal component (Manly, 2004).

2.3.3 Aggregation of indicators and CSI formulation

Once the principal components are extracted, we computed the intermediate sustainability indicators (SSI_{ji}), corresponding to each of the principal components j. This was done by calculating a weighted aggregation of indicators:

$$SSI_{ji} = \sum_{k=1}^{k=n} w_{kj}\ I_{ki} \tag{2}$$

where SSI_{ji}, is the intermediate sustainability indicator for the component j and the year i, the w_{kj} represents the weight of indicator k in the component j and I_{ki} is the normalized indicator k achieved in the year i. The weights w_{kj} are obtained from the factor loadings rotation matrix as:

$$w_{kj} = \frac{(factorloading_{kj})^2}{eigenvalue_j} \tag{3}$$

where $factor\ loading_{kj}$ is the value of the factor loading k in the principal component j and $eigenvalue_j$ is the eigenvalue of the jth principal component.

Finally, the CSI can be calculated as a weighted aggregation of the sub sustainability indicators:

$$CIS = \sum_{j=1}^{j=2} a_j\ SSI_{ji} \tag{4}$$

where CIS is the value of the composite indicator for the year i and a_j is the weight applied to the sub sustainability indicator j. These weights are calculated as follows:

$$a_j = \frac{eigenvalue_j}{\sum_{j=1}^{j=2} eigenvalue_j} \tag{5}$$

2.4 Results

The PCA developed in this study is used to compute a composite sustainability indicator that summarize information from different indicators and sustainability dimensions of the Stavropol Territory (Schuschny and Soto, 2009). Table (2.4) reports the results of the correlation matrix.

The results highlight positive correlations among economic indicators, with a few exceptions. In particular, there is a negative correlation with economic factors for the

Table 2.4: Correlation matrix from PCA)

	AGRGDP	RURALPOP	LANDPROD	LABOURPR	WAGESHARE	FORGANIC	SOIL	EMAIRPOLL
AGRGDP	1.00							
RURALPOP	-0.77	1.00						
LANDPROD	0.81	-0.97	1.00					
LABOURPR	0.81	-0.98	1.00	1.00				
WAGESHARE	0.51	-0.83	0.79	0.80	1.00			
FORGANIC	0.45	-0.81	0.73	0.75	0.93	1.00		
SOIL	0.49	-0.07	0.07	0.09	-0.26	-0.26	1.00	
EMAIRPOLL	-0.39	0.18	-0.30	-0.30	0.25	0.25	-0.50	1.00

Source: Own elaboration based on linear-correlation regression

Table 2.5: Extracted principle components variance

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total (eigenvalue)	% of variance	Cumulative %	Total (eigenvalue)	% of variance	Cumulative %
1	5,035	62,93	62,93	4.974	62,17	62,17
2	2,017	25,21	88,14	2,077	25,97	88,14

Kaiser-Meyer-Olkin measure of sampling adequacy 0.673
Source: own-elaboration based on PCA

rural population share and air pollutant emissions. Based on these correlations, we estimated the principal components (Table 2.5), with a Kaiser-Meyer-Olkin coefficient of 0.673, suggesting that the dataset is adequate for the PCA. In terms of the variance explained, two principal components are retained from the set of individual variables and together explain 88% of the variance. The cumulative variance method considers 60% as a minimum percentage of variance explained for the social sciences (Garcia-Sanchez et.al, 2015). Therefore, we selected both components. To better understand their meaning, then, we analyzed the rotated factor loadings of the various indicators, as shown in Table 2.6.

Table 2.6 shows the composition of the principal components in terms of indicators. The first principal component, which explains the highest variance, has high component loadings for socioeconomic factors and organic fertilization. The second principal component, instead, has high component loadings for environmental indicators such as soil and emissions. We applied then the rotation of factors to minimize the number of indicators that have a high loading on the same principal component.

Finally, the two composites are aggregated by weighting each composite using equation 2 and 4.

The sustainable composite index of sustainable agricultural development was computed for the period from 2005-2014 and illustrated in Figure 2.1. According to the composite index trend, the sustainable agricultural development of the Stavropol Territory has an overall positive trends in the past years.

Table 2.6: Principal components by indicators

Rotated Component Loading	Component 1	Component 2
AGRGDP	0.74	0.56
RURALPOP	-0.97	-0.14
LANDPROD	0.96	0.23
LABOURPR	0.96	0.23
WAGESHARE	0.92	-0.29
FORGANIC	0.89	-0.35
SOIL	-0.06	0.86
EMAIRPOLL	-0.08	-0.84
Explained variance	0.62	0.26
Proportion of Variance	0.71	0.29

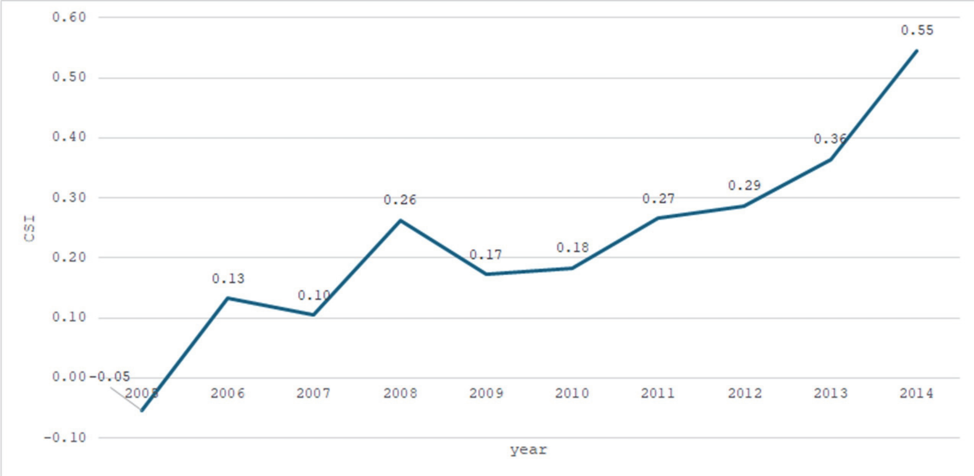
Source: own-elaboration based on Varimax rotation Extraction method

Table 2.7: PCA weights for composite indicator computation

	Domain weight	Weight of the Respective Component	Weight Score (w_i)	Resulting Weight $\sum w_i = 1$
AGRGDP	0.15	0.29	0.04	0.05
RURALPOP	0.19	0.71	0.13	0.15
LANDPROD	0.18	0.71	0.13	0.15
LABOURPR	0.19	0.71	0.13	0.15
WAGESHARE	0.17	0.71	0.12	0.14
FORGANIC	0.16	0.71	0.11	0.13
SOIL	0.36	0.29	0.10	0.12
EMAIRPOLL	0.34	0.29	0.10	0.11

Source: own-elaboration based on Varimax rotation loadings

Figure 2.1: CSI trend of the agricultural sustainable development in the Stavropol Territory



Source: own elaboration based on PCA, with Federal State Statistics Service as Data Source

2.5 Discussion and Conclusion

To understand the regional agricultural sustainability of the Stavropol Territory, this paper conducted a holistic sustainability assessment of the local agricultural development. We developed a composite sustainability index by means of PCA for the region and assessed its trend over the period 2005-2014.

The approach outlined in this paper provides an integrated sustainability assessment that can be used to support agricultural development. It offers an overview of sustainable agricultural development trends by aggregating empirical evidence for individual socioeconomic and environmental factors' that impact agriculture. The approach also considers the relative effects of each of those factors on such development. This can support the establishment of a better regulatory framework for the sustainable agricultural growth of the region, developing a set of measures for guaranteeing a holistic sustainable advancement. This composite index could be useful for managerial decision-making at the regional and national levels.

Common relationships between key variables are revealed and quantified by the results of the correlation matrix. For the sustainability of agricultural development in Stavropol Territory, economic factors are crucial. AGRGDP shows a strong positive correlation with productivity factors, land use, and organic fertilization. Conversely, a significant negative correlation is observed between the economic indicator and rural population, indicating a potential urbanization dynamic. Moreover, the inverse correlation between Environmental Air Pollution and economic and productivity factors suggests potential agricultural implications of environmental degradation.

Based on this correlation matrix, we derived two principal components, elucidating a significant proportion of the total variance. The first one aligns with the economic and productivity dimensions, the most important factors. Component 2, on the other hand, showcases distinctive loadings from the environmental dimension. Finally, looking at the composite indicator developed based on the PCA, there is an overall positive trend (Figure 2.1) in the sustainable agricultural development in Stavropol Territory over the past decade. However, as previously noted, this trend is mainly driven by economic and productivity factors. There was a decline in 2006-2007 and 2008-2009; these declines were caused by environmental challenges and a marked reduction in quality of life during the post-crisis period. This includes unsolved problems of environmental pollution and deterioration of the living conditions for rural citizens, such as insufficient prosperity of rural settlements and a decline in the quality of medical and educational services. Looking at the changes in each indicator separately over time, the weakness in these social and environmental indicators become evident. The proportion of the rural residents in the total population has consistently decreased, primarily due to migration towards more desirable urban areas. This decline in the rural population share has had a significant impact on the number of farms, resulting in considerable amounts of unused land.

Besides promoting economic and productive development, regional development policies must address other specific needs of rural communities. Our research highlights the importance of integrating environmental and social considerations into rural development policies for more sustainable growth. The significance of community-level natural resource management should be emphasized, showcasing the ability of local communities to sustainably manage and benefit from natural resources. This can be achieved by facilitating participatory decision-making processes to ensure inclusive and effective resource governance. It may also involve supporting sustainable tourism policies that balance economic benefits and preservation of cultural and natural assets in rural regions. Finally, it is important to emphasize the importance of education and capacity building. Policies should be implemented to improve education and environmental awareness in rural communities, as well as training programs to promote sustainable practices. Only addressing these dimensions together can improve the sustainable agricultural development in Stavropol Territory.

Although there is data available from the Federal State Statistics Service, the current research has certain limitations in terms of the number of indicators, particularly in the environmental dimension. This has resulted in a reduction in the variables considered when constructing the composite index. Consequently, the findings are affected, and a comprehensive view of agricultural development cannot be obtained. Additional indicators are required to complement the data. According to the literature, the perception of agricultural development's impact on the environment is that addressing environmental issues incurs higher costs. Therefore, an ecosystem-based approach should be employed.

Further studies are needed to address the identified limitations. To ensure the robustness of the results for the Stavropol Territory, it is crucial to collect data from other regions and conduct analyses. For example, it would be useful to compare the economic and territorial position of the Krasnodar Krai and the Stavropol Territory. Additional variables to be considered in the analysis include the potential implementation of alternative methods for aggregating and weighting the base indicators to construct a composite indicator. Such methods comprise the Analytic Hierarchy Process (AHP) and Data Envelopment Analysis.

Chapter 3

Innovation Policy and Sustainable Regional Development in Agriculture: A Case Study of the Stavropol Territory, Russia

Abstract

This chapter considers innovations as one of the factors of sustainable agricultural development of the Stavropol Territory. It focuses on the impact of state policy at the regional level in the field of innovations on the sustainable development of the region's agriculture. This chapter tests whether the implementation of the policy in innovations increased the sustainable growth of agricultural development. To do so, a model with switch variables was used. Principle component analysis was used to calculate a composite sustainability index of selected socio-economic and environmental indicators. The hypothesis that the introduction of a state policy aimed at innovation has a positive impact on the sustainable development of the regional agriculture was corroborated. We also assessed the impact of implementing this policy within each dimension separately. The socio-economic indicator is more important than the environmental indicator.

Keywords: agricultural policy; innovations; principal component analysis; switching regression model; composite indicator; state program.

This chapter is based on: Chaplitskaya, A., Heijman, W., Ophem, J. V., and Kusakina, O. (2021). Innovation policy and sustainable regional development in agriculture: A case study of the Stavropol territory, Russia. Sustainability, 13(6), 3509.

3.1 Introduction

In modern society, innovations are the prerequisites for the development of agriculture. They not only have a positive impact on the competitiveness of the economy but are also of importance for implementing policies of import substitution of food products and maintaining a country's food security, an objective of Russian agricultural policy. Thus, innovations contribute to the dynamic sustainable development of agriculture. Sustainable development of agriculture remains very relevant both for the country as a whole as well as for its regions such as the Stavropol Territory in the Caucasus (Chupryakova, 2015).

In recent years, for a number of reasons, Russian agriculture has experienced a certain decline in innovation. Even the existing innovation potential of the agro-industrial complex is used within 15-20%. (Vaskin and Kubyshev, 2015). When it comes to innovation within the agricultural sector of the region, the innovative sphere of the Stavropol Territory is at the initial stage of its development. Compared to the other regions of the North Caucasus Federal District, the Stavropol Territory is at a higher level of innovation, but it lags behind the average level of the Russian Federation, as evidenced by the data presented in various ratings, including the data of the rating made by the Association of Innovative Regions of Russia (AIRR) in 2017.

In the context of fostering innovation, agritourism appears as a potential key driver of innovations, especially for rural areas. Recognized as an integral part of sustainable rural development (Roman and Prus, 2020), agrotourism holds great promise for injecting innovation into local economies in Russia. However, despite the rich tourism resources present in the Stavropol Territory, this potential opportunity remains underutilized are not actively used. There is also a significant effect on agricultural technology innovation and sustainable agricultural development in the region by rural financial efficiency. Improving the level of agricultural technology innovation is beneficial for rural economic development (Liu et al, 2021; Boon and Edler, 2018). Sustainable development of agriculture can be achieved if the reproduction of production potential, human resources and the natural environment are ensured for a longer period of time. State policy can play a decisive role in ensuring the balance of the economic, social and environmental components of sustainable development.

From this perspective, this chapter has a double objective. Firstly, we assess the agricultural sustainable development of the Stavropol Territory, Russia, of the Stavropol Territory, Russia, aiming to quantify sustainability in three dimensions: economic, social and environmental aspects of sustainable development. Secondly, the chapter aims to test the hypothesis suggesting that the implementation of a state policy focused on innovation has a positive impact on the sustainable development of regional agriculture. It is organized as follows: Theoretical Orientation discusses innovation in agriculture and describes government policies in the area of innovation. The Data and Methodology section presents the data and explains the methodology used to construct a composite indicator of agricultural development. It also presents the Switching Regression Model (SRM). The next section presents the results, and the final section contains the discussion and conclusions.

3.2 Theoretical orientation

In recent decades agriculture has been shown to be able to meet the challenge of the sustainability paradigm, with producers implementing principles of agro-ecological production, alternative food networks and local food systems together with productivity systems that have adhered to the principles of sustainability (De Luca et al., 2018). These innovative agricultural systems consist of either new technical or organizational solutions. However, the core issue in sustainable innovation is the kind of knowledge that is produced and shared. The collaboration and fostering of participation between scientific research, stakeholders, local actors, and policymakers should lead to process innovation (Faure et al., 2013; Triomphe and Rajalahti, 2013).

According to Porter (1998), innovation is a new way of doing things in a commercial setting. In this sense, innovation is all about turning ideas into cash. For the type of innovation needed to bring about a more sustainable development, the new ideas should not only contribute to cash but also to environmental and social quality. This needs an extra step that transforms a standard innovation. New arrangements in society itself can support new modes of agricultural production in order to lead to not only new industry and commerce, but also a new relationship with the surrounding environment.

Defining and measuring innovation performance with regard to sustainability goals in the real world requires reliable evaluation tools to understand the direction in which changes should be oriented (Boon and Edler, 2018; Calik and Bardudeen, 2016). Sustainable innovation can be considered as “any new or significant improvement of products, services, technological or organizational processes, commercialized or internally implemented, that not only provide economic benefits but also generate positive social and environmental impacts” (Chupryakova, 2015, p.135).

Innovation in agriculture means the use of new varieties of plants, breeds of farm animals, production technologies in crop production, livestock and agricultural processing. Innovative processes in the agricultural sector have their own characteristics. They differ in the variety of regional, branch, functional, technological and organizational features. The conditions and factors contributing to the innovative development of the agricultural sector are the availability of natural resources, significant scientific and educational potential, a domestic food market and the ability to produce environmentally friendly, natural food.

That is why the environmental innovations occupy a special place in the system of innovations applied in agriculture because at present the main limitation of economic growth of agriculture is the continually increasing ecological requirements to the process of production, quality of agricultural products. Environmental innovations ("eco-innovations") are the innovations carried out within the framework of the technological, organizational or marketing innovations, contributing to the reduction in or prevention of the negative impact on the environment, balancing economic, environmental and social interests (Ozusaglam, 2012). There are different types of environmental innovations implemented in agriculture: product, process, organizational, marketing, social and systemic.

In order to achieve sustainable growth in agricultural productivity, the use of natural resources must be carried out by ecological requirements. Organic agriculture, as an innovative technology, aims for the following objectives:

- preservation and possible improvement of soil fertility;
- cultivation of healthy plants and animals without chemical means and forage additives;
- the production of physiologically complete products in sufficient quantity and quality and at affordable prices;
- minimize consumption of nonrenewable natural resources;
- ensuring a safe environment (Zakharova and Kerashev, 2009).

Unfortunately, the desire to increase the effectiveness and efficiency of agriculture, including extensive farming, irrational use of land and other natural resources, has led to negative environmental consequences, such as environmental degradation, increasing health hazards and changes in landscapes. The specific features of agriculture as a complex economic, ecological and social systems are poorly taken into account when reorganizing and choosing the directions of agrarian transformations in agricultural production (Chavas and Nauges, 2020; Dolmatova, 2010).

Analysis of the socioeconomic situation in Russia in the agricultural sector in recent years shows a decrease in automation of agricultural work. The intensity of the process of development and introduction of innovative agricultural machinery and technologies by large farms and small farmers has declined (Goncharov, 2016). At best, modern farms prefer to purchase imported models of machinery and introduce foreign technologies, but the majority of enterprises use rather badly worn out and obsolete equipment. All this aggravates the degradation of the complex's industries, which leads to an increase in the cost price and low competitiveness of products, hindering the socio-economic development of rural areas and sharply reducing the quality of life in the countryside (Polushkina, 2016). So, there is room for improvement. Innovation can contribute to achieve this. Measures for the transition to a new level of agricultural production should be substantially supplemented by projects focused on the formation of a unified environment that stimulates innovative transformation of agrarian territories using the most advanced technological capabilities of human potential development and its effective use. It is very important that the whole complex of infrastructure that accompanies modern business in agriculture is formed.

Today's global food systems are entering a fundamentally new stage of technological development called Agriculture 4.0. Moreover, it is based on the introduction of "smart" solutions (robotics, precision farming, Internet of Things), biotechnology, alternative technologies and raw material sources.

The development of scientific potential and implementation of innovative solutions becomes critical (in the period of transition) to ensure competitiveness and further develop Russia's agro-industrial complex. Otherwise, in the next decade, the gap with developed countries may significantly increase, and many markets will cease to exist for Russian agro-industrial complex products.

Further technological development of the Russian agro-industrial complex could take place in the following directions:

- strengthening its fundamental base of productivity growth: technologies of breeding and improvement of genetic potential in conjunction with technologies to ensure the best realization of this potential;
- the introduction of digital technologies and cross-platform solutions in the agro-industrial complex;
- diversification of the assortment of food products with a priority of high margin segments of healthy, functional and personalized nutrition, deep processing of agricultural raw materials;
- development of the agro-industrial complex waste recycling sector: the current situation in the sphere of their formation and utilization is becoming critical in many Russian regions.

One of the areas of the organization's strategy is to disclose information about its environmental, social and economic impacts, which is a prerequisite for analyzing and monitoring the impact of sustainability change on its business performance. This will ensure effective management of the organization, increase competitiveness, justify investments, and respect stakeholders' interests. According to Gamerschlag et al. (2011), the most profitable organizations are associated with greater environmental disclosure.

The Global Reporting Initiative (GRI) Sustainability Reporting Guidelines defines key sustainability reporting indicators. In early 2015, the GRI launched the Reporting 2025 project to encourage international discussion about the future of nonfinancial reporting. In this way, both financial and nonfinancial reporting, as sources of information, aim to meet stakeholders' interests by providing financial, economic, social and environmental indicators of an organization's performance and efficiency. For example, environmental performance indicators include energy conservation, water conservation, waste, transport, environmental assessment of suppliers, and greenhouse gas emissions (Global Reporting Initiative, 2018; Tarquino et al., 2018). Specifically, this guide now includes an indicator of clean production (EN30) that identifies the costs of prevention and environmental management based on extra expenditures required to install clear technologies or for green purchases (Alonso-Almeida et al., 2014).

An extremely low level of innovation activity is connected with, among other things, imperfections in the organizational and economic mechanism for mastering innovation. When there are no well-developed mechanisms of innovative activity (a system of scientific and technical information corresponding to a market economy), there is no approved effective scheme for interaction between scientific institutions and innovation structures (Litvinenko and Kijanova, 2017; Wan, 2012).

Innovation in agriculture can be fostered by state policy. The Russian Federation, for example, has implemented a policy that is aimed at long-term socio-economic development and includes a phased transition to an innovative development path for the period until 2020 (State program 2013–2020)[1]. The main modernization task of the government is the replacement of the developed model of economic growth. Instead of "oil growth" it is necessary to move to an "innovative" one.

The innovation policy in agriculture should lie in the main directions of its development in the short and long terms. The main trends can include: the stimulation of scientific and technological activities and formation on this basis of effective agro-industrial production; material and technical support of the industry, ecological agriculture, improvement of economic and land relations, rationalization of the production and management structure. Additionally, implementing a social policy is conducive to creating decent living conditions for the rural population.

The state innovation policy in the agro-industrial complex is the creation and assistance of appropriate mechanisms and techniques that guarantee the promotion of high-tech resource-saving projects, the promotion of the incorporation of scientific and technical developments into production and the stimulation of innovative activity of companies, nanotechnology. Through the implementation of this program the largest innovative projects are commodity farms, meat processing plants, vegetable hothouses, super technology hothouses, drip irrigation systems, etc.

The development of innovations in the agro-industrial sector of the Stavropol Territory is carried out in accordance with the strategy for the development of innovative activities in the region for the period until 2020 (Federal Law 2015) and "On Amendments

[1]State program for development of agriculture and regulation of markets of agri-cultural products, raw materials and foodstuffs for 2013-2020. Available at `http://www.mcx.ru/navigation/docfeeder/show/342.html`.

to the Federal Law" On Science and State Science and Technology policy (Federal Law of the Russian Federation No. 254-FZ, 2016).

There is another subprogram in the State Program, titled "Development of innovative, investment and technological activities in agriculture", focused on the development of agriculture in the Stavropol Territory for the period 2014–2020. This subprogram is implemented at the regional level. The expected results of the implementation of the Subprogram are presented in the program's passport (State Program of the Stavropol Territory, 2020).

The scope of the implementation of the Subprogram is an innovative base (machine-technological complex) of agricultural production in the Stavropol Territory, it regulates the volume, quality and economic characteristics of the agricultural products in the Stavropol Territory and the adoption of highly efficient and resource-saving technologies. The use of high-tech agricultural machinery and equipment is necessary to preserve the production of agricultural products in the Stavropol Territory and ultimately to solve the food security of the Russian Federation.

In Russia, there is a pressing need to promote innovation in agriculture due to various challenges such as a decreasing rural population, geopolitical conflicts, sanctions, and changing international dynamics. Although there are global reference tools such as the Global Innovation Index and the Innovation Capacity Index (Nechaeva, 2012; Kovryakov, 2014; Ushacheva, 2017; Fedorenko, 2017) to assess innovative progress, there is a notable lack of a consistent methodological foundation specifically tailored to assess the innovation landscape in Russia's agriculture. Inherent limitations in the systematic collection of statistical data contribute to this deficiency. Our research aims to fill critical gaps by providing a comprehensive methodology to monitor and evaluate shifts in sustainable development resulting from the implementation of innovation policies, using the available dataset. By outlining a systematic approach, our methodology aims to contribute to a more robust understanding of innovation dynamics within the agricultural sector in Russia.

Using the experience of the Stavropol Territory, we combined Chaplitskaya et al.'s (2017) approach with a switching regression analysis to determine if the implementation of a state policy for innovation has a positive impact on sustainable development in regional agriculture in Russia. This analytical framework is better suited for evaluating dynamic systems with varying patterns over time. The study analyzes both federal and regional programs that share the same goals.

3.3 Data and Methods

We used principal component analysis (PCA) for constructing a composite sustainable index (CSI) to evaluate the sustainability of agricultural development of the region. We

Table 3.1: The set of indicators (acronyms between brackets)

Type of dimension	Indicators	Metric
Economic	Agricultural Gross Domestic Product (AGRGDP)	RUB per year
	Land productivity (LANDPROD)	RUB/ha
	Labor productivity (LABOURPR)	RUB per capita
Environmental	Organic fertilization (LABOURPR)	tons/ha
	Soil cover for agriculture (SOIL)	ha per year
	Emissions of most air pollutants from stationary sources (EMAIRPOLL)	tons of CO2 per year
Social	Proportion of rural population (RURALPOP)	%
	Share of rural and residents' income (WAGESHARE)	%

Data Source: Chaplitskaya et al. (2015)

consider the following dimensions of sustainability in the analytical framework: economic, environmental and social. The selection of the indicators is based on the literature. Chaplitskaya et al. (2017) selected a set of indicators at the regional level in the Stavropol Territory based on criteria such as usefulness, versatility, consistency, and sufficiency in data time series. Furthermore, indicators are based on the same sustainable agriculture principles that are mentioned in the Federal Law "On the Development of Agriculture" (Federal Law No. 11 FL), Federal target program "Sustainable Rural Development for 2014-2017 and the period up to 2000" (Federal Targeted Program, 2019). The composite indicator is an effective instrument for policymakers and public connection in different areas such as economy, society, environment and technological evolution. (Federal Law of the Russian Federation No. 254-FZ, 2016).

Data for each indicator within these three dimensions for 2000-2016 period were collected from the official website of the Federal State Statistics Service of the Russian Federation, such asincluding the Socio-Economic Indicators of Russian Regions Statistical[2] and 'Russia in figures'[3] annual reports. Stata 17 was used as statistical software for the data computation. Data for each indicator for the period (2000-2016) were taken from the official annual publications of the Federal State Statistics Service such as 'Socio-Economic Indicators of Russian Regions Statistical and 'Russia in figures' annual digests. Table 3.1 presents an overview of the indicators used in the analysis, based on Chaplitskaya et al. (2017).

[2]Socio-Economic Indicators of Russian Regions Statistical Digest: Federal State Statistics Service (Rosstat). https://rosstat.gov.ru/folder/210/document/13204

[3]Russia in figures/ Federal State Statistics Service (Rosstat): https://rosstat.gov.ru/folder/210/document/12993

Table 3.2: Rotated Component Loading by PCA

Indicator	Economic-Social	Environmental
AGRGDP	0.738	0.561
RURALPOP	-0,972	-0.137
LANDPROD	0.956	0.226
LABOURPR	0.962	0.226
WAGESHARE	0.921	-0.285
FORGANIC	0.888	-0.349
SOIL	0.056	0.862
EMAIRPOLL	-0.077	-0.835
Explained variance	0.62	0.26
Proportion of Variance	0.71	0.29

Data Source: own-elaboration based on Varimax rotation

Table 3.3: Weights of indicators by PCA

Indicator	Weight Score (w_i)	Resulting Weight ($\sum w_i = 1$)
AGRGDP	0.044	0.051
RURALPOP	0.135	0.154
LANDPROD	0.131	0.149
LABOURPR	0.132	0.151
WAGESHARE	0.121	0.138
FORGANIC	0.113	0.128
SOIL	0.104	0.118
EMAIRPOLL	0.097	0.111

Data Source: own-elaboration based on Varimax rotation loadings

In our case, the Kaiser–Meyer–Olkin (KMO) coefficient value is 0.673, which is acceptable because the minimum sufficient value is 0.500. The set of individual variable explains 88% of the variance. We can use them for the building of two main components.

Table 3.2 demonstrates two main extracted components from the combination of variables. We label them the economic-social and environmental component.

The weights of each indicator were obtained by PCA from the factor loading rotation matrix in Table 3.3. Their weights led to the determination of the CSI.

The CSI model (Model 1) tests if a structural change of the model takes place while its parameters change. In this case a state policy is the extra parameter. Model testing can test our hypothesis about the influence of the state policy on innovations on the sustainable agricultural development of the region. We applied the switching regression model (SRM) (Davis et al., 2006; Goldfeld and Quant, 1973; Kurek et al., 2020), which integrates the vectors of parameter regimes that could change due to the structural change. This method considers the assumption of a structural change to the CSI model, where a state policy is expected to stimulate the CSI dynamics.

Model 1 describes the changes in sustainable agricultural development over time.

$$\text{(Model 1) } CSI_t = \alpha + \beta t + \gamma P_t + \delta W_t + \epsilon_t \tag{1}$$

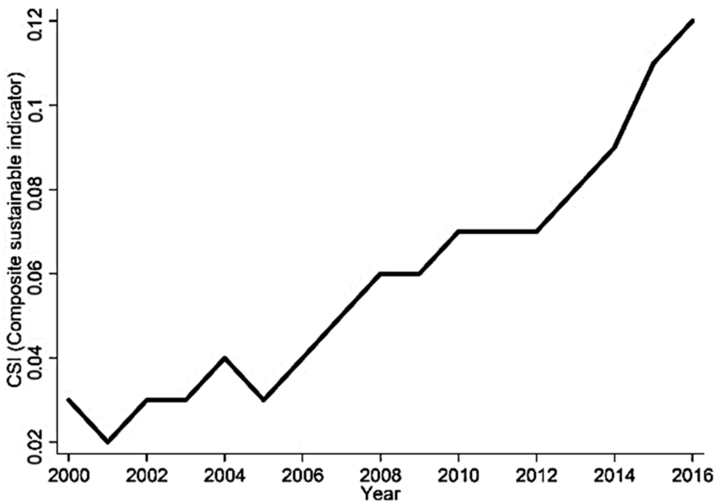
where:

- CSI = value of the composite sustainable indicator of the agricultural development at the t-th moment
- α = constant
- t = time variable
- P_t = switch variable (0,1) that indicates the presence or absence of a policy, where $P_t = 0$ for $t < t_s$ and $P_t = 1$ for $t > t_s$
- t_s = year of introducing a state policy
- W_t = switch variable P at time t, where $W_t = 0$ for $t < t_s$ and $W_t = t$ for $t \geq t_s$; the W coefficient indicates the speed of agricultural development if a switch took place
- β = regression coefficient that identifies the time in the model
- γ = regression coefficient that identifies the change in the model dynamics because of a policy change
- δ = regression coefficient that identifies the change of tempo in the model
- ϵ_t = t-th residual.

The CSI model (Model 1) allows us to test for a positive trend development after the introduction of the state policy in the region. The change of the CSI variable depends on the results of the switch variables (P and W), as it can grow quicker or slower. If the P coefficients are significant, then a structural change in the CSI model occurs and the state policy will change the CSI over time. The W coefficient indicates the speed of agricultural development if there is a structural change.

After testing Model 1 on the CSI we decided to assess how the implementation of the state policy affected the two components (socio-economic and environmental) separately. This has led to Models 2 and 3.

Figure 3.1: Trend in the agricultural composite sustainable indicator in the Stavropol Territory.



Source: own elaboration

$$\text{(Model 2) } EconSocial_t = \alpha + \beta t + \gamma P_t + \delta W_t + \epsilon_t \tag{2}$$

where:

- $EconSocial$ = value of the economic-social development indicator of the at the t-th moment.

$$\text{(Model 3) } Env_t = \alpha + \beta t + \gamma P_t + \delta W_t + \epsilon_t \tag{3}$$

where:

- Env = value of the environmental development indicator at the t-th moment.

3.4 Results

For the period 2000–2016, the computation of composite sustainable indicators (CSIs) of agricultural development was made. Figure 3.1 represents CSI scores for the 16-year period. The CSI has increased over the 2000–2016 period, especially after 2012.

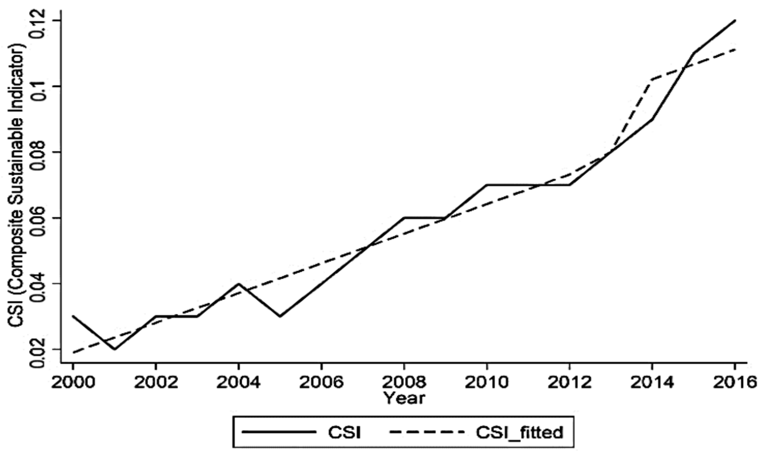
Table 3.4 shows the results of using Model 1 for the agricultural development of the Stavropol Territory. Figure 3.2 represents the actual results plot of the CSI obtained by

Table 3.4: Model 1 results for the agricultural development of the Stavropol Territory.

Region	Variable	Regression coefficient estimator	t-statistic	p-value
	α (constant)	-9.0018	-9.19	0
Stavropol	β	0.0045	9.24	0
Territory	γ	0.0176	2.94	0.012
	δ	1.13E-06	0.75	0.466

$R^2 = 0.9542$; D-W Statistics = 1.76
Source: own elaboration

Figure 3.2: Actual and fitted plots of the switch regression model for the Stavropol Territory.



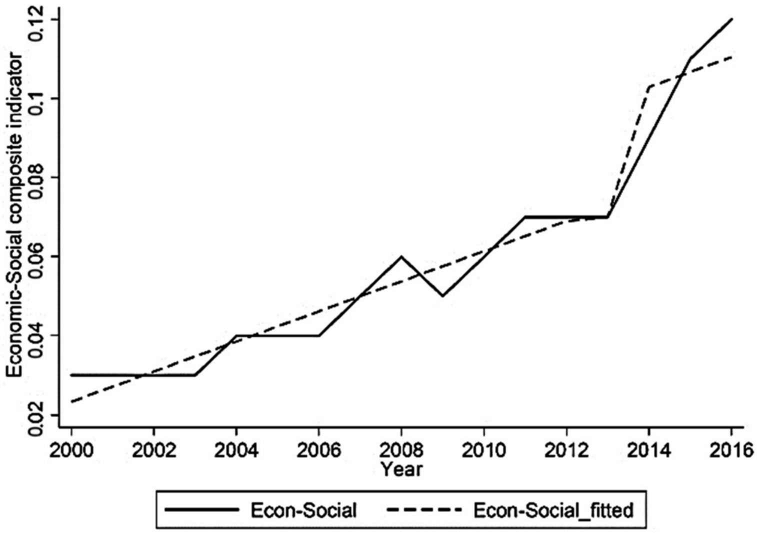
Source: own elaboration

PCA and the fitted plot of regression Model 1.

A significant switch in the sustainable agricultural development model is related to the years 2012 and 2013. Considering the year of introduction of the state program (subprogram: development of innovative, investment and technology activity in the agricultural production), it sped up the sustainable agricultural development. Both the actual and fitted CSIs reflect the switch in the sustainable agricultural development and show the rapid increase in the variable CSI, whereas δ is insignificant—the value is very small. Only γ and δ are significant.

After testing Model 1 in the CSI, we decided to assess how the implementation of the state policy affected the two components (socio-economic and environmental) separately. Table 3.5 demonstrates the results of Model 2 for the socio-economic component and Model 3 for the environmental component with regards to the agricultural development of the Stavropol Territory. Figure 3.3 and Figure 3.4 represent the actual results plot of

Figure 3.3: Actual and fitted plots of the switch regression model for the socio-economic component.



Source: own elaboration

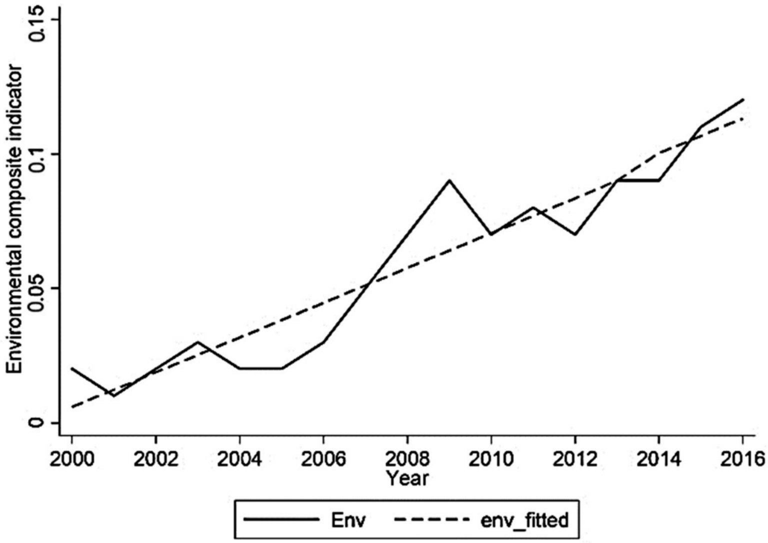
the socio-economic and environmental dimension reached by PCA and the fitted plots of the regression model.

As we can see from 3.3 and Figure 3.4, the state policy had a great impact on the socio-economic and environmental dimension. The introduction of the state policy increases the positive development trend. This relationship is responsible for the switch in the socio-economic development in agriculture and shows the rapid increase in the variable EconSocial. At the same time, Model 3 observes the near absence of the switch in the environmental indicator structure in relation to the state policy in 2012. We also can notice that in that case W is not significant. There is no double switch of development speed in Model 3. The result of the Durbin–Watson statistical tests is relatively low in Models 1 and 3, but it is still above the critical value of the statistical test. This result is only a potential value since the indicators connected with the environment were mentioned less in the state policy than social and economic ones.

3.5 Discussion and Conclusion

To understand whether the implementation of the policy on innovations increased the sustainability of the agricultural development in the Stavropol Territory, we examined

Figure 3.4: Actual and fitted plots of the switch regression model for the environmental component.



Source: own elaboration

Table 3.5: Model results for the dimensions (socio-economic and environmental)

Dimension	Variable	Regression coefficient estimator	t-statistic	p-value	R-squared	D-W statistic
Economic-Social	α (constant)	-7.5845	-10.12	0	0.9582	1.83
	β	0.0038	10.18	0		
	γ	0.0291	4.58	0.001		
	δ	-1.38E-06	-0.94	0.363		
Environmental	α (constant)	-12.9283	-6.99	0	0.8966	1.26
	β	0.0064	7.01	0		
	γ	0.0037	0.71	0.49		
	δ	6.17E-08	0.02	0.988		

Data Source: own elaboration

the impact of the Russian State program 'On the Development of Agriculture for 2014-2020' (subprogram 'Development of innovative, investment and technologic activity in the agricultural production') on sustainable agricultural development employing a composite index computation with SRM (Keruk et al., 2020). SRM helped us to test the hypothesis that the introduction of a state policy aimed at innovation has a positive impact on agricultural development.

Overall, the introduction of a state policy on agricultural innovations leads to a structural change in sustainable agricultural development in the region suggesting that innovation is a significant and positive driving force for it (Nechaeva, 2012; Kovryakov, 2014; Avolio, 2014; Hojnik and Ruzzier, 2016; Ushacheva,2017; Fedorenko, 2017). Model 1 revealed that the introduction of the state policy on innovations changed the overall structure of sustainable agricultural development, leading to the conclusion that innovation is a significant, positive factor for it in the Stavropol Territory. However, we also checked the impact of implementing this policy within each dimension separately and the results show a positive effect of the state innovation policy on socio-economic development (Model 2) but, looking at the environmental dimension only, the results indicate that the state policy has not had a significant impact on it (Model 3). Therefore, the current focus on promoting agricultural innovation in Russia seems to be primarily on improving productivity, rather than giving equal importance to environmental progress. However, despite the emphasis on productivity, Russia is actually making efforts to foster agricultural innovation for the sake of environmental sustainability, as outlined in the State program 'On the Development of Agriculture for 2014-2020', although its impact is limited. That is why the process of introducing ecological innovations in the sphere of agriculture should become one of the priority directions of state policy in the agrarian sphere (Chupryakova, 2015).

The main directions of the system of state support for the introduction of ecological innovations in agricultural production can be:

- improving the normative-legal base regulating the process of creation and implementation of innovations;

Enhancement of legislation at the federal and regional levels is sometimes outdated, but at the same time changes rapidly. Reducing the burden on the regulatory authorities (e.g., tax authorities and Russia's state veterinary and phytosanitary service) and improving judicial practice in patent law are also important. Development of cooperation in certification and licensing at the international level merely lacks at this stage.

- formation and implementation of effective economic and administrative mechanisms to stimulate and hold entrepreneurs accountable;

New incentives for the development of innovative activities could be: additional mechanisms for subsidizing scientific developments, including their transfer; provision of preferences to commercial organizations investing their funds in scientific developments and introducing innovative solutions. This could also include modification of state support criteria: adjusting terms, requirements and conditions of its provision to the actual practice of implementation of innovation projects in a particular area.

- creation of appropriate innovation infrastructure;

The government is the main initiator of such an innovation system and ensures its development by providing financial resources. The creation of a favorable environment for innovation is an important strategic development issue. This infrastructure may consist of organizations building up the local innovation environment to develop science and technology entrepreneurship. This infrastructure's elements could be specialized scientific centers and innovation organizations, science (innovation) parks and business incubators, new legislation, venture capital funds and others.

- promoting the integration of science, education and industry;

Modernization of the agricultural education system aims for improvement of educational programs' quality, timely education of new specialties and reductions in the current staff shortage, as well as the establishment of effective communications with science, systematic participation of business in the coordination of research areas and topics, and the formation of terms of reference for scientific organizations on new developments (World Bank, 2012).

The development of practical activities in the field of implementation of ecological innovations directly connects with the possibility of obtaining many specific benefits in solving not only environmental but also economic and social problems, such as: increasing the competitiveness of products, access to foreign markets, environmental conservation, and improving the quality of life of rural areas

The state program has positively affected the sustainable development of agriculture. However, there are difficulties in implementing the directions of modernization of the country's agriculture and that of its regions. An insufficient level of the financing of fundamental and applied agricultural science, the creation of scientific and technical developments and the presence of private and state investments exist. The mechanism of the development and stimulation of innovative activity are not fully developed. All these aspects in turn restrain the growth rates of agricultural production (Khodos, 2013).

Due to the data availability from the Federal Sate Statistics Service, our research has some limitations in terms of the number of indicators for constructing the composite index of sustainable agricultural development. Another crucial need is a system of indicators that objectively and fairly yet fully describe the innovative processes that take place in agriculture. The programs contain only a plan for subsidizing innovative projects and not the main areas of innovative development. In general terms, they speak about biotechnology, the weakness of the domestic innovation system and the low rates of renewal of the machine park at the expense of domestic technology, yet the problem of the insufficient financing of innovations is unanalyzed. There are no measures stimulating an increase in demand for innovations and mechanisms of state support for the transfer of innovations.

An analysis of the innovation policy of the Stavropol Territory shows that the creation of conditions in the region for the growth of high-tech production, including for the sustainable development of agricultural enterprises, has been successful but not enough for taking leading position in the rating of the Association of Innovative Regions of Russia (AIRR). . Indicators of efficiency are flagship enterprises, most of which have achieved average grain yields above 80 centners/ha. Additionally, there are trends in the industry towards introducing precision farming technologies based on satellite navigation systems; satellite monitoring of crop development and electronic mapping of agricultural land are being introduced. Technology is continually being improved by using new crop protection technologies, replacing pesticides with biologicals and implementing new approaches in cultivating crops without tillage (the no-till technology). Large-scale innovation projects are also intensively developed and implemented in the Stavropol Region to develop the agricultural sector on an intensive growth basis and at a mass scale. The formation of an integrated innovation policy in the region and specific mechanisms for its implementation will create the conditions for not only accelerating economic development but also for a purposeful impact on the commercial utilization of science and technology. One of the measures to stimulate innovation in the sector is the development of rural infrastructure (social, transport, information) and this in turn is one of the most important objectives of state policy. The problem of population outflow from rural areas is important not only for the agricultural sector, but also for the country as a whole. The main task is to create and promote a positive image of modern life in rural areas and work in the agricultural sector. Further research is needed to investigate the theme of complex assessment of conditions of sustainable development of separate territories (rural and urban). This will be carried out by analysis of mutual influence of satisfaction with social, economic and environmental conditions of living and readiness of community to live and work (to contribute to sustainable development, respectively) in a given territory. The main reason for migration from rural to urban areas is the higher standard of living and well-being. We assume the key indicators for representatives of different generations will differ significantly due to value and meaning life attitudes, lifestyle and life strategies of rural population. In addition, differences will be determined at the level of the types of settlements: industrial cities and resort towns; large rural settlements, including municipal centers and small rural settlements.

At the same time, sustainability should not be forgotten in a wide range of relations, including relations with the natural environment. The new paradigm in environmental protection, which is based on the concept of sustainable development, proceeds from the realization of the need to abandon the current consumer's relationship with the natural environment and to build partnership relations between them. The challenge is not only to adopt environmentally friendly and resource-efficient technologies that will undoubtedly have an economic, environmental and social impact. Equally important is the cultivation of an environmental ethic and a deep respect for our environment. This transformative effort must be undertaken in the coming decades.

It would be beneficial for further research to conduct a comprehensive assessment of the system of indicators influenced by innovation as well as taking into account the conditions of rural development. The variety of agricultural innovation systems not only in different countries but as well within Russia, encompassing difference in actors, ambitions, governance, funding mechanism, and incentives, presents a challenge in the establishment of a universal approach.

Chapter 4

Exploring Well-Being Disparities between Urban and Rural Contexts:

a Case Study from the Stavropol Territory, Russia

Abstract

Based on their social, economic, and environmental backgrounds, this study aims to identify the key indicators of satisfaction and differences between rural and urban citizens in the Stavropol Territory, Russia. We aim to determine whether there are well-being disparities between rural and urban areas. We used primary data collection facilitated by a survey based on the European Social Survey (ESS) framework to investigate the potential differences between these areas. By computing the regional Well-Being Index using principal component analysis, we found that there is no statistically significant difference in well-being between rural and urban areas in the Stavropol Territory. Based on the key indicators, the results showed that rural residents feel psychologically more comfortable and safer, assess their family relationships better, and adhere more to traditions and customs. However, urban areas show better economic and social conditions (e.g., infrastructures, medical care). This implies a better understanding of a region's local needs, its advantages, and unique qualities, thereby gaining insight into effective or ineffective government programs. Policymakers and local authorities can consider targeted interventions, based on this study's findings and strive to enhance the well-being of both urban and rural residents.

Keywords: well-being, happiness, rural territory, urban territory, principal component analysis

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4.1 Introduction

Although the global population reached the milestone of 8 billion individuals on November 15, 2022, rural regions have witnessed a gradual depopulation trend in recent decades. Rural areas are geographic regions characterized by lower population density (Panteleeva, 2011) and greater dependence on agriculture and natural resources than urban areas (Balandin, 2018). Despite their crucial role in providing a significant portion of the world's food supply, rural regions have historically lagged behind their urban counterparts in terms of socioeconomic development (Vorobyov and Bugai, 2017). This disparity in development has contributed to the ongoing depopulation phenomenon observed in rural areas (Kluza, 2020), affecting the well-being of both rural and urban populations. Sustainable rural development is vital for the economic, social, and environmental viability of nations; it is essential for poverty eradication, as global poverty is predominantly rural and crucial for preserving natural resources, improving the well-being of rural communities, and ensuring equitable distribution of resources (Desa, 2016).

The consequences of rural depopulation are severe and wide-ranging (Wojewódzka-Wiewiórska, 2021). With fewer people residing in rural areas, there is a decline in agricultural productivity and economic activity, as businesses struggle to thrive without a sufficient customer base. This leads to fewer job opportunities and lower income levels. Consequently, this situation encourages the migration of the rural population, particularly those of working age, thereby exacerbating the aging of the rural population and contributing to increased social isolation. In this context, the challenge of maintaining essential public services, such as health, education, and transportation, intensifies and becomes less effective (Meerstra-de Haan et al., 2020; Supule, 2020). Furthermore, the adverse impacts of climate change trigger migration due to unfavorable living and working conditions (Igić et al., 2020), thus perpetuating a vicious cycle between environmental issues and migration. For instance, Oliveira et al. (2020) suggest that low-population-density rural areas are particularly vulnerable to environmental degradation, which often leads to an increase in environmental problems, such as forest fires. Thus, safeguarding the sustainable well-being of rural areas is of paramount importance for a nation to ensure food security and conservation of environmental resources, as well as the utilization of agricultural production and labor potential.

The relationship between well-being and sustainable development is significant, as achieving sustainable development is strongly correlated with self-reported measures of well-being (De Neve and Sachs, 2020). According to the World Happiness Report (2020), sustainable development aims to balance economic, social, and environmental aspects, which are closely linked to the determinants of well-being, such as income, social support, health, and freedom. Sustainable well-being is achieved when improving individual well-being is correlated with improving the well-being of other members of society and the natural environment (Ronen and Kerret, 2020). This suggests that sustainable development is essential for promoting the well-being of current and future generations.

Well-being encompasses several distinct aspects. The academic literature suggests three key groups of factors (Huppert and So, 2013). The first group refers to economic factors allowing residents to hold job positions that provide them with financial, economic, and material well-being, as well as a high level of personal satisfaction (Diener and Biswas-Diener, 2002; Kahneman and Deaton, 2010). The second group is associated with satisfying individuals' social needs, including education, culture, leisure, and access to quality medical and household services (Thoits, 2011), which should be ensured by the state through public services (Helliwell & Putnam, 2004). The third group pertains to satisfaction with the quality of available food and environmental resources (Gifford, 2014; Keniger et al., 2013), such as satisfactions with climatic conditions and the safety of agricultural production.

Community engagement, local empowerment, and participatory approaches are other important factors, especially in rural contexts. However, these factors are often overlooked by the level of aggregation in well-being indices that neglect the disparities between urban and rural areas, which are crucial aspects for ensuring equitable well-being outcomes (Afanasova, 2018), especially for countries like Russia, where rural regions have undergone substantial devastation compared with the urban areas in the past decades (Ibragimov et al., 2022).

As the largest nation in the world in terms of land area, Russia has a huge area for agricultural activities (Godeev, 2017). In 2020, over a quarter of Russia's population (37.6 million people) lived in rural settlements[1] , totaling about 132.3 and covering more than 70% of the entire land area of the country. However, Russian rural areas are compromised by steady depopulation. According to the Federal Statistical Service (Rosstat), the total rural population in Russia decreased by 2 million people during 1990-2021 (-5.14 % from the 1990 levels), with a 1.1 million decline since 2015 (Ibragimov et al., 2022; Nefedova and Mkrtchyan, 2017). In 2020, as reported by Ibragimov et al. (2022), rural households experienced a significant disparity in disposable income per capita, recording 56.6% less than their urban counterparts (which was 34.8% in 2015). The unemployment rate in rural areas is 8-10%, double that of urban areas, and 22% of the rural population is living below the poverty line. In addition, the absence of essential infrastructure is glaring: an estimated 65% of rural settlements lack health facilities, 70% lack consumer services, and 40% lack stores or outlets (Romanyuk and Lichko, 2019).

Therefore, improving well-being and quality of life in rural areas has taken center stage in Russian state policies. One of the most elaborated initiatives undertaken by the Russian government and the Ministry of Agriculture is the "Strategy for the Sustainable

[1]Settlements, villages, hamlets, farmsteads, and other rural areas classified as rural settlements under the administrative-territorial division established by the Russian Federation in the Concept of Sustainable Development of Rural Areas document.

Development of Rural Areas in the Russian Federation for the Period to 2030," which began in 2015. This strategy involves a budget allocation of 299.2 billion rubles for the creation of 31.8 thousand job opportunities, the construction of 5.4 million sqm of housing for rural residents, the construction of cultural and recreational facilities, and the establishment of schools with a total capacity of 9.9 thousand and 22.3 thousand places, respectively. Despite these attempts, however, rural areas continue to be degraded (Ibragimov et al., 2022).

The evidence unequivocally points to a persistent malaise and underscores the need for policymakers to gain a deeper understanding of the specific needs of rural communities, along with the persistent disadvantages they face. Furthermore, it is imperative to recognize the inherent advantages and attributes that have the potential to attract vital resources to rural areas, thereby facilitating their sustainable development. This involves a more inclusive, careful, and effective use of the nation's rural resources, with the goal of safeguarding a higher level of well-being and quality of life for its residents (Singhet al.,2023; Trigo et al., 2023; Nigmatullina et al., 2022). Notably, it is important to undertake a comparative analysis of the disparities in well-being between urban and rural areas, considering local specificities that could shape the lifestyles and perspectives of inhabitants (Sonnino et al., 2022; Nissi and Sarra, 2018). The analysis of these disparities has the potential to shed light on pressing contemporary challenges that require immediate attention.

In our research effort, we undertake a holistic analysis of the multiple factors influencing the well-being of the residents of the Stavropol Territory, chosen as a case study. While the development of rural settlements in Russia has been studied primarily from an economic perspective, our study adopts an intersectional analysis. Recognising the complex interplay of economic factors with social relations, sense of security and environmental conditions within rural landscapes, we aim to provide a more nuanced picture of the challenges faced by Russian people. Going beyond the traditional scope, our research delves into the lived experiences and perspectives of individuals, revealing innovative facets such as the impact of climate change and the digital divide. Furthermore, by using the European Social Survey (ESS) framework, our research not only facilitates in-depth comparative studies between regions and countries facing similar rural challenges, but also acts as a catalyst for national strategies that actively seek solutions and promote positive change in Russia's rural communities.

Drawing on the theoretical framework adopted from the ESS on well-being (Organization for Economic Co-operation and Development (OECD), 2013), adapted to the national context of Russia, we conducted a principal component analysis (PCA) of survey responses to investigate whether and how well-being and living standards in urban areas are higher than in rural areas and whether the level of well-being is indeed directly dependent on the spatial conditions in which residents live. Subsequently, the key indicators for assessing the satisfaction of urban and rural populations with regard to social, economic, and environmental needs, taking into account that these indicators differ for the different spatial groups analyzed. Based on the results, the study concluded with relevant policy implications for better understanding regional specifics and improving their development.

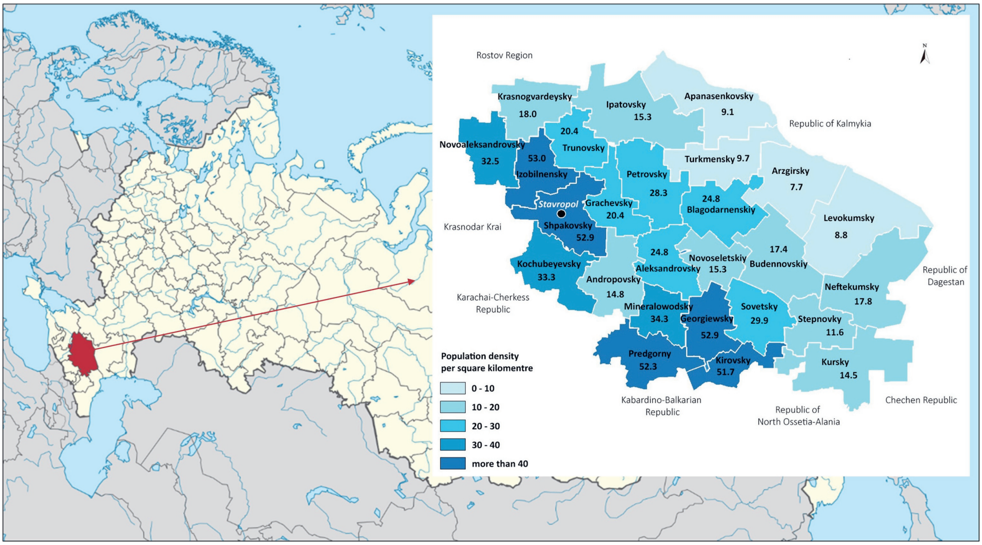
This chapter is structured into the following distinct sections. The Case study section describes the geographic domain of the Stavropol Territory as a relevant case study. Subsequently, the Material and methods delineate the survey methodology employed and elucidates the dataset gathered from inhabitants residing in both rural and urban settings. This includes a detailed exposition of the indicators employed to delineate well-being across social, economic, and environmental dimensions on a regional scale. The Results section systematically presents the outcomes of the survey and PCA. Lastly, the Discussion section critically examines these results, formulates the main conclusions, and informs remarkable recommendations for future initiatives.

4.2 Case study area

The Stavropol Territory is located in the central part of the North Caucasus and is bordered by most of the neighboring republics and regions (see Figure 4.1). The Stavropol Territory is situated in the central part of the Pre-Caucasus and the northern slope of the Greater Caucasus. The region's relief is mainly composed of the Stavropol Upland, with altitudes ranging from 300 to 600 meters. The highest peak is Mount Strizhament, which stands at 831.8 meters. The climate of the region is moderate continental (Britannica, 2017). In 2021, the region had about 2.8 million residents between the seven urban-type settlements (where about 60 percent of the population is concentrated) and the 736 rural settlements (five of which are now completely abandoned). Due to its central geopolitical position, the region holds a special place in Russia's territorial development strategy (O'Loughlin et al., 2007).

By physical attributes, location, and human capital,the Stavropol region is one of the most important agricultural regions and second main producer of grain in Russia (Ioffe et al., 2014). Rural communities, however, have suffered from the transition from the Soviet agricultural model, which marked a decline in rural residents (O'Loughlin et al., 2007). Recently, the rural population of Stavropol Territory has declined by 2.7% compared with the 2015 level, a trend opposite the 1.5% growth of urban areas (Rosstat, 2023). Demographic trends in the Stavropol region closely resemble those observed in many other areas of the Russian Federation, exacerbated by a declining natural population growth rate and an increasing proportion of aging residents. In 2021, migration intensity statistics from the Stavropol Statistical Office (Stavstat) reported a notably lower birth rate (9.6 births per 1,000 individuals) than the death rate (15.1).

Figure 4.1: Administrative regions of the Stavropol Territory



Source: Adapted from the Federal State Statistics Service in the North Caucasus Federal District, 2021

There are no recent studies in the literature regarding the region that account for disparities between rural and urban backgrounds. Nevertheless, O'Loughlin et al. (2007) studied the population and migration changes in the Stavropol Territory during the conflict in neighboring Chechen Republic, reporting a widespread malaise within the society. Most of the residents interviewed by the authors focused primarily on daily activities to earn a living and described (in 86 % of cases) living conditions as difficult or intolerable. More recently, Leshcheva et al. (2021) identified the lag of well-being in the Stavropol rural areas compared with the city as a reason to inhibit all attempts at renewal and transformation in the region. Due to the contemporary challenges facing the region and its geopolitical importance, the Stavropol Territory represents a relevant case study for research on wealth disparities between rural and urban residents in Russia.

4.3 Materials and methods

4.3.1 Primary data collection

To investigate the potential differences in well-being between urban and rural areas, we undertook an empirical investigation using primary data collection, which was facilitated by a survey based on ESS framework (ESS, 2024). The ESS is a cross-national, academic survey designed to examine social trends and well-being across Europe. From 2001 to

2022, the ESS has conducted 10 rounds of surveys, each covering a wide range of topics, including core thematic domains[2] and questionnaires. The questions in the ESS are designed through a rigorous process to ensure high-quality, comparable data collection in each participating country. The selection involves the preparation of the national questionnaire, including translation, addressing pressing societal and policy priorities through an open call for proposals from external academics, with the final selection made by the ESS Scientific Advisory Board. In addition, national teams have the opportunity to include a set of country-specific questions in each round of the ESS. Finally, the ESS uses multitrait-multimethod analysis to assess the reliability and validity of the questions and provides freely accessible data for academics, policymakers, civil society, and the wider public.

In designing the questionnaire for this study, we relied on the well-established ESS infrastructure, which provides high-quality, comparative social surveys on a wide range of social variables, including attitudes and behavior, immigration, human values, and welfare attitudes (ESS, 2024). Our study, therefore, can benefit from a cross-national comparability and ethical research practices that emphasize the importance of the participants' privacy and well-being. Given that the Russian Federation is one of the participating countries (ESS, 2018) and the themes are relevant to our aims, we collected a total of 45 questions from the Well-being Round 3 ('Personal and social well-being') and Round 4 ('Welfare').

The survey maintained respondent anonymity and comprised distinct sections: an initial introduction featuring warm-up inquiries intended to encourage participation, a comprehensive segment probing well-being encompassing 27 indicators, a socio-demographic component to garner insights into respondent's attributes, such as age, marital status, and educational attainment, and a supplementary section eliciting additional pertinent information (Supplementary Information Appendix 1 for comprehensive details). Except for the 27 well-being queries, the questions adopted a binary or multiple-choice structure. The binary variant consisted of dichotomous items, characterized by responses confined to 'yes' or 'no.' By contrast, the multiple-choice questions allowed respondents to select one among several feasible options.

4.3.2 Well-being variables

Table 4.1 presents the 27 variables referred to in the respective well-being questions collected from the ESS sources. These variables are grouped into six dimensions, including subjective well-being and social relations, quality of life (in terms of education, employment, security, and health), financial conditions, and environmental conditions. Thus, the

[2]Domains include: Moral and social values, Health and well-being, Trust in institutions, Education and occupation, Social capital and social trust, Household circumstances, Citizen involvement and democracy, Social exclusion, Political values and engagement, Socio-demographic characteristics, Immigration, and Crime.

Table 4.1: Dimensions and variables of the Regional Well-being Index

Dimension	Variable
Social relationship	All my relatives live here
	Most people are friendly and can be trusted
	No possibility of going elsewhere
	To think of new ideas and be creative
	To follow the traditions and customs
	Social life and social activities around here
	Social benefits/services
	To have an exciting life
	Provision of the internet on different devices such as computer, tablets, and smartphones
Education and work	To have a fair chance of achieving a high level of education
	To have a fair chance of getting a job
	Good standard of living for unemployed individuals
	Good standard of living for pensioners
	Provision of affordable childcare services for working parents
Economic well-being	To be rich and have money and expensive things
	Tax authorities give special advantages
	Good transport system
	The government considers the interests of all citizens
Environment	Good care for nature and the environment
	No harmful toxic production
	Care about climate change
Security	To live in secure and safe surroundings
	Housing and living environment
Health	Good provision of health care
	Quality of food
	Water and sanitation
	Possibility to exercise and maintain a good physical shape

Data Source: European Social Service, Round 3 and 4 (ESS, 2024)

questions gather evidence by taking into account the multifaceted nature of well-being and provide policymakers and researchers with a more holistic perspective on all groups of social, economic, and environmental factors that the existing literature considers key to the study of well-being and quality of life at the regional level, as reported in the introduction.

To gauge the respondents' perceptions of well-being, the questions related to these 27 variables adopted a Likert scale , whereby respondents were prompted to indicate their level of agreement or disagreement within the range of 1 to 5 (where 1 means entirely disagree and 5 completely agree). This evaluative framework facilitated the derivation of average response scores, enabling a nuanced depiction of multifaceted relationships.

The questionnaire developed has a balanced distribution of social and economic variables, while the environmental dimension is less representative. Contributing to the dynamic nature of the well-being research field, some researchers argue for the greater importance of the environmental side in human well-being (Ojala, 2012; Pecl et al., 2017).

Alternative frameworks often emerge in response to different contexts and changing societies. According to the literature (Mkrtchyan et al., 2018), environmental factors, such as warming winter months and decreasing wind speeds, may contribute to increased life satisfaction among the population in the northern regions of Russia but are less perceived in the southern regions, such as the Stavropol Territory. Nevertheless, we included three entries for environmental factors to collect up-to-date evidence and monitor their importance in Russia, with reference to the Stavropol Territory.

4.3.3 Respondents

The survey was conducted following a snowball sampling strategy among residents of the Stavropol Territory, encompassing both urban and rural locales. Google Forms' technological infrastructure was harnessed to collect responses, ensuring expeditious and efficient data compilation. The fieldwork occurred in April 2021. The sample composition encompassed 156 respondents hailing from rural areas and 251 from urban areas, resulting in a total of 407 respondents. The questionnaire respondents were predominantly from urban areas, likely due to their better access to technological infrastructure and the Internet, as well as their greater familiarity with online platforms like Google Forms. However, we were able to obtain a representative sample from both rural and urban areas.

To confirm the representativeness of our sample, we used the Sample Size Calculation method (Taherdoost, 2017), which involves determining the minimum sample size required to detect meaningful effects within the population. For the population of Stavropol Territory (2.8 million people), the minimum required number of surveys is 385 to have a confidence level of 95.00%, with the real value within ± 5.00% of the measured value. Our sample size of 407 people meets these criteria. The study maintained a margin of error of 5% for the urban population and 8% for the rural population at a confidence level of 95%. Table 4.2 reports the collected demographic parameters of the participants.

4.3.4 A regional Well-being Index (WBI) via PCA

PCA was used to construct a composite regional WBI to compare the regional well-being in urban and rural areas. PCA identifies the underlying patterns and relationships among the indicators and creates new variables called principal components; the first principal component represents the combination of indicators that explains the most variance in the data. The method of Nicoletti et al. (2008) was used for the construction and weighting of the composite index. This method accounts for factor loadings of the first and subsequent extracted components to weight the composite index, allowing the maximum possible fraction of the total variation to be retained. The method is described in the OECD Guidelines for constructing composite indices after data normalization (OECD, 2008). Since the data have common scale (from 1 to 5), there was no need to standardize the data or transform it to a common range. To interpret and compare the main components

Table 4.2: Sociodemographic parameters of the participants

Parameter	Urban group(n=251)	Rural group(n=156)
Gender		
Male [p]	99 (39.4)	51(32.7)
Female [p]	152(60.6)	105 (67.3)
Age [years]		
30	121(48.2)	60 (38.5)
31-40	29(11.6)	12 (7.7)
41-50	52(20.7)	45 (28.8)
51-60	25(10)	16 (10.3)
>60	24(9.6)	23 (14.1)
Civil status		
Married/—partnership	116(46.2)	91 (58,3)
Single/divorced /widowed	122(48.7)	60 (39.3)
No response	13(5.2)	5 (3.2)
Having children		
yes	134(53.4)	109(69.9)
no	117(46.6)	47 (30.1)
Education		
Incomplete secondary	22(8.8)	13(8.3)
Secondary	32(12.7)	28(17.9)
Upper secondary/vocational training	83(33.1)	59(37.9)
University	101(40.2)	51(32,7)
Postgraduate	13(5.2)	5 (3.2)
Occupation		
Employee	139(55.4)	83(53.2)
Self-employed	33(13.1)	13(8.3)
Working for own Family business	19(7.6)	6(3.8)
Not aplicable	60(23.9)	54(34.6)

Data Source: own elaboration from primary data (ESS survey)

Table 4.3: Result of PCA (extracted components) for the whole sample.

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total (eigenvalue)	% of variance	Cumulative %	Total (eigenvalue)	% of variance	Cumulative %
1	10.01	37.09	37.09	4.44	16.44	16.44
2	2.15	7.98	45.07	4.2	15.56	32
3	1.43	5.31	50.38	3.43	12.7	44.71
4	1.35	5	55.38	2.88	10.68	55.38

Kaiser-Meyer-Olkin measure of sampling adequacy: 0.93
Bartlett's Test of Sphericity: $x^2 = 5263.27$ df351 Sig.000
Source: own elaboration based on PCA

obtained, the original matrix of factor loading was rotated by the Varimax method, which provides the most explicit conceptual division of indicator loadings into components.

4.4 Results

4.4.1 Composite regional WBI

Table 4.3 presents the PCA analysis results. The total explained variance for survey participants from the urban and rural areas of the Stavropol territory who rated their satisfaction with their resident place of living is 55.4% and defined by four components. The high Kaiser-Meyer-Olkin value of 0.930 (close to 1.0) indicates that the PCA is valid for the selected set of data; the results of Bartlett's Test of Sphericity also exceed the minimum acceptable value (less than 0.05). The choice of the number of extracted components was based on the Kaiser rule (the number of PCs with an eigenvalue less than unity should not be taken into consideration and extracted).

The analysis of the component matrix loadings (Table 4.4) made it possible to divide the existing set of indicators into four groups based on what the main component cares about as the maximum load on the variable. The first principal component, which explains 67% of the total variance (Table 4.4), is highly correlated with eight indicators related to the socio-economic issues. Thus this component 'Society & Economy.' The second group includes seven indicators on 'Ecology &Security.' The third consists of five indicators for 'Society & Communication,' and the last group consists of four indicators for 'Human Capital & Opportunities.'

Table 4.5 describes the steps for deriving the final weights based on the squared factor loading matrix scaled to the unity sum and the weight for each component. The sum of the obtained average weights is taken as 100%, and the new final weights are calculated.

Table 4.4: Rotated component loadings for individual indicators based on PCA

	Extracted Component				Squared factor loading			
	1	2	3	4	1	2	3	4
All my relatives live here	0.1	0.4	0.1	0.1	0	0	0	0
To have a fair chance of getting a job	0.2	0.1	0.2	**0.8**	0	0	0	**0.3**
To be rich and have money and expensive things	0.1	0.1	0.2	**0.8**	0	0	0	**0.3**
Tax authorities give special advantages	**0.6**	0.3	0	0.3	**0.1**	0	0	0
Good care for nature and the environment	0	**0.6**	0.2	0.3	0	**0.1**	0	0
To have a fair chance of achieving a high level of education	0.3	0.2	0.2	**0.5**	0	0	0	**0.2**
Most people are friendly and can be trusted	0.2	**0.6**	0.1	0.2	0	0.1	0	0
To live in secure and safe surroundings	0.2	**0.7**	0.3	0.1	0	0.2	0	0
Good provision of health care	0.3	0.3	0.1	**0.6**	0	0	0	**0.2**
Good provision of social benefits and services	**0.7**	0.4	0	0.3	**0.1**	0	0	0
Quality of food	0.2	**0.6**	0.2	0.3	0	0.1	0	0
Water and sanitation	0.1	**0.6**	0.3	0.3	0	0.1	0	0
Housing and living environment	0.1	**0.7**	0.2	0.3	0	0.2	0	0
No harmful toxic production	0.2	**0.7**	0.2	0	0	0.2	0	0
To think new ideas and being creative	0.3	0.4	0.5	0.3	0	0	0	0
To follow traditions and customs	0.2	0.5	0.5	0	0	0	0	0
To have an exciting life	0.1	0.3	**0.8**	0.2	0	0	**0.3**	0
Good transport system	0.3	0.1	**0.5**	0.3	0	0	**0.1**	0
Social life and social activities around here	0.3	0.2	**0.6**	0.2	0	0	**0.2**	0
Possibility to exercise and maintain good physical shape	0	0.2	**0.8**	0.2	0	0	**0.3**	0
Good standard of living for unemployed individuals	**0.8**	0.1	0.2	0.1	**0.2**	0	0	0
Good standard of living for pensioners	**0.8**	0	0.2	0.1	**0.2**	0	0	0
Provision of affordable childcare services for working parents	**0.5**	0.3	0.4	0.1	**0.1**	0	0	0
Social benefits/services	**0.7**	0.3	0.2	0.2	**0.1**	0	0	0
The government takes into account the interests of all citizens	**0.6**	0.2	0.2	0.3	**0.1**	0	0	0
Provision of the internet on different devices sas computer, tablets and smartphonesuch	0.2	0.2	**0.6**	0	0	0	**0.2**	0
Care about climate change	**0.6**	0	0.1	0.1	**0.1**	0	0	0
Total eigenvalue	10	2.2	1.4	1.4				
Proportion of variance	0.7	0.1	0.1	0.1				

Note: Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 6 iterations.
Loadings >0.5 (absolute values) are indicated in bold
Source: own elaboration based on PCA Extraction method
Variable selected from European Social Service, Round 3 and 4 (ESS, 2024)

Table 4.5: Assigned weights for indicators as determined by the PCA

	Domain weight	Weight score
Component 1: Society & Economy (Tot. var = 0.67)		
Tax authorities give special advantages	0.09	0.06
Good provision of social benefits and services	0.12	0.08
Good standard of living for unemployed individuals	0.18	0.12
Good standard of living for pensioners	0.17	0.11
Provision of affordable childcare services for working parents	0.08	0.05
Social benefits/services	0.14	0.09
The government takes into account the interests of all citizens	0.11	0.07
Care about climate change	0.11	0.07
Component 2: Ecology & Security (Tot. var = 0.14)		
Good care for nature and the environment	0.13	0.02
Most people are friendly and can be trusted	0.14	0.02
To live in secure and safe surroundings	0.16	0.02
Quality of food	0.12	0.02
Water and sanitation	0.13	0.02
Housing and living environment	0.16	0.02
No harmful toxic production	0.16	0.02
Component 3: Society & Communication (Tot. var = 0.10)		
To have an exciting life	0.26	0.03
Good transport system	0.12	0.01
Social life and social activities around here	0.18	0.02
Possibility to exercise and maintain good physical shape	0.28	0.03
Provision of the internet on different devices such as computer tablets and smartphones	0.16	0.02
Component 4: Human capital & opportunities (Tot. var = 0. 09)		
To have a fair chance of getting a job	0.33	0.03
To be rich and have money and expensive things	0.34	0.03
To have a fair chance of achieving a high level of education	0.15	0.01
Good provision of health care	0.18	0.02

Note: Tot. var = total variance.

Source: own elaboration based on factor loadings

Table 4.6: Reliability scale analysis α

Rotated components	Cronbach's alpha
1. Society & Economy (n=8)	0.86
2. Ecology & Security (n=7)	0.86
3. Society & Communication (n=5)	0.81
4. Human capital & Its Opportunities (n=4)	0.78
All items (n=27)	0.93

Note: $0.9 \leq \alpha. <$ Excellent, $0.8 \leq \alpha < 0.9$ Good, $0.7 \leq \alpha < 0.8$ Acceptable
Source: own elaboration based on cronbach's alpha reliability test

4.4.2 Analysis of reliability and aggregation

The value for the Cronbach's alpha for the entire survey, which consists of 27 items, was $\alpha = 0.93$. All calculations of Cronbach's alpha for each of the four sub-scale components were within two acceptable range limits, namely, $0.8 \leq \alpha \leq 0.9$, demonstrating excellent reliability of the whole scale and good reliability for the sub-scale components (Table 4.6).

4.4.3 Comparison of regional WBI with direct questions on happiness, health, and income

Table 4.7 shows the result of a comparison of the 27 well-being items across urban and rural respondents.

On average, rural residents are more satisfied with the environmental conditions compared with the environmental satisfaction of the urban residents. Despite the generally perceived fact of worse living conditions, the rural citizens feel more comfortable psychologically and safer than the residents. Rural residents are better than urban residents at assessing their family relationships, and adherence to traditions and customs. Safety in rural settlements was slightly higher than in cities. It is likely that the tempo of urban life and the higher expectations of city life trigger inner discomfort, which finds itself in the respondents' answers. Indicators such as financial well-being, access to quality higher education, highly qualified medical care, quality transport infrastructure, and access to Internet technology show a higher result for the urban respondents than the rural ones, and staff qualifications in rural hospitals may differ from their urban counterparts.

For the PCA, the 27 well-being indicator questions were scored from 1 to 5 on an agree-disagree Likert scale . The questionnaire also included direct questions about happiness, income, and health conditions. Figure 4.2 reports the results from the direct questions, which confirms the PCA results. There is no a relevant difference between the well-being of rural and urban areas in the Stavropol Territory.

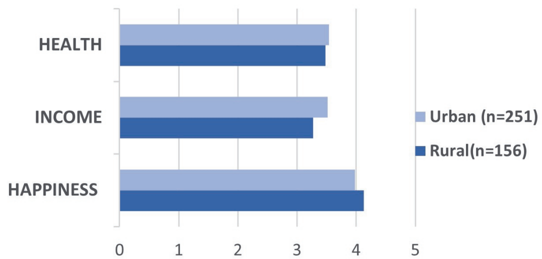
The final stage was the aggregation of each intermediate sub-index with the propor-

Table 4.7: Well-being items according to rural and urban respondents

Variables	Urban (n=251)		Rural (n=156)			
	Mean	Std. dev.	Mean	Std. dev.	Sig.	
All my relatives live here	3.4	1.68	3.9	1.41	0	**
To have a fair chance of getting a job	2.5	1.42	2.2	1.38	0.1	
To be rich, and have money and expensive things	2.5	1.41	2.1	1.29	0.01	**
Tax authorities give special advantages	2	1.38	2.1	1.43	0.2	
Good care for nature and the environment	3.1	1.53	3	1.6	0.56	
To have a fair chance of achieving a high level of education	2.7	1.5	2.4	1.41	0.01	*
Most people are friendly and can be trusted	2.9	1.46	3.2	1.47	0.12	
To live in secure and safe surroundings	3.2	1.44	3.6	1.53	0.01	*
Good provision of health care	2.5	1.36	2.2	1.27	0.02	*
Good provision of social benefits and services	2.4	1.49	2.5	1.51	0.5	
Quality of food	2.9	1.4	3.1	1.46	0.11	
Water and sanitation	3	1.48	3.1	1.44	0.78	
Housing and living environment	3	1.46	3.3	1.42	0.03	*
No harmful toxic production	3	1.58	3.4	1.65	0.03	*
To think of new ideas and be creative	2.8	1.58	2.9	1.6	0.49	
To follow the traditions and customs	3	1.63	3.6	1.54	0	***
To have an exciting life	3	1.52	3.1	1.49	0.55	
Good transport system	3	1.39	2.5	1.47	0	***
Social life and social activities around here	2.7	1.58	2.9	1.47	0.17	
Possibility to exercise and maintain good physical shape	3.5	1.53	3.2	1.62	0.06	
Good standard of living for enemployed individuals	2.2	1.58	2.4	1.44	0.08	
Good standard of leaving for pensioners	1.9	1.47	2.1	1.36	0.24	
Provision of affordable childcare services for working parents	2.6	1.62	3	1.51	0.02	*
Social benefits/services	2.4	1.59	2.5	1.45	0.6	
The government takes into account the interests of all citizens	2.4	1.49	2.6	1.4	0.3	
Provision of the internet on different devices such as computer tablets and smartphones	3.3	1.49	2.9	1.47	0.02	*
Care about climate change	2.1	1.65	2.0	1.38	0.27	

Note: *t-Test: Two -Sample Assuming Equal Variance
t-value <0.05*, t-value <0.01**, t-value <0.001*** significant
Kendall's tau 0.640** Sig. (2-tailed) .000**
Source: own elaboration based on primary data

Figure 4.2: Direct questions' results for the two groups about happiness, income, and health



Note: 0-not satisfied, 5-completely satisfied. Source: own elaboration based on primary data tion of explained variance in the dataset. According to the study's findings, people living in urban and rural areas of the Stavropol Territory are almost equally happy. The WBI is 2.46 for urban areas and 2.54 for rural. The study results still show that the WBI of the rural population is slightly higher than that of the urban population. However, the difference is minor and not statistically significant, disproving our hypothesis of a difference in urban-rural well-being levels.

4.5 Discussion

This study analyses the differences in well-being and living standards between urban and rural areas in the Stavropol Territory of Russia. The objective is to identify potential disparities and the factors that influence residents' overall satisfaction. The findings challenge the initial hypothesis that well-being is higher in urban areas. The research presents an alternative narrative, suggesting that individuals in rural areas experience comparable levels of well-being to their urban counterparts in this specific context.

The findings align with the concept of the 'rural happiness paradox' (Sørensen, 2013; Burger et al., 2020), contrary to the initial hypothesis of higher well-being in urban settings. The results indicate that individuals in rural areas may report similar levels of well-being to their urban counterparts or even experience higher subjective well-being.

It is important to note that individuals who were discontented with their living conditions may have already migrated elsewhere, leaving behind a population content with their rural lifestyle. It is possible, therefore, that the similarity in well-being levels between urban and rural areas is due to a saturation point. This could suggest that the conditions, while not optimal, have reached a point of equilibrium where those dissatisfied with their circumstances have already opted for a different living environment.

In light of these considerations, the study suggests a reevaluation of the relationship between urban and rural well-being in the Stavropol Territory. It confirms the complex and dependent relationship that exists between urban and rural status in the region, which may constrain the well-being of residents regardless of their spatial conditions (Berry and Okulicz-Kozaryn, 2011).

Overall, for the first time, the measurement of well-being, through the creation of a regional WBI, was implemented in the Stavropol Territory. This can be a meaningful contribution to a new perspective on understanding the complex society, such as the one of the Stavropol Territory, based on the analysis of the well-being and spatial conditions of the residents. Considering these research findings, we find that people living in the Stavropol Territory's urban and rural areas are almost equally happy. It is not clear whether the well-being in the rural areas became better and reached the same level as the urban areas because of the efficient state programmers and policies, or because the urban well-being declined compared with the rural well-being level due to the lack of attention to the urban areas. Nevertheless, politicians and local authorities can benefit from these results by exploring targeted interventions to enhance the well-being of urban and rural residents alike. This can be achieved by cultivating partnerships between urban and rural areas, as well as promoting sustainable development throughout the region (UN-Habitat, 2017).

In the study, key indicators were also identified within all dimension groups, which will allow a thorough approach to assessing the well-being and quality of life of the urban and rural areas in general and in certain areas. Rural areas have different characteristics and features: from suburban areas with developed infrastructure to remote places with limited access to services. Despite the generally perceived fact of worse living conditions, the rural citizens feel more comfortable psychologically and safer than the urban ones. Rural residents are better than urban residents at assessing their family relationships (Camfield et al., 2009) and adherence to traditions and customs. Safety in rural settlements was slightly higher than in cities. It is likely that the tempo of urban life and the higher expectations of city life trigger inner discomfort, which finds itself in the respondents' answers. Indicators such as financial well-being, access to quality higher education, highly qualified medical care, quality transport infrastructure, and access to Internet technology show a higher result for the urban respondents than the rural ones. For example, a village is likely to have slow or no Internet. In addition, not every settlement can be connected. Staff qualifications in rural hospitals are also very different from their urban counterparts. These indicators and trends will form the necessary information base for the justification of strategic decisions at the municipal level in developing socio-economic policy aimed at improving the population's life. The grouping of indicators by thematic blocks will guide local public authorities to identify the most priority development directions, identify weaknesses, and eliminate problematic situations. The presented system of indicators is one of their practical tools in managing the sustainable development of territories.

Finally, this study stands to enrich the body of research within the World Database of Happiness (Veenhoven, 2023), potentially shedding light on the region's happiness trends. Despite the extensive global coverage of diverse nations, the representation of Russian regions has been relatively modest. Notably, while neighboring areas like Rostov Oblast and Krasnodar Krai find their place in the database, the Stavropol Territory's absence is conspicuous.

4.6 Conclusion

Based on our research, rural and urban well-being levels are equal in the Stavropol region, showing the state program works but is not entirely successful. Successful implementation of the program on the ground requires the involvement of the population living in these territories. When examining key indicators within all dimensions, there are some areas for improvement. Indicators such as financial well-being, access to quality higher education, transportation infrastructure, highly qualified medical care, and access to Internet technology still show a higher score for urban areas. Contrary to the idea of worse living conditions, rural residents feel more psychologically comfortable and secure than urban residents. They value family relationships more highly, are more attached to traditions, and feel slightly safer in rural settlements than in cities.

The balance between the factors of the well-being studied evolves over time and can easily change with respect to the conditions collected in 2019. In the present post-pandemic context of Russia, there have been significant effects on the country's economy, particularly due to new fiscal pressures (Gould-Davies, 2023). Based on the results of this study, economic indicators may have influenced the perceived well-being of urban residents more, while the perceived well-being of rural residents, which has been influenced more by constant social dynamics (Lyons et al., 2016), may have been less affected.

To investigate this further, future research could use the questionnaire proposed in this study to monitor changes in well-being variables among urban and rural citizens in Russia following recent major shocks. Moreover, by recruiting more participants from more contexts, it is possible to improve the representativeness of the sample and conduct other quantitative analyses complementary to the PCA analysis. Furthermore, socio-economic factors, such as demographic characteristics (gender, age, and education), cultural norms, social networks, and government policies, should be explored in depth. Lastly, to enhance the generalizability of the findings and avoid the limitations of short time frames, future research could conduct longitudinal studies across multiple regions or nations using the same methodology proposed here to identify important similarities and differences between similar or different contexts.

Policymakers and local authorities can consider targeted interventions based on this study's findings and strive to enhance the well-being of both urban and rural residents. Urban areas should not be neglected, and efforts should be made to address factors contributing to declining urban well-being. Fostering partnerships between urban and rural areas can contribute to the sustainable development of the region.

Annex

Study Title: SURVEY ON WELL-BEING FOR RESIDENTS OF THE STAVROPOL TERRITORY (BASED ON EUROPEAN SOCIAL SURVEY)

Researchers: Anastasia Chaplitskaya, Wim Heijman, Johan van Ophem, Wageningen Social Sciences (WASS), Agricultural Economics and Rural Policy (AEP) group and Urban Economics Group in the Netherlands

We're inviting you to take a survey for research. This survey is completely voluntary.

There are no negative consequences if you don't want to take it. If you start the survey, you can always change your mind and stop at any time.

We are conducting the research "Urban-Rural Differences in Well-Being" in the different regions of the Stavropol Territory in Russia. We want test the hypothesis about differences in urban-rural well-being

The information I would like to obtain from you will be used for academic purposes only. Your identity will remain confidential. The results of our research may be published in a scientific journal or presented at a conference. Only group patterns will be described, and your identity will not be revealed.

Agreement to Participate

Your participation is completely voluntary, and you can withdraw at any time.

To take this survey, you must be at least 18 years old

If you meet this criterion and would like to take the survey, click the button below to start.

Thank you for your participation and support!

How happy would you say you are?

- extremely happy
- happier than not
- rather unhappy
- extremely unhappy
- refusal
- don't know

Have you ever thought about changing your place of residence?

- yes
- no
- don't know

Are you an aboriginal of the place where you currently live?

- yes
- no
- don't know

Can you say about yourself that in general, you are doing well in life?

- yes
- no
- don't know

If there is something that you are not satisfied with, from which area of life?

- state of health service
- state of education
- present state of the economy in the region
- employment opportunities
- income
- standard of living
- childcare services
- nature and environment
- safety of life
- migrants resettle
- the threat of a pandemic
- inequality of people
- poor quality food
- transport
- federal government
- regional government
- local government

Gender

- Male
- Female
- No answer

In what year were you born? (enter the year)

Some people choose big cities to live in, at the same time others live happily in small villages. We offer you to assess the living conditions of the area where you live.

Please tell me on a score of 1 to 5, where 1 means you entirely disagree and 5 means that you completely agree.

Which one of the descriptions on this card describe your legal marital status?

- Married
- In a civil partnership
- Separated (still legally married)
- Separated (still in a civil partnership)
- Divorced
- Widowed
- Formerly in civil partnership, now dissolved

	1	2	3	4	5	Don't know
All my relatives live here.						
No possibility of going elsewhere						
Most people are friendly and can be trusted						
To live in secure and safe surroundings						
Social life and social activities around here						
Possibility to exercise and maintain good physical shape						
Provision of affordable childcare services for working parents						
Good provision of health care						
Good transport system						
Good provision of social benefits and services						
The government takes into account the interests of all citizens						
Provision of the Internet on different devices such as computer tablets and smartphones.						
To have a fair chance of achieving a high level of education						
To think of new ideas and be creative						
To follow the traditions and customs						
To have an exciting life						
To have a fair chance of getting a job						
To be rich and have money and expensive things						
Tax authorities give special advantages						
Good standard of living for pensioners						
Good standard of living for unemployed individuals						
Good care for nature and the environment						
Quality of food						
Water and sanitation						
Housing and living environment						
No harmful toxic production						
Care about climate change						

- Formerly in civil partnership, partner died
- Never married and never in civil partnership
- Refusal
- Don' know
- No answer

Have you ever had any children of your own, stepchildren, adopted chil-

dren, foster children or a partner's children living in your household?

- yes
- no
- don't know

What is the highest level of education you have achieved?

- No formal education
- Primary education
- Incomplete high school
- Professional education without secondary education
- Completed secondary school
- Professional education on secondary level
- Special technical education
- Several grades of college with no certificate
- Bachelor degree from college
- Master degree from college
- Completed college by 5-6 grade system
- Post-college education without specific degree
- Scientific degree
- Refusal
- Don't know
- No answer

Which phrase on this card best describes the area where you live?

- A big city (population over 500 000)
- Suburbs or outskirts of big city
- Town or small city (population up to 100 000)
- Village district center
- Village (population up to 3,000)
- Village (population up to 1,000)
- Don't know
- No answer

How long have you lived in this area? (enter the year)

Please consider the income of all household members and any income which may be received by the household as a whole. What is the main source of income in your household?

- Wages or salaries
- Income from self-employment (excluding farming)
- Income from farming

- Pensions
- Unemployment/redundancy benefit
- Any other social benefits or grants
- Income from investments, savings etc.
- Income from other sources
- Refusal
- Don't know
- No answer

Which of the descriptions on this card comes closest to how you feel about your household's income nowadays?

- Living comfortably on present income
- Coping on present income
- Difficult on present income
- Very difficult on present income
- Refusal
- Don't know
- No answer

In your main job are/were you. . . ?

- Employee
- Self-employed
- Working for own family business
- Not applicable
- Refusal
- Don't know
- No answer

How would you describe your state of health in general?

- Very good
- Good
- Quite well
- Bad
- Very bad

How satisfied are you with the way health services in the region have dealt with the coronavirus pandemic and its consequences?

- Completely dissatisfied
- Satisfied
- Completely satisfied
- I don't know

Has any of the following happened to you as a result of the coronavirus pandemic? Please list anything that has happened at any time since the pandemic began, even if it no longer affects you. Select anything that applies.

- I have been fired/ lost my job
- Income from my work has decreased
- My working hours have been reduced
- Has been placed on unpaid leave
- Was forced to take unpaid leave/vacation
- None of this
- I haven't worked since pandemic started

Source: Questionary have been constructed according to European Social Survey on Wellbeing Round 3 and 4, where Russian Federation included

https://www.europeansocialsurvey.org/findings/wellbeing.html

Chapter 5

Rural-Urban Migration in Russia: Prospects and Drivers

Abstract

This study investigates migration flows between urban and rural areas in Russia from 2011 to 2020 and explores potential drivers using a combination of Markov chain and spatial interaction modelling approaches. The findings indicate a high likelihood of rural-to-urban migration, leading to increased urbanization pressure and depopulation of rural areas in the country, further worsened by high mortality and low fertility rates. Socioeconomic and environmental factors, including population size, wages, employment, housing availability, and precipitation, have a significant impact on migration flows, and the effects tend to vary according to whether the origin and destination are rural or urban. In general, origin effects are more pronounced than destination effects, meaning that the decision to migrate in Russia is mainly influenced by departure factors.

Keywords: interregional migration; intraregional migration; spatial econometrics; federal distric.

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5.1 Introduction

Considerable social and economic disparities exist between regions in Russia, particularly between urban and rural areas. Rural areas comprise over 70 percent of the national territory and are home to less than a quarter of the Russian population (approximately 144 million in 2023). Poverty levels are generally one and a half times higher in the countryside than in the cities (Zubarevich, 2019), which are characterized by significantly higher average earnings, as Moscow with an average income 33 percent higher than the rest of Russia (Borison, 2019). In addition, social and employment services are often less efficient in rural settlements, due to their low population density and geographical remoteness (Amini and Nivorozhkin, 2015). These and other differences contribute to social insecurity and the desire for higher living standards (Guriev and Vakulenko, 2015), leading to steady rural depopulation and unbalanced urbanization processes (World Bank, 2024) that undermine the country's economic growth and development (Mareeva, 2020).

Internal migration flows have significant impacts both on origin and destination areas. In rural areas that are the origin of consistent outflows, migration primarily affects the region's agricultural sector (United Nations, 2017; Abdulraheem, 2019) by altering labor availability, land use, innovation, and production techniques. Furthermore, it reduces the efficiency of public and social services (Cañal-Fernández and Álvarez, 2022), which leads to a lower level of regional development (Tacoli et al., 2015; Jia et al., 2017; Vakulenko, 2019). On the contrary, urban residents have generally better access to economic and social opportunities and tend to have greater occupational and geographic mobility (Butler et al., 2002). However, the excessive concentration of migration flows in a few urban areas puts undue pressure on social services, infrastructure, and housing, which can undermine their efficiency (Margolies, 1978; Zhang, 2003; Rodríguez-Pose and von Berlepsch, 2018) and hinder regional development.

Besides internal migratory pressures, other factors like population decline and climate change contribute to the strain. Russia experienced a natural population growth decline of 0.72 percent in 2021, with deaths outnumbering births by 1.04 million. The COVID-19 pandemic exacerbated this situation, resulting in high mortality rates, particularly in metropolitan areas (Nikitin et al., 2023). It has also significantly affected spatial mobility patterns, leading to changing migratory systems (González-Leonardo et al., 2022). In various countries worldwide, there was a migration phenomenon marked by a substantial population shift from urban to rural areas (Fielding and Ishikawa, 2021; Vogiazides and Kawalerowicz, 2022; Rowe et al., 2022). Conversely, climate change is altering the comparative advantage of regions and driving increased migration to urban areas (Adger et al., 2020). This development presents both opportunities and uncertainties, highlighting the need for a cautious yet proactive approach to address the risks and benefits of migration for the economic growth, well-being, and sustainable development of a country (FAO, 2018).

To effectively design and adapt interventions in this regard, it is essential to monitor present and future prospects of migration movements within a country. It is important to recognize where and why people are moving to reduce future costs and facilitate adaptation to economic, social, and climatic changes within and outside national borders. The academic literature currently lacks up-to-date evidence on migration flows in Russia, specifically when distinguishing between rural and urban areas. Additionally, there is insufficient evidence linking current migration to environmental conditions, such as increasing temperatures or changes in rainfall patterns. This study aims to cover these gaps and explore what are the prospects and drivers of migration flows within Russia, considering the rural or urban nature of origin and destination regions.

To achieve this goal, the study incorporates two complementary analyses. Firstly, we provide an overview of the current trends and prospects of migration flows within Russia's federal districts using a Markov chain approach. For this analysis, we obtained the most recent publicly available data from Rosstat on migration flows between rural-to-urban (RU), rural-to-rural (RR), urban-to-rural (UR), and urban-to-urban (UU) areas at the federal district level between 2011 and 2020. We then integrated the database on migration flows with the physical, economic, and social characteristics of each urban and rural area. This resulted in a panel dataset that was analyzed using a spatial interaction regression model to explore the main drivers behind intraregional and interregional migration flows, taking into account both origin and destination effects as well as network spillover effects.

5.2 Literature review

Rural-urban migration is a crucial aspect of demographic transitions and urbanization trends. According to Niva et al. (2023), internal migration has grown rapidly over the past decade and dominates over international migration; the 'urban pull-rural pressure' phenomenon (Jedwab et al., 2017) characterizes it, with a positive net migration in urban areas and a negative net migration in rural areas. However, there is a wide variation in migration rates around the world and the global trend of urban attraction and rural depression may become less consistent when analyzing migration patterns at national and subnational scales. Indeed, it is necessary to conduct (sub)national analyses to better inform policies, encourage national and international cooperation, and promote shared responsibilities in migration management (Niva et al., 2023).

The Russian Federation consist of eight federal districts (Figure 1), which are integral part of the state administration and responsible for the implementation of key strategic goals for the sustainable development (Cherkasov, 2008; Fedorez, 2018). Rural-urban migration patterns in Russia involve movements both within and among federal districts. Before the end of the Soviet Union, there was high inward mobility in the eastern and northern regions, including rural areas; after the collapse of the Soviet Union, the direction

Figure 5.1: Map of Russian Federal Districts illustrated regarding a population (millions of people) and net migration (thousands of people) in 2021.

Source: Own elaboration based on Rosstat data (2021)

has shifted in the opposite direction (Kalamanov, 2003), concentrating in western and metropolitan areas, specifically within the Central, Northwestern, and Southern Federal Districts. Since then, the rural population of Russia has gradually declined (Mkrtchyan, 2019), losing about 3.7 million people (World Bank, 2024). However, the decline of the rural population has recently slowed due to markedly positive rural migration in some districts (Niva et al., 2023). Our paper analyzes these flows in more detail, examining the extent of the 'urban pull-rural pressure' phenomenon among Russian federal districts, and explores what social, economic, demographic, and environmental factors may influence them.

There is substantial academic literature investigating the socio-economic and demographic factors affecting migration flows within a country. Firstly, population size plays a key role in shaping migration patterns. A larger population in the origin region is expected to positively influence migration flows by increasing the likelihood of migration, while regions with larger populations act as magnets for migrants due to their greater demand for goods and services, leading to more robust labor markets and attracting individuals and businesses from other areas (Lewer and Van den Berg, 2008). Another principal stimulus for migration is the scarcity of economic prospects; individuals strive for improved job opportunities, wages, and living standards in the destination areas (Vakulenko, 2019; Zhang and Song, 2003, 2011). Wage levels and unemployment rates are often used as indicators to assess the economic well-being and labor market conditions within a region.

A destination region's appeal is expected to rise with higher wage levels and a decrease in unemployment rates (Anderson et al., 2003); as for the origin size, higher wage levels might both disincentive out-migration and potentially increase the number of people who can afford migration, making its impact on the origin region ambiguous (Sardadvara and Vakulenko, 2020). In the case of the unemployment rate, it is likely to be positively associated with out-migration. Additionally, Lewer (2008) suggests including in migration analysis how well destination and source regions respectively provide housing stock, as the availability of housing can be a significant factor in attracting or repelling migrants. Finally, there are also evidences for which migration patterns are related to environmental conditions (Backhause, 2015; Tol, 2017), such as rising temperatures or changes in rainfall patterns, which especially affects rural areas where, for example, recurrent droughts can lead to a decrease in productive farmland.

Several authors have analyzed distinct aspects of migration flows in the Russian Federation. The empirical study by Guriev and Vakulenko (2015) examines the barriers to labor mobility and the geographical poverty traps resulting from the intra-country movements. Examining net region-to-region migration flows in Russia from 1996 to 2010, the authors identify a lack of affordable housing, poor infrastructure and difficulty finding a job in the destination region among the factors limiting labor mobility. The study concludes by emphasizing how internal migration can help break these poverty traps and promote interregional convergence in the country. Recently, Makhotaeva and Nikolaev (2023) demonstrate the significant influence that socio-economic factors have on the migration behavior of highly skilled specialists, resulting in a favorable impact on the economic progress of both the regions from which they depart and those to which they relocate. As Tacoli (2015), Abdulraheem (2019), and Makhotaeva and Nikolaev (2023) have highlighted enhanced education access and improved healthcare accessibility stand out as the primary factors driving young people from rural to urban regions. Accordingly, Kovanova (2018) suggests that rural areas are more likely to be populated by older, less educated or married people (Cuadrado-Roura, 2001) than younger people, especially those who are educated, unmarried or not interested in the agricultural sector and do not consider starting a household farm as an easy job. Moreover, women demonstrate a greater inclination to migrate than men (Bednaříková et al., 2016). Finally, examining migration movements between 1998-2010, Sardadvara and Vakulenko (2020) indicate that it is easier to understand migration patterns in Russia by acknowledging the existence of different regions of origin and destination, specifically the West (Europe) and East (Asia) regions, according to previous evidence (Sardadvar and Vakulenko, 2016). The same authors also suggested estimating and interpreting internal migration movements in Russia, considering network effects, including social ties and information flows. These factors notably affect migration patterns in Russia and refine the accuracy of the analysis, yielding policymakers with enhanced understanding of mobility-related factors.

In terms of methods, the study of migration processes has gained importance since the beginning of the 20th century, when population movements within and between countries increased (Korepina, 2017); since then, different approaches and methodologies have been developed on the topic. One of the well-established approaches in the literature is the Markov chain theory; based on a stochastic approach, Markov chains illustrate a system's development over time contingent on the previous epoch's state (Bertsekas et al., 1996). In the migration domain, chains result in trends depicting flow of individuals between areas over time, influenced by their previous movements. This article applies the Markov chain approach to reveal current trends in internal (rural-urban) migration flows in Russia, emphasizing patterns and dynamics. However, this approach does not provide any information on the factors driving the migration trends. Thus, to complete the descriptive analysis of Markov chains, a complementary analysis is needed to deepen the knowledge of the emerging prospects by exploring possible drivers. For this purpose, two main strands of literature exist.

The first one uses the well-established gravity model approach (Poot, et al., 2016). These models, based on the principles of Newton's law of gravity, assume that flows between two regions are directly proportional to their size (economic or demographic) and inversely proportional to the distance between them (Todaro and Smith, 2011; Ramos, 2016). The gravity models are then extended with variables related to different attracting and pushing factors of migration. Nevertheless, such models neglect spatial relationships among different observations, which are instead considered by spatial econometrics (LeSage and Pace, 2008).

In this second strand (see LeSage 2008 for a comprehensive overview of spatial econometric models and methods), the analysis recognizes that the value of a variable in one location may be influenced by the values of the same variable in neighboring locations. Spatial interaction models (LeSage and Fisher, 2016) extend the traditional gravity model by using spatial connectivity matrices for origins and destinations to account for the spatial spillovers from neighboring regions. Thus, these models clarify the intricate interplay of factors and spatial dependencies in migration processes through multiple effects. Origin effects refer to the influence of characteristics or attributes of the origin location on the flow between two regions. Destination effects are the attributes of the destination location that influence the interaction between regions. Network origin and destination effects involve the influence of network structures at the origin and destination, respectively, on migration between locations. Finally, intra-regional effects can also be isolated, highlighting the internal dynamics and interactions within the same region.

Spatial panel models have recently also gained popularity due to the increasing availability of datasets that track different spatial units over time. Panel data provides greater opportunities for research modelling compared to single-equation cross-sectional data. It is typically more informative, exhibiting reduced collinearity between variables and more variation. Using panel data allows for greater degrees of freedom, which enhances estimation efficiency and enables more sophisticated behavioral hypotheses. In this paper, we investigated potential drivers for the trends outlined by the Markov chains, alongside a ten-year panel-based spatial interaction model as described in the next section.

5.3 Material and methods

5.3.1 Data collection

To attain our research goals, we gathered data on migration flows and constructed a so-called Tally matrix for each year of the time frame (T) of 2011 to 2020 [1] (Table S1 in the Supplementary Information provides an overview of the available data) . The off-diagonal elements x_{ij} in a Tally matrix represents the mean number of persons who migrated from place i to place j at time t; whereas the diagonal elements of the matrix represent those persons who continued to live in the same region, including persons who moved within the same region (intra-regional migration). The Rosstat publicly shares migration statistics that distinguish between rural and urban origins and destinations across each Federal District. Based on this data, each of the eight federal districts is figuratively split into a rural (e.g., Rural Central Federal District) and an urban region (e.g., Urban Central Federal District) and we developed ten matrices detailing within and between movements of people among 16 regions (n=16). Given this feature, migration flows can be of four types: rural to rural (RR), rural to urban (RU), urban to rural (UR), and urban to urban (UU). Furthermore, migratory flows can be differentiated between interregional (from region i to region j) and intraregional (within the same region i) population movements. To complete the needs of the Markov chain analysis, we also collected the births of the last year (i.e., 2020) and the deaths of the first year (i.e., 2011).

Moving on to the needs of the spatial regression analysis, we constructed a panel dataset. The migration flows from the Tally matrices, excluding residents who did not move (reported in the diagonals), are organized in a destination-centric order according to LeSage and Fisher (2016). The first n rows represent all flows to i = 1 from origin j = 1,2,...,16 for the first year, the rows from n+1 to i = 2 from j = 1,2,...,16, and so on for the same year. This pattern repeats for each subsequent years. Next, for each year, we collected and added the explanatory variables for urban or rural region.

As explanatory variables, the panel dataset includes key indicators that capture the economic, social, and environmental conditions of each region, representing both attractive and/or hindering forces. The socioeconomic and environmental factors selected in this study encompass the primary determinants of migration choices recognized in the academic literature and for which data are available at the urban-rural Federal District

[1] Although the current federal districts in Russia were established in 2000, there were significant changes in the statistics in 2010 (Rosstat). Thus, the comparability of data for previous years is compromised, and for this reason, our data collection begins from 2011.

Table 5.1: Descriptive statistics

		Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
	Total flows (people)	48.00	1060.00	2836.00	15340.00	10060.00	410180.00
	Total population (mln people)	143.05	143.67	146.41	145.63	146.78	146.88
Rural	Population (1000 p)	1504.00	2285.00	4925.00	4736.00	6164.00	8625.00
	RR flows (people)	48.00	458.50	905.50	5833.70	2119.20	93716.00
	RU flows (people)	207.00	1344.00	2488.00	14612.00	5917.00	205036.00
	Wage (RUB, 2020 price)	17071.00	23782.00	27629.00	32468.00	32790.00	86088.00
	Unemployment rate (%)	4.60	5.83	7.55	8.13	9.70	17.50
	Housing availability (mln m2)	34.00	69.25	109.50	120.99	143.50	255.00
	Air temperature (°C)	-16.90	-5.13	2.10	1.46	7.14	12.75
	Precipitation (mm)	19.00	40.00	48.50	49.01	57.38	82.50
	Weighted air temperature	-0.27	-0.09	0.04	0.09	0.33	0.53
	Weighted precipitation	0.32	0.84	1.53	1.63	2.22	3.95
Urban	Population (1000 p)	4670.00	8003.00	10904.00	13525.00	15832.00	32454.00
	UR flows (people)	164.00	1169.00	2712.00	12369.00	5583.00	169885.00
	UU flows (people)	895.00	5292.00	10868.00	28545.00	22616.00	410180.00
	Wage (RUB, 2020 price)	31159.00	38952.00	44549.00	49754.00	57346.00	86088.00
	Unemployment rate (%)	2.60	4.10	5.20	5.48	6.03	12.30
	Housing availability (mln m2)	34.00	182.20	273.00	327.40	372.80	898.00
	Air temperature (°C)	-16.90	-3.08	3.05	2.47	8.88	12.75
	Precipitation (mm)	19.00	40.00	48.50	49.70	58.50	82.50
	Weighted air temperature	-1.15	-0.20	0.33	0.29	0.67	2.05
	Weighted precipitation	1.00	2.01	4.04	4.92	5.24	18.10

Note: mln = million; RUB = Ruble currency; m2 = meter squared; °C = Celsius degree; mm = millimetres.

Source: Federal State Statistic Service (period 2011-2020)

level. These include population, average wage (adjusted for constant 2020 prices), unemployment rate, and housing availability (measured as residential building area in square meters per capita). Regarding potential environmental effects, we followed the approach proposed by Dell et al. (2014) to incorporate population weights into climate data to provide a more accurate understanding of how climate variations affect people within a specific region. All data were collected from Rosstat's Annual Russian Statistical Book, except for wages for urban areas, which are available through the annual Rosstat's collection 'Regions of Russia. Main Socio-Economic Indicators of Cities'. Table 5.1 presents the descriptive statistics of the dataset, which includes 2816 observations for ten years and seven explanatory variables. Data management and analysis were performed using R-software (version 4.2.3).

5.3.2 Markov chain

This study analyzes migration patterns within the country by utilizing Markov chain theory and estimating a non-stationary transition matrix, as proposed by Hierro and

Maza (2009), to account for changes in intra-distribution dynamics over time. We began by taking the average of two consecutive Tally matrices outlined in the preceding section, resulting in a sequence of nine transition count matrices. Next, we accommodated the birth and death processes. Following Collins (1975), we arranged the sample population of births and deaths alongside the original transition count matrices by adding the births of the most recent year as the bottom row and deaths of the prior year as the additional right-hand column. Thus, the transition count matrices are a square (17x17) matrix. To complete the matrices, we assigned the bottom right box, defined as the reservoir acting as a source of potential inputs and outputs from the system, a value such that the average of the Russian population was 145.6 million people. As reported and demonstrated by Collins (1975), any considerable number in the reservoir is sufficient and does not affect the final prediction of the model.

After the construction of these matrices, we computed the probabilities of moving from one location to another and constructed the sequence of transition probability matrices $P(t_{2011}, t_{2012}), P(t_{2012}, t_{2013}), \ldots, P(t_{2019}, t_{2020})$. The elements of P-matrices represent the probability of transitioning from state i to state j for a single time step, and the rows of P sum to 1. According to Hierro and Maza (2009), based on the Chapman-Kolmogorov equation, the non-stationary transition matrix $P(t_{2011}, t_{2020})$ is equivalent to the product of all yearly transition matrices.

Once the non-stationary transition matrix was estimated, we constructed a Markov chain (Casella & Berger, 2002) by multiplying the initial state of the systems (referring to the state of the system in 2011) with each successive power of the initial transition matrix. In our case, the new vectors refer to the expected distribution of the Russian population among rural and urban territories for the state systems in 2011, 2021, 2031, and so on.

5.3.3 A spatial interaction regression model

A spatial interaction regression model is implemented to explore and clarify the underlying drivers explaining the dynamics of migration flows as described by the Markov chains, considering the spillover effects that one region may have on the surrounding or nearby regions. We modeled the spatial interaction of endogenous and exogenous variables using the model proposed by LeSage and Fisher (2016) as applied in a similar panel form by Sardadvar and Vakulenko (2020):

$$\begin{aligned} M = \alpha + \iota + \widetilde{X}_O\beta_O + \widetilde{X}_D\beta_D + X_I\beta_I + \\ + W_oM\rho_o + W_dM\rho_d + W_O\widetilde{X}_O\theta_O + W_D\widetilde{X}_D\theta_D + \varepsilon \end{aligned} \tag{1}$$

The dependent variable M of stacked annual flows is represented by a $n^2T \times 1$ vector assuming a destination-centric organization. The $(n^2 \times 1)$ vectors α and ι represent the stacked vectors of pairwise and time fixed effects, respectively. Next, defining X as the $(nT \times k)$ matrix of k(=6) characteristics for each region and year, we constructed the $X_O = \iota_n \otimes X$ and $X_D = X \otimes \iota_n$ matrices, sized $n^2T \times k$, using the $(n \times 1)$ identity vector ι_n to create a matrix of characteristics associated with each origin (destination) region. To isolate the intraregional effects, we then computed the $n^2T \times k$ matrices for the origin and destination region as $\widetilde{X}_O = (X_O - X_I)$ and $\widetilde{X}_D = (X_D - X_I)$, respectively; these matrices exclude the values of the explanatory variables where the origin and destination regions are identical (i.e., intraregional migration), which are instead isolated in the $n^2T \times k$ matrix X_I. Based on this framework, the β_O, β_D, and $\beta_I(k \times 1)$ vectors represent the coefficients associated with the origin, destination, and intraregional effects, respectively.

Endogenous spatial interactions are modelled as $\rho_o W_o M$ and $\rho_d W_d M$. This type of interaction refers to situations where feedback on flow magnitudes from neighboring regions of origin and destination leads to a reaction (LeSage and Pace, 2008). To quantify the spatial relationships that exist among the features in the dataset, we defined contiguity $n \times n$ spatial weights matrix W based on whether two regions share a common border. Having divided a federal district into an urban and a rural region, we assumed that these two spatial units are contiguous with each other and share the same federal district boundaries; diagonal elements of W are instead set to zero to prevent self-contiguity. The matrix is then row-standardized, such that the sum of the weights is equal to 1, allowing the spatial lag to be interpreted as a weighted average of the neighboring features. Finally, the W is expanded based on the relationships between dependent and explanatory variables to $W_o = W \otimes I_{nT}$ and $W_D = I_{nT} \otimes W$, with I_{nT} being an $nT \times nT$ identity matrix. The ρ_O and ρ_D are the coefficients associated with origin-based and destination-based dependence, respectively. Similarly, spatial lags of the endogenous variable are modelled as $W_O\widetilde{X}_O$ and $W_D\widetilde{X}_D$. These specifications indicate the spatial spillover impacts of neighboring source and destination regions, acknowledging that a change in the characteristics of a neighboring region could affect the magnitude of flows between regions. The θ_O and $\theta_D(k \times 1)$ vectors represent the coefficients associated with the network origin and destination effects, respectively.

Both the dependent and independent variables are taken as logs to directly interpret the coefficients as elasticities. The estimation is based on maximum likelihood assuming a Poisson distribution feasible for migration flows as they are counted (LeSage and Pace, 2009). Equation 1[2] is used to estimate five specifications to take account of the fact that rural and urban regions may differ; the first estimate relates to all observations, while the remaining ones relate only to specific types of migration (UU, UR, RU, or RR). The

[2]Using likelihood-ratio (LR) tests (LeSage and Pace, 2008), we compared restricted versions of the Equation 1 assuming: (i) $\rho_o = \rho_d = 0$; (ii) $\theta_o = \theta_d = 0$; or (iii) $\rho_o = \rho_d = \theta_o = \theta_d = 0$. Table S2 displays the log-likelihood values, alongside an LR test of the imposed restrictions for each model versus the unrestricted one. Equation 1 dominates all other versions of the model, exhibiting significant lower likelihoods.

Table 5.2: Results for the contiguity spatial interaction specification

Year	Rural								Urban								Total
	Central	North West	South	North Caucasus	Volga	Ural	Siberian	Far Eastern	Central	North West	South	North Caucasus	Volga	Ural	Siberian	Far Eastern	Russia
2011	7.1 (5.0%)	2.2 (1.6%)	5.2 (3.6%)	4.8 (3.4%)	8.7 (6.1%)	2.4 (1.7%)	4.6 (3.2%)	2.4 (1.7%)	31.3 (21.9%)	11.4 (8.0%)	8.7 (6.1%)	4.6 (3.3%)	21.2 (14.8%)	9.7 (6.8%)	12.6 (8.8%)	6.0 (4.2%)	142.9 (100%)
2021	5.3 (3.8%)	2.0 (1.5%)	5.2 (3.7%)	5.5 (3.9%)	6.9 (4.9%)	2.1 (1.5%)	3.8 (2.7%)	1.9 (1.4%)	32.8 (23.2%)	12.0 (8.5%)	9.7 (6.9%)	5.5 (3.9%)	20.2 (14.3%)	10.2 (7.3%)	12.2 (8.7%)	5.6 (4.0%)	140.9 (100%)
2031	5.2 (3.7%)	2.1 (1.5%)	5.3 (3.8%)	5.9 (4.2%)	6.5 (4.6%)	2.0 (1.4%)	3.6 (2.6%)	1.8 (1.3%)	33.2 (23.5%)	12.3 (8.7%)	10.2 (7.2%)	6.0 (4.3%)	19.3 (13.7%)	10.3 (7.3%)	11.9 (8.4%)	5.3 (3.7%)	140.9 (100%)
2041	5.2 (3.7%)	2.1 (1.5%)	5.3 (3.8%)	6.0 (4.3%)	6.4 (4.5%)	2.0 (1.4%)	3.6 (2.6%)	1.7 (1.2%)	33.2 (23.6%)	12.3 (8.7%)	10.3 (7.3%)	6.1 (4.3%)	19.2 (13.6%)	10.3 (7.3%)	11.8 (8.4%)	5.2 (3.7%)	140.9 (100%)
2051	5.2 (3.7%)	2.1 (1.5%)	5.3 (3.8%)	6.0 (4.3%)	6.4 (4.5%)	2.0 (1.4%)	3.6 (2.6%)	1.7 (1.2%)	33.3 (23.6%)	12.3 (8.7%)	10.3 (7.3%)	6.1 (4.4%)	19.2 (13.6%)	10.3 (7.3%)	11.8 (8.4%)	5.2 (3.7%)	140.9 (100%)

Source: Own elaboration based on non-stationary Markov chain

analysis was performed via the R package 'fixest' (Berge et al., 2023).

5.4 Results and Discussion

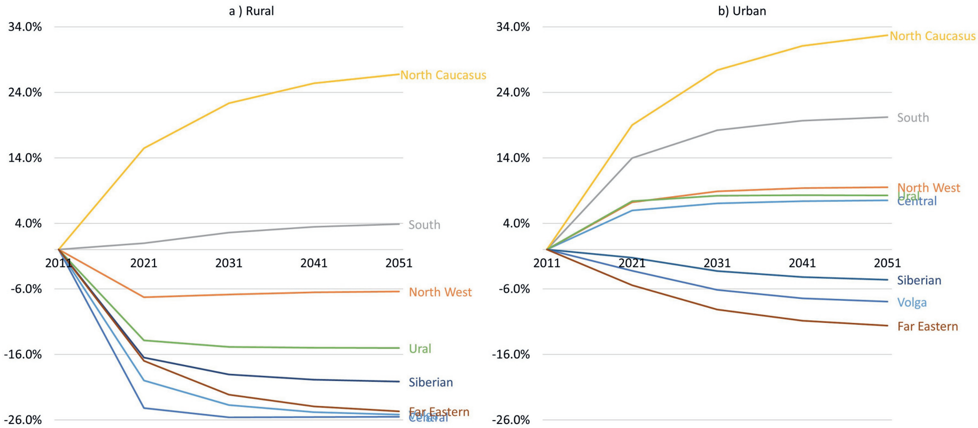
5.4.1 The prospects of rural-urban migration within Russia

Using a Markov chain analysis (section 5.3.2), we examined the internal migration patterns between urban and rural areas in Russia by Federal District. We then projected these trends into the future (until 2051), stressing the current prospects if the patterns remain unchanged. Thus, the results provide insights into which rural and urban areas are currently attracting more people, which are more relatively stable in terms of population, and which are experiencing depopulation trends.

Table 5.2 displays the current migration patterns obtained through Markov chain analysis. We present both absolute and relative values of the urban and rural population across Federal Districts in Russia over time. In terms of absolute figures, the country exhibits a decrease in population due to mortality, with the total population of Russia projected to decrease from 142.9 million in 2011 to 140.9 million in 2051, which is not as negative as the UN estimate of 133 million (UN, 2022). Nevertheless, in relative terms it is evident that the population is becoming more concentrated in urban areas. Figure 5.1 emphasizes this observation by illustrating the relative changes in population distribution compared to the 2011 baseline.

The proportion of individuals residing in rural regions drops across all districts except for the North Caucasus and South, whilst experiencing a surge in all urban areas except for Volga and Siberia. There are different rates of change between rural (Figure 4a) and urban (Figure 4b) areas based on expected interregional migration patterns. Among rural regions, the Central district shows the highest rate of change, with a 25.5 percent decrease in the share of Russian residents living in this area compared to the 2011 level. On the other hand, Figure 2b illustrates that among the urban areas, the

Figure 5.2: Trends of the change in the distribution of the projected population in Russia from the initial state in 2011 for rural (a) and urban (b) territories.



Source: own elaboration based on non-stationary Markov chain

North Caucasus has the highest rate of change, with a 34 percent increase in the proportion of Russian residents. The chart indicates that positive changes are expected only in the South and North Caucasus regions of both rural and urban areas, in relation to the 2011 figures. As mentioned previously, to gain more insight into these perspectives, we combined the descriptive Markov chain framework with a spatial interaction regression analysis, examining potential drivers for these trends.

5.4.2 Potential drivers of urban-rural migration patterns

The results of the spatial interaction regression analysis for all five specifications are reported in Table 5.3. Recalling both the dependent and independent variables are taken as logs, Table 5.3 presents effect estimates that depict actual partial derivatives, illustrating how migration flows react to alterations in the explanatory variables within the origin and destination regions, own region, and neighboring areas. Given the short period, the results should be interpreted as short-term effects.

From Table 5.3, we can first see that a non-spatial interaction specification of a traditional gravity model would suffer from omitted variable bias due to the exclusion of significant spatial lags. ρ_o is positive and significant in all specifications, indicating a spatial dependence between neighbors at the origin. Thus, migration flows in a given origin, whether urban or rural, are affected by the magnitude of migration in locations close to the origin. In contrast, the spatial autoregression of the destination shows non-significant effects.

Table 5.3: Results for the contiguity spatial interaction specification

Model:	All regions	Urban to Urban	Urban to Rural	Rural to Urban	Rural to Rural
d	0.00 (0.01)	0.01 (0.03)	0.03 (0.02)	0.01 (0.01)	-0.01 (0.03)
o	0.78*** (0.03)	0.58*** (0.09)	0.82*** (0.03)	0.94*** (0.07)	0.32*** (0.08)
Origin effects					
Population	0.51*** (0.11)	0.22 (0.18)	0.31** (0.14)	0.84*** (0.08)	0.70*** (0.13)
Wage	-0.34*** (0.10)	0.33** (0.15)	-0.02 (0.14)	-0.46** (0.21)	0.21** (0.10)
Unemployment rate	0.26*** (0.10)	0.60*** (0.22)	0.23** (0.10)	0.31*** (0.11)	-0.01 (0.11)
Housing	0.09* (0.07)	0.10 (0.13)	0.01 (0.07)	0.22* (0.13)	0.08 (0.07)
Temperature	0.06 (0.09)	0.07 (0.11)	-0.01 (0.06)	0.18 (0.25)	-0.10 (0.22)
Precipitation	0.06* (0.03)	0.08* (0.04)	0.07*** (0.03)	-0.04 (0.06)	0.01 (0.06)
Destination effects					
Population	0.04 (0.06)	0.30** (0.15)	0.04 (0.06)	0.07 (0.09)	0.42*** (0.11)
Wage	0.17 (0.11)	0.13 (0.11)	-0.02 (0.09)	-0.01 (0.14)	0.21 (0.15)
Unemployment rate	0.03 (0.04)	-0.11 (0.14)	-0.08*** (0.03)	0.08 (0.08)	-0.07 (0.13)
Housing	0.11*** (0.04)	0.12** (0.06)	-0.03 (0.07)	0.19 (0.15)	0.01 (0.04)
Temperature	-0.01 (0.06)	-0.06 (0.07)	-0.17 (0.19)	-0.02 (0.06)	-0.12 (0.22)
Precipitation	-0.02 (0.02)	0.03 (0.03)	-0.07 (0.03)	0.04* (0.02)	0.00 (0.07)
Intraregional effects					
Population	0.52*** (0.14)	0.30 (0.24)			0.90*** (0.17)
Wage	-0.22 (0.13)	0.19 (0.18)			0.25*** (0.08)
Unemployment rate	0.35*** (0.07)	0.61*** (0.16)			0.04 (0.14)
Housing	-0.06 (0.07)	-0.08 (0.07)			0.06 (0.06)
Temperature	0.02 (0.11)	-0.02 (0.13)			-0.07 (0.27)
Precipitation	0.04 (0.04)	0.07 (0.07)			0.03 (0.08)
Network origin effects					
Population	-0.57** (0.26)	-0.07 (0.32)	-0.5292	-0.82*** (0.19)	-0.55*** (0.15)
Wage	1.16** (0.50)	0.62*** (0.12)	0.12 (0.23)	0.74* (0.41)	0.24 (0.44)
Unemployment rate	-0.29 (0.29)	0.07 (0.47)	0.02 (0.44)	-0.53** (0.21)	-0.32 (0.21)
Housing	-0.07 (0.23)	-0.0084	-0.04 (0.08)	-0.10 (0.08)	-0.09 (0.08)
Temperature	-0.04 (0.17)	-0.09 (0.12)	0.03 (0.13)	0.07 (0.32)	-0.33 (0.53)
Precipitation	-0.03 (0.06)	-0.06 (0.07)	-0.12** (0.06)	0.10 (0.09)	-0.08 (0.13)
Network destination effects					
Population	0.02 (0.03)	-0.07*** (0.02)	-0.14 (0.09)	-0.03 (0.07)	0.00 (0.04)
Wage	-0.03 (0.03)	0.06** (0.03)	0.01 (0.07)	0.04 (0.09)	-0.02 (0.07)
Unemployment rate	-0.02 (0.03)	0.06** (0.03)	0.19*** (0.04)	0.03 (0.06)	0.08 (0.07)
Housing	0.01 (0.07)	0.08*** (0.02)	0.01 (0.04)	0.11*** (0.04)	0.00 (0.04)
Temperature	0.06 (0.04)	0.09 (0.06)	0.13 (0.11)	-0.01 (0.08)	0.07 (0.14)
Precipitation	-0.03 (0.07)	0.07* (0.03)	0.13* (0.07)	-0.02 (0.07)	0.02 (0.04)
Model characteristics					
Observations	2,560	640	640	640	640
(Within) R-squared	0.49	0.39	0.64	0.69	0.52

Note: Clustered (Years) standard-errors in parentheses; Significance codes: ***: 0.01, **: 0.07, *: 0.1

Sorce: own elaboration based on spatial regression analysis

Next, we see that a larger region of origin in terms of population leads to an increase in migration flows in all specifications except when people move between urban areas of different federal districts (UU). The same can be said for larger destinations, when people move between urban (UU) or rural (RR) areas of different federal districts. The positive and significant population coefficients are consistent with expectations; a larger population may increase the likelihood of migration at origin or indicate a more attractive destination with more job opportunities, better infrastructure and services, and a more vibrant economy (Lewer and Van den Berg, 2008). The intraregional effects of population are also positive for all regions and RR specifications, suggesting more intraregional flows for larger (rural) federal districts area, which makes intuitive sense (LeSage and Fischer, 2014; Sardavar and Vakulenko, 2020). Regarding the network effects, spatial spillovers from the larger regions neighboring the source and destination regions are negative when significant, i.e., in all specifications except for the UU for origin network effects and the opposite for destination network effects. A negative coefficient for regions close to the origin or destination means that an increase in population in neighboring regions decreases flows from origin to destination, perhaps because migrants take the opportunity to travel shorter distances or because the destination becomes less attractive, suggesting a destination competition effect associated with larger urban areas (Sardavar and Vakulenko, 2020).

Regarding wages, the models show significant different behavior depending on whether the origin wage is referred to. The wage coefficients are positive, significant in the RR and UU models, and negative in the RU and All regions' specifications. When people move between the same type of area (rural or urban) of different federal districts, an increase in wages in the origin location increases migration flows. One of the possible explanations is that higher wages in the origin location may indicate a growing economy and higher living standards, which lead to an increase in the cost of living and make it more difficult for some people to afford to live there. In this case, migration from the place of origin may be a way for people to seek more affordable living conditions elsewhere. When the coefficient is negative, it suggests instead that higher wage levels in the origin discourage migration flows, especially those from rural to urban areas; individuals seem to be less likely to migrate, possibly due to the availability of suitable employment and good income prospects in their local communities. A correlation observed also in Zhang (2003), Zhang and Song (2011), and Jia (2017). Intra-regional effects are also positive and statistically significant in the overall and RR specification, suggesting more intra-regional movement with higher wages, especially between rural areas of the same federal district. The positive origin spillover effects of wages indicate a competitive influence, i.e., higher wages in neighboring regions stimulate increased migration from the origin regions, except for migration to rural areas. On the other hand, an urban destination becomes less attractive when higher wages are available in neighboring regions, as suggested also in Vakulenko (2019).

For the unemployment rate variable, an increase in the proportion of unemployment would increase outflows from the origin, except for RR movements, playing the role of pull-factor and suggesting that migration can be a response to a lack of employment opportunities (OECD, 2023). On the destination side, movements from urban to rural areas are negatively correlated with a higher unemployment rate in the rural destination region. As in the case of larger rural regions, the effect of unemployment on within region migration flows is positive; note that population and unemployment are the only variables displaying statistically significant intraregional effects. The effects of higher unemployment rates relative to neighboring regions is negative and significant only in the RU specification, meaning that inflows from neighboring regions would be smaller in this case. In contrast, the effects of higher unemployment rates in the neighboring regions of the destination are positive and significant in the case of urban origins, suggesting a greater inflow to destination regions (urban or rural) that have neighbors with fewer job opportunities.

Overall, housing availability has positive and significant effects on origin and destination, as well as in the RU specification for origin effects and in the UU specification for destination effects. An increase in the housing availability in the destination (urban) locations would therefore, as expected, increase the migration flows to this region. Conversely, a positive origin effect could be due to previous population losses, as motivated by Sardavar and Vakulenko (2020), who found the same evidence as we do here. The effect of housing availability on migration flows within the same region is not significantly different from zero, suggesting that the retention and competition effects are offsetting (LeSage and Fischer, 2014). The spillover effect of more housing availability in regions neighboring the origin is negative but significant only in the UU specification, suggesting that inflows from neighboring regions would be lower in this case. Such effect is significant opposite in regions neighboring urban destinations (i.e., in UU or RU specifications), which means that there are more inflows to the destination districts that have neighbors with a higher housing supply.

Regarding the environmental factors, temperature shows insignificant effects, suggesting that it does not influence decisions to move from one place to another. On the contrary, precipitation does in certain circumstances. The origin effects of precipitation are positive and significant in the overall model and in the specifications when the origin is urban, indicating that higher precipitation levels coincide with more significant migration flows. It is possible that heightened rainfall will have adverse repercussions on the economy, infrastructure, and access to clean water, which would stimulate emigration from a given area (Backhause, 2015; Tol, 2017), due to, for instance, floods, landslides, and mudslides (Black et al., 2011; McLeman, 2011). Spatial spillover effects due to rainfall in regions close to the place of origin are negative and significant only in the UR specification, implying a retention effect for urban areas surrounded by those with higher precipitation. On contrary, spatial spillover effects of higher rainfall in the neighboring regions of the destination region is positive and significant for UU and UR specifications, suggesting higher inflow from urban areas to destination regions that has neighboring regions with higher rainfall, a competition effect. Overall, given that these effects estimates are elasticities, we can compare them and observe that origin effects are more important than destination effects. This suggests that the decision to migrate in Russia is mainly influenced by departure factors.

5.5 Conclusions

This study was designed to analyze the prospects and drivers of recent migration flows within Russia, addressing the rural or urban nature of origin and destination regions. We provide insights into the expected rural-urban distribution within Russia's federal districts by mid-century using a Markov chain analysis. The results confirm a general trend of depopulation and urbanization, with the total population decreasing and relatively more people moving to urban areas; only the North Caucasus and Southern Federal Districts show a positive trend for both their rural and urban areas.

We then applied a spatial regression analysis to investigate the plausible causes of these trends, considering origin-destination, intra-regional and spatial spillover effects. The results provide several important insights into the determinants of migration flows in Russia. First, given the importance of spatial dependence between neighboring regions, traditional gravity models would suffer from omitted variable bias if ignoring spatial interactions. Population size, both at origin and destination, tends to increase migration flows. With respect to wages, we identify two main migration trends. Higher wages in rural areas tend to discourage migration from these areas; conversely, in the urban-urban and rural-urban scenarios, higher wages encourage individuals to seek better-paid jobs in urban areas in other federal districts. The unemployment rate also plays a significant role, acting as a push factor in response to a lack of job opportunities. The housing availability also influences migration; in particular, greater housing availability in destination regions encourages migration to those regions. In terms of the environment, temperature does not seem to play a key role, but rainfall can stimulate certain migration flows due to its direct or indirect impacts on the region. The overall results underline the complex interaction of these factors, especially when distinguishing between rural and urban areas, and highlight the predominance of origin factors in influencing migration decisions in Russia.

The generalizability of these results is subject to certain limitations. One main limitation of the study regards the aggregation level of data. Publicly available data on migration flows within Russia, accounting for urban or rural origin and destination, are available at the federal districts level, which made us assume the contiguity matrices of the rural and urban area. Furthermore, it was not possible to assess key demographic attributes of migrants, as gender, age, or education, which literature show a correlation. Regarding the Markov chain analysis, one main limitation concerns the fact that the probability of moving from one region to another is constant over time, which may not be the case. Changes in economic, social, or political conditions may change migration patterns and make them deviate from expected trends based on past data alone. Future research should address these limitations by using alternative data and models that allow for more robust and flexible estimates of migration patterns and drivers. In this respect, much more work needs to be done to determine the influence of alternative destinations on bilateral migration rates, so-called multilateral resistance (Maza et al., 2019).

Decision-makers can benefit from the evidence gathered in this paper to design targeted interventions to support rural areas and address the challenges of urbanization. The South and North Caucasus Federal Districts stand out as the only federal districts where, in contrast to the others, both rural and urban areas are experiencing positive relative population growth. It is also likely, according to our results, that these two neighboring regions are influencing each other through spatial effects. This unique trend calls for policymakers and other stakeholders to examine the factors contributing to this positive outlook and to draw lessons that can be applied in other federal districts, such as successful initiatives to promote balanced population growth between rural and urban areas. By implementing these targeted policies, the government can create employment opportunities, improve living standards, and reduce the pressure on rural residents to migrate to urban areas in search of a better quality of life.

Supplementary Information

Table S2: Log Likelihoods for Alternative Models

Model version	Log-likelihood	Degree of freedom	Critical Value ($\alpha = 0.05$)	p-value
Unrestricted (Eq.1)	-134,218.20	-	-	
$\rho_0 = \rho_d = 0$	-171,072.80	2	5.99	0
$\theta_0 = \theta_d = 0$	-145,959.90	12	21.03	0
$\rho_0 = \rho_d = \theta_0 = \theta_d = 0$	-189,755.00	14	23.68	0

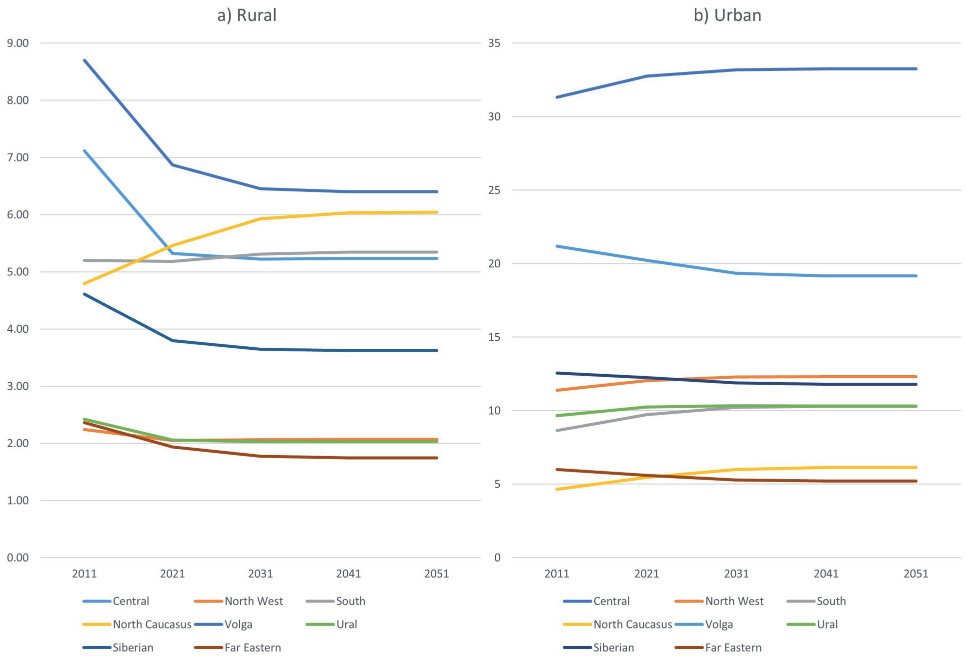
Source: Own elaboration based on spatial econometrics

Table S1: Tally matrix, as the average of movements (expressed in thousands of people) among rural and urban areas of federal districts (2011-2020)

		RURAL								URBAN								Deaths 2011
		Central	North West	South	North Caucasus	Volga	Ural	Siberian	Far Eastern	Central	North West	South	North Caucasus	Volga	Ural	Siberian	Far Eastern	
RURAL	Central	6057.5	1.7	2.6	1.3	2.6	0.4	0.6	0.3	142.3	7.3	3.8	1.3	5.0	2.1	1.8	1.4	129.2
	North West	1.6	1861.1	0.8	0.4	0.9	0.2	0.3	0.1	5.1	57.0	1.2	0.5	2.1	0.8	0.8	0.5	39.1
	South	2.9	0.9	5092.3	3.1	1.3	0.6	0.7	0.4	11.1	4.5	58.2	2.8	2.9	3.3	2.4	1.8	72.9
	North Caucasus	2.0	0.7	3.9	4290.5	0.9	0.4	0.3	0.2	8.9	3.7	6.0	32.3	1.7	5.8	1.9	0.8	41.0
	Volga	4.3	1.3	1.9	0.8	7286.1	1.9	0.6	0.4	17.8	5.7	2.8	0.7	164.7	14.1	2.1	1.3	145.2
	Ural	0.6	0.2	0.9	0.4	1.8	2006.9	0.7	0.1	2.0	1.1	1.2	0.3	2.4	54.9	1.5	0.5	36.7
	Siberian	1.2	0.5	1.5	0.3	0.7	0.9	3865.0	1.0	3.7	2.2	1.9	0.3	1.2	4.4	110.0	3.4	82.4
	Far Eastern	0.5	0.2	0.8	0.2	0.4	0.1	0.9	1977.5	2.1	1.2	1.3	0.2	0.9	0.5	2.2	44.3	22.5
URBAN	Central	130.2	5.2	8.8	5.3	11.0	1.2	2.1	1.3	28080.7	31.6	22.5	9.7	32.1	10.1	11.8	7.6	407.2
	North West	8.0	54.1	4.5	2.3	4.5	0.7	1.3	0.7	35.3	10177.8	11.1	3.7	15.7	5.9	6.8	4.9	150.5
	South	4.8	1.7	46.3	4.3	2.0	0.7	1.0	0.7	31.0	12.3	8498.6	6.6	6.8	5.8	5.2	4.0	117.4
	North Caucasus	2.2	0.9	3.2	23.1	0.7	0.3	0.2	0.2	16.5	5.8	9.2	4189.9	1.9	2.9	1.3	0.9	39.3
	Volga	8.3	3.5	4.1	1.3	136.5	2.2	0.9	0.7	55.1	21.8	9.9	1.8	18591.6	20.2	4.7	3.2	281.4
	Ural	3.2	1.5	5.0	3.4	11.9	44.1	3.0	0.4	17.3	10.1	9.7	2.5	20.0	8681.6	8.1	1.8	117.1
	Siberian	3.7	2.1	5.2	1.5	2.2	1.6	87.5	2.0	22.8	13.6	11.7	1.5	6.0	10.4	11117.4	8.7	182.1
	Far Eastern	2.6	1.5	3.4	0.7	1.4	0.4	3.1	32.7	14.4	10.1	8.9	1.1	4.3	2.3	10.4	5244.9	61.9
Births 2020		51.5	15.2	53.0	71.0	72.1	23.1	44.8	26.1	304.4	112.1	103.8	65.6	197.0	107.8	125.2	64.1	12677.8

Source: Federal State Statistic Service (avarage period 2011-2020)

Figure S1: Markov chain (i.e., to 2051) for absolute values.



Source: own elaboration based on non-stationarity Markov chain

Chapter 6

General Discussion

6.1 Synthesis

The fundamental role of rural areas, including Russia's, in ensuring food security was emphasized in the 1996 World Food Security Declaration. Despite their notable achievements in agriculture, rural regions face the problem of depopulation. Russia's 'Strategy for Achieving Sustainable Rural Growth by 2030' endeavors to address this concern. Rural-to-urban migration in places such as the Stavropol Territory is driven by issues like poverty and environmental degradation, causing a decline in rural populations, as shown in the previous chapter. To support these communities in the face of economic, social and environmental challenges, there's an urgent need to bridge the gap between theoretical ideas and practical implementation (Wegren, 2016). This thesis aims to analyze sustainable rural development, using the Stavropol Territory as a case study due to its economic context, agricultural importance and environmental conditions. The following section summarizes the main answers and findings from the four main research questions (RQ) of this thesis.

Research Question 1: What are the core elements of sustainable regional agricultural development in the Stavropol Territory (Russia), and how can they be integrated into a composite indicator to guide policies for social welfare and sectoral improvement?

As highlighted earlier, rural areas play a crucial role in ensuring national and food security. The conditions necessary for the sustainable development of rural areas are diverse and directly related to the efficient use of resources, improving the welfare of the rural population, and increasing the attractiveness of life in rural areas. A healthy and dynamic agricultural sector is an important foundation of rural development (CSD, 2009). Chapter 2 highlights the assessment of agricultural sustainability in the Stavropol Territory during the period from 2005 to 2014. The evaluation model developed in the study involved the calculation of a composite index (Nicoletti et al., 2000; Gomez-Limon and Riesgo, 2009) of sustainable agricultural development. This index was used to measure the region's progress in terms of several sustainability dimensions, including economic, social, and environmental aspects (Nicoletti et al., 2000; Riesto and Gomes-Limon, 2009; Emelynova et al., 2015).

The composite index for the sustainable agricultural development of the Stavropol territory exhibited changes over the ten-years period under consideration. Noticeable fluctuations can be noticed in the index trend, with two significant decline intervals occurring from 2006-2007 and 2008-2009; these declines were attributed to various factors, including unresolved environmental issues and a decline in the quality of life due to the global economic crisis of 2007-2009 (Smirnov, 2012). In Chapter 2, we identified several challenges that contributed to these declines, such as inadequate waste management, water pollution, land desertification, deteriorating rural living conditions, and reduced quality of medical and educational services (Assessment,2005; Omofonmwan and Osa-Edoh, 2008). During our comprehensive analysis of each sustainability dimension, we carefully examined individual indicators and identified specific areas that require attention, such as the increasing emissions of air pollutants and the declining share of the rural population. These declines can be attributed also to the intra-country migration to the more desirable urban areas, as proven in Chapter 5. One of the best options for sustainable development is to establish a supportive environment (such as regional legislation) for the growth of agro-tourism or rural tourism. Implementing agro-tourism businesses could be a driving force for further sustainable development. It is noteworthy noting that, despite the negative impact of these factors, sustainable agricultural development remains on a positive trajectory. This may suggest that, despite demographic changes and air pollution, the region is moving towards a more sustainable agricultural path using economically viable agricultural practices. Our research contributed to the understanding of the development and challenges faced by the Stavropol Territory in agriculture in recent times. In doing so, I highlighted areas for improvement, such as rural depopulation and air pollution, providing insights for future policy development on agricultural sustainability in the region.

Research Question 2: What are the impacts of a local policy aimed at agricultural innovation in Russia for sustainable rural development?

In modern society, innovations are the prerequisites for the development of agriculture (Scuderi et al., 2022). They not only have a positive impact on the competitiveness of the economy but are also of importance for implementing policies of import substitution of food products and maintaining a country's food security, an objective of Russian agricultural policy. Thus, innovations contribute to the dynamic sustainable development of agriculture (Singh et al., 2023).

In Chapter 3, the composite indicator of the previous chapter was used as instrument in evaluating the effect of state policy state policy implementation. We examined the impact of the State program 'On the Development of innovative, investment and technologic activity in the agricultural production) employing this composite sustainability index (CSI) with switching regression model (SRM) (Keruk et al., 2020). Overall, the introduction of a state policy on agricultural innovations leads to a structural change in sustainable agricultural development in the region suggesting that innovation is a significant and positive driving force. To evaluate the effects of the innovation policy on different dimensions of the sustainable agricultural development, the analysis employs similar models by differentiate a socio-economic and environmental indicator from the composite index. The results indicate a positive effect of the policy on socio-economic development within the regional agriculture sector. However, looking at the environmental dimension only, the results indicate that the state policy has not had a significant impact on it. Environmental sustainability is in fact prioritized less than economic and social agricultural development. There is room for improvement in terms of environmental sustainability and the inclusion of ecological innovations, such as environmentally friendly agricultural practices preservation of natural resources, reduction of pollution, and promotion of biodiversity (Galliano et al., 2017).

Research Question 3: What are the differences and related key factors affecting well-being and quality of life between rural and urban residents in Russia?

Sustainable agricultural development and rural area development are closely linked to people's involvement. Rural territories play a crucial role in achieving balanced regional development, and sustainable development in these areas is essential for preserving social, cultural, and natural aspects, reducing territorial disparities, and generating a dynamic rural economy with diverse employment opportunities (Roldan et al., 2023). FAO (2018) emphasizes the importance of farmer involvement as the key to sustainable agricultural and rural development. Therefore, the active participation of rural communities is fundamental to achieving sustainable agricultural development and the overall development of rural territories (Webb et al. 2022).

Within the context of the Stavropol Territory, Chapter 4 focused on the well-being and standard of living in both urban and rural areas. This chapter used key indicators of well-being, compare satisfaction levels between urban and rural populations. We conducted a survey designed from the European Social Survey among 156 rural and 251 urban residents from different sub-regions of the Stavropol Territory. Respondents were prompted to indicate their level of agreement or disagreement on 27 questions, including six dimensions for well-being, describing the quality of life and its satisfaction, financial conditions, and subjunctive well-being. The survey results were used to construct a composite Well-Being Index (WBI) (Nicoletti et al., 2000; OECD, 2008). This index provides a localized understanding of well-being in both urban and rural areas and may serve as a valuable tool for policy decisions by monitoring the state of development and key drivers.

The analysis revealed that despite urban areas' presumed advantages in terms of infrastructure and services, rural residents often feel more comfortable and safer. Rural people reported better family relationships and adherence to traditions, while the hastiness of urban life and higher expectations in urban settings were suggested as factors contributing to inner discomfort among urban residents. It also highlighted disparities between urban and rural areas in key indicators such as financial well-being, access to education, medical care, transportation, and Internet technology. Urban areas generally performed better in these aspects, with rural areas facing challenges like limited internet connection and mixed healthcare staff qualification. Due to these trade-offs, the study found that individuals in rural areas generally undergo equivalent levels of well-being compared to those in urban areas overall, supporting evidence collected from other studies (Berry and Okulicz-Kozaryn, 2011; Sørensen, 2013; Okulicz-Kozaryn, 2017; Burger et al., 2020).

Research Question 4: What are the prospects and drivers of migration flows within Russia, considering the rural or urban nature of the areas?

Rural migration is closely linked with agricultural and rural development in a bidirectional relationship: agricultural and rural development affects migration and are themselves affected by migration (FAO, 2018). Chapter 5 involves an in-depth analysis of the prospects and drivers of migration flows within Russia, focusing on the rural or urban nature of the regions of origin and destination. Using Markov chain analysis, we were able to provide valuable insights into the anticipated rural-urban distribution across federal districts in Russia by mid-century. The findings verify a prevailing tendency towards depopulation and urbanisation, evidenced by a decrease in population overall and a greater proportion of individuals relocating to urban centres. It is only in the North Caucasus and Southern Federal Districts that there is a positive trend for both rural and urban areas.

Furthermore, by means of spatial regression analysis we investigated the possible causes of these trends, highlighting several origin-, destination-, intra- and spatial spillover effects as significant. It appears that several factors have a significant impact on migration flows in Russia. An increase in the population size of both the source and destination areas has a positive effect on migration flows (+50% and +4%, respectively), as do higher wages (+33%), which encourage individuals to seek better-paid jobs between urban areas, the unemployment rate (+26%) as a push factor in response to a lack of job opportunities, or the greater availability of housing in the destination area (+11%). Conversely, higher wages in rural regions tend to discourage people to migrate from these areas (-45%). In terms of environmental factors, while temperature does not exert a noteworthy influence, precipitation greatly impacts migration flows due to its direct or indirect effects on the region, especially in urban areas. Such effects significantly affect migration patterns. Increased rainfall in both the regions of origin and destination can have an impact on migration flows. It can either cause emigration from areas with adverse effects (+7%) or attract migration to areas with perceived advantages (+4%). The results indicate the complex interaction of these factors, particularly in distinguishing between rural and urban areas. They also highlight the predominance of origin factors in influencing migration decisions in Russia.

Overall, this thesis constitutes a substantial leap forward in advancing the global academic understanding of sustainable rural development, agricultural innovation, and the well-being of rural communities in Russia. The research systematically addresses a noticeable gap in the international academic literature, particularly the absence of holistic sustainability assessments of agricultural production systems in Russia. Unlike predominant economic-centric studies, our approach is distinctive, embracing an innovative intersectional perspective that recognizes the multifaceted nature of rural challenges, delving into the lived experiences and perspectives of individuals.

When examining the sustainability dimensions of agricultural development in the Stavropol Territory, it becomes clear that sustainable development relies heavily on agricultural intensification and technological progress as driving forces, as noted in Chapters 1 and 2. However, the long-term sustainability of this approach is questionable due to increased pressure on natural resources and ecosystems (Chapter 1), which are further compromised by changes in weather patterns and extreme events resulting from climate change. Within their framework, Russian government programmes claim to address environmental concerns, but as noted in Chapter 2, innovation driven by policy implementation only has an impact in Stavropol Territory when the economic dimension is included in the impact assessment.

From a social perspective, rural poverty, economic disparities, and limited access to basic services in rural areas persist. Traditionally, this would suggest disparities in well-being, particularly between urban and rural residents from a social perspective. However, our study (Chapter 4) presents a counter-narrative, indicating that individuals in rural areas experience comparable levels of well-being to their urban counterparts. One possible explanation is that the similarity in well-being levels is due to a saturation point, where conditions have reached equilibrium despite being suboptimal. This can be explored in further research on the topic.

From a methodological perspective, our research illustrates the strategic cohesion of different methodologies to meet specific research needs. Notably, we showcase the versatility of PCA and its synergistic advantages when integrated with other methods. This coupling facilitates a data-driven approach for computing composite indicators, providing a more systematic evaluation of shifts in sustainable development resulting from the implementation of innovation policies, or for the interpretation of survey results. Moreover, in the realm of migration studies, we demonstrate the enhanced insights derived from coupling Migration Markov Chain analysis with Spatial Econometrics, which can better presents a comprehensive assessment of migration patterns and their drivers.(Hierro et al., 2013; LeSage and Pace, 2009)

Finally, this work significantly contributes to the international literature by providing publicly available empirical evidence that can deepen the understanding of sustainable rural development, innovation, and well-being in Russia. In this sense, our research forces the discourse forward, offering valuable insights for both academia and policymakers in fostering positive change in rural communities.

6.2 Limitations and further research

Firstly, data availability and quality remain a common limitation in all studies. Limited indicators, missing data or outdated information can affect the accuracy and comprehensiveness of the analysis. (McKnight et al., 2007). In Chapter 2, the research acknowledges the limitations of data availability especially in the environmental dimension, which impacts the construction of composite indices for agricultural sustainability. This can lead to an incomplete picture and potentially lopsided results; the study advocates, therefore, for the incorporation of additional environmental indicators to provide a more holistic and robust assessment of sustainable development in Russia. Some of the environmental indicators that can be considered include soil erosion, environmental assessment of suppliers, irrigation water use, energy use and greenhouse gas emissions (Tarquinio et al., 2018; Field to Market, 2021). These indicators, along with others related to water quality, biodiversity, and soil carbon, can contribute to a better assessment of the environmental implication of agricultural practices (OECD, 2013). To ensure the applicability of the results obtained for Stavropol Territory, it is necessary to collect empirical data for other regions and conduct a comparative analysis. For instance, a comparison of the economic and territorial positions of Krasnodar Territory, the nearest neighboring region and one of the largest agricultural producers, and Stavropol Territory would be valuable to broaden the applicability and understanding of the study results.

Additional factors, which have not been explored in the research in Chapters 2-5, can contribute to sustainable rural and agricultural development and effective migration management in Russia. Factors such as demographic attributes (e.g., gender, age, household type and size, and education), cultural norms, social networks, and specific government policies might play crucial roles (Diener and Suh, 2003; FAO, 2017; Castelli, 2018), which were not extensively addressed in the thesis due to limitation in data availability and research resources.

In Chapter 4, the initial questionnaire was originally developed in English. To Russian. It is important to acknowledge the possibility of misinterpretation of certain indicators during the translation process. The importance of caution and diligence in considering the responses is underscored by the potential for misinterpretation. It is crucial to recognize that linguistic nuances may impact the accuracy of the data collected. Measures were taken to minimize translation errors, but it is still necessary to remain aware of this factor when interpreting and analyzing the questionnaire results.

One more limitation regards the aggregation level of data. Publicly available data on migration flows within Russia, accounting for urban or rural origin and destination, are available only at the federal district level, which made us assume the contiguity matrices of the rural and urban areas (Chapter 5). This can be explained by the lack of sufficient data, which are mainly provided by the Federal State Statistics Service (Rosstat) and its regional and municipal divisions in Russia. Federal-level statistical data flows are arranged in such a manner that they are circulated in a consolidated format. This imposes limitations on the ability to perform subsequent analysis and compute analytical and forecasting measures that are required by public entities, experts, and businesses (Gokhberg et al., 2020). It is crucial to invest in initiatives aimed at improving data collection and the quality of existing data, not only at the level of a single region, but also at the level of its constituent municipalities. Especially in areas where data is limited, such as environmental indicators (Chapter 2) or the demographic details about migrants (Chapter 5).

In consideration of the period and extent of application, the research covers distinct timeframes, notably including the phase from 2005 to 2014 (Chapter 2) and 2011 to 2020 (Chapter 5). While these time frames provide valuable insights into trends, they may not capture longer-term developments or variations that occur over more extended periods (Caruana et al., 2015). Additionally, the findings might be specific to the Stavropol Territory and Russia, thereby limiting their generalizability to other regions or countries. To overcome the limitations of short time and geographical frames, future research could conduct longitudinal and comparative studies with other regions or countries. This would help identify similarities, differences, and best practices that can be applied, especially in the post-recent major shocks' context. This would provide a more comprehensive understanding of changes and patterns in agricultural sustainable development, well-being, and migration dynamics.

Chapter 5 discusses Markov chain analysis, which has a limitation in assuming a consistent probability of migration between regions over time. This may not accurately reflect real-world dynamics as migration patterns can be influenced by economic, social, or political shifts, deviating from expected trends derived solely from historical data. To address these limitations, future research should explore alternative data and models that offer more resilient and adaptable estimates of migration patterns and their determinants. Specifically, in-depth investigations into the impact of alternative destination choices on bilateral migration rates, commonly referred to as multilateral resistance (Maza et al., 2019), are required.

In relation to the evaluation of innovation policy's impact on agricultural development (in Chapter 2), it would be beneficial for further research to conduct a comprehensive assessment of the effectiveness of policy measures, accounting for their impacts on sustainable agriculture in both the short-term and long-term. Furthermore, there is a necessity for a more comprehensive system of indicators to assess the influence of innovation (Mamay, 2015 considering the conditions of rural development. The variety of agricultural innovation systems in different countries as well within Russia, encompassing differences in actors, ambitions, governance, funding mechanisms, and incentives, presents a challenge in the establishment of a universal approach. Although efforts to enhance the influence of public spending and foster a more collaborative and demand-driven system continue, most nations, including Russia, remain entrenched in top-down methodologies (OECD, 2019). Additionally, assessing the effects of various policy measures on trade, innovation, and access, as well as evaluating the anticipated consequences of new crop varieties and the impact of specific pests and diseases, necessitates extensive information and advanced methodologies (OECD, 2013b; Maredia et al., 2014). Overall, this thesis provides valuable results, but addressing the identified shortcomings and conducting further research in the suggested areas will improve the reliability and applicability of the findings. Finding more comprehensive data, considering a wider range of indicators, and exploring alternative models and policies will contribute to a better understanding of sustainable rural development.

6.3 Contributions to the literature and policy recommendations

The core Chapters 2 to 5 provided new valuable insights into the nexus among rural development, agricultural sustainability, well-being, and migration dynamics in Russia. The findings highlight the complex relationships among the various aspects and ways forward for promoting balanced and sustainable growth between rural and urban areas in the country. Drawing on the key findings of each chapter, this section further outlines policy recommendations addressing the challenges identified at both regional and national levels.

Methodologically, this thesis integrates PCA with three approaches: Composite Index Formulation, SRA, and Regression Analysis. This innovative synthesis provides a comprehensive framework to assess rural sustainability, policy implementation in agricultural innovation, and the well-being of both urban and rural populations.The versatility of PCA is demonstrated in the merging of indicators into composite measures that enhance our understanding of trends in sustainability and well-being. It also sheds light on potential structural changes in the relationship with SRA. We also investigate the patterns and drivers of rural-urban migration using Markov chains and spatial econometric techniques. This analytical approach provides invaluable insights into the dynamic landscape of migration. It unravels spatial interdependencies and identifies the multiple factors influencing internal population movements.

This framework demonstrates its adaptability and applicability in various regional contexts. Policy makers in similar regions, particularly those with comparable socio-economic indicators and agricultural characteristics may consider adopting similar assessment models. Table 6.1 presents the Russian regions that are part of different federal district and share similarities with Stavropol Territory in some socio-economic characteristics. Despite the fact that there are significant differences between these regions, the

Table 6.1: Socio-economic indicators of Russian regions by federal districts

Federal district	Region	Share of rural population %	Territory area, ths.km2	Population, ths. people	Population growth rate, %	Average income, rub	gross regional product, bln.rub	Agricultural production, bln.rub	Emissions, tons
North-West	Leningrad region	32.9	83.9	2023.8	0.9	38963	1481	119.5	248
Volga	the Republic of Bashkortostan	37.7	142.9	4077.6	-0.3	35269	2000	258.3	433
North-Caucasus	Stavropol Territory	39.3	66.2	2891.2	-0.4	27626	1025	278.4	107
Central	Tambov Region	39.6	34.5	966.3	-1.3	34092	429	208.9	62
Ural	Orenburg Region	40.1	123.7	1841.4	-0.8	30334	1394	191.7	398
Far East	Republic of Buryatia	40.9	351.3	974.6	-0.3	32823	342	20.7	107
Siberia	the Altai Territory	41.7	168	2130.9	-1.1	27940	845	249.4	195
South	Krasnodar Territory	42.9	75.5	5819.3	-0.2	48279	3201	602.9	358

Source: Federal State Statistics Service (2022)

distribution of rural population and agricultural productivity is almost the same (exceptions are the Republic of Buryatia and the Krasnodar Territory).

Primary initiatives established in Russia to oversee agricultural development and rural areas include: the State Programme for Agricultural Development and Regulation of Agricultural Raw Materials and Foodstuff Markets (up to 2025); the Federal Target Programme Sustainable Development of Rural Territories (up to 2030); and the Federal Scientific and Technical Programme for Agricultural Development (up to 2025). While these programmes provide advantages in enhancing agricultural productivity, ensuring market stability, and promoting sustainable practices within the agricultural sector, one main shortcoming is that as they do not directly tackle the environmental condition of rural regions; there are only instruments supporting the ecological balance concerning crop production (Yarkova, 2021). More policy attention should be given to addressing environmental challenges, waste management and water pollution. With this in mind and to enable a more complete sustainability evaluation, it is necessary to expand the acquisition of data on environmental indicators such as soil erosion, energy consumption, irrigation water usage and greenhouse gas emissions.

Prioritising sustainable agricultural development in government innovation policy is also imperative especially relevant in the context of international sanctions and the adopted strategy of import substitution. The analysis of the impact of local policies on agricultural innovation, based on the case of Stavropol Territory, provides important insights into the role of state policies in promoting sustainable development. Policymakers in other regions can examine the identified success factors and challenges in this agricultural region. Understanding how innovation policies interact with various dimensions of sustainable agricultural development can guide the formulation of region-specific strategies. Agricultural science faces several challenges, such as insufficient funding, the lack of fully developed mechanisms to stimulate innovative activity and the need for a more comprehensive system of indicators to assess the impact of innovation (Orlova et al., 2002). Policymakers should emphasise ecological innovation by updating outdated legislation and incentivising organisations to invest in scientific progress by promoting international cooperation in certification and licensing. Building an innovation-friendly infrastructure, integrating science, education, and industry, and providing targeted support for scientific progress are essential components of a thriving innovation ecosystem.

According to the 'Strategy of Sustainable Development of Rural Areas of the Russian Federation for the Period to 2030', rural areas are vital resources in the context of globalization and the value of Russia's natural and territorial resources, although their development is uneven. This programme aims to ensure a consistent enhancement of the well-being and living standards of the rural population as its main objective (Rosstat, 2015). However, the Russian management approach to rural development, focussed on programmes, lacks widespread effectiveness, notably in socio-economic conditions (Yarkova, 2021). Strategic plans and implemented programmes often lack practical application, resulting in discrepancies between anticipated and actual progress (Gromov, 2020). Upon review of these initiatives, it becomes evident that their focus is mainly on infrastructure, with a noticeable disparity between the proposed and accomplished aims, insufficient allocation of resources, and underfunding during implementation in comparison to the criteria set at the outset (Gorhov et al., 2021). Initiatives need to be more effectively designed to enhance the living conditions of rural areas, mainly by improving public, medical and educational services in rural areas. In 2020-2021, the Ministry of Agriculture in Russia conducted monitoring to assess rural development sectors. However, comparability is hindered due to the use of different data and conceptual frameworks by Federal Statistic Agencies (Ministry of Agriculture, 2022). To address this issue, a unified and accessible database for rural development indicators needs to be created. This would improve the reliability of state program assessments at national, regional and municipal levels, promoting consistency and informed policymaking.

Based on the Stavropol region case study, which represents the average life conditions in the country well, the level of rural and urban prosperity tends to converge over the years and the gap narrows. Empirical evidence is needed to ascertain the underlying reasons for this phenomenon. It remains unclear whether the shift can be attributed to an improvement of rural areas or a decline in urban areas. Based on this thesis, state programs to support rural communities provide some benefits, although they are not entirely effective. Analysis of key sustainability indicators reveals areas in need of improvement, including financial well-being, access to quality higher education and transport infrastructure, highly qualified medical care, and access to internet technology, with a significant disparity between urban and rural areas. To achieve optimal and impactful results from program implementation, it is crucial to involve the population in its execution (Kurbatova, 2020). For the first time, the measurement of well-being through the creation of a regional Well-Being Index (WBI) was implemented in the Stavropol Territory. This can be a meaningful contribution to a new perspective on understanding the complex society of the Stavropol Territory based on the spatial conditions in which residents live. Politicians and local authorities should explore targeted interventions to enhance the well-being of urban and rural residents alike. This can be achieved by cultivating partnerships between urban and rural areas, as well as promoting sustainable development throughout the region (UN-Habitat, 2017). Moreover, this initiative stands to enrich the body of research within the World Database of Happiness (Veenhoven, 2023), potentially shedding light on the region's happiness trends. Despite the extensive global coverage of diverse nations, the representation of Russian regions has been relatively modest. Notably, while neighbouring areas like Rostov Oblast and Krasnodar Krai find their place in the database, the Stavropol Territory's absence is conspicuous. Similarities and differences in the well-being of rural populations can be identified by comparison with other regions. Policymakers can consider adapting interventions based on the specific challenges facing their respective regions, whether related to infrastructure, services, or socio-cultural factors that influence well-being.

Another main objective of this strategy of sustainable development of rural areas is to maintain the share of the rural population in the total population of the Russian Federation at a level of at least 25.3% (Ministry of Agriculture, 2022). In Russia, both intraregional and interregional migration occurs, but intraregional migration appears to be more prevalent (Gorohov et al., 2021). By examining the migration patterns and drivers, we identified the forces and trends behind urbanization and depopulation, while also considering a decline in the overall population. In general, socio-economic and some environmental factors (such as rainfall) have an impact on migration phenomena, both directly and through indirect effects among neighbouring regions. The most effective strategies for balancing migration flows, especially from rural to urban areas, are socio-economic strategies that generate better wages and ensure better living conditions in rural areas.

Our research reveals two exceptions (i.e., the North Caucasus and the South Caucasus) that exhibit a positive trend for both rural and urban areas, in contrast to the remaining regions. Future sustainable development policies should thoroughly investigate the factors and context that lead to such contrasting and positive results in these unique cases. The government can provide employment, increase living standards, and ease the burden on urban residents by enhancing the conditions for balanced intra-regional and intra-country migration through similar targeted policy implementation.

To conclude, the research presented in this thesis provides a multifaceted understanding of the dynamics of sustainable rural development at regional and country levels, encompassing interrelated concepts of sustainable agricultural and rural development, well-being and migration. The findings and policy recommendations underscore the need for integrated strategies and international cooperation that address the challenges facing rural areas and the agrarian economy in Russia. Policymakers can effectively foster sustainable and accountable growth that ultimately benefits all stakeholders only by implementing a comprehensive strategy that addresses all aspects of sustainability, including economic, social and environmental factors. Only emphasising collaborative initiatives and cross-border knowledge sharing it will be possible to improve these strategies and facilitate the use of empirical evidence to advance sustainable rural development.

6.4 Overall conclusion

The research conducted in this thesis allowed us to identify priority areas for sustainable development of rural areas in Russia using the case of Stavropol Territory. An integrative relationship between sustainable agricultural development, rural well-being, and migration dynamics was established. We formulated a theoretical and methodological approach to integrated assessment, modelling, and determining priority directions for sustainable development of rural territories based on principal component analysis, composite indicators, Markov chains, and regression analyses. Our findings highlight the central role of economic and productivity factors as primary catalysts in the region, driving growth through agricultural intensification and technological advances supported by government initiatives. However, the relentless pursuit of economic gains has placed a strain on ecosystems and the environment, revealing a critical misalignment with government support mechanisms. This imbalance resonates across rural communities, which now find themselves at a suboptimal equilibrium of well-being. The stark depopulation of rural areas over the past decade, an alarming trend persisting in most regions, underscores the urgency of recalibrating this approach. This ripple effect extends beyond the rural landscape and affects the entire nation. Urbanization is under increasing pressure, public services are strained by greater demand, and the fragile balance of natural resource management is at risk. In addition to a diagnosis of these challenges, this thesis offers strategic policy recommendations to lead a better way to a balanced and sustainable rural renaissance in Russia. The findings and policy recommendations underscore the need for integrated strategies and international cooperation that address the challenges facing rural areas and the agrarian economy in Russia. Policymakers can effectively foster sustainable and accountable growth that ultimately benefits all stakeholders only by implementing a comprehensive strategy that addresses all aspects of sustainability, including economic, social and environmental factors. Improving these strategies and advancing sustainable rural development can only be achieved by placing a strong emphasis on collaborative initiatives and fostering cross-border knowledge sharing.

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Summary

Rural areas are vital in ensuring national and global food security. The Russian Federation has an important role to play in the global food market due to the resources available in the country. However, rural areas within Russia have faced various challenges in recent decades. Challenges such as impoverishment and environmental degradation persist despite public strategies such as the 'Strategy for Sustainable Rural Growth to 2030', which promotes the preservation of agrarian regions and their inhabitants. The multifaceted breakdown of rural localities in the Russian Federation has resulted in a progressive increase in migration flows within the country, from rural areas to urban areas. This phenomenon is evident in regions such as the Stavropol Territory, where the rural population is declining, even though the region is a highly traditional agricultural area.

Rural communities are facing a challenging future. To enhance sustainability and well-being in these areas, it is necessary to provide more efficient support, tangible measures, and international cooperation. In this regard, empirical evidence and in-depth research is essential to bridge the gap between theoretical concepts and practical application of sustainable rural development strategies, which risks reducing effectiveness and positive outcomes.

This thesis is a response to this situation and a contribution to the ongoing debate on sustainable rural development in the Russian Federation. The thesis comprises of four core multidimensional investigations highlighting the interconnectivity between the fields of agricultural and rural development, well-being, and intra-country migrations. Empirical evidence was gathered on the economic, social, and environmental aspects of sustainable rural development in Russia, with particular focus on the Stavropol Territory. The high level of heterogeneity in agricultural production, pedoclimatic conditions, and economic context of this region ensures better generalizability of the evidence within the Russian context.

Following a general introduction in Chapter 1 providing a detailed description of Stavropol Territory, Chapter 2 begins by examining agricultural sustainability in that region, using a new Composite Sustainability Index (CSI). The chapter presents an overview

of the economic, social, and environmental factors influencing the agricultural sustainability of the region, whilst highlighting trends and constraints. The analysis indicates that the CSI is on an upward trend, despite fluctuations related to ecological and socio-economic circumstances. Attention should be paid to the depopulation trend in rural areas and growing concerns about air pollution. Thanks to the evidence that has been gathered, this chapter provides a forward-thinking vision of change that outlines strategic directions for guiding policymaking and the region towards a more sustainable and resilient agricultural development path.

Next, Chapter 3 delves into the significance of agricultural innovation for sustainable rural development in the Stavropol Territory. The analysis presented here investigates the impact of governmental policies on agricultural innovation and reveals that its implementation led to a structural change with some positive effects in the region, especially on the socio-economic side. However, despite these positive results, mainly due to the implementation of high-tech practices, challenges remain in terms of securing adequate funding, developing mechanisms, and a systematic monitoring framework for impacts assessment. Furthermore, regarding the environmental sustainability dimension, the state policy had minimal impact, implying a high preference for economic development over environmental concerns. The findings highlight, therefore, the need for greater integration of all dimensions of sustainability, improving eco-innovation and enhancing environmental sustainability.

As part of the in-depth analysis of the Stavropol Territory, we compared the well-being and quality of life of urban and rural residents (Chapter 4). We conducted a survey based on the European Social Survey to determine the main differences in satisfaction levels across various socio-economic and environmental needs of people. We developed a Well-Being Index, based on the responses, to assist policymakers in gaining a better understanding of the level of local well-being in rural and urban areas. Urban areas were found to perform better than rural areas in many areas such as financial well-being, access to education, health care, transport, and technology. In contrast, rural areas face limited-service provision, such as internet access and health care provision. However, despite better infrastructure and services in urban areas, respondents reported feeling more comfortable and secure within rural areas, exhibiting stronger family ties and adherence to cultural traditions. Conversely, urban residents express greater discomfort due to the frantic tempo and high expectations of urban lifestyle. Summing up all these factors, the study indicates that the overall well-being of rural and urban inhabitants is comparable, challenging the idea of urban superiority in terms of well-being.

Moving to a national perspective, Chapter 5 is an analysis of the complex dynamics of intra-country migration in the Russian Federation. The research investigated the significance of origin and destination factors that impact migration decisions, clarifying the complexity of their interplay, and highlighting distinctions between rural and urban localities. The multifaceted factors contributing to migration include population size, wages, unemployment rates, housing availability, and climate. This chapter quantifies and validates the main influence of socio-economic conditions on rural depopulation, revealing a marked trend towards urbanisation, for reasons such as higher average wages. On the environmental side, the study also shows that rainfall plays an important role; increased rainfall can cause people to migrate from areas that experience adverse effects but can also pull people to areas that are perceived as advantageous (such as agricultural areas). The chapter provides valuable insights into the expected urban-rural disparities across Russian Federal Districts, underlining the complexities that shape migration demography and pointing to important exceptions, such as the North Caucasus and Southern Federal Districts, which show positive migration trends in both rural and urban areas that deserve further attention.

Finally, Chapter 6 offers a general discussion with a comprehensive overview of the main findings from the previous core chapters, acknowledging the main limitations and suggesting final recommendations for future research and policy making that could promote more sustainable rural development in the Russian Federation.

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About the author

Anastasia Chaplitskaya is an accomplished individual with a diverse educational background and academic expertise. Originally from Orenburg, Russia, she has devoted her career to the fields of economics, linguistics, agricultural policy and sustainable rural development. Her academic journey commenced at Stavropol State University (Russia), where she attained her specialist degree in "Applied Informatics in Economics".

Driven by her passion for linguistics, she continued her studies at Stavropol State University and obtained a master's degree in Linguistics. After completing the Erasmus IAMONET programme in the Netherlands, Anastasia's academic commitment extended to a PhD programme in Agricultural Economics and Rural Policy at Wageningen University and Research.

Anastasia has held a senior teaching position at Stavropol State Agrarian University, contributing to the Department of Foreign Languages within the Faculty of Socio-Cultural Services and Tourism. Her commitment to academic research is evidenced in her diverse publications, which explore various themes such as rural well-being and sustainability, agricultural policies, migration, cross-cultural communication, and the promotion of human capital in rural economies. Her work continues to impact and influence these topics, shedding light on the complexities and interconnections within them.

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