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Evaluating eco- and human capital efficiency in Russian regions: insights from subjective well-being indicators in the context of geo-economic fragmentation

ABSTRACT.
Relevance. Fostering well-being ranks high on regional social policy agendas. With the dynamic shifts in the international economic landscape, known as geo-economic fragmentation, there's a pressing urgency for stakeholders to optimize resource allocation at the regional level, increasing interest in efficient strategies to adapt to sanctions while enhancing overall well-being.
Research objective. This article aims to investigate the dimensions and determinants of the eco- and human capital efficiency in Russian regions in the context of geo-economic fragmentation and sanctions pressure.
Data and methods. A proposed three-stage approach integrates factor analysis to identify subjective well-being indicators, data envelopment analysis (DEA) to evaluate socio-eco-efficiency, and panel tobit regression to examine the determinants of efficiency. Microdata from the Rossat Comprehensive Observation of Living Conditions database were utilized, covering the period from 2014 to 2022. To assess efficiency, a DEA model is employed. The output indicators from this model were the estimated measures of subjective well-being. These indicators were validated through factor analysis and included professional satisfaction, safety assessment, accessibility and quality of social and cultural infrastructure in the regions.
Results. In the given period, people reported feeling increasingly satisfied with jobs and quality of life, though there was a noticeable slowdown in the growth of human capital development indicators, environmental investments, and real income by early 2023. Efficiency varied significantly among the regions. Industrially developed mining areas and republics in the North Caucasus consistently showed high socio-eco-efficiency, despite limited resources. The efficiency benefited both from digitalization and increased per capita gross regional product, but urbanization had a negative impact.
Conclusions. Amid geo-economic fragmentation, regional communities and job markets face significant challenges in adaptation. With the looming risk of declining satisfaction and perceived quality of life, it is imperative for regional policies to bolster tangible well-being indicators and invest in social capital and infrastructure to address these issues effectively.

KEYWORDS
sustainability, subjective well-being, regional development, eco-efficiency, human capital efficiency, geo-economic fragmentation, data envelopment analysis, panel tobit regression

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Экоэффективность и эффективность человеческого капитала российских регионов на основе показателей субъективного благополучия в условиях геоэкономической фрагментации

АННОТАЦИЯ
Актуальность. Поддержание благополучия часто рассматривается как стратегическая цель региональной социальной политики. Политически

мотивированный разворот в международной экономике, известный как геоэкономическая фрагментация, особенно привлекает внимание стейкхолдеров к региональной эффективности распределения ресурсов для достижения благополучия и адаптации к санкциям.
Цель исследования. Целью данной статьи является изучение измерений и детерминант эффективности человеческого капитала и экологической активности в российских регионах в контексте геополитической фрагментации и внешнего санкционного давления.
Данные и методы. Предложен трехстадийный подход, комбинирующий факторный анализ для выявления индикаторов субъективного благополучия регионов, анализ охвата данных (АОД) для оценки социо-эко-эффективности и панельную тобит-регрессию для оценки детерминант эффективности. В исследовании использованы микроданные Комплексного наблюдения условий жизни населения Росстата за период с 2014 по 2022 годы. Для оценки эффективности предлагается модель АОД, результирующим показателем в которой являются оценочные индикаторы субъективного благополучия. Индикаторы валидированы с помощью факторного анализа и отражают профессиональную удовлетворенность, оценку безопасности, качества и доступа населения к социально значимой инфраструктуре регионов.
Результаты. За рассмотренный период наблюдается ощутимый рост субъективного благополучия при замедлении прироста объективных показателей развития человеческого капитала, экологических инвестиций и реальных доходов к началу 2023 года. Исследованные регионы весьма неоднородны по показателям эффективности. Высокую социо-эко-эффективность стабильно демонстрируют промышленно развитые добывающие регионы, а также республики Северного Кавказа, характеризующиеся высоким уровнем субъективного благополучия при существенных ресурсных ограничениях. Цифровизация и рост подушевого валового регионального продукта оказывают положительное влияние на эффективность, однако урбанизация ее снижает.
Выводы. В условиях геоэкономической фрагментации региональные экосистемы и рынки труда находятся в условиях предела прочности адаптации, риска снижения удовлетворенности и воспринимаемого качества жизни, что требует выработки политики роста объективных показателей благополучия и инвестиций в социальный капитал и инфраструктуру.

КЛЮЧЕВЫЕ СЛОВА
устойчивость, субъективное благополучие, региональное развитие, эко-эффективность, эффективность человеческого капитала, геоэкономическая фрагментация, анализ охвата данных, панельная тобит-регрессия

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基于地缘经济碎片化条件下主观幸福感指标的俄罗斯地区生态效率和人力资本效率

摘要
现实性：维护福祉通常被视为地区社会政策的战略目标。政治驱动的国际经济逆转，即所谓的地缘经济碎片化，尤其引起了利益相关者对地区福利和资源分配效率的关注。
研究目标：本文的目的是研究地缘政治碎片化和外部制裁压力背景下俄罗斯各地区人力资本效率和环境活动的各个层面及其决定因素。
数据与方法：本研究提出了一种三阶段方法，即结合因素分析来确定各地区的主观幸福感指标，结合数据包络分析（DEA）来评估社会生态效率，以及利用面板固定效应Tobit回归来评估效率的决定因素。研究使用的微观数据来自俄罗斯国家统计局的《人口生活条件综合观测》，时间跨度为 2014 年至 2022 年。为评估有效性，我们提出了主观幸福感估计指标- AOD 模型。这些指标通过因素分析进行验证，反映了专业满意度、安全评估、质量以及居民对各地区重要社会基础设施的使用情况。

关键词
可持续性、主观幸福感、区域发展、生态效率、人力资本效率、地缘经济分割、数据包络分析、面板固定效应Tobit回归

研究**结果**：报告期内，主观幸福感显着提高，但到2023年初，人力资本发展、环境投资和实际收入等客观指标增速放缓。研究的地区在效率指标方面存在很大差异。工业发达的矿区以及北高加索共和国一贯表现出较高的社会生态效率，其特点是主观幸福感较高，但资源有限。数字化和人均地区生产总值的增长对效率有积极影响，但城市化会降低效率。

结论：在地缘经济碎片化的背景下，区域生态系统和劳动力市场的适应能力已达到极限，生活满意度和可感知的生活质量有可能下降，这就需要制定政策，增加衡量福祉的客观指标，并对社会资本和基础设施进行投资。

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Introduction

Sustainable practices have encountered significant challenges in recent years, primarily due to limited resources and growing skepticism towards environmental initiatives among consumers, businesses (Farooq & Wicaksono, 2021), and academia (King et al., 2023). This trend is exacerbated by deglobalization and geopolitical fragmentation, hindering global commitments to sustainability and economic growth (Aiyar et al., 2023). Geo-economic fragmentation, driven by political motives, divides global economic activity into blocs or regions, disrupting supply chains, reproductive and knowledge systems, and amplifying social vulnerability, especially in nations facing sanctions (Campos et al., 2023).

Despite conflicting global interests, achieving harmony among digital technologies, production processes, financial structures, and environmental systems remains crucial for future well-being, especially amidst climate change (Cepni et al., 2023). Economic policy is shifting towards evaluating subjective well-being, including satisfaction and happiness, as indicators of regional economic performance (Qasim & Grimes, 2022). Human capital development through education, healthcare, and environmental practices is essential for effective technological development and measuring well-being based on objective and subjective indicators.

Resource efficiency, optimizing outcomes within environmental constraints, is crucial for sustainable well-being (Castellano et al., 2023). The examination of socio-eco-efficiency is valuable for shaping regional economic policies and enhancing well-being (Vaičiukynas et al., 2023). However, there is still a lack of research on on subjective well-being in the sustainable transformation of Russian regions (Almakaeva & Gashenina, 2020), as well as on the impact of geo-economic fragmentation on regional economies (Zubarevich, 2022).

This research aims to fill this gap by conducting a comprehensive analysis of the efficiency of social and environmental practices in achieving subjective well-being. It identifies the effectiveness of human capital and environmental activities in Russian regions from 2014 to 2022, amid geo-economic fragmentation. Using a three-stage model, it examines various factors influencing subjective well-being, including human capital utilization, regional environmental activity, and structural capital.

The article has the following structure. The first section discusses recent research that supports the theoretical framework, illustrating a transition toward using subjective well-being as a benchmark for assessing socio-eco-efficiency in regions. The second section describes the research methods, highlighting data envelopment analysis as a key non-parametric optimization methodology for evaluating efficiency. The discussion and results section presents estimates of socio-eco-efficiency and identifies their determinants. The conclusions section briefly discusses the policy implications, limitations, and future research directions.

Theoretical framework

Subjective well-being, sustainability and geo-economic fragmentation

Concepts of quality of life, welfare, and well-being form a comprehensive research agenda for regional social policy, which is particularly pertinent during the global geo-economic transformation impacting national institutional environments. Here, measuring the performance and effectiveness of institutions is crucial for adaptation and sustainable social and economic development. Welfare traditionally denotes the provision of material and financial support by governments and organizations (Engelbrecht, 2009). Historically, welfare programs have focused on meeting basic needs such as food,

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shelter, healthcare, and income assistance, addressing immediate and tangible needs like poverty alleviation and social safety. Well-being, initially aimed at enhancing welfare measures, broadens the understanding of quality of life beyond material needs to encompass physical, mental, emotional, and social aspects of health and happiness (Engelbrecht, 2009; Fumagalli, 2021). The shift from welfare to well-being reflects a methodological transition from simplistic preferences to a multidimensional preference-satisfaction theory in societal priorities and values, moving from survival to the pursuit of flourishing and fulfillment (Heutel, 2024; Oliveira-Silva & Porto, 2021).

Subjective well-being is a distinct category in economic analysis, which has become increasingly popular as an indicator for long-term development and a guiding principle for regional social policy (Diener et al., 2018). The prevailing theoretical perspective conceptualizes well-being within a continuous, self-reinforcing developmental cycle, where well-being and economic growth are intricately intertwined and mutually reinforcing (Llena-Nozal et al., 2019). Initially, interest in subjective well-being arose from incorporating social indicators into regional economic statistics. The contemporary focus has shifted to environmental efficiency and climate change concerns, recognizing the social externalities associated with economic growth (Austin, 2016). In modern research, regional well-being involves a variety of values, prioritizing growth opportunities in education, healthcare, legal regulation, cultural development, and resource allocation mechanisms to balance the interests of future generations. Subjective well-being indicators provide stable measures relevant for differentiated regional policies over extended periods, guiding government interventions by understanding the dynamics of these indicators and the heterogeneity of goals among individuals and communities (Johnston & Stavrunova, 2021).

The concept of subjective well-being encompasses both hedonic and eudemonic interpretations, reflecting individuals' internal attitudes and psychological states influenced by environmental factors, personal traits, and experiences (Diener et al., 2018). Subjectivity in this context refers to individuals expressing their opinions on happiness, well-being, and satisfaction through abstract scales. In recent decades, these indicators have been viewed as complements or even potential replacements for traditional financial metrics like GDP and objective social indicators such as education, life expectancy, and infrastructure quality. Hedonic interpretations emphasize affective aspects of well-being like happiness, emotional harmony, and joy (Diener et al., 1999), while eudemonic aspects focus on life goals, meaning, engagement, and authenticity (Oliveira-Silva & Porto, 2021).

Subjective well-being serves as a measure of quality of life derived from personal experiences, representing the non-financial returns on investments in human capital. It involves the creation of capabilities such as civil and political rights (Bérenger & Verdier-Chouchane, 2007), with key determinants including education, health, and material wealth (Bérenger & Verdier-Chouchane, 2007; He et al., 2023). Following the 2008 financial crisis, there has been increased interest in the role of subjective well-being in entrepreneurial activities and consumer behavior, as well as studies on regional determinants and living conditions affecting life satisfaction (Skachkova et al., 2023). Moreover, there's a growing focus on the holistic impact of sustainability on well-being (Qasim & Grimes, 2022), with proponents of strong sustainability advocating for a shift towards understanding the role of natural capital in future well-being (Qasim, 2017).

Geo-economic fragmentation and sanctions pressure pose additional threats to achieving Sustainable Development Goals by 2030, leading to increased costs, reduced knowledge spillovers, and limited access to new technologies in developing countries (Aiyar et al., 2023). Heightened geopolitical tensions and inefficiencies in international institutions lead to confrontations between world regions, disrupting supply chains and destabilizing economic development and well-being (Campos et al., 2023). For instance, sanctions impact social welfare and educational strategies in countries like Iran (Moeeni, 2022), and in Russia, there are risks of underutilization of human capital due to technological regression (Gimpelson, 2022). Trends also suggest a decrease in real wage growth and high unemployment rates in certain industries, affecting regional economies (Kapeliushnikov, 2023). Overall, research literature predominantly presents negative assessments of fragmentation for both developed and developing countries.

In the short term, geo-economic fragmentation can initially trigger a "rally 'round the flag"

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effect, garnering support and approval from the population despite a decline in objective well-being due to confrontation and perceived external threats (Onder, 2021). Over time, however, as people adapt, subjective well-being may gradually improve even amidst fragmentation. Social identity plays a pivotal role here, because belonging to a particular group significantly shapes how individuals perceive and evaluate events. Kamalov and Ponarin (2020) highlight the importance of national pride, particularly its positive impact on subjective well-being indicators until 2017, which could also aid in adapting to declining objective well-being.

Human capital and subjective well-being

Social factors are pivotal in understanding subjective well-being, encompassing various states and conditions experienced by individuals and households. Education, a cornerstone of human capital, has demonstrated a positive impact on well-being, particularly benefiting low-income individuals (Diener et al., 1999). Emotional intelligence, which involves understanding and empathizing with others' emotions, alongside traditional cognitive skills, significantly enhances subjective well-being (Diener & Ryan, 2009). Yakovleva and Kryachko (2021) illustrate that high life satisfaction among academic workers positively influences their creative academic productivity, compensating for material living condition gaps.

A comprehensive view of human capital suggests that population health serves as an investment resource at individual and regional levels, fostering productivity and well-being (Tan, 2014). Investments in health capital, realized through healthcare system infrastructure and human capital development, yield returns in increased productivity, earnings, life expectancy, and life satisfaction (Rivera & Currais, 2003). Human capital, as a reservoir of skills and knowledge, mediates the regional effectiveness of health capital investments, influencing productivity and economic growth (Yang, 2020). Enhancing health capital, whether through positive self-perception or mitigating chronic illness and disability, significantly contributes to subjective well-being (Bérenger & Verdier-Chouchane, 2007; Diener & Ryan, 2009).

Recent studies have extensively examined regional determinants of subjective well-being related to human capital in Russia. Job satisfaction among individuals with higher education positively influences overall life satisfaction, particularly in non-capital cities (Soboleva, 2020). Nazarova (2023) identifies the significance of human capital in reducing dissatisfaction with life, demonstrating a substantial decrease associated with higher educational attainment. Additionally, active social engagement significantly reduces dissatisfaction, while health issues and disabilities negatively impact well-being, underscoring the intricate interplay of various factors in shaping subjective well-being.

Socio-eco-efficiency and subjective well-being: insights from data envelopment analysis

Previous studies on sustainable regional well-being have relied heavily on the data envelopment analysis (DEA) methodology to evaluate the effectiveness of socio-eco-indicators (Emrouznejad & Yang, 2018). DEA is a nonparametric optimization method that enables the calculation of efficiency, allowing the determination of production frontiers based on available resources for achieving well-being (Castellano et al., 2023). This methodology offers a promising approach to assessing effectiveness, diverging significantly from the traditional rating approach where evaluations are often based on the subjective notion that "the higher the indicator, the better." The use of DEA in evaluating efficiency is advantageous as it provides insights into the ratio of resources expended to achieve a specific outcome. This approach enhances the understanding of how efficiently resources are utilized to contribute to well-being, offering a more nuanced and objective perspective compared to traditional subjective assessments.

The external factors of a "good life" are determined not only by the level of socio-economic development but also by the activities of formal institutions, therefore subjective satisfaction becomes an important indicator of the effectiveness of these institutions (Shibalkov et al., 2022). The concept of socio-eco-efficiency was developed as a part of the research agenda on regional well-being; it is a complex theoretical construct that combines the ideas of achieving well-being in the institutional environment, considering not only natural resources and ecosystem sustainability but also multidimensional institutional profiles of the regions. Socio-eco-efficiency reflects the degree to which the opportunities provided by investments in human capital, technological, and social infrastructure are translated into indicators of well-being (Muhammad Anwar et al., 2021; Vaičiukynas et al., 2023). Achieving socio-eco-efficiency requires optimization considering the high cost of investments in environmental protection and human capital.

Research evidence demonstrates a direct and positive correlation between education attainment and regional eco-efficiency, indicating optimization of energy consumption and a decrease in carbon dioxide emissions using human capital (Mahmood et al., 2019). However, there is a nonlinear relationship: initially, investments in education and healthcare, associated with economic growth, may actually escalate carbon dioxide emissions, and only after surpassing a certain threshold countries tend to allocate resources towards the creation of green human capital, thereby facilitating the transition to alternative energy sources (Payab et al., 2023). Modern DEA methods can also quantify resource slacks, thereby identifying areas for potential improvement and investment opportunities (He et al., 2023). Using extensive empirical evidence, Qasim and Grimes (2022) show that, in general, strong sustainability and well-being are subject to trade-offs and severe resource constraints, but countries with a commitment to strong sustainability are gradually recovering well-being indicators.

The reviewed studies use various indicators to assess the social and environmental effectiveness of regions in achieving subjective and objective well-being. Castellano et al. (2023) evaluate 37 OECD countries, focusing on the technical, social, and eco-efficiency of material resource use in promoting well-being. Their findings indicate that beyond a certain threshold, GDP no longer significantly impacts well-being. Developed countries, despite steady income growth, have not seen an increase in well-being over the past half-century on average. Shi et al. (2023) note a high level of regional differentiation in achieving green well-being across 35 major cities in China. They find that the best economic indicators of a city do not necessarily indicate efficient resource use, and larger government size has a negative effect, emphasizing the role of government in optimizing spending on social services and well-being investments (Mihaylova-Borisova & Nenkova, 2021).

A study of global high-tech companies reveals a weak relationship between financial and socio-environmental performance (Vaičiukynas et al., 2023). He et al. (2023) find that regions with higher investment levels tend to have higher eco-efficiency rates, but efficiency assessment results vary depending on researchers' focus, such as energy, water, or land consumption indicators. Socio-eco-efficiency can also be influenced by regional factors; urbanization has negative effects, while investment openness improves efficiency (He et al., 2023).

Financial resources largely invest in structural capital, which drives innovations to increase eco-efficiency (Seleim & Bontis, 2013). Matsumoto and Chen (2021) demonstrate that industrial R&D investments drive innovations, leading to robust structural and innovative capital accumulation, fostering the development and adoption of eco-friendly technologies and sustainable practices.

Shibalkov et al. (2023) propose a DEA model assessing the healthcare system's state and older people's satisfaction with institutional work in Russian regions. They highlight economic, organizational, and sociocultural mechanisms in achieving regional healthcare systems, emphasizing the need for improved resource planning. The quality of life study of the elderly also reveals significant regional differentiation, with subjective assessments reflecting objective institutional activities' results (Shibalkov et al., 2022). Indicators of subjective quality of life assessment in Russian regions include well-being, living environment, health, and healthcare system satisfaction (Shibalkov et al., 2021), emphasizing living conditions and safety as significant well-being indicators.

The literature review suggests that achieving subjective well-being enhances a region's social attractiveness, helping retain accumulated human capital amid geo-economic challenges. However, regions may vary significantly in efficiency levels despite high resource indicators. Based on this review, the author formulates two research questions:

1) What are the indicators of human capital and eco-efficiency efficiency for Russian regions, and how do they evolve from 2014 to 2022 under the influence of geo-economic fragmentation?

2) How does human capital and eco-efficiency depend on regional development variables expressed through financial and social dimensions?

Methods and Data

The study uses a three-stage approach to analysis, including the steps to identify factors of sub-

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jective well-being, the level of efficiency in the use of regional resources to ensure well-being, and determine the factors influencing the efficiency of the environmental activities and human capital.

In the initial stage, subjective well-being variables were identified through exploratory factor analysis using SPSS 23. This method facilitated the reduction of subjective well-being variables, emphasizing principal components in the structure. Consistent with prior research on subjective well-being, evaluative indicators were employed, where respondents independently assessed quality of life and job satisfaction (Soboleva, 2020; Nazarova, 2023). To calculate indicators for each region, microdata from the Comprehensive Observation of Living Conditions (COLC)[1] and the statistical database Regions of Russia[2] of Rosstat for the period from 2014 to 2022 were used. Considering the quality of the data, 79 regions of Russia were selected for analysis. Since the indicators include job satisfaction, well-being estimates for all periods were made only for the employed population aged 15 years and older. The Rosstat data used in this study contained two groups of variables. The first group reflected infrastructural problems in the region (groups of variables I02_03_... in the original Rosstat database), and the second showed professional satisfaction (I05_20_...).

At the second stage, a DEA model was proposed and efficiency indices were calculated based on nonparametric optimization using java lpsolve 5.5. The advantages of the method are the absence of a specific production function, the ability to include many input and output variables, and the ability to apply to a small number of observations. The study uses the slacks-based efficiency model (SBM) proposed by Tone (2002). Accordingly, a specific region plays the role of decision-making unit (DMU). For each region *j*, the efficiency level was defined as the ratio of *m* input indicators *x* (i =1, 2, …, m) and *s* output indicators *y* (r = 1, 2, …, s), for which weights λ were found in the optimization process. Based on the optimization, slack variables s_i^- for input and s_r^+ for output were also calculated. In order to maximize subjective well-being, an output-oriented model under the constant returns-to-scale assumption was used for the efficiency indicator ρ_o:

$$\frac{1}{\rho_o} = \max_{\lambda, s-, s+} 1 + \frac{1}{s}\sum_{r=1}^{s} \frac{s_r^+}{y_{ro}}, \quad (1)$$

subject to

$$\begin{aligned} x_{io} &= \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- \ (i=1,\ \dots,\ m) \\ y_{ro} &= \sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ \ (r=1,\ \dots,\ s) \quad (2) \\ \lambda_j &\geq 0(\forall j),\ s_j^- \geq 0(\forall i),\ s_r^+ \geq 0(\forall r). \end{aligned}$$

The input and output variables in the model are listed in Table 1 below. The data sources for the model were previously calculated factors of subjective well-being, as well as Rosstat data published at the end of December 2023. Annual weights were applied for each respondent for COLC data to calculate average subjective well-being for each region. Data on regional gross regional product (GRP) for 2022 were presented as part of preliminary estimates of regional ministries of economy. To calculate indicators of the average accumulated number of years of education and work experience in the given region, data from the Rosstat Labor Force Survey[3] were used, and annual weights were applied for each individual. Population vitality was a technical indicator calculated as the inverse ratio of morbidity, reflecting the positive return on investment in the health of the regional population.

In the third stage, efficiency indicators were evaluated concerning regional factors using panel Tobit regression in Stata 17. The analysis encompassed 79 regions from 2014 to 2022, with intervals of 2 years, resulting in a total of 395 observations. Estimates were computed for pooled OLS and models with fixed or random effects. The choice of the model was influenced by the censored nature of the dependent measure ρ_o, which ranged from 0 to 1. The choice between a random or fixed effects model was based on the Hausman test. Fixed effects estimates were obtained using the method of Honore (1992). The regression model included efficiency as a dependent variable

[1] Rosstat. Comprehensive Observation of Living Conditions (COLC). Retrieved from: https://rosstat.gov.ru/free_doc/new_site/GKS_KOUZH_2022/index.html (Date of access 12.10.23)

[2] Rosstat. Regions of Russia. Socio-economic indicators. Retrieved from: https://rosstat.gov.ru/folder/210/document/13204 (Date of access 30.12.23)

[3] Rosstat. Russian Labor Force Surveys Microdata. https://rosstat.gov.ru/storage/mediabank/bd_ors-2022-%D1%81%D0%B0%D0%B9%D1%82.rar (Date of access 20.12.23)

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Table 1

DEA model inputs (I) and outputs (O) for the six sustainable socio-eco-efficiency dimensions as suggested by the author

First-order factors	Second-order variables	Human capital efficiency	Health capital efficiency	Structural capital efficiency	Eco-efficiency	Sustainable overall efficiency	Sustainable well-being efficiency
Human capital	Educational attainment, human-years per capita	I	–	–	–	I	I
	Experience, human-years per capita	I	–	–	–	I	I
Health capital and social investments	Number of outpatient department visits per 10,000 population	–	I	–	–	–	–
	Medical doctors per 10,000 population	–	I	–	–	I	I
	Share of social investments in income, %	–	I	–	–	I	I
Structural capital	Innovation activity, %	–	–	I	–	I	I
	Investments in R&D per capita, rubles	–	–	I	–	I	I
Environmental capacity	Environmental investments per capita, rubles	–	–	–	I	I	I
	Share of recycled water, %	–	–	–	I	I	I
	Share of recycled air pollution, %	–	–	–	I	I	I
Physical capital capacity	Capital investments, MM rubles	–	–	I	–	I	I
	Cost of fixed assets, MM rubles	–	–	I	–	I	I
Subjective well-being	Multicriterial job satisfaction	O	O	O	O	O	O
	Safety and environmental compliance	O	O	O	O	O	O
	Access to infrastructure	O	O	O	O	O	O
	Quality of infrastructure	O	O	O	O	O	O
	Access to social and cultural infrastructure	O	O	O	O	O	O
Health capital performance	Population vitality (1/Morbidity rate) × 1000	–	O	–	O	O	–
Economic performance	Real wages, rubles	O	O	O	–	O	–
	GDP per capita, rubles	–	–	O	O	O	–

and a set of regional determinants of economic development and investment activity:

$$\rho_{odjt} = \alpha_{dj} + \beta_{1d}VRP + \beta_{2d}CAP_{IN} + \beta_{3d}EDU + \beta_{4d}SOC + \beta_{5d}SC + \beta_{6d}DIG + \beta_{7d}SEC + \beta_{8d}OPEN + \beta_{9d}URBAN + \varepsilon_{djt}, \quad (3)$$

$$\rho_{odjt} = \begin{cases} 0, \ \rho^*_{odjt} \le 0 \\ \rho^*_{djt}, \ \rho^*_{odjt} > 0 \end{cases} \quad (4)$$

The number of efficiency indicators d, was 6 (Table 1). Regional determinants that predicted socio-eco-efficiency included the GRP per capita in rubles (GRP); investment in fixed capital per capita in rubles (CAP_{IN}); number of tertiary education graduates in the current year (EDU); share of social investments in the income of the region's population, % (SOC); investments in research and development in rubles (SC); share of the region's population using the Internet daily, %

Table 2

Results of factor analysis of subjective well-being indicators for the merged Rosstat database for 2014-2022

Variable and COLC database original name	Name	Mean	SD	FL	VE	aK
Duties performed (I05_20_03)	Multicriterial job satisfaction	4,495	0,002	0,747	19,4	0,807
Moral satisfaction at work (I05_20_07)		4,361	0,002	0,745		
Professional satisfaction (I05_20_08)		4,246	0,002	0,739		
Working conditions (I05_20_05)		4,461	0,002	0,697		
Employer reliability (I05_20_02)		4,373	0,002	0,661		
Working hours (I05_20_04)		4,630	0,002	0,613		
Wages (I05_20_04)		3,604	0,002	0,549		
Low risk of drugs distribution (I02_03_14)	Safety and environmental compliance	0,849	0,000	0,822	12,9	0,752
Low risk of alcoholism (I02_03_15)		0,720	0,001	0,772		
Low risk of vandalism (I02_03_13)		0,845	0,000	0,677		
Low level of environmental pollution (I02_03_16)		0,710	0,001	0,598		
Low level of crime (I02_03_01)		0,928	0,000	0,596		
Remoteness of recreation and leisure facilities (I02_03_07)	Access to cultural infrastructure	0,697	0,001	0,856	10,9	0,854
Remoteness of cultural institutions (I02_03_06)		0,766	0,001	0,814		
Remoteness of physical education and sports facilities (I02_03_08)		0,723	0,001	0,800		
Accessibility of state and municipal preschool and school education (I02_03_03)	Access to social infrastructure	0,905	0,000	0,711	4,9	0,706
Accessibility of state and municipal medical services (I02_03_02)		0,763	0,001	0,667		
Remoteness of retail outlets (I02_03_04)		0,895	0,000	0,663		
Remoteness of pharmacies (I02_03_05)		0,814	0,001	0,649		
Condition of roads and road safety (I02_03_12)	Quality of infrastructure	0,487	0,001	0,688	4,8	0,765
Organization of housing and communal services (I02_03_09)		0,682	0,001	0,678		
Amenities, sufficient landscaping (I02_03_11)		0,736	0,001	0,670		
Organization of public transport (I02_03_10)		0,773	0,001	0,594		

Source: author's calculations
Note. SD – standard deviation, FL – factor loadings, VE -variance explained, aK – Cronbach's alpha.

(*DIG*); share of high-tech sectors in regional GRP, % (*SEC*); balance of foreign investment into the region in millions of US dollars (*OPEN*; for 2022, data from 2021 was selected due to restrictions in the publication of statistics); share of urban population in the region, % (*URBAN*).

Results and discussion

Stage 1. Exploratory factor analysis. At the first stage, Rosstat data were used, namely binary variables (quality of life) and scale ratings (job satisfaction). Since the output variables should reflect the desired outcomes, the author used reverse scales for these two groups according to the principle "the higher the better." Satisfaction indicators were recoded into a five-point scale. Next, a factor analysis was conducted for 25 variables, based on the principal component method and varimax rotation. The variables were grouped into 5 factors. Kaiser–Meyer–Olkin (KMO) test showed acceptable sampling adequacy (KMO = 0.847), Bartlett's Chi-square *p*-value is less than 0,1%. Only variables with factor loadings above 0,5 were used. The total proportion of explained variance was 52%. Of the 8 initial job satisfaction variables, 7 were selected, excluding commute satisfaction. Out of the initial 17 quality of life variables, only one variable was omitted, specifically, the availability of government documentation services. After assessing the average values of satisfaction, several regions of the North Caucasus Federal District were excluded from the analysis, as they demonstrated abnormally high satisfaction rates, approaching 100% for all indicators. The results of the analysis for 79 regions are shown in Table 2.

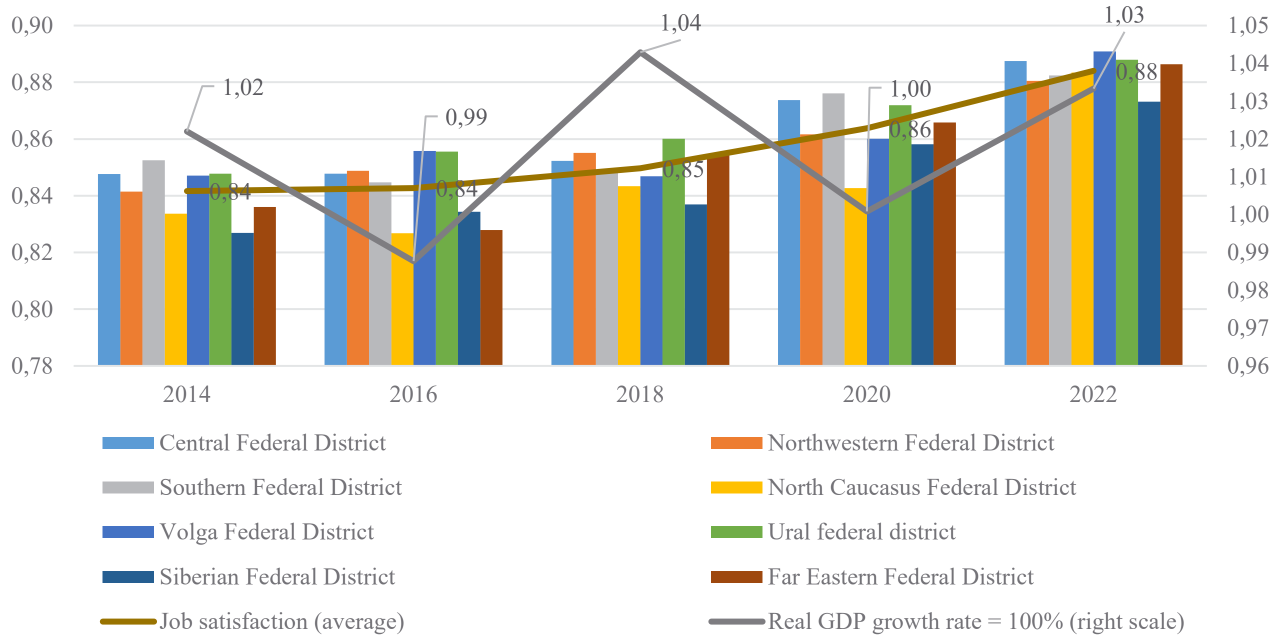

Figure 1. *Dynamics of multicriterial job satisfaction in federal districts (left scale) and real GDP growth (right scale) in 2014-2022. Real GDP growth rates were calculated for a two-year period.*
Source: compiled by the author based on COLC[4] and Rosstat data[5].

A well-known problem in assessing subjective well-being is reliability associated with the influence of factors such as the mood of respondents and measurement errors (Krueger & Schkade, 2008). To assess the reliability of satisfaction indicators, correlation coefficients between well-being indicators for different years were calculated. The robustness check assumes that there will be significant correlations between the measures during the several comparable periods. The analysis showed that Pearson correlation coefficients between regional indicators weakened over time, but remained significant; for example, for the quality of infrastructure, the correlation between the values for 2014 and 2016 was 0,733, and for the 2022 indicator it decreased to 0,594, but remained significant. All this suggested the reliability of the obtained estimates over time.

Multicriterial job satisfaction was the most significant factor, explaining almost a fifth of the variation in the data. Average satisfaction ratings for the period ranged from 4,5 to 3,6 points out of 5, with the lowest satisfaction characteristic for the salary indicator. Heat maps of changes in satisfaction and quality of life over the period are shown in Table A1 in the Appendix. o facilitate analysis, the regions were categorized into federal districts. Over the entire period, most regions showed a significant increase in indicators of subjective well-being, however, residents of the Siberian, Far Eastern and Southern Federal Districts were less satisfied with the quality and access to social and cultural infrastructure, the same applies to safety.

The growth in job satisfaction increased despite the sanctions crisis of 2014, the pandemic of 2020 and the escalation of sanctions pressure in 2022. This resilience suggests a high level of adaptability within both the population and the national labor market, echoing findings from prior studies (Kamalov & Ponarin, 2020; Kapeliushnikov, 2023). Examining the job satisfaction indicator, the analysis focused on its relationship with real GDP growth from 2014 to 2022 (see Figure 1). Remarkably, despite minimal GDP growth in 2016 and 2020, satisfaction continued to rise steadily. The highest levels were observed in central Russia, while the southern and northern regions reported lower levels.

This growth persisted even in the absence of significant improvements in objective well-being indicators. Despite modest GDP and real wage

[4] Rosstat. Comprehensive Observation of Living Conditions (COLC). Retrieved from: https://rosstat.gov.ru/free_doc/new_site/GKS_KOUZH_2022/index.html (Date of access 12.10.23)

[5] Rosstat. National accounts. Retrieved from: https://rosstat.gov.ru/statistics/accounts (Date of access 03.10.23)

growth – averaging less than 1% across most regions – there was an increase in social investments. However, indicators such as health capital and education saw slight declines. Notably, human capital experienced a transformation during this period. While the educational structure of the population remained largely unchanged, accumulated experience surged by an average of 20–30%, attributed to an aging workforce and reduced youth influx into regional labor markets.

Positive trends were particularly evident in the Central and Far Eastern Federal Districts, though subjective well-being indicators remained on par with the national average.

Stage 2. Data envelopment analysis. To answer the first research question, based on the previously discussed model (1), socio-eco-efficiency indicators were assessed, including indicators of human capital and environmental activity of the regions. The author first tested the data for endogeneity, which suggests a significant correlation between model input indicators and efficiency estimates (Santín & Sicilia, 2017). The presence of endogeneity, as with statistical analysis, significantly impairs efficiency estimates derived from DEA and leads to inappropriate policy recommendations. In the case of the data for Russian regions, Spearman's correlations between efficiency estimates ρ_o and input variables were negative or did not exceed 0,25, which was a satisfactory result.

Similar to studies on OECD countries (Castellano et al., 2023) and China (He et al., 2023), significant differentiation among performance indicators was observed across Russian regions, as detailed in Table A3 in the Appendix. Eco-efficiency challenges were particularly prevalent in the Volga, Northwestern, and Siberian federal districts, where issues such as atmospheric pollutant levels and recycled water usage were prominent. Typically, increases in these indicators correlate with heightened industrial activity, often leading to decreased satisfaction with quality of life and work.

Conversely, regions with minimal industrial presence, such as the North Caucasus and the Far East, exhibited superior eco-efficiency indicators. Additionally, oil and gas-rich areas in the Ural Federal District showcased notable eco-efficiency alongside effective utilization of human capital, driven by high wages and sustained satisfaction levels.

Certain central regions also demonstrated high efficiency, characterized by consistent investments in environmental initiatives, R&D, and competitive labor market wages, resulting in elevated well-being levels. However, several regions faced challenges in human capital development, notably small areas in western Russia and parts of the Far Eastern coast (see Figure 2).

The analysis of efficiency changes revealed a significant overall increase in socio-eco-efficiency across nearly all dimensions and regions by 2022. Primarily, this was attributed to a general uptick in subjective well-being coupled with either a slight decrease or very modest increase in the objective measures previously analyzed. Furthermore, health capital, considered as part of human capital, exhibited increased efficiency creation for most regions for similar reasons. Under the health capital model's specifics, it was posited that medical infrastructure and services contributed to the subjective well-being of regions.

The North Caucasus and Ural Federal Districts emerged as efficiency frontrunners, despite a decline in population vitality – a trend contradicting morbidity indicators. Morbidity rates increased from 2% in the North Caucasus Federal District to 20% in the Northwestern Federal District over the nine-year period. These effects may partly stem from both negative and positive factors, such as enhanced diagnostic accuracy or pandemic-related consequences.

Structural capital effectiveness was a control variable, highlighting the influence of material indicators on subjective well-being. This variable reflected innovation activity, R&D investment, and fixed capital as an input. It became evident that not all regions managed to establish infrastructure conducive to subjective well-being growth; more specifically, the Volga and Southern Federal Districts noticeably lagged in terms of efficiency.

However, the results of efficiency assessments for the last two models – sustainable overall efficiency and sustainable well-being efficiency—yielded less adequate outcomes. The inclusion of a larger number of factors allowed regions to achieve efficiency amidst significantly varied resource configurations. Consequently, this approach may be less suited for crafting differentiated regional policies, and decision-makers should rely on separate indicators to assess efficiency changes. As an illustration, let us look at the North Caucasus Federal District, where the average efficiency indicator for a composite model incorporating both subjective and objective outputs

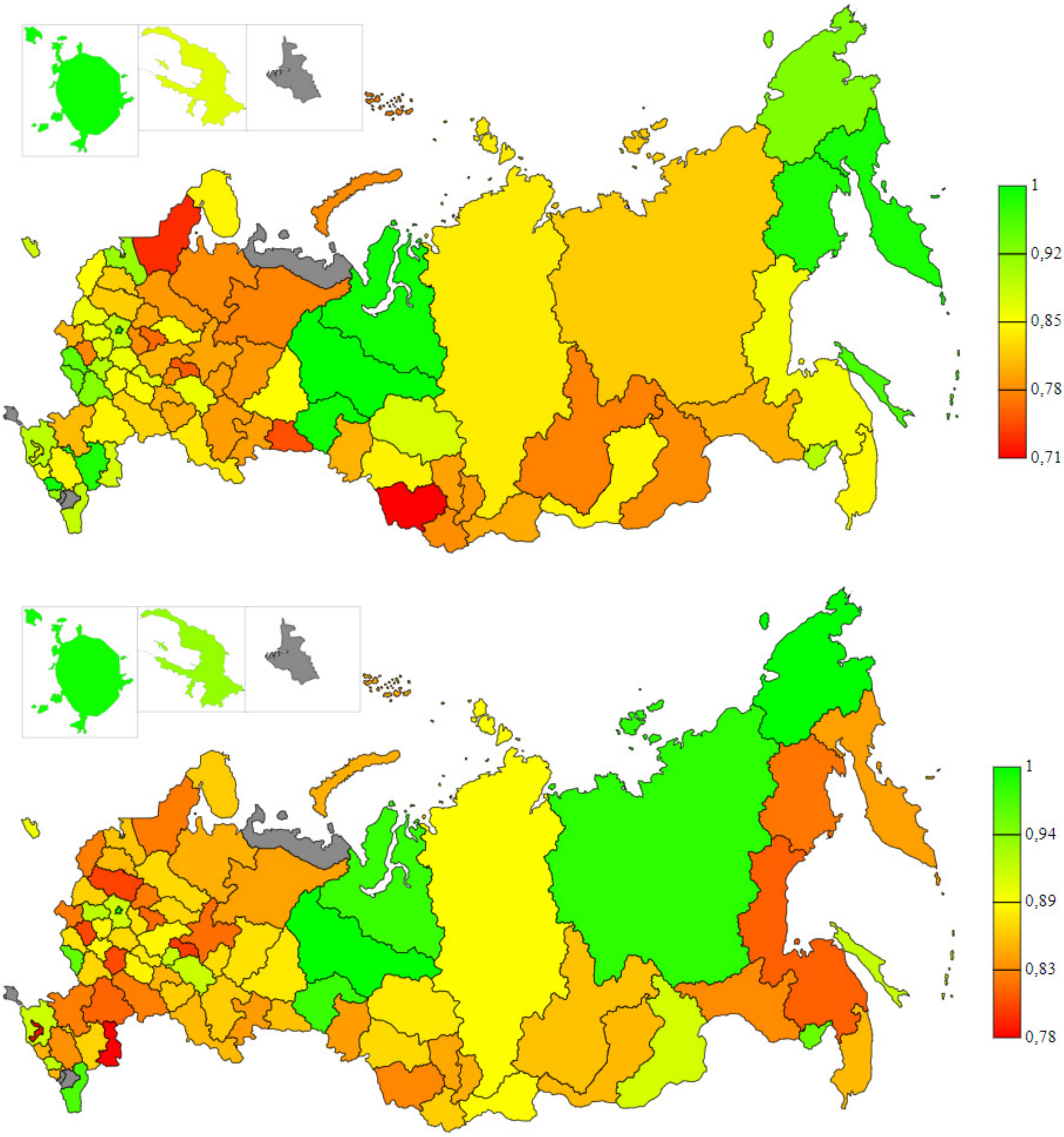

Figure 2. *Indicators of average eco-efficiency (top figure) and efficiency of human capital (bottom figure) for Russian regions in 2014-2022. There is no reliable data for regions highlighted in gray.*
Source: obtained by the author based on COLC[6] data.

revealed low efficiency at 0.69. However, when focusing solely on subjective well-being indicators, efficiency approached 1.

Stage 3. Tobit panel regression. This stage addressed the second research question regarding the determinants of eco-efficiency and human capital efficiency. With the exception of eco-efficiency, the Hausman test results showed the effectiveness of random effects estimates. Eco-efficiency was influenced by specific individual characteristics that did not change over time and were likely related to the industrial structure and geography of regions. GRP had a significant impact on these indicators (Table 3), which was especially noticeable in the example of the oil and gas regions of the Urals. For human capital, it was like-

[6] Rosstat. Comprehensive Observation of Living Conditions (COLC). Retrieved from: https://rosstat.gov.ru/free_doc/new_site/GKS_KOUZH_2022/index.html (Date of access 12.10.23)

ly that it exerted its influence through real wages, as they showed a high correlation with GRP. Social investment had a positive effect on the efficiency of health capital, despite the fact that it was significantly negatively correlated with the level of real wages. An increase in the share of social payments in the income structure had, as a rule, a negative impact on all objective indicators of well-being, primarily on real wages, but it was an effective tool for subjective well-being given limited tangible and intellectual resources in the regions.

The digitalization of regions played a predominantly positive role in enhancing eco-efficiency and the return on human capital across almost all cases. Regular internet usage notably influenced human capital efficiency but had a comparatively lesser impact on health capital creation. Conversely, digitalization indicators exhibited no discernible effect on structural capital or overall efficien-

Table 3

Results of regression analysis: pooled OLS, fixed and random effects panel regressions

Variables	Eco-efficiency			Human capital			Health capital		
	Pooled OLS	Fixed	Random	Pooled OLS	Fixed	Random	Pooled OLS	Fixed	Random
GRP	$1,09\times10^{-7}$ ***	$1,97\times10^{-7}$ **	$1,78\times10^{-7}$ ***	$1,05\times10^{-7}$ ***	$2,45\times10^{-7}$ ***	$1,62\times10^{-7}$ ***	$2,84\times10^{-8}$	$2,09\times10^{-7}$ ***	$1,02\times10^{-7}$ ***
	(4,33)	(2,82)	(5,95)	(4,25)	(3,55)	(4,62)	(1,19)	(5,26)	(3,34)
CAP_{IN}	$-1,77\times10^{-7}$ *	$-3,69\times10^{-8}$	$-1,13\times10^{-7}$	$-8,81\times10^{-8}$	$-1,94\times10^{-7}$ *	$-1,60\times10^{-7}$	$6,40\times10^{-8}$	$1,81\times10^{-7}$	$2,00\times10^{-7}$ ***
	(−2,20)	(−0,37)	(−1,84)	(−1,12)	(−2,16)	(−1,55)	(0,84)	(1,72)	(3,35)
EDU	$-2,70\times10^{-4}$	$4,11\times10^{-4}$	$1,05\times10^{-4}$	$3,28\times10^{-4}$	$-3,01\times10^{-4}$	$4,77\times10^{-4}$	$3,24\times10^{-5}$	$8,18\times10^{-4}$ *	$7,07\times10^{-4}$ *
	(−1,26)	(1,09)	(0,36)	(1,56)	(−0,28)	(1,51)	(0,16)	(1,99)	(2,32)
SOC	$-5,19\times10^{-3}$ ***	$2,05\times10^{-3}$	$-1,20\times10^{-3}$	$-4,97\times10^{-4}$	$4,18\times10^{-4}$	$-2,12\times10^{-4}$	$2,72\times10^{-3}$ ***	$1,08\times10^{-2}$ ***	$9,11\times10^{-3}$ ***
	(−6,69)	(1,32)	(−1,09)	(−0,65)	(0,18)	(−0,19)	(3,69)	(8,31)	(7,77)
SC	$1,26\times10^{-6}$	$1,22\times10^{-6}$	$1,59\times10^{-6}$	$2,25\times10^{-6}$	$1,86\times10^{-6}$	$2,16\times10^{-6}$	$1,19\times10^{-6}$	$2,19\times10^{-7}$	$7,09\times10^{-7}$
	(1,37)	(0,60)	(1,30)	(2,51)	(0,74)	(1,65)	(1,37)	(0,13)	(0,57)
DIG	$1,60\times10^{-3}$ ***	$4,42\times10^{-4}$	$9,69\times10^{-4}$ ***	$1,29\times10^{-3}$ ***	$8,91\times10^{-4}$ *	$1,46\times10^{-3}$ ***	$1,21\times10^{-3}$ ***	$-1,95\times10^{-4}$	$5,15\times10^{-4}$ *
	(5,76)	(1,79)	(4,05)	(4,74)	(2,05)	(4,77)	(4,57)	(−0,61)	(2,09)
SEC	$-2,88\times10^{-3}$	$-2,08\times10^{-4}$	$-9,01\times10^{-4}$	$-1,72\times10^{-3}$	$-3,28\times10^{-3}$	$-2,85\times10^{-3}$	$-1,71\times10^{-3}$	$1,34\times10^{-3}$	$6,34\times10^{-4}$
	(−1,58)	(−0,17)	(−0,78)	(−0,97)	(−2,02)	(−1,54)	(−0,99)	(1,05)	(0,55)
OPEN	$5,37\times10^{-6}$	$-1,56\times10^{-6}$	$-1,40\times10^{-6}$	$-2,96\times10^{-6}$	$-2,65\times10^{-6}$	$-3,43\times10^{-6}$	$6,22\times10^{-6}$	$-9,04\times10^{-7}$	$1,31\times10^{-7}$
	(1,97)	(−1,09)	(−0,64)	(−1,11)	(−1,63)	(−1,04)	(2,40)	(−0,63)	(0,06)
URBAN	$-1,58\times10^{-3}$ ***	$-3,98\times10^{-3}$	$-2,29\times10^{-3}$ ***	$-1,63\times10^{-3}$ ***	$7,67\times10^{-3}$	$-2,07\times10^{-3}$ ***	$-1,07\times10^{-3}$ ***	$2,88\times10^{-3}$	$-1,66\times10^{-3}$ *
	(−5,01)	(−0,88)	(−3,60)	(−5,28)	(1,27)	(−4,09)	(−3,59)	(0,70)	(−2,49)
_cons	0,951		0,901	0,868		0,869	0,817		0,696
	*** (34,08)		*** (20,28)	*** (31,76)		*** (21,91)	*** (30,77)		*** (14,79)
R^2	0,4063	—	—	0,3160	—		0,2082	—	—
LL	—	—	602,91	—	—	470,27	—	—	549,34
LLT(p)	—	66,86 (0,000)	124,84 (0,000)	—	90,92 (0,000)	125,46 (0,000)	—	217,60 (0,000)	279,17 (0,000)
HT(p)	—	—	130,28 (0,000)	—	—	11,15 (0,132)	—	—	11,35 (0,124)

Source: Author's calculations using Stata 17

Note. T-statistics in parentheses. LL – Likelihood ratio; LLT(p) – Likelihood ratio test χ^2 (p-value); HT(p) – Heckman test χ^2 (p-value); t-statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001; _cons – constant.

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cy levels (see Table 4 below), primarily contributing to the return on accumulated education and work experience.

Urbanization had a consistent negative influence on eco-efficiency and human capital efficiency. While satisfaction with work and infrastructure quality tended to be higher in urban centers, the surplus administrative resources yielded a lower return on subjective well-being compared to less urbanized areas. This phenomenon likely stems from suboptimal resource utilization in cities, aligning with findings from prior studies on the developing Chinese economy (He et al., 2023). Despite offering additional opportunities, the efficiency of resource use declined due to escalating environmental issues, inequality, and population morbidity. This underscores the imperative to reassess urban development policies to prioritize social factors that bolster subjective well-being. Consequently, regions may eventually encounter limitations concerning human capital components, further diminishing the efficacy of adaptation strategies or precipitating a significant decline in subjective well-being.

Table 4

Results of regression analysis: pooled OLS, fixed and random effects panel regressions

Variables	Structural capital			Overall efficiency			Well-being only		
	Pooled OLS	Fixed	Random	Pooled OLS	Fixed	Random	Pooled OLS	Fixed	Random
GRP	$2,57\times10^{-7}$ ***	$9,19\times10^{-8}$	$5,02\times10^{-7}$ ***	$1,21\times10^{-7}$ ***	$1,13\times10^{-7}$	$4,30\times10^{-7}$ ***	$5,17\times10^{-8}$	$2,20\times10^{-7}$ ***	$8,39\times10^{-8}$ *
	(8,34)	(1,35)	(7,04)	(3,93)	(1,30)	(3,51)	(1,88)	(5,12)	(2,41)
CAP_{IN}	$-6,07\times10^{-7}$ ***	$-2,96\times10^{-7}$ *	$-1,07\times10^{-6}$ ***	$-2,67\times10^{-7}$ **	$-1,04\times10^{-7}$	$-6,67\times10^{-7}$ *	$-8,93\times10^{-8}$	$-1,51\times10^{-7}$	$-1,42\times10^{-7}$
	(−6,17)	(−2,28)	(−6,04)	(−2,70)	(−1,21)	(−2,35)	(−1,01)	(−1,69)	(−1,84)
EDU	$1,13\times10^{-4}$	$-1,44\times10^{-3}$	$7,65\times10^{-4}$	$7,15\times10^{-5}$	$-8,32\times10^{-4}$	$-1,90\times10^{-4}$	$4,47\times10^{-4}$	$-1,29\times10^{-4}$	$2,90\times10^{-4}$
	(0,43)	(−1,82)	(1,14)	(0,27)	(−1,26)	(−0,20)	(1,90)	(−0,17)	(0,77)
SOC	$8,54\times10^{-4}$	$-9,30\times10^{-4}$	$1,74\times10^{-4}$	$-3,12\times10^{-3}$ ***	$-4,20\times10^{-3}$	$-6,80\times10^{-3}$ *	$-4,44\times10^{-4}$	$-2,37\times10^{-3}$	$-1,52\times10^{-3}$
	(0,90)	(−0,42)	(0,09)	(−3,28)	(−1,88)	(−2,23)	(−0,52)	(−1,25)	(−1,06)
SC	$1,03\times10^{-6}$	$-4,14\times10^{-6}$	$-1,04\times10^{-6}$	$-1,64\times10^{-6}$	$-2,22\times10^{-6}$	$-1,81\times10^{-6}$	$2,82\times10^{-7}$	$1,18\times10^{-6}$	$1,41\times10^{-6}$
	(0,92)	(−1,18)	(−0,49)	(−1,46)	(−0,59)	(−0,55)	(0,28)	(0,40)	(0,89)
DIG	$-2,86\times10^{-4}$	$-6,19\times10^{-4}$	$-7,25\times10^{-4}$	$-1,80\times10^{-5}$	$-1,35\times10^{-4}$	$-2,90\times10^{-4}$	$3,39\times10^{-4}$	$1,00\times10^{-4}$	$3,76\times10^{-4}$
	(−0,84)	(−1,30)	(−1,63)	(−0,05)	(−0,36)	(−0,39)	(1,11)	(0,29)	(1,18)
SEC	$-2,94\times10^{-3}$	$-4,80\times10^{-3}$ *	$-6,39\times10^{-3}$ *	$-1,06\times10^{-3}$	$-4,12\times10^{-3}$	$-7,92\times10^{-3}$ *	$5,00\times10^{-4}$	$-1,62\times10^{-3}$	$-1,01\times10^{-3}$
	(−1,32)	(−2,05)	(−2,47)	(−0,47)	(−2,11)	(−2,05)	(0,25)	(−1,10)	(−0,64)
OPEN	$7,76\times10^{-7}$	$1,65\times10^{-6}$	$-1,42\times10^{-6}$	$4,35\times10^{-6}$	$1,32\times10^{-6}$	$1,35\times10^{-5}$	$1,33\times10^{-6}$	$-1,67\times10^{-6}$	$-5,41\times10^{-7}$
	(0,23)	(1,46)	(−0,25)	(1,30)	(0,83)	(1,16)	(0,45)	(−1,36)	(−0,21)
URBAN	$-2,02\times10^{-3}$ ***	$1,24\times10^{-2}$	$-3,04\times10^{-3}$ ***	$-2,25\times10^{-3}$ ***	$7,66\times10^{-3}$	$-5,58\times10^{-3}$ ***	$-2,61\times10^{-3}$ ***	$5,37\times10^{-3}$	$-3,60\times10^{-3}$ ***
	(−5,26)	(1,51)	(−3,33)	(−5,81)	(1,02)	(−3,59)	(−7,58)	(0,85)	(−4,57)
_cons	0,985 ***		1,068 ***	1,147 ***		1,488 ***	1,052 ***		1,148 ***
	(28,86)	—	(15,74)	(33,47)	—	(12,57)	(34,40)	—	(20,06)
R^2	0,2020	—	—	0,1800	—	—	0,1601	—	—
LL	—	—	266,05	—	—	55,20	—	—	426,72
LLT(p)	—	18,39 (0,031)	70,18 (0,000)	—	19,93 (0,018)	45,76 (0,000)	—	45,29 (0,000)	26,32 (0,002)
HT(p)	—	—	3,80 (0,704)	—	—	4,95 (0,666)	—	—	1,32 (0,988)

Source: Author's calculations using Stata 17

The study's findings carry significant theoretical and policy implications. Conceptually, the study advances a socio-eco-efficiency model aimed at sustaining subjective well-being. This model integrates crucial sustainability determinants, including human capital, regional environmental performance, and structural capital. The study's core idea revolves around decomposing socio-eco-indicators, with a primary emphasis on human capital and environmental activity indicators. The efficacy of this approach is validated by the obtained results, revealing substantial differentiation among regions in the areas under consideration.

The proposed three-stage approach combines the benefits of factor analysis, DEA-based efficiency estimation, and the identification of long-term efficiency determinants through panel tobit regression. This comprehensive approach facilitates the grouping of factors influencing subjective well-being, assessing regional effectiveness in subjective well-being creation, and pinpointing elements crucial for transformative strategies such as digitalization, social investments, and urbanization to enhance regional efficiency.

In evaluating regional effectiveness, it is imperative to integrate indicators of both objective and subjective well-being. Furthermore, efficiency assessment should encompass the optimal allocation of available resources while accommodating constraints. Notably, financially stable regions with high material wealth don't consistently leverage tangible resources to enhance subjective well-being efficiency. Hence, a shift from adaptation strategies amid limited growth towards strategies promoting objective well-being growth is recommended. Failing to do so may lead to a decline in subjective well-being over time.

Conclusions

Research on subjective well-being contributes to our comprehension of economic agent behavior in regional ecosystems and provides principles for crafting human capital development strategies that balance individual and social interests. The current surge of interest in subjective well-being increasingly emphasizes environmental performance metrics and the use of accrued human capital, spurred by mounting green skepticism and climate uncertainty (King et al., 2023).

An essential factor reshaping well-being strategies is geo-economic fragmentation: two waves of sanction pressure and pandemic disruptions have significantly impacted objective indicators in Russian regions (Zubarevich, 2022), yet satisfaction and subjective assessments of quality of life have continued to ascend. Adaptation during the past two decades of economic transition is pivotal in understanding this rise in satisfaction. Human capital emerges as a crucial element in the adaptability of the Russian regional economy. However, by 2023, labor supply has contracted significantly, real wage growth has diminished, and educational strategies face threats from technological simplification (Gimpelson, 2022; Kapeliushnikov, 2023).

Empirical studies yield several key insights. Firstly, in numerous cases, there is a weak relationship between objective and subjective well-being indicators, particularly evident in their dynamics. While developed countries often exhibit the Easterlin paradox—slower growth in subjective well-being despite increased objective wealth (Easterlin, 2001; Easterlin et al., 2010)—Russian regions demonstrate the opposite phenomenon, which can be explained by their adaptation to geo-economic fragmentation and evolving realities. A consistent rise in subjective well-being occurs alongside marginal fluctuations in objective indicators.

Secondly, regions vary in how effectively they turn both tangible and intellectual resources into subjective well-being. Differences in structure mean that major cities and regional centers, which gather many resources, sometimes end up with more than they need.

Lastly, the drivers for enhancing socio-eco-efficiency are digitalization and per capita GRP growth. Digitalization serves as a primary catalyst for technological transformation, with its social repercussions increasingly central in subjective well-being research (Elmassah & Hassanein, 2022). Digitalization positively impacts regional socio-eco-efficiency through improved decision-making support and heightened productivity. However, its influence on structural capital effectiveness and overall well-being contribution appears marginal.

Social investment and capital positively contribute to health capital creation. However, the current pace of urbanization in developing countries, as noted in prior studies (He et al., 2023), remains costly and leads to inefficient resource reallocation.

Limitations and avenues for further research include the reliance on evaluative well-being measures that overlook affect and emotional expres-

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sions of happiness. Additionally, the absence of focus on social capital—crucial for regional socio-eco-efficiency due to the lack of reliable indicators in Rosstat microdata bases—poses a limitation. Future research should aim to identify stable assessments of overall life satisfaction in regions and uncover determinants of regional efficiency in sustaining subjective well-being.

Appendix

Table A1

Heat map of changes in subjective well-being by federal districts from 2014 to 2022

Indicator	District	2014	2016	2018	2020	2022
Multicriterial job satisfaction (on a Likert scale from 1 to 5, where 5 is a complete satisfaction)	CFD	4,24	4,24	4,26	4,37	4,44
	NWFD	4,21	4,24	4,28	4,31	4,40
	SIFD	4,26	4,22	4,24	4,38	4,41
	NCFD	4,17	4,13	4,22	4,21	4,42
	VFD	4,24	4,28	4,23	4,30	4,45
	UFD	4,24	4,28	4,30	4,36	4,44
	SFD	4,13	4,17	4,18	4,29	4,37
	FEFD	4,18	4,14	4,27	4,33	4,43
Safety and environmental compliance (here and after: a share of respondents who did not note the problems in their region of residence, unit fractions)	CFD	0,77	0,79	0,84	0,84	0,86
	NWFD	0,72	0,72	0,80	0,79	0,81
	SFD	0,81	0,85	0,86	0,83	0,86
	NCFD	0,85	0,85	0,91	0,89	0,94
	VFD	0,77	0,79	0,84	0,83	0,84
	UFD	0,72	0,73	0,80	0,78	0,82
	SIFD	0,69	ц0,72	0,75	0,76	0,78
	FEFD	0,68	0,69	0,76	0,77	0,78
Access to cultural infrastructure	CFD	0,69	0,74	0,73	0,70	0,75
	NWFD	0,71	0,74	0,75	0,73	0,79
	SFD	0,70	0,60	0,65	0,66	0,68
	NCFD	0,59	0,59	0,62	0,65	0,78
	VFD	0,72	0,68	0,72	0,70	0,73
	UFD	0,74	0,77	0,82	0,77	0,81
	SIFD	0,69	0,68	0,68	0,68	0,70
	FEFD	0,70	0,70	0,66	0,74	0,73
Access to social infrastructure	CFD	0,85	0,86	0,85	0,82	0,86
	NWFD	0,85	0,84	0,85	0,84	0,86
	SFD	0,83	0,83	0,88	0,82	0,84
	NCFD	0,85	0,88	0,81	0,85	0,92
	VFD	0,85	0,84	0,85	0,85	0,85
	UFD	0,84	0,87	0,87	0,86	0,89
	SIFD	0,81	0,79	0,79	0,81	0,79
	FEFD	0,82	0,83	0,80	0,84	0,84
Quality of infrastructure	CFD	0,65	0,67	0,69	0,68	0,72
	NWFD	0,59	0,62	0,66	0,66	0,68
	SFD	0,58	0,56	0,59	0,63	0,57
	NCFD	0,59	0,57	0,62	0,70	0,74
	VFD	0,63	0,62	0,69	0,68	0,66
	UFD	0,65	0,68	0,71	0,68	0,73

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Indicator	District	2014	2016	2018	2020	2022
Quality of infrastructure	SIFD	0,58	0,61	0,61	0,62	0,64
	FEFD	0,52	0,54	0,57	0,60	0,61

Note. CFD – Central Federal District; NWFD – Northwestern Federal District; SFD – Southern Federal District; NCFD – North Caucasus Federal District; VFD – Volga Federal District; UFD – Ural federal district; SFD – Siberian Federal District; FEFD – Far Eastern Federal District.

Table A2

Heat map of changes in objective well-being by federal districts from 2014 to 2022, in percentages, values for 2014 = 100%

Indicator	District	2014	2016	2018	2020	2022	Average growth
Real wages	CFD	100,00	89,78	99,44	106,30	107,46	100,80
	NWFD	100,00	90,69	100,79	106,86	106,91	100,74
	SFD	100,00	90,99	102,02	109,88	100,56	100,06
	NCFD	100,00	88,36	99,30	107,63	104,57	100,50
	VFD	100,00	91,95	102,09	109,63	111,58	101,22
	UFD	100,00	89,15	95,75	102,23	107,93	100,85
	SIFD	100,00	91,49	103,18	111,70	112,92	101,36
	FEFD	100,00	92,60	103,83	113,19	117,05	101,76
GRP per capita	CFD	100,00	101,22	106,19	108,48	119,59	102,01
	NWFD	100,00	102,44	104,81	105,64	117,34	101,79
	SFD	100,00	99,07	104,76	105,57	108,69	100,93
	NCFD	100,00	99,04	99,44	100,11	110,12	101,08
	VFD	100,00	99,13	103,07	103,96	108,66	100,93
	UFD	100,00	96,31	100,31	93,35	99,53	99,95
	SIFD	100,00	99,33	103,33	102,87	107,54	100,81
	FEFD	100,00	101,23	106,28	109,64	119,38	101,99
Environmental investments per capita	CFD	100,00	89,32	100,77	109,21	148,95	104,53
	NWFD	100,00	86,06	100,04	89,37	88,48	98,65
	SFD	100,00	72,06	67,55	74,19	88,58	98,66
	NCFD	100,00	99,48	91,96	109,54	138,43	103,68
	VFD	100,00	65,88	68,76	80,40	77,00	97,14
	UFD	100,00	88,92	75,71	84,76	123,97	102,42
	SIFD	100,00	81,08	76,67	87,35	92,76	99,17
	FEFD	100,00	122,87	126,48	161,95	203,25	108,20
Share of social investments in income	CFD	21,99	21,91	22,63	25,27	24,89	2,91
	NWFD	22,75	23,44	23,58	26,25	26,02	3,27
	SFD	20,62	21,17	21,02	24,57	23,83	3,22
	NCFD	18,78	20,08	20,88	25,92	25,60	6,82
	VFD	21,85	23,16	24,37	27,81	27,49	5,64
	UFD	18,76	20,50	21,16	24,74	24,56	5,80
	SIFD	24,12	25,41	25,74	29,79	29,41	5,29
	FEFD	18,84	19,68	19,59	21,89	21,89	3,05
Population vitality	CFD	100,00	100,05	100,45	101,77	95,35	99,47
	NWFD	100,00	94,20	93,67	101,64	95,00	99,43
	SFD	100,00	99,50	99,26	102,91	95,94	99,54
	NCFD	100,00	96,48	97,45	92,96	91,13	98,97

Indicator	District	2014	2016	2018	2020	2022	Average growth
Population vitality	VFD	100,00	100,86	101,14	105,69	100,22	100,02
	UFD	100,00	97,74	97,37	99,35	93,82	99,29
	SIFD	100,00	102,56	102,53	108,06	102,60	100,29
	FEFD	100,00	101,54	101,26	105,92	99,45	99,94
Educational attainment in human-years	CFD	100,00	101,04	99,35	99,70	98,95	99,88
	NWFD	100,00	100,78	99,29	100,01	98,75	99,86
	SFD	100,00	101,29	99,90	100,79	100,12	100,01
	NCFD	100,00	101,51	100,52	99,75	98,87	99,87
	VFD	100,00	101,03	99,29	99,73	98,73	99,86
	UFD	100,00	100,83	99,50	98,96	98,40	99,82
	SIFD	100,00	100,88	99,44	99,67	98,31	99,81
	FEFD	100,00	100,80	100,47	101,36	100,22	100,02
Work experience in human-years	CFD	100,00	105,41	115,24	121,29	124,69	102,48
	NWFD	100,00	106,07	117,29	122,14	124,69	102,48
	SFD	100,00	108,62	119,30	127,15	132,51	103,18
	NCFD	100,00	104,00	116,58	116,51	120,53	102,10
	VFD	100,00	106,49	115,09	119,94	122,48	102,28
	UFD	100,00	105,20	117,10	116,72	123,02	102,33
	SIFD	100,00	106,60	115,93	120,67	123,12	102,34
	FEFD	100,00	105,94	116,84	125,81	130,02	102,96

Table A3

Heat map of changes in average socio-eco-efficiency by federal districts from 2014 to 2022. Evaluations are based on efficiency scale from 0 to 1, where 1 is the production frontier level of efficiency.

Indicator	District	2014	2016	2018	2020	2022
Eco-efficiency	CFD	0,84	0,85	0,88	0,86	0,87
	NWFD	0,81	0,81	0,82	0,84	0,85
	SFD	0,88	0,88	0,88	0,88	0,87
	NCFD	0,88	0,90	0,89	0,91	0,93
Eco-efficiency	VFD	0,80	0,80	0,81	0,82	0,82
	UFD	0,87	0,87	0,88	0,87	0,88
	SIFD	0,78	0,79	0,80	0,82	0,82
	FEFD	0,86	0,87	0,88	0,90	0,90
Human capital	CFD	0,85	0,86	0,87	0,86	0,90
	NWFD	0,83	0,84	0,88	0,86	0,91
	SFD	0,84	0,81	0,83	0,84	0,84
	NCFD	0,87	0,85	0,86	0,90	0,96
	VFD	0,85	0,84	0,88	0,87	0,89
	UFD	0,88	0,88	0,92	0,91	0,96
	SIFD	0,85	0,85	0,86	0,86	0,89
	FEFD	0,87	0,85	0,90	0,90	0,94
Health capital	CFD	0,90	0,91	0,92	0,93	0,94
	NWFD	0,88	0,88	0,88	0,94	0,96
	SFD	0,88	0,88	0,88	0,92	0,90
	NCFD	0,94	0,93	0,94	0,92	0,97
	VFD	0,85	0,86	0,88	0,91	0,92

Indicator	District	2014	2016	2018	2020	2022
	UFD	0,93	0,95	0,95	0,96	0,97
Health capital	SIFD	0,84	0,86	0,87	0,93	0,93
	FEFD	0,85	0,85	0,85	0,91	0,92
	CFD	0,93	0,91	0,90	0,87	0,92
	NWFD	0,88	0,87	0,87	0,87	0,92
	SFD	0,91	0,88	0,85	0,84	0,87
Structural capital	NCFD	0,93	0,96	0,95	0,93	0,97
	VFD	0,90	0,88	0,89	0,87	0,88
	UFD	0,92	0,92	0,95	0,91	0,95
	SIFD	0,95	0,93	0,91	0,88	0,90
	FEFD	0,92	0,91	0,91	0,89	0,90
	CFD	0,91	0,88	0,90	0,83	0,87
	NWFD	0,81	0,77	0,77	0,76	0,86
	SFD	0,91	0,92	0,90	0,87	0,88
Overall efficiency	NCFD	0,70	0,69	0,65	0,66	0,69
	VFD	0,84	0,82	0,79	0,69	0,75
	UFD	0,89	0,95	0,88	0,86	0,93
	SIFD	0,91	0,89	0,84	0,81	0,85
	FEFD	0,96	0,94	0,93	0,90	0,94
	CFD	0,91	0,91	0,92	0,89	0,92
	NWFD	0,89	0,88	0,89	0,89	0,92
	SFD	0,92	0,93	0,91	0,88	0,92
Well-being only	NCFD	0,98	0,97	0,97	0,96	0,99
	VFD	0,90	0,89	0,90	0,88	0,91
	UFD	0,94	0,93	0,94	0,92	0,95
	SIFD	0,89	0,89	0,88	0,87	0,91
	FEFD	0,84	0,85	0,86	0,87	0,89

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