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Regional foresight and scenario modelling of socio-economic transformation: The case of the Kostanay Region, Kazakhstan

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Abstract. This study examines labour market transformation in the Kostanay Region of Kazakhstan, a peripheral agrarian region experiencing persistent demographic decline, negative net migration, and growing territorial differentiation. The research applies a regional foresight framework to explore possible development trajectories of employment under conditions of limited and short regional statistical time series. The analysis is based on an exploratory mixed-methods design that combines descriptive analysis of official regional statistics for 2018–2023, expert-based foresight with elements of the Delphi method, and qualitative scenario modelling up to 2039. Quantitative indicators are used exclusively for descriptive and contextual purposes to identify recent demographic, migration, and sectoral employment trends, without causal inference or forecasting claims. Expert elicitation (n = 42) from academia, business, and public administration is employed to identify key drivers of labour market transformation, emerging competency clusters, and sources of uncertainty. Scenario modelling is used to construct three qualitatively distinct, place-based development pathways: an inertial baseline scenario, an innovation-driven scenario, and a green growth scenario–expressed as relative deviations from the 2023 baseline. These scenarios are not interpreted as probabilistic forecasts but as analytically grounded representations of alternative futures under different technological, institutional, and environmental assumptions. The results reveal pronounced territorial differentiation in labour market trajectories within the region. While technological and environmental modernisation is associated with rising productivity and export potential in selected districts, employment adjustment is spatially uneven and constrained by migration outflows, human capital losses, and institutional capacity. Productivity gains are shown to coexist with employment contraction in routine-intensive sectors, underscoring the distinction between quantitative employment levels and qualitative job transformation. The study contributes to regional science by demonstrating how skill-biased and routine-biased technological change manifests in a demographically shrinking agrarian region with marked core–periphery contrasts, and by illustrating the analytical potential and limitations of integrating descriptive statistics, expert foresight, and scenario analysis under data constraints. The proposed framework offers a transferable, transparent approach for analysing labour market transformation in peripheral regions facing structural change and demographic decline.

Key words: regional foresight; scenario analysis; labour market transformation; peripheral regions; Kostanay

1 Introduction

Regional labour markets in peripheral and resource-oriented territories are shaped by the combined influence of demographic, economic, and institutional factors (Kassymova et al. 2025). Population decline, migration outflows, and structural changes in the economy – further intensified by technological modernisation and the green transition – create a context of heightened uncertainty for regional policymakers. These processes are particularly pronounced in agrarian regions, where employment dynamics are closely linked to sectoral restructuring, investment activity, and labour mobility (Kazbekova, Ogami 2024).

Regional studies demonstrate that such transformations are accompanied by pronounced territorial heterogeneity. Differences between urban and rural areas, core and peripheral districts, as well as zones with distinct sectoral specialisations, generate divergent labour market trajectories within a single region. The out-migration of young and skilled populations, combined with the uneven spatial distribution of investment, increases the vulnerability of peripheral territories and reinforces existing structural imbalances. At the same time, technological and environmental modernisation may raise labour productivity without necessarily leading to employment growth, thereby complicating the assessment of the social and territorial implications of these processes (Goos, Manning 2007, Autor 2019).

Despite sustained interest in spatial disparities within regional studies, empirical analyses of labour markets at the subnational level are often constrained by data availability. In many regions, long and spatially disaggregated time series are lacking, which limits the application of rigorous econometric and spatial modelling approaches (Eralina, Alshanov 2023, Ibraeva, Aimagambetov 2025). Under these conditions, foresight-based approaches are gaining increasing relevance, as they focus not on identifying causal relationships but on exploring possible development trajectories and supporting strategic decision-making under high uncertainty. Nevertheless, applied research has so far paid insufficient attention to the systematic and transparent use of regional foresight for analysing labour market transformations while explicitly accounting for territorial heterogeneity (Intykbayeva et al. 2022, Yegenisova et al. 2024).

The present study seeks to address this gap by employing regional foresight as an analytical framework to examine labour market transformation in the Kostanay Region of the Republic of Kazakhstan. The region represents a peripheral agrarian territory characterised by persistent population decline, a negative migration balance, and pronounced socio-economic disparities at the district level, alongside investment-driven modernisation of the agri-food sector and related industries (Makhambetov et al. 2024). These characteristics allow the Kostanay Region to be considered not only as an object of regional policy but also as an analytical case that reflects broader mechanisms of labour market adaptation in peripheral and resource-oriented regions.

The aim of this study is to analyse possible trajectories of labour market transformation in the Kostanay Region using a regional foresight approach that combines descriptive analysis of statistical data, expert assessments, and scenario modelling under conditions of a limited and short regional statistical time series. As such, the Kostanay Region provides an analytical case that informs broader debates in regional science on regional resilience and spatially uneven labour market adjustment in peripheral and resource-oriented regions.

Methodologically, the study is based on the integration of three interrelated analytical components: (1) a descriptive analysis of demographic, migration, and labour indicators with an emphasis on territorial differentiation; (2) a structured expert study aimed at identifying key drivers of labour market transformation and sources of uncertainty; and (3) scenario modelling that reflects alternative pathways of sectoral and territorial reconfiguration of employment over a long-term horizon. This approach ensures analytical

coherence between empirical observations, expert judgements, and scenario narratives, without claiming strict causal interpretation or point forecasting.

The scientific novelty of this study lies in the application of a regional foresight approach to the analysis of the labour market of a peripheral agrarian region under conditions of a constrained empirical base; in identifying the role of migration constraints, sectoral structure, and territorial heterogeneity in shaping differentiated employment trajectories; and in demonstrating the potential of scenario analysis as a tool for supporting place-based policy and adaptive regional governance.

From the perspective of regional science, the study contributes to a deeper understanding of labour market transformation mechanisms in peripheral and agrarian-oriented regions experiencing demographic decline. The findings show that employment adaptation to technological and environmental change is spatially heterogeneous and is shaped by differences in institutional capacity, investment activity, and migration resilience across districts within a single region, resulting not in a single trajectory but in multiple territorially differentiated labour market development pathways.

2 Literature Review

Contemporary labour market transformations are largely interpreted through the lens of technological change, digitalisation, and the development of artificial intelligence. Labour economics highlights the dual nature of these processes: technological progress simultaneously generates labour displacement effects, whereby automation replaces routine tasks, and complementarity effects associated with the emergence of new tasks that enhance the productivity of human labour (Brynjolfsson, Mitchell 2017, Acemoglu, Restrepo 2019). As a result, labour markets do not exhibit a uniform decline or expansion of employment, but rather a divergence of trajectories –marked by a contraction of middle-skilled routine occupations and an expansion of high-skilled analytical and creative employment, alongside selected segments of low-wage service jobs.

A key methodological implication of these processes has been a shift in analytical focus from occupations to tasks, commonly referred to as the task-based approach. Within this framework, employment vulnerability and adaptability are assessed on the basis of task composition, using indicators of exposure to artificial intelligence and automation (Felten et al. 2021). This approach is widely applied to identify areas of employment risk as well as potential sources of job growth.

Alongside digital transformation, the influence of environmental factors is becoming increasingly pronounced. The green transition–including decarbonisation, improved resource efficiency, and the development of circular technologies–is reshaping occupational structures and generating demand for "green" skills and competencies (Branca et al. 2022, While, Eadson 2022, Hanna et al. 2024). Research within the just transition framework suggests that the aggregate employment effects may be positive; however, they are accompanied by pronounced sectoral and territorial imbalances, which heighten the importance of regionally differentiated reskilling and upskilling policies.

From the perspective of regional science, it is crucial that global technological and institutional drivers manifest unevenly across space (Godet 2005). Studies emphasise the role of selective migration, spatial mismatch between labour supply and demand, and persistent divergences between urban and rural areas. Peripheral and mono-specialised regions are particularly subject to cumulative causation effects, whereby the out-migration of young and skilled populations erodes labour market adaptability and undermines long-term regional resilience (Dingel, Neiman 2020, Donald et al. 2024, Tsai, Urmetzer 2024, Jamal et al. 2025, Steinberg et al. 2025).

In post-Soviet economies, these processes are reinforced by the combined effects of demographic decline, migration flows, and structural economic transformation. Economic modernisation requires the reorientation of human capital towards emerging sectors; however, the spatially uneven distribution of educational and employment opportunities generates persistent regional imbalances between labour demand and supply (Balatsky, Ekimova 2021, Komarovsky 2023).

In Kazakhstan, regional heterogeneity of labour markets is particularly pronounced.

Industrial regions are characterised by a high concentration of employment in extractive and metallurgical industries and by increasing risks of technological substitution, whereas agrarian regions – including the Kostanay and North Kazakhstan Regions – concentrate labour in agriculture, where digitalisation and the automation of agri-technologies are rapidly transforming the structure of labour demand. Large cities, such as Almaty and Astana, function as centres of employment growth in education, information and communication technologies (ICT), and the creative economy (Nurlanova et al. 2024, Alzhanova et al. 2024).

Under conditions of high uncertainty and limited availability of regional statistical data, foresight approaches are becoming increasingly widespread. In regional science, foresight is not viewed as a tool for precise forecasting, but rather as an analytical framework for exploring possible development trajectories and supporting strategic choice. Depending on research objectives, a distinction is commonly made between exploratory and normative scenarios, as well as between scenarios based on the extrapolation of current trends and structural scenarios that assume changes in key system parameters (Westhoek et al. 2006, Strelkovskii et al. 2020).

Compared with alternative methods of regional analysis – such as shift-share models, input-output frameworks, and spatial panel models – the foresight approach offers distinct advantages in contexts where the application of formal quantitative methods is constrained by short time series or the absence of spatially disaggregated data. Its key strength lies in the ability to integrate empirical observations with structured expert knowledge, provided that procedures are transparent and that clear links are established between scenario assumptions and the interpretation of results.

Human capital occupies a central position in research on regional resilience and labour market adaptation. In peripheral regions, the loss of human capital through migration outflows represents one of the main development constraints, reinforcing the need for scenario-based and place-based approaches to the analysis of employment transformation (Nurlanova et al. 2025). In Kazakhstan, these challenges are reflected in the development of Atlases of New Professions (Nurbek et al. 2022); however, their application at the regional level is limited by labour market spatial heterogeneity and the scarcity of comparable data. This situation underscores the relevance of analytical approaches focused on interpreting multiple territorially differentiated trajectories of labour market transformation, which defines the methodological logic of the present study (Koshanov, Chulanova 2021, Nyussupova et al. 2022, Sergeyeva et al. 2025).

3 Materials and Methods

3.1 Overall methodological framework

The study adopts an exploratory mixed-methods design that combines quantitative and qualitative approaches within a regional foresight framework. The methodological logic is grounded in the recognition that short regional time series, pronounced territorial heterogeneity, and high structural uncertainty substantially limit the scope for strict causal identification and precise forecasting. Accordingly, the analytical objective of the study is not to construct an econometric forecasting model, but to provide a structured interpretation of plausible labour market transformation trajectories that are relevant for strategic regional governance.

The methodological architecture is organised as a sequential analytical workflow in which each method serves a clearly defined role:

- Descriptive quantitative analysis to diagnose current demographic and labour market trends and to identify the scale of territorial differentiation;
- Expert-based foresight analysis to identify key transformation drivers, sources of uncertainty, and potential structural shifts;
- Scenario modelling to construct qualitatively distinct long-term development trajectories;

- Exploratory regression analysis to assess the consistency of scenario assumptions with observed statistical associations;
- SWOT analysis to qualitatively evaluate the feasibility of scenarios in light of regional institutional and policy conditions.

Although spatial heterogeneity is central to the research question, the study does not employ formal spatial econometric techniques (Moran's I, SAR, SEM, SDM). This choice reflects the limited temporal depth and the absence of consistent panel data at the district level. Spatial differentiation is therefore analysed descriptively and interpretatively through district-level mapping, expert-based typologies, and scenario differentiation rather than through statistical testing of spatial dependence.

3.2 Data sources and empirical base

The empirical basis of the study draws on official regional statistics published by the Bureau of National Statistics of the Republic of Kazakhstan (BNS RK) for the period 2018–2023. The dataset includes indicators of population dynamics, migration balance, employment structure, income levels, gross regional product, and fixed capital investment. This time span was selected to ensure both data availability and methodological consistency across regional indicators (BNS RK 2025a,b).

Analytical reports produced by the International Labour Organization (ILO), the OECD (Employment Outlook), and the World Economic Forum (WEF) were used as contextual reference points to situate regional labour market developments within broader macroeconomic, technological, and institutional transformations. These sources were not employed as primary empirical inputs, but rather as interpretative benchmarks supporting the analytical framing of the study (ILO 2021, 2023).

The qualitative component of the study draws on an expert-based foresight exercise with 42 participants from the business sector (n = 15), academia (n = 14), and public administration (n = 13). Experts were selected according to clearly specified criteria, including a minimum of five years of relevant professional experience, direct involvement in regional development and labour-market issues, and the absence of direct conflicts of interest. This composition was intended to secure a balanced mix of strategic, analytical, and operational perspectives and to enhance the robustness of expert judgements used in scenario development. A detailed account of expert selection, elicitation procedures, qualitative coding, and the audit trail from expert input to scenario construction is provided in Appendix A.

3.3 Qualitative methods and expert foresight

The expert component of the study was implemented as a two-stage foresight process informed by selected elements of the Delphi method. In the first stage, experts identified key technological, demographic, institutional, and environmental drivers shaping labour market transformation. In the second stage, these drivers were systematically ranked according to their expected impact and the degree of associated uncertainty.

The resulting materials were analysed using content analysis and thematic coding. Clusters of emerging competencies and scenario factors were derived from the recurrence of key themes and the degree of convergence across expert judgements. The expert component is used to inform scenario assumptions rather than to provide statistical validation, serving as a qualitative input to the scenario-building process (Popper 2008, Alabugin et al. 2022).

No econometric modelling is used in the study to test hypotheses, estimate effects, or support inference. All quantitative indicators serve an illustrative and contextual function only.

3.4 Scenario modelling

Scenario modelling was used to develop qualitatively distinct alternative trajectories of regional labour market development over the horizon to 2039. The scenarios are not

forecasts and should not be interpreted as probabilistic representations of the future (Duncan, Wack 1994).

Scenario parameters were calibrated as relative deviations from the 2023 baseline and are intended to illustrate directional differences between alternative development pathways rather than to estimate future indicator values. The calibration was informed by: (1) current statistical levels, (2) expert assessments of the direction and intensity of structural change, and (3) comparisons with similar transformation processes observed in comparable regions.

The analysis resulted in three scenarios: an inertial (baseline) scenario, an innovation-driven scenario, and an environmentally oriented scenario. Quantitative values are used solely to support the comparative interpretation of these scenarios.

3.5 SWOT analysis as a tool for qualitative validation

SWOT analysis was applied at the final stage of the study as a qualitative tool to assess the practical feasibility of the scenarios in light of the region's institutional capacity and regional policy priorities. Rather than generating new empirical evidence, the SWOT framework serves to integrate analytical findings into a broader policy and governance context.

District classification was conducted using a descriptive grouping procedure based on cumulative net migration balance (2018–2023), sectoral employment structure, and investment intensity. Threshold values were defined using natural breaks in the empirical distributions of these indicators, allowing districts to be grouped into analytically comparable territorial types.

The authors acknowledge several limitations related to the short length of the available time series, the absence of spatially disaggregated panel data, and the exploratory nature of the econometric analysis. Accordingly, the results are interpreted as analytically grounded scenario-based insights rather than as econometrically validated effects or predictive estimates. Although spatial heterogeneity is central to the analysis, formal spatial econometric models were not applied due to the short length of available time series and the absence of consistent district-level panel data. Spatial differentiation is therefore analysed descriptively through district-level indicators, expert-based typologies, and scenario differentiation rather than through statistical testing of spatial dependence.

4 Results

4.1 Demographic dynamics and migration processes

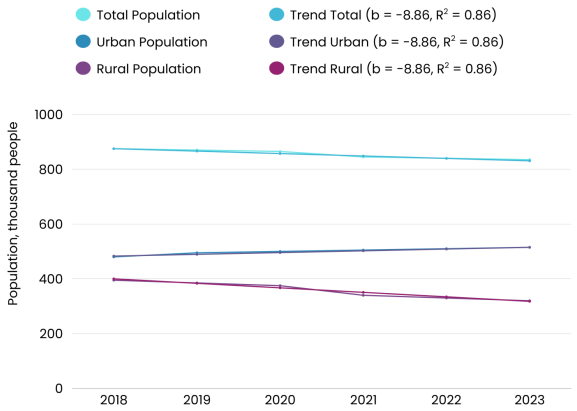
The results presented below are descriptive and interpretative in nature and should not be read as statistical tests of relationships. As of 2023, the population of the Kostanay Region amounted to 829.5 thousand people, of whom 517.9 thousand resided in urban areas (62.4%) and 311.6 thousand in rural areas (37.6%). The region accounted for 4.1% of the total population of the Republic of Kazakhstan. Between 2018 and 2022, the population declined by 40.6 thousand people, with the most pronounced decrease observed in rural areas, while urban population growth remained modest. Preliminary data for 2023 confirm the persistence of this trend.

Figure 1 illustrates the dynamics of total, urban, and rural population in the Kostanay Region over the period 2018–2023, together with linear trends estimated using ordinary least squares.

These trends are descriptive in nature and are intended to illustrate the general direction of demographic change. They are not interpreted as forecasting models and do not imply causal relationships.

Estimates of linear trends over the short period 2018–2023 allow a descriptive characterisation of the direction of demographic change: an annual decline in total population of approximately 9–10 thousand people, moderate growth of the urban population, and an accelerated decrease in the rural population. Taken together, these processes indicate a trend towards population concentration in urban centres against the backdrop of over-

all demographic decline and are used subsequently as contextual information for spatial and scenario-based analysis.



Source: compiled by the authors based on data from the Bureau of National Statistics of the Republic of Kazakhstan.

Figure 1: Dynamics of total, urban, and rural population in the Kostanay Region, 2018–2023

The spatial distribution of migration flows is presented in Figure 2, where districts are classified according to the intensity and direction of net migration over the period 2018–2023.

Northern districts – such as the city of Lisakovsk and the Altynsarin, Mendykara, and Fyodorov districts – recorded net in-migration, indicating relatively more favourable living and employment conditions. In contrast, major administrative and industrial centres (Kostanay, Rudny, and Arkalyk), along with a group of peripheral districts (Zhitikara, Auliekol, Karasu, Zhangeldy, and Amangeldy), are characterised by persistent migration outflows and the largest cumulative population losses.

The dynamics of migration processes are presented in Figure 3. The overall net migration balance remains negative (-4.9 thousand people in 2022); however, compared with 2019 (-6.7 thousand), an improvement is observed.

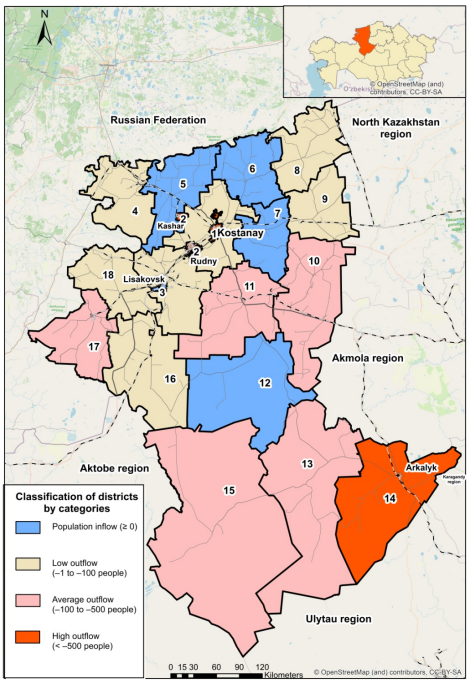
Losses from external migration have declined, while internal migration has shifted towards intensified outflows. The increase in both arrivals and departures in 2021–2022 points more to rising population mobility than to stabilisation. These dynamics are consistent with the hypothesis of growing spatial polarisation of demographic and labour potential, concentrated in a limited number of relatively stable territories.

Taken together, the evidence presented in Figures 1-3 reflects a transformation of the region's settlement structure, characterised by accelerated rural population decline, selective concentration in specific urban and northern districts, and a persistently negative migration balance. These trends are subsequently used in the typologisation of districts and the allocation of territories across scenario trajectories.

4.2 Expert-based qualitative analysis of regional development trajectories

The expert interviews portray Kostanay Region as a mature agrarian–industrial region that simultaneously fulfils a strategic role in Kazakhstan's food security and industrial output and faces a cumulative set of structural vulnerabilities. Experts from public administration emphasised that the region remains one of the country's key grain producers and hosts important mining and processing capacities, including iron ore, bauxite, and aluminium production. At the same time, they pointed to a persistent dependence on a relatively narrow set of sectors and to the sensitivity of regional dynamics to external shocks, climatic variability, and demographic change.

Across interviews, experts consistently identified three groups of sectors as strategically central for the region's long-term development: (1) the agro-industrial complex,



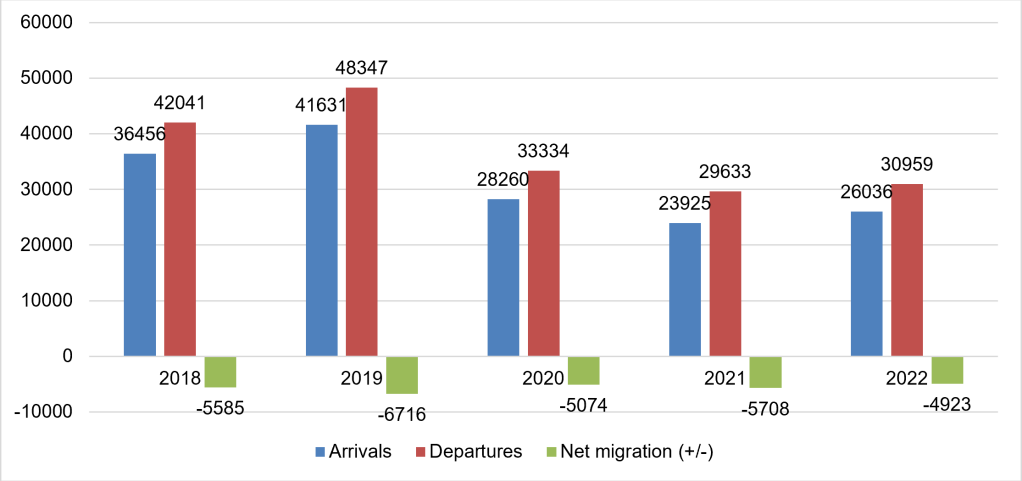
Source: compiled by the authors based on data from the Bureau of National Statistics of the Republic of Kazakhstan.

Figure 2: Classification of districts in the Kostanay Region by cumulative net migration, 2018–2023 (descriptive grouping)

combining crop production, livestock, and deeper processing of agricultural raw materials; (2) mining, metallurgy, and machine-building, including the emerging automobile cluster and associated supplier networks; and (3) social and knowledge-intensive sectors such as healthcare, education, IT, and transport–logistics. This configuration echoes the survey evidence, where respondents most frequently associated the future of the region with the development of services and tourism, industrial innovation, and the agro-industrial complex, while infrastructure and environmental improvements were perceived as important but somewhat secondary priorities.

Experts broadly agreed that the last five years were characterised by a combination of shocks and opportunities. On the one hand, geopolitical tensions and disruptions in neighbouring Russia were seen as affecting external trade links, logistics, and investor uncertainty. Climatic stresses, including recurrent droughts, were highlighted as a major risk for grain production and, by extension, for regional income and employment. On the other hand, experts repeatedly underscored the positive momentum generated by new investment projects in construction, processing industries, and machine-building, citing growth in construction output, the commissioning of new housing and infrastructure, and the expansion of automobile and agricultural machinery production. These changes were interpreted as early signs of economic diversification and the formation of emerging industrial clusters, but also as processes that critically depend on the availability of qualified labour.

A central theme running through the interviews is the growing tension on the regional labour market. Representatives of construction firms, industrial enterprises, and agricultural organisations independently described acute shortages of skilled workers and engineering professionals. In construction, deficits were reported for site engineers, cost estimators, surveyors, and various skilled trades. In agriculture, experts noted a lack of agronomists, veterinarians, and machinery operators, especially in rural areas. Industrial and machine-building experts emphasised the increasing demand for engineers in automation, robotics, and industrial IT, as production lines become more automated and quality control more technologically sophisticated.



Source: compiled by the authors based on data from the Bureau of National Statistics of the Republic of Kazakhstan.

Figure 3: Migration flows and net migration balance in Kostanay Region, 2018–2022 (descriptive statistics)

At the same time, experts did not portray the regional labour force as passive or resistant to change. Their assessments resonate with the survey results, which show that around three quarters of respondents are willing to undertake additional training to master new and in-demand professions, primarily under conditions of higher wages, clear career prospects, and interesting work content. From the experts' perspective, this willingness is increasingly supported by the emergence of corporate training infrastructures – such as corporate universities and in-house training centres at large enterprises – and by initial steps towards dual education and closer cooperation between firms and educational institutions. However, they also stressed that these initiatives still remain fragmented and do not fully compensate for systemic weaknesses in regional education and training systems.

The education–labour market interface was identified by almost all experts as a critical bottleneck. While some interviewees from business and industry assessed the regional education system as broadly capable of meeting quantitative needs, they simultaneously pointed to a persistent mismatch between graduates' skills and the practical requirements of modern production. Experts from public administration and education underlined the limited practical orientation of many programmes, the insufficient involvement of employers in curriculum design, and the lack of up-to-date equipment in vocational and higher education institutions. Several experts explicitly argued for a stronger role of dual education, expanded production internships, and the systematic involvement of practitioners and industrial experts in teaching.

Territorial disparities emerged as another important dimension of expert assessments. Respondents from agriculture and construction stressed that rural areas face particularly acute challenges in attracting and retaining qualified personnel, including teachers, doctors, and agricultural specialists. In their view, low levels of rural infrastructure, housing shortages, and limited access to services reduce the attractiveness of rural locations for young professionals, even when financial incentives or state support programmes are available. Experts linked these conditions to ongoing youth out-migration and warned that, without targeted interventions, the resulting spatial imbalance in human capital could further constrain regional development and accentuate centre–periphery divides within the region.

Despite these concerns, the expert narratives also highlight substantial transformational potential associated with technological and organisational change. Interviewees described active experimentation with precision agriculture, digital farm management, and smart farming technologies in larger agricultural enterprises, as well as the gradual diffusion of automation and robotics in industrial and automobile production. In their

Table 1: Descriptive parameters of linear OLS trends for demographic and migration indicators, 2018–2023

Indicator	b, units/year	R^2
Total population (thousand people)	–9.0	0.890
Urban population (thousand people)	+6.3	0.773
Rural population (thousand people)	–15.3	0.909
Migration balance (thousand people)	+0.29	0.414

Note: Linear trend coefficients are reported for descriptive purposes only. Due to the short time series (n = 6), no inferential interpretation is implied.
Source: Compiled by the authors.

view, these processes are likely to reshape the qualitative structure of labour demand: reducing the need for low-skilled manual labour while increasing demand for technicians, engineers, and hybrid profiles combining sector-specific knowledge with digital competences. Experts from both industry and science emphasised that the success of such a transition will depend on the region's capacity to mobilise and retain a new generation of specialists, and on the ability of educational institutions and scientific organisations to act as mediators and co-creators of knowledge.

Taken together, the expert assessments offer a coherent but differentiated picture of regional development trajectories. They converge on the diagnosis of Kostanay Region as a structurally important but vulnerable agrarian–industrial region, in which climatic risk, demographic pressures, and institutional capacity will interact with technological and investment dynamics. At the same time, experts stress the existence of locally specific assets – established industrial enterprises, emerging clusters, corporate training infrastructures, and a relatively high motivation of the population to invest in their own skills. These findings underpin the scenario logic developed in the subsequent sections of the paper: an inertial trajectory that reproduces current imbalances; an innovation-driven path centred on digitalisation, industrial upgrading, and skills development; and a green growth scenario in which ecological constraints and sustainability concerns become explicit structuring elements of regional development.

4.3 Sectoral structure of employment

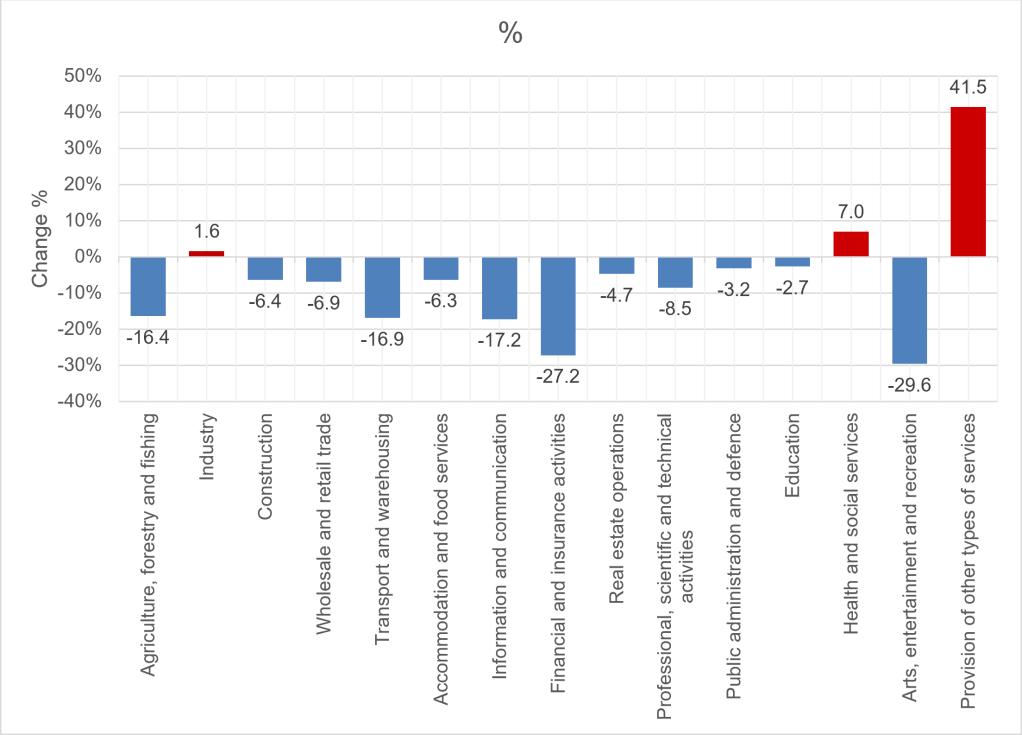
Against the backdrop of ongoing demographic and migration changes, a decline in employment across several key sectors of the regional economy was recorded in 2023. The largest relative contractions were observed in arts, entertainment, and recreation (–29.6%), financial and insurance activities (–27.2%), information and communication (–17.2%), transport and storage (–16.9%), agriculture, forestry, and fishing (–16.3%), water supply (–14.3%), electricity generation and distribution (–13.4%), wholesale and retail trade (–6.8%), and construction (–6.4%). Figure 4 presents the percentage changes in employment by type of economic activity.

These changes point to simultaneous pressures on both the region's innovative and logistical potential – through declining employment in ICT, financial, and transport sectors – and its traditional agrarian base. In the subsequent sections, these descriptive sectoral shifts are interpreted in conjunction with expert assessments, scenario trajectories, and the results of the exploratory regression analysis.

The parameters of the linear trends reported in Table 1 are used for descriptive purposes to provide a general characterisation of the direction and relative intensity of demographic and migration changes in the Kostanay Region over the period 2018–2023.

4.4 Expert identification of transformation drivers and emerging competencies

The foresight component of the study was aimed at the systematic identification of key drivers shaping the transformation of the regional labour market and the associated changes in the structure of professional competencies. The analysis focused on the agricultural sector as the system-forming branch of the Kostanay Region's economy, given



Note: The figure presents descriptive sectoral changes and does not imply causal interpretation.
Source: compiled by the authors based on official statistical data (2023).

Figure 4: Percentage change in employment by economic sector in Kostanay Region (2023 compared to 2022)

its central role in employment, spatial organisation, and the region's socio-economic resilience.

Expert input was collected through a two-stage procedure informed by elements of the Delphi method. In the first stage, participants compiled an extended list of technological, economic, social, and institutional factors with potential influence on employment dynamics and labour demand. In the second stage, these factors were ranked according to two criteria: their expected magnitude of impact and the likelihood of implementation in the medium term. This process resulted in an "impact × probability" matrix, from which a group of high-impact, high-probability (High–High) factors was identified. These factors were subsequently used to parameterise the scenario trajectories of regional development. The key trends identified through this procedure are summarised in Table 2.

Table 2: Key expert-identified trends in the agricultural sector used for scenario construction (horizon up to 2039)

Category	Trends
Technological	Digitalisation of agricultural production, implementation of GIS technologies, robotics and drones, use of bioproducts
Economic	Growth of exports, product branding, price volatility, increase in production capacity
Social	Emergence of new professions, disappearance of traditional ones, development of agrotourism, human resource management

Source: Compiled by the authors.

To analyse the qualitative content of expert assessments, a content analysis of questionnaire materials was conducted, followed by thematic coding. This process made it possible to identify four stable clusters of emerging competencies that reflect the directions of structural employment transformation in the region's agricultural sector:

1. Data and digital agro-technologies, including sensor systems, geoinformation solutions, and data analytics, generating demand for specialists in digital monitoring, modelling, and decision-support systems;

2. Bio- and agro-engineering, implying a growing need for biotechnological, genetic, and laboratory-analytical skills in the context of agricultural modernisation;

3. Sustainable land use and environmental management, oriented towards resource efficiency, waste processing, risk reduction, and compliance with green standards;

4. Service-oriented employment models, associated with the development of agrotourism, service support for farming enterprises, and the expansion of non-agricultural income sources in rural areas.

In parallel, experts noted a declining relative importance of several traditional functional roles (for example, veterinary operators and specialists engaged in routine chemical control), reflecting a shift in labour demand towards interdisciplinary professional profiles combining digital, engineering, and environmental competencies. The identified clusters are subsequently used to interpret scenario development trajectories and to substantiate priority directions for the modernisation of educational programmes and vocational retraining systems.

4.5 Scenario trajectories to 2039 and spatial differentiation

Scenario modelling was employed to construct three qualitatively distinct configurations of regional labour market development over the horizon to 2039. The baseline (inertial) scenario assumes the continuation of existing structural trends under conditions of limited technological and institutional change. The innovation-driven scenario is characterised by accelerated digitalisation, mechanisation, and the strengthening of cluster effects in the agricultural sector and related industries. The green growth scenario prioritises the adoption of green technologies, organic farming, value-added processing, and the development of rural ecotourism.

All scenario outcomes are expressed as relative changes with respect to the 2023 baseline (set to 100%) and are interpreted as conditional scenario projections rather than probabilistic forecasts.

In the innovation-driven scenario, the combined adoption of digital technologies, robotics, and biotechnologies in agriculture is, according to expert assessments and conditional numerical calibration, associated with a 15–20% increase in labour productivity and a 15–20% reduction in production costs relative to the 2023 level. The resulting improvement in the cost–productivity ratio creates conditions for a 30–35% expansion of export potential, as well as for the emergence of niche segments such as agrotourism, organic farming, and the production of bio-based products. For rural households, income structures are expected to diversify by 10–12 percentage points through the expansion of non-agricultural activities.

The green growth scenario implies a more moderate but more stable development trajectory: productivity and export growth remain below those projected in the innovation-driven scenario, while vulnerability to price and climate shocks is reduced and environmental constraints are more fully integrated into land-use decisions. The baseline scenario preserves the existing pattern of specialisation, characterised by limited diversification and high sensitivity to external shocks.

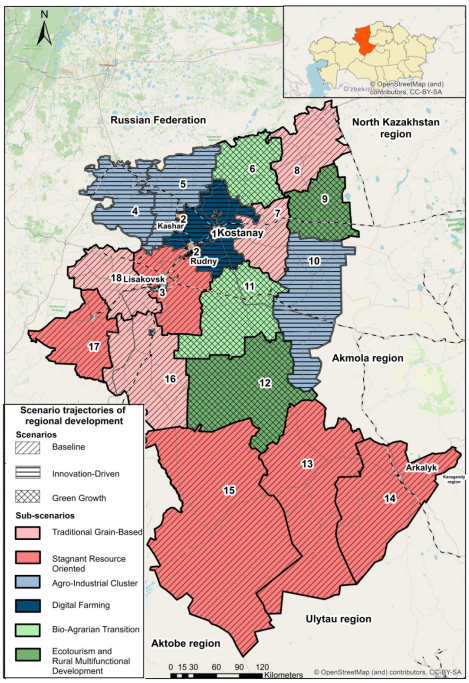
Figure 5 illustrates the spatial configuration of scenarios across the districts of the Kostanay Region, taking into account differences in economic structure, technological readiness, and natural conditions. Three territorial groups can be distinguished. The baseline scenario (southern and south-western parts of the region) comprises monospecialised grain-producing districts characterised by low population density, youth outmigration, and limited investment activity. The innovation-driven scenario (northern and central areas) includes industrial–agrarian nodes with developed infrastructure, agri-industrial clusters, and a high concentration of labour resources. The green growth

scenario (central and eastern districts) covers areas with high natural potential and opportunities for the development of organic farming and ecotourism.

The scenarios represent qualitative, place-based configurations derived from expert-based foresight and are expressed relative to the 2023 baseline. They do not constitute probabilistic forecasts. The focus of the scenario analysis on the agricultural sector is justified by its central role in employment and the territorial organisation of the region. Under conditions of a limited statistical base, concentrating on a single system-forming sector allows the mechanisms of technological and environmental transformation to be traced more transparently, without claiming comprehensive coverage of all sectors of the economy.

A simple sensitivity check, in which key assumptions (for example, average annual growth rates) were varied within expert-defined plausible ranges, did not alter the relative ranking of scenarios. This supports the robustness of the qualitative conclusions, although it does not provide a formal quantification of uncertainty.

Overall, the results indicate pronounced territorial differentiation in labour market trajectories across the Kostanay Region. These findings are consistent with place-based approaches in regional studies that emphasise differentiated territorial responses rather than uniform policy solutions.



Source: compiled by the authors based on the results of the regional foresight study.

Figure 5: Scenario trajectories of agricultural sector development in the Kostanay Region until 2039

4.6 SWOT synthesis and territorial implications

SWOT analysis was applied at the final stage of the study as a qualitative synthesis tool integrating demographic and migration trends, expert assessments, scenario configurations, and the results of the exploratory regression analysis within a regional policy context (Table 3).

The strengths of the Kostanay Region include a rich resource base, well-developed agri-industrial infrastructure, a strategic border location, and educational potential. Key constraints are associated with persistent migration outflows – particularly of young and skilled workers –environmental pressures in industrial zones, limited economic diversification, and uneven digitalisation of rural areas.

Table 3: SWOT analysis of the socio-economic development of the region

Strengths	**Weaknesses**
1. Rich natural resource base, including iron ore, bauxite, and brown coal.	1. Persistent population out-migration, particularly among youth and skilled workers.
2. Well-developed agricultural sector based on fertile soils and water availability.	2. Economic dependence on a limited number of core industries.
3. Established industrial base (metallurgy, processing industries).	3. Low level of digitalisation and limited internet access in remote rural areas.
4. Strategic border location supporting cross-border trade.	4. High poverty and social inequality in rural territories.
5. Sufficient educational and human capital potential.	5. Environmental degradation and infrastructure deficits in industrial zones.
Opportunities	**Threats**
1. Attracting investment into infrastructure, logistics, and economic diversification.	1. Intensification of climate and environmental risks (droughts, soil degradation).
2. Expansion of export markets for agricultural and processed products.	2. Continued demographic decline and labour-force outflow from rural areas.
3. Development of renewable energy and green technologies.	3. Declining investment attractiveness without technological modernisation.
4. Expansion of vocational training, retraining, and digital upskilling programmes.	4. Rising interregional competition for investment and labour resources.
5. Development of ecotourism and multifunctional rural economies.	5. Growing dependence on imported technologies and equipment.

Source: compiled by the authors.

The region's opportunities are largely driven by investment and technological factors, including the expansion of export markets, the development of transport and logistics corridors, the adoption of renewable energy sources, and the scaling up of vocational training and digital upskilling programmes. Major threats stem from demographic decline, intensifying interregional competition for investment and labour, climate-related risks, and dependence on imported technologies.

From a spatial perspective, the interaction of these factors generates differentiated development trajectories: innovation-oriented industrial–agrarian nodes, peripheral grain-producing districts facing a high risk of depopulation, and "green growth" territories focused on environmentally sustainable and diversified rural development. These territorial configurations link descriptive statistical results and scenario narratives with labour market adaptation mechanisms and provide a foundation for the formulation of place-based strategies.

5 Discussion

In substantive terms, the study contributes in three complementary directions. First, it adds to the regional foresight literature by proposing a transparent and transferable expert-based analytical protocol for labour market analysis under conditions of limited subnational data, explicitly incorporating territorial heterogeneity into scenario design. Second, it contributes to regional labour market research by demonstrating how migration constraints, sectoral structure, and institutional capacity jointly shape spatially differentiated employment trajectories within a single peripheral agrarian region. Third, it informs regional policy design by illustrating how scenario-based analysis can support place-based decision-making, including the identification of critical vulnerability domains and priority intervention areas for adaptive regional governance.

5.1 Technological change and task reallocation in the regional labour market

The results obtained for the Kostanay Region are broadly consistent with the propositions of skill-biased and routine-biased technological change (SBTC/RBTC). The observed decline in employment in sectors with a high share of routine tasks – such as

agriculture, transport, and trade – coincides with expert-identified growth in demand for digital, engineering, and interdisciplinary competencies. This supports the applicability of the task-based approach, according to which technological change primarily reshapes the structure of tasks performed rather than leading to the complete disappearance of occupations.

At the same time, the regional context reveals pronounced spatial heterogeneity in these processes. Urban and agri-industrial nodes display higher levels of readiness for digitalisation and technological adaptation, whereas peripheral rural districts face institutional and human-capital constraints. This underscores the importance of place-based approaches in both the analysis and governance of regional labour markets.

5.2 Productivity, employment structure, and spatial differences

At first glance, employment declines observed in several sectors appear to contradict scenario assumptions that imply rising productivity, export potential, and technological intensity. This apparent tension, however, is resolved when employment is interpreted in structural and qualitative terms rather than as a purely quantitative indicator.

In both the innovation-driven and green growth scenarios, productivity gains do not translate automatically into an expansion of total employment. Instead, they are associated with a reallocation of labour demand towards a smaller number of more skilled and more productive jobs, alongside a contraction of low-productivity and routine positions. This pattern is consistent with international empirical evidence documenting similar dynamics in agrarian and industrial regions (World Economic Forum 2020, 2023).

Accordingly, the key challenge for the Kostanay Region lies not in the absolute level of employment, but in the region's capacity to manage the transition towards new task profiles and skill requirements through reskilling, occupational mobility, and effective institutional coordination.

5.3 Demography, migration, and regional resilience

Negative net migration and the accelerated depopulation of rural areas intensify the effects of technological change on the labour market. Population outflows – particularly among younger and more educated groups – reduce the local supply of adaptive labour, thereby constraining the adoption of digital and environmental technologies. At the same time, limited opportunities for employment diversification in peripheral districts reinforce migration incentives, generating cumulative dynamics typical of regions on a downward development trajectory.

From the perspective of regional resilience theory, these processes indicate a weakening of the region's adaptive capacity. In the Kostanay Region, demographic decline functions not only as an external constraint but also as an endogenous component of labour market transformation, shaping both the feasibility and the social consequences of modernisation strategies.

5.4 Implications and study limitations

The scenario analysis allows several broader implications for regional development to be identified. First, technological modernisation and economic diversification are necessary conditions for long-term competitiveness, but they do not automatically result in inclusive labour market outcomes. Measures aimed at workforce adaptation – including reskilling, lifelong learning, and targeted support for younger cohorts – should therefore be considered integral components of development strategies alongside investment-driven growth.

Second, development pathways require clear territorial differentiation. Innovation-driven trajectories are more feasible in urban areas and agri-industrial clusters, whereas green growth and multifunctional rural development pathways appear more adaptive for peripheral districts with a limited industrial base.

The interpretation of the results accounts for several study limitations related to the short length of available time series, the exploratory nature of the regression analysis, and

the potential selectivity of expert assessments. Accordingly, the scenario trajectories are treated as analytically grounded representations of possible futures rather than as causal conclusions or probabilistic forecasts. The proposed analytical framework is transferable to other peripheral agrarian regions experiencing demographic decline under conditions of limited data availability.

From a regional science perspective, the results support an analytical centre–periphery typology, where districts differ in migration resilience, sectoral labour demand, and institutional capacity, leading to territorially differentiated labour market adjustment mechanisms rather than a single regional trajectory.

6 Conclusions

This study analysed the transformation of the labour market in the Kostanay Region, a peripheral agrarian region characterised by persistent demographic decline, negative net migration, and increasing territorial heterogeneity. The results reveal the coexistence of rising economic activity and investment with a shrinking population base, generating structural tensions between labour demand, labour supply, and the spatial organisation of employment.

The empirical findings require careful interpretation. The exploratory regression analysis, based on short regional time series, identifies statistical associations between employment, investment, digitalisation, gross regional product, and migration, but does not provide a basis for causal inference. Accordingly, regression estimates are used to characterise the direction of relationships rather than to quantify effects or produce forecasts.

Scenario modelling to 2039 is treated as an analytical device for comparing alternative development trajectories under different technological, institutional, and environmental assumptions, rather than as a probabilistic forecast. The innovation-driven scenario is associated with higher productivity and export potential, while the green growth scenario emphasises resilience and reduced exposure to resource- and climate-related risks. The inertial scenario reflects the persistence of existing structural constraints. Importantly, productivity gains may be accompanied by employment declines in certain sectors, underscoring the distinction between quantitative employment levels and the qualitative characteristics of jobs.

The expert-based foresight component complements the quantitative analysis by providing insights into emerging competencies, institutional constraints, and sources of uncertainty that are only weakly captured in official statistics. The integration of statistical and expert evidence enables a more comprehensive interpretation of labour market transformation under conditions of limited empirical data.

From the perspective of regional studies, the contribution of the paper lies in demonstrating the manifestation of skill-biased and routine-biased technological change in a demographically shrinking agrarian region with pronounced core–periphery contrasts, as well as in illustrating both the potential and the limitations of a mixed methodological approach. The findings highlight the spatially uneven effects of technological and environmental transformation and the emergence of differentiated development trajectories across districts.

The implications of the scenario analysis are indicative rather than prescriptive. Enhancing the resilience of the regional labour market requires place-based strategies that combine technological modernisation, human capital development, and environmental management while explicitly accounting for demographic constraints and territorial inequality.

The study is subject to several limitations, including the short length of available time series, the exploratory nature of the econometric analysis, and the potential selectivity of expert assessments. These limitations point to directions for future research, such as the use of longer panel datasets, spatial analytical methods, and more detailed examination of employment structure and job quality. Nevertheless, the proposed framework offers a replicable approach for analysing labour market transformation in peripheral regions experiencing demographic decline and structural change.

Declarations

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A Appendix: Expert Foresight Protocol

A.1 Purpose and rationale

The expert component was designed to support exploratory, place-based scenario construction rather than hypothesis testing, statistical inference, or prediction. This choice reflects empirical constraints typical for subnational labour-market analysis in peripheral agrarian regions, including short time series, limited spatial disaggregation, and high structural uncertainty. Expert judgement is used as an analytical input for identifying key drivers and plausible development logics, not as a substitute for quantitative validation.

A.2 Expert selection and panel composition

Experts were selected through purposive sampling based on predefined criteria: at least five years of relevant professional experience; direct involvement in regional or sectoral decision-making, research, or implementation; familiarity with peripheral and agrarian regional contexts; and absence of direct conflicts of interest.

The final panel comprised 42 experts from business and industry (n = 15), academia (n = 14), and public administration (n = 13). This composition ensured a balanced representation of strategic, analytical, and operational perspectives. Participation was voluntary, and all responses were collected individually.

A.3 Elicitation design (Delphi elements)

The foresight exercise incorporated selected Delphi elements and consisted of two rounds.

In Round 1, experts identified key technological, economic, social-demographic, institutional, and environmental drivers of labour-market transformation in Kostanay Region up to 2039 using open-ended questions.

In Round 2, drivers were ranked by expected impact and degree of uncertainty. Rankings were synthesised into an impact–uncertainty matrix that informed scenario logic. Anonymity was maintained throughout, and controlled feedback was limited to aggregated summaries. The process was terminated after the second round due to convergence in high-impact drivers.

A.4 Qualitative analysis and synthesis

Expert responses were analysed using inductive qualitative content analysis. Coding focused on recurring themes, constraints, and transformation mechanisms rather than frequency counts. Initial codes were iteratively grouped into higher-order categories through author consensus and interpreted as structural drivers and emerging competency domains. Formal intercoder reliability statistics were not calculated, as coding served analytical structuring for scenario design rather than measurement.

A.5 Audit trail to scenario construction

Expert input was translated into scenarios through a transparent sequence:

1. identification of drivers;
2. selection of high-impact/high-uncertainty factors;
3. thematic clustering;
4. construction of place-based scenarios (inertial baseline, innovation-driven, green growth);
5. calibration of scenario parameters as relative deviations from the 2023 baseline, informed by expert judgement, descriptive statistics, and comparable regional cases.

Scenarios are interpreted as conditional representations of alternative regional futures, not probabilistic forecasts.

A.6 Scope and limitations

The expert foresight component provides structured qualitative insight under conditions of limited statistical data and territorial heterogeneity. It complements descriptive analysis and scenario modelling but does not support causal inference or predictive claims. Limitations related to expert subjectivity are mitigated through panel diversity, anonymity, controlled feedback, and transparent documentation.