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## TWIN TRANSITION AND CHANGING PATTERNS OF SPATIAL MOBILITY: A REGIONAL APPROACH

### MOBI-TWIN D3.3 - THE EFFECTS OF SPATIAL MOBILITY DURING TWIN TRANSITION ON SELECTED LEFT-BEHIND AND DEMOGRAPHICALLY DECLINING AREAS IN TERMS OF DEMOGRAPHICS, SOCIETY, WELFARE SYSTEM AND LABOUR MARKET

<b>Work package</b>	WP3: Assessing the impact of spatial mobility on EU regions
<b>Task</b>	Task 3.3: Assess the effects of spatial mobility on selected left-behind and demographically declining areas in terms of demographics, society, welfare system and labour market
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<b>Abstract</b>	<p>This deliverable presents the main results of Task 3.3 – <i>Assess the effects of spatial mobility on selected left-behind and demographically declining areas in terms of demographics, society, welfare system and labour market</i> within WP3 of the MOBI-TWIN project. The analysis provides a quantitative assessment of how changing mobility patterns associated with the Twin Transition may affect demographic structures, labour-market outcomes, income distribution, welfare systems, public finances, and the urban–rural divide in five pilot regions: Castilla-La Mancha, Central Macedonia, Groningen, Lombardy, and North and East Finland.</p> <p>Building on scenario narratives developed in Task 3.2, the study develops a combined spatial and tax-benefit microsimulation framework using EUROMOD, the European Union’s microsimulation model. Synthetic regional populations are constructed and simulated under four alternative scenarios (Leapfrog, Lion’s Den, Snail’s Pace, Dark Horse) relative to a baseline projection to 2035.</p> <p>Results indicate that regional trajectories depend strongly on how mobility patterns interact with labour demand, skills adaptation, and welfare institutions. Scenarios characterised by stronger labour-market integration and human-capital upgrading are associated with improved employment, higher fiscal revenues, and lower poverty risks, while adverse mobility dynamics may reinforce demographic decline and economic stagnation. The findings provide policy-relevant evidence to support place-based strategies for inclusive and balanced regional development across the EU.</p>
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## EXECUTIVE SUMMARY

This deliverable presents the main results of Task 3.3 – *Assess the effects of spatial mobility on selected left-behind and demographically declining areas in terms of demographics, society, welfare system and labour market*, within WP3 of MOBI-TWIN. It provides a quantitative assessment of how changing mobility patterns may affect selected pilot regions in terms of demographic structures, labour-market outcomes, income distribution, welfare systems, public finances, and the urban–rural divide. The analysis focuses on five pilot regions - Castilla-La Mancha, Central Macedonia, Groningen, Lombardy, and North and East Finland - and evaluates four alternative development scenarios (Leapfrog, Dark Horse, Snail’s Pace, and Lion’s Den) relative to a baseline projection to 2035.

The work is organically embedded within WP3. The simulations conducted under Task 3.3 build directly on the scenario narratives developed in Task 3.2 (*Scenario development for assessing the effects of changing spatial mobility patterns on EU regions*), which provide the conceptual and quantitative backbone for our modelling assumptions. The results are complementary to those produced in Task 3.4, which develops an agent-based model to project population dynamics under alternative scenarios and policy assumptions. While Task 3.4 focuses primarily on behavioural mechanisms and demographic trajectories, Task 3.3 concentrates on the fiscal and redistributive implications of the Twin Transition through a combined spatial and tax-benefit microsimulation framework. Together, these tasks contribute to a comprehensive assessment of the effects of spatial mobility in the pilot regions and provide an integrated evidence base to inform public debate and stakeholder engagement activities under WP4 - *Stakeholder engagement and open policy discussion*.

Methodologically, the analysis combines spatial microsimulation with tax-benefit microsimulation using EUROMOD, the European Union’s tax-benefit microsimulation model. This approach enables the construction of synthetic regional populations and the simulation of household incomes, taxes, transfers, and public revenues under each scenario.

The results indicate that regional trajectories will depend critically on how mobility patterns interact with labour demand, skill adaptation, and welfare systems in the context of the Twin Transition. Scenarios characterised by stronger labour-market integration and human capital upgrading are associated with higher employment, improved fiscal balances, and lower poverty rates, whereas adverse mobility dynamics risk reinforcing demographic decline, reducing fiscal revenues, and intensifying economic stagnation.

Overall, this deliverable provides policy-relevant evidence on the distributional and fiscal consequences of alternative Twin Transition mobility trajectories, supporting EU, national, and regional policymakers in designing strategies that promote inclusive and balanced regional development.



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## LIST OF TERMS AND ABBREVIATIONS

TT	Twin Transition
EL	Greece
ES	Spain
FI	Finland
IT	Italy
NL	Netherlands
ABM	Agent-based model
MS	Microsimulation

# 1 INTRODUCTION

This document presents the main output of Work Package 3 (WP3), Task 3.3, which aims to assess the effects of spatial mobility on selected left-behind and demographically declining areas in terms of demographics, society, welfare systems, and labour markets.

Focusing on five pilot regions - Castilla-La Mancha (Spain), Central Macedonia (Greece), Groningen (Netherlands), Lombardy (Italy), and North and East Finland (Finland) - this analysis contributes to a broader understanding of how the twin green and digital transition (Twin Transition) may reshape regional dynamics in areas facing structural economic or demographic challenges.

Many regions across Europe are grappling with the complex interplay of ageing populations, out-migration of younger cohorts, labour shortages, and rising pressures on welfare systems. These trends threaten to exacerbate territorial inequalities, undermine social cohesion, and limit the capacity of lagging regions to benefit from ongoing structural transformations. The Twin Transition presents new opportunities through technological innovation, evolving skill demands, and changing patterns of production and mobility. Understanding how spatial mobility interacts with these transformative processes is therefore crucial for designing policies that foster balanced regional development and inclusive growth.

Building on the work conducted in Task 3.2, which engaged regional experts through Delphi surveys and workshops to develop future scenarios regarding the potential effects of the Twin Transition, this deliverable provides a quantitative assessment of the implications of spatial mobility under various development trajectories. We develop a new microsimulation model to investigate the fiscal and distributional effects of four alternative scenarios describing how new mobility patterns may shape the future of the five regions: (i) Leapfrog—suggesting rapid improvement through accelerated adjustment and innovation; (ii) Dark Horse—implying an unexpected positive performance of a region; (iii) At Snail's Pace—referring to conditions evolving slowly; and (iv) Lion's Den—indicating adverse or highly challenging circumstances. We assess what the four scenarios imply in terms of labour market outcomes, poverty and inequality, social spending and public revenues, urban-rural divide, relative to a baseline of current population projections for the year 2035.

Methodologically, the study employs a combination of two microsimulation techniques: spatial microsimulation and tax-benefit microsimulation. Spatial microsimulation enhances traditional models by incorporating geographically disaggregated data, allowing us to create synthetic populations that are representative of the regions under various scenarios. Following this, we use EUROMOD, the European Union's tax-benefit microsimulation model, to simulate taxes, benefits, and other fiscal aggregates on these synthetic populations. EUROMOD is widely recognised for its capacity to evaluate the redistributive effects of public policies, and in our case,

it facilitates a comparative analysis between the scenarios and the baseline, assessing impacts on public accounts, the sustainability of welfare systems, and indicators of poverty and income inequality. This work also contributes to ongoing efforts to spatialise EUROMOD (EUROMOD-Spatial), adapting it for local-level public policy analysis rather than relying solely on national data.

Our findings indicate that the development trajectory of the pilot regions will depend substantially on how effectively they respond to the challenges and opportunities presented by the Twin Transition. By quantifying the effects of alternative mobility patterns on demographic structures, labour-market outcomes, household incomes, and public budgets, this deliverable provides evidence to support policy design at EU, national, and regional levels. More broadly, it illustrates the usefulness of microsimulation as a tool for analysing place-based effects of changes in population dynamics, labour market conditions, and public policies.

## 1.1 DOCUMENT STRUCTURE

The structure of this document is as follows: Section 2 details the data and methodology employed in the analysis. Section 3 presents the results region by region, elucidating the implications of our findings. Section 4 discusses the integration of Responsible Research and Innovation (RRI) principles into our work. Finally, Section 5 concludes with a summary of our findings and outlines the next steps for future research.

## 2 DATA AND METHODOLOGY

This section describes the methodology and data used within the framework of Task 3.3 of the MOBI-TWIN project, *Assess the effects of spatial mobility on selected left-behind and demographically declining areas in terms of demographics, society, welfare systems and the labour market*. The main objective of the task is to assess the effects of Twin-Transition-related spatial mobility under the four scenarios developed in Task 3.2 (Leapfrog, Lion's Den, Snail's Pace, and Dark Horse) across the five MOBI-TWIN pilot regions: Castilla-La Mancha (Spain), Central Macedonia (Greece), Groningen (Netherlands), Lombardy (Italy), and North and East Finland (Finland).

The analysis focuses on a medium-term time horizon of approximately ten years (up to 2035), assuming alternative development trajectories influenced by mobility patterns related to the Twin Transition. The output of the task consists of quantitative estimates of key socio-economic indicators describing population characteristics, including disposable income distribution statistics, public finance aggregates, indicators of income poverty and inequality, and labour market outcomes. These results are used to evaluate the potential impact of Twin-Transition-related mobility on regional economies, with particular attention to the sustainability of welfare systems and broader social impacts. The findings aim to support the formulation of policy recommendations and to assist stakeholders in anticipating and assessing future regional development scenarios, contributing to work package 4 of the project.

To this end, a range of methodologies and data sources are employed to carry out the analysis. The work draws in particular on microsimulation techniques, an analytical approach rooted in economics and geography. Microsimulation has a long-standing tradition and is widely used both in academia and by governments and public institutions for the assessment of public policies. Microsimulation models represent an effective tool for analysing the effects of economic and social policies, as well as for simulating alternative future scenarios. In this task, microsimulation provides the core methodological framework for the analysis of the different scenarios. Specifically, our approach combines two complementary microsimulation techniques whose use is well established in the academic literature and has been shown to deliver robust results: spatial microsimulation and tax-benefit microsimulation.

**Spatial microsimulation** consists in adding a more granular spatial dimension to a microdata dataset that originally refers to a broader population, typically survey microdata available at supra-regional or national level. Spatial microsimulation is commonly used to overcome the lack of geographically disaggregated data and operates by combining aggregate population data at small-area level (usually derived from census or administrative sources) with survey microdata, which are recalibrated to generate synthetic populations whose characteristics mirror as closely as possible those of each local area. The selection of key socio-demographic variables that are constrained to match aggregate census values during the calibration process ensures that the

resulting synthetic population is representative of the small-area population in its main characteristics. Spatial microsimulation has been used by geographers for nearly three decades to study social phenomena at the local level in contexts where geographically detailed data are not available, for example to analyse labour market outcomes and population dynamics (Ballas, 2001; Ballas et al., 2007) or multidimensional poverty indicators (Panori et al., 2017). For comprehensive reviews of the methodology, see Ballas et al. (2007) and Tanton et al. (2009).

In this analysis, spatial microsimulation is applied in a particular way. Rather than calibrating survey microdata to replicate observed aggregate characteristics of existing small areas, the microdata are recalibrated to match projected aggregate characteristics of regional populations in 2035, according to the alternative development trajectories defined in Task 3.2 of the MOBI-TWIN project. This approach results in the creation of five distinct synthetic populations for each pilot region, corresponding to the baseline, Leapfrog, Lion's Den, Snail's Pace, and Dark Horse scenarios.

The second methodological tool employed in this work is fiscal, or **tax-benefit, microsimulation**. A tax-benefit microsimulation model typically uses as input survey or administrative microdata that are representative of a given population (for example, individuals, households, or firms) and applies policy rules to simulate the taxes and benefits that each unit in the population is required to pay or is entitled to receive. For example, tax-benefit models can simulate income taxes, property taxes, social contributions, social assistance, income-related benefits, and other transfers, supplementing the underlying survey data with additional information not directly observed in the original datasets. Tax-benefit microsimulation is a well-established methodology in economics and has been in use for more than sixty years, since the seminal work of Orcutt (1957). In this project, we make use of **EUROMOD**, the European Union tax-benefit microsimulation model. EUROMOD is frequently used by researchers and policy analysts across Europe and beyond, as well as by Member State governments and the European Commission. The model enables users to calculate, in a fully comparable manner, the effects of taxes and benefits on household incomes and work incentives for the population of each Member State of the European Union. Cross-country comparability is ensured by coding the policy systems of all Member States within a common framework based on a standard set of modelling conventions (Sutherland and Figari, 2013).

One of the main limitations of tax-benefit microsimulation models such as EUROMOD is their traditional reliance on national-level input data, which often lack the geographical detail required to conduct analyses at regional or small-area level. A solution to this limitation is the combination of spatial microsimulation and tax-benefit microsimulation. Spatial microsimulation allows the introduction of a geographical dimension into the input datasets, generating synthetic populations that can then be used as inputs for tax-benefit models, thereby enabling tax-benefit analysis at the local level. This combined approach has only been partially explored in the past, with a limited number of applications (e.g. Ballas, 2005; Tanton et al., 2009),

but has recently been further developed within EUROMOD through the introduction of the EUROMOD-spatial extension (Figari et al., 2025). The use of tax–benefit microsimulation with EUROMOD-spatial in this project therefore allows us to calculate the distribution of direct taxes, social assistance benefits, social contributions, income-related benefits, and other transfers within the synthetic populations representing alternative future scenarios in the pilot regions in 2035. On this basis, we derive the distribution of disposable income as well as key public finance aggregates, from which the final indicators used in the analysis are computed.

With regard to the **data** used, this work is characterised by the integration of datasets that differ in nature, scope, and source. In particular, the analysis draws on the following data sources:

- Results from the **Delphi survey** conducted within Task 3.2 of the MOBI-TWIN project: these consist of qualitative and quantitative responses collected from experts and stakeholders in the pilot regions. Respondents were presented with alternative scenarios concerning the impact of twin-transition–related mobility and were asked to assess the likelihood and expected trends of a set of demographic and socio-economic variables describing regional populations under each scenario.
- Eurostat regional (NUTS-2) **population projections for 2035**: these projections provide the baseline scenario for the analysis, representing expected demographic developments in the absence of mobility effects related to the twin transition.
- **2021 census** data: census information is used as a benchmark to assess the expected changes in key variables and indicators by 2035.
- **EU-SILC** (European Union Statistics on Income and Living Conditions): EU-SILC is an annual survey collecting individual information on income, poverty, social exclusion, and living conditions of households and represents the main data source for monitoring social cohesion and well-being in the European Union. In this work, national EU-SILC microdata are used as input for both spatial and tax–benefit microsimulation. The richness of information contained in the dataset allows for detailed microsimulation exercises and subsequent analyses, substantially expanding the informational content of the scenario analysis beyond what can be obtained from aggregate population-level data alone.

Figure 1 provides a schematic overview of the workflow of Task 3.3 and of the data sources used at each stage of the analysis. The following sections describe in detail the methodologies and data employed across the different phases of the work, with particular focus on the processing of the results from Task 3.2, spatial microsimulation and tax–benefit microsimulation.

Figure 1: Workflow of Task 3.3 for Scenario-Based Microsimulations

## 2.1 PROCESSING AND SYNTHESIS OF TASK 3.2 RESULTS

The first phase of our work involved processing and synthesizing the results of Task 3.2, “Scenario Development for Assessing the Effects of Changing Spatial Mobility Patterns on EU Regions.” Task 3.2 focused on the development of **four scenarios** to assess the effects of changing spatial mobility patterns on EU regions during the twin transition, considering various forms of spatial mobility and the level of regional digital transition. The scenario typology was structured around different developmental pathways, each representing distinct regional trajectories under the twin transition:

- **Leapfrog** – illustrating improvement of the current situation with rapid movements overcoming obstacles;
- **Dark Horse** – representing the success of a region that was initially underestimated;
- **Snail’s Pace** – describing conditions that evolve very slowly;
- **Lion’s Den** – indicating the presence of challenging or threatening circumstances.

Following the co-creation of scenario narratives involving MOBI-TWIN regional partners, a Delphi survey was conducted to evaluate the likelihood and impact of each scenario on the five

MOBI-TWIN pilot regions: **Castilla-La Mancha (ES)**, **Central Macedonia (GR)**, **Groningen (NL)**, **Lombardy (IT)**, and **North & East Finland (FI)**. A total of 60 experts completed the survey, distributed as follows: 13 from Spain, 12 from Finland, 12 from the Netherlands, 12 from Italy, and 11 from Greece. This expert input provided a basis for the definition of the scenarios, reflecting a credible cross-section of views from relevant fields and ensuring a scientifically grounded perspective on the likelihood and impact of each scenario. To ensure that the scenarios reflected specific local features, the Delphi results were further validated through workshops with stakeholders from the pilot regions, including representatives from local and regional administrations, students, community groups, and members of the general public. A total of 52 participants attended the workshops, with the following geographical distribution: 12 from Italy, 11 from Finland, 10 from Spain, and 9 from the Netherlands. The main results of the survey and the scenario descriptions for each region are reported in MOBI-TWIN Deliverable D3.2, Scenarios for Assessing the Effects of Spatial Mobility on EU Regions during the Twin Transition (MOBI-TWIN, 2024, Deliverable D3.2).

During the survey, experts were asked to quantify the projected percentage change of key socio-economic and demographic characteristics of the regional population for each scenario. These variables included **age groups** (0–24, 25–64, 65+), **gender** (male, female), **educational attainment** (primary or lower, secondary, tertiary), and **labour market status** (high-/mid-/low-skilled employees, high-skilled self-employed). For each category within these variables, respondents provided quantitative predictions of percentage change after each scenario has materialized. This information represents a key input for our work, providing a quantitative description of the scenarios that we subsequently used to define the totals of each variable as inputs for microsimulation.

Operationally, for each region we aggregated the survey responses by computing the unweighted average across all regional experts, providing an initial estimate of the percentage change for each variable. To ensure overall consistency of the projections and their usability in subsequent simulations, further processing was carried out. In particular, since variations in different variables within the same scenario could result in inconsistent total population figures, age group responses were used as the reference to define changes in total population. Variations in the remaining categories were then normalized to ensure consistency with the new total population. Labour market status categories for which quantitative predictions were not explicitly requested (namely low- and mid-skilled self-employed and ‘not in employment’) were assumed to remain fixed in absolute terms across scenarios.

Table 1 reports the percentage changes defining each scenario for the pilot regions, as processed and normalized in this work (MOBI-TWIN, 2024, Deliverable D3.2).

**Table 1: Projected Percentage Changes in Key Population and Labour Market Variables Relative to the 2035 Baseline by Scenario**

<b>CASTILLA-LA MANCHA</b>						
		Leapfrog	Lion's Den	Snail's Pace	Dark Horse	
Total population		3,97%	-5,77%	-4,64%	8,25%	
Age group	0-24	0,58%	-21,27%	-12,73%	8,73%	
	25-64	2,17%	-11,82%	-8,91%	9,82%	
	65+	9,92%	17,45%	9,55%	5,00%	
Gender	Male	3,92%	-6,10%	-4,72%	7,82%	
	Female	4,01%	-5,44%	-4,55%	8,69%	
Education	Primary or lower	-5,20%	-6,15%	-4,40%	0,97%	
	Secondary	3,51%	-8,37%	-5,68%	10,22%	
	Tertiary	19,10%	0,60%	-2,69%	15,12%	
Labour market status	Employee	High-skilled	21,84%	-16,55%	-13,88%	29,97%
		Mid-skilled	8,46%	-17,64%	-12,62%	24,13%
		Low-skilled	5,74%	-16,76%	-15,13%	20,57%
	Self-employed	High-skilled	24,34%	-20,42%	-10,73%	29,40%
Scenario probability		12,59%	35,71%	43,64%	8,06%	

<b>CENTRAL MACEDONIA</b>					
		Leapfrog	Lion's Den	Snail's Pace	Dark Horse
Total population		6,30%	-4,31%	-1,69%	7,91%
Age group	0-24	-1,30%	-13,88%	-6,29%	9,00%
	25-64	15,60%	-8,86%	-3,57%	9,00%
	65+	-4,18%	11,00%	5,14%	5,17%
Gender	Male	5,39%	-6,46%	-2,14%	6,71%
	Female	7,16%	-2,28%	-1,26%	9,04%
Education	Primary or lower	-6,34%	-1,75%	-3,09%	6,17%

Labour market status	Employee	<i>Secondary</i>	8,69%	-2,48%	-1,22%	6,17%
		<i>Tertiary</i>	21,12%	-12,45%	-0,50%	14,55%
		<i>High-skilled</i>	30,84%	-16,65%	-4,51%	36,61%
		<i>Mid-skilled</i>	19,55%	-13,43%	-5,84%	22,12%
		<i>Low-skilled</i>	8,42%	-12,67%	-7,49%	16,74%
	Self-employed	<i>High-skilled</i>	33,16%	-16,04%	-3,03%	38,85%
<i>Scenario probability</i>			10,35%	26,37%	46,31%	16,97%
<b>GRONINGEN</b>						
			Leapfrog	Lion's Den	Snail's Pace	Dark Horse
Total population			7,63%	-9,63%	6,77%	16,00%
Age group	0-24		4,42%	-22,50%	5,67%	21,30%
	25-64		7,27%	-10,30%	6,20%	14,20%
	65+		11,36%	4,00%	8,90%	14,20%
Gender	Male		6,34%	-11,43%	6,15%	17,43%
	Female		8,90%	-7,84%	7,39%	14,57%
Education	<i>Primary or lower</i>		1,00%	-6,00%	3,27%	14,17%
	<i>Secondary</i>		5,14%	-9,23%	7,66%	10,11%
	<i>Tertiary</i>		18,87%	-13,69%	7,96%	30,31%
Labour market status	Employee	<i>High-skilled</i>	18,16%	-22,82%	19,09%	38,18%
		<i>Mid-skilled</i>	11,99%	-18,65%	13,72%	31,58%
		<i>Low-skilled</i>	15,37%	-20,46%	7,80%	30,62%
	Self-employed	<i>High-skilled</i>	30,08%	-19,29%	9,12%	38,54%
<i>Scenario probability</i>			18,98%	25,56%	40,19%	15,28%
<b>LOMBARDY</b>						
			Leapfrog	Lion's Den	Snail's Pace	Dark Horse
Total population			8,60%	0,98%	-4,76%	4,21%
Age group	0-24		5,67%	-9,37%	-8,86%	0,29%

		25-64	8,11%	-0,50%	-6,86%	2,43%
		65+	11,63%	11,25%	2,00%	10,29%
Gender		Male	8,00%	1,24%	-4,81%	4,09%
		Female	9,19%	0,73%	-4,71%	4,33%
Education		Primary or lower	4,31%	-0,86%	-6,94%	-0,32%
		Secondary	7,77%	0,34%	-5,24%	2,95%
		Tertiary	18,88%	6,53%	0,70%	16,64%
Labour market status	Employee	High-skilled	23,98%	1,51%	-12,38%	13,10%
		Mid-skilled	20,18%	-0,13%	-11,75%	7,53%
		Low-skilled	19,39%	5,55%	-11,50%	11,10%
	Self-employed	High-skilled	28,89%	1,81%	-14,15%	12,10%
Scenario probability			10,39%	33,37%	42,99%	13,24%
<b>NORTH &amp; EAST FINLAND</b>						
			Leapfrog	Lion's Den	Snail's Pace	Dark Horse
Total population			6,18%	-10,85%	-0,61%	7,24%
Age group		0-24	-0,17%	-22,89%	-9,88%	1,25%
		25-64	5,92%	-15,13%	-4,25%	7,25%
		65+	11,50%	5,13%	12,25%	11,87%
Gender		Male	7,00%	-7,23%	1,44%	8,37%
		Female	5,35%	-14,49%	-2,65%	6,11%
Education		Primary or lower	-1,43%	-9,32%	-3,27%	-0,13%
		Secondary	6,38%	-9,56%	0,15%	7,74%
		Tertiary	10,67%	-15,14%	-0,77%	10,86%
Labour market status	Employee	High-skilled	17,30%	-32,29%	-2,45%	23,32%
		Mid-skilled	17,78%	-31,10%	-1,29%	18,82%
		Low-skilled	16,18%	-26,25%	-0,56%	16,89%
	Self-	High-skilled	19,70%	-31,64%	-4,49%	21,23%

	employed					
<i>Scenario probability</i>		12,92%	32,08%	40,39%	14,61%	

**Note:** Tables report projected percentage changes relative to the 2035 baseline. Educational attainment follows ISCED 2011 (primary: 0–1; secondary: 2–3–4; tertiary: 5–6–7–8). Skill levels for employed individuals are based on an authors’ reclassification of ISCO groups (high: 1–2–3; medium: 4–5–6; low: 7–8–9). Percentage changes are normalised to ensure consistency in total population across variables. Results are based on authors’ own calculations using data collected within the MOBI-TWIN project (Task 3.2).

We used these numerical values as input for the spatial microsimulation model to define the constraint variables, i.e., the totals used for the calibration of survey microdata. Official EUROSTAT population projections for 2035 were used as baseline. EUROSTAT provides projections by age and gender at NUTS-2 level, but not for educational attainment or type of occupation. For these variables, we assumed that the proportions of each category remained constant over time and were held fixed at their most recent observed values (corresponding to the 2021 Census) for the 2035 baseline. Overall, integrating EUROSTAT projections enhances the robustness of the scenario-based estimates.

The baseline values for each pilot region were then adjusted by applying the scenario-specific percentage changes derived from Task 3.2. This procedure resulted in a matrix reporting the total population in 2035 for the following variables:

- **Age group** (0–24, 25–64, 65+)
- **Educational attainment** (primary or below, secondary, tertiary)
- **Gender** (male, female)
- **Labour market status** (Employee: high-/mid-/low-skilled; Self-employed: high-/mid-or low-skilled; Not in employment)

Minor adjustments were applied to ensure that the totals of each variable were equal within each scenario, a requirement necessary for both the calibration and the descriptive consistency of the model. The final projections are reported in Table 2, including the values of 2021 census for reference.

**Table 2: Projected Levels of Key Population and Labour Market Variables by Scenario (2035)**

		CASTILLA-LA MANCHA						
		Census 2021	Baseline 2035	Leapfro g	Lion's Den	Snail's Pace	Dark Horse	
Total population		2.052.506	1.939.099	2.015.99 1	1.827.20 1	1.849.198	2.099.153	
Age group	0-24	517.562	416.615	419.045	327.990	363.591	452.974	
	25-64	1.145.414	987.321	1.008.71 3	870.638	899.360	1.084.258	
	65+	389.530	535.163	588.233	628.573	586.247	561.921	
Gender	Male	1.028.696	969.733	1.007.73 7	910.578	923.933	1.045.518	
	Female	1.023.810	969.366	1.008.25 4	916.623	925.265	1.053.635	
Education	Primary or lower	663.950	627.264	594.671	588.657	599.683	633.341	
	Secondary	958.105	905.167	936.975	829.435	853.798	997.642	
	Tertiary	430.451	406.668	484.345	409.109	395.717	468.170	
Labour mark et status	Employee	High-skilled	178.228	168.380	205.153	140.508	145.013	218.846
		Mid-skilled	204.117	192.838	209.149	158.825	168.501	239.362
		Low-skilled	266.208	251.498	265.931	209.351	213.435	303.239
	Self- employed	High-skilled	40.769	38.516	47.891	30.650	34.382	49.839
		Mid-/Low- skilled	110.918	104.789	104.789	104.789	104.789	104.789
Not in employment		1.252.266	1.183.078	1.183.07 8	1.183.07 8	1.183.078	1.183.078	

<b>CENTRAL MACEDONIA</b>								
		Census 2021	Baseline 2035	Leapfro g	Lion's Den	Snail's Pace	Dark Horse	
Total population		1.793.926	1.659.678	1.764.200	1.588.158	1.631.677	1.790.975	
Age group	0-24	433.972	361.636	356.935	311.459	338.905	394.183	
	25-64	952.459	826.540	955.480	753.332	797.021	900.929	
	65+	407.495	471.502	451.785	523.367	495.751	495.863	
Gender	Male	865.439	805.854	849.271	753.810	788.646	859.943	
	Female	928.487	853.824	914.929	834.348	843.031	931.032	
Education	Primary or lower	593.911	549.470	514.615	539.880	532.485	583.366	
	Secondary	826.977	765.088	831.587	746.126	755.781	812.286	
	Tertiary	373.038	345.121	417.998	302.152	343.412	395.323	
Labour market status	Employee	High-skilled	145.343	134.467	175.931	112.078	128.396	183.698
		Mid-skilled	183.313	169.595	202.745	146.814	159.694	207.114
		Low-skilled	149.501	138.314	149.962	120.794	127.950	161.469
	Self- employed	High-skilled	59.518	55.064	73.324	46.233	53.398	76.456
		Mid-/Low- skilled	114.612	106.035	106.035	106.035	106.035	106.035
	Not in employment		1.141.639	1.056.203	1.056.203	1.056.203	1.056.203	1.056.203

<b>GRONINGEN</b>							
		Census 2021	Baseline 2035	Leapfro g	Lion's Den	Snail's Pace	Dark Horse
Total population		586.933	566.152	609.323	511.646	604.506	656.711
Age group	0-24	168.792	143.169	149.492	110.956	151.282	173.664
	25-64	298.764	274.216	294.159	245.972	291.217	313.155
	65+	119.377	148.767	165.672	154.718	162.007	169.892
Gender	Male	293.474	281.992	299.880	249.774	299.340	331.152
	Female	293.459	284.160	309.443	261.872	305.166	325.559

Education		<i>Primary or lower</i>	128.689	124.131	125.372	116.688	128.194	141.721
		<i>Secondary</i>	313.060	301.977	317.485	274.091	325.117	332.502
		<i>Tertiary</i>	145.184	140.044	166.466	120.868	151.195	182.488
Labour market status	Employee	<i>High-skilled</i>	126.366	121.892	144.024	94.082	145.159	168.431
		<i>Mid-skilled</i>	72.728	70.153	78.563	57.068	79.778	92.310
		<i>Low-skilled</i>	53.862	51.955	59.940	41.323	56.010	67.866
	Self-employed	<i>High-skilled</i>	16.010	15.443	20.088	12.464	16.851	21.395
		<i>Mid-/Low-skilled</i>	15.631	15.078	15.078	15.078	15.078	15.078
Not in employment		302.336	291.631	291.631	291.631	291.631	291.631	
<b>LOMBARDY</b>								
			Census 2021	Baseline 2035	Leapfrog	Lion's Den	Snail's Pace	Dark Horse
Total population			9.943.004	10.370.917	11.262.665	10.472.917	9.877.311	10.807.779
Age group		<i>0-24</i>	2.266.069	2.165.623	2.288.342	1.962.596	1.973.811	2.171.810
		<i>25-64</i>	5.372.761	5.260.160	5.686.817	5.233.859	4.899.463	5.387.907
		<i>65+</i>	2.304.174	2.945.134	3.287.506	3.276.462	3.004.037	3.248.062
Gender		<i>Male</i>	4.881.528	5.139.687	5.550.745	5.203.373	4.892.577	5.349.904
		<i>Female</i>	5.061.476	5.231.230	5.711.920	5.269.544	4.984.734	5.457.875
Education		<i>Primary or lower</i>	2.467.361	2.573.548	2.684.363	2.551.355	2.395.035	2.565.206
		<i>Secondary</i>	5.967.676	6.224.504	6.708.448	6.245.966	5.898.387	6.408.052
		<i>Tertiary</i>	1.507.967	1.572.865	1.869.855	1.675.596	1.583.890	1.834.521
Labour market	Employee	<i>High-skilled</i>	986.269	1.028.715	1.275.421	1.044.278	901.324	1.163.443
		<i>Mid-skilled</i>	1.107.900	1.155.580	1.388.796	1.154.058	1.019.784	1.242.567

status		<i>Low-skilled</i>	1.374.618	1.433.777	1.711.787	1.513.344	1.268.914	1.592.891
	Self-employed	<i>High-skilled</i>	444.072	463.183	596.999	471.575	397.627	519.215
		<i>Mid-/Low-skilled</i>	546.376	569.890	569.890	569.890	569.890	569.890
	Not in employment		5.483.769	5.719.772	5.719.772	5.719.772	5.719.772	5.719.772

<b>NORTH &amp; EAST FINLAND</b>								
		Census 2021	Baseline 2035	Leapfrog	Lion's Den	Snail's Pace	Dark Horse	
Total population		1.274.651	1.193.997	1.267.753	1.064.393	1.186.744	1.280.470	
Age group	<i>0-24</i>	342.174	277.680	277.217	214.122	250.259	281.151	
	<i>25-64</i>	614.999	558.060	591.079	473.653	534.342	598.519	
	<i>65+</i>	317.478	358.257	399.457	376.618	402.143	400.800	
Gender	<i>Male</i>	637.242	597.333	639.164	554.157	605.908	647.348	
	<i>Female</i>	637.409	596.664	628.589	510.236	580.836	633.122	
Education	<i>Primary or lower</i>	200.902	188.185	185.489	170.655	182.032	187.942	
	<i>Secondary</i>	769.049	720.391	766.379	651.536	721.487	776.119	
	<i>Tertiary</i>	304.700	285.421	315.885	242.202	283.225	316.408	
Labour market status	Employee	<i>High-skilled</i>	183.739	172.116	201.893	116.546	167.891	212.253
		<i>Mid-skilled</i>	130.309	122.066	143.768	84.103	120.489	145.036
		<i>Low-skilled</i>	123.856	116.021	134.797	85.567	115.366	135.615
	Self-employed	<i>High-skilled</i>	18.958	17.759	21.257	12.140	16.962	21.529
		<i>Mid-/Low-skilled</i>	34.765	32.566	32.566	32.566	32.566	32.566
	Not in employment		783.024	733.471	733.471	733.471	733.471	733.471

**Note:** Tables report projected levels of key population and labour market variables by scenario. Values are shown for the 2021 Census, the 2035 baseline and alternative scenarios. Educational attainment follows ISCED 2011 (primary: 0–1; secondary: 2–3–4; tertiary: 5–6–7–8). Skill levels for employed individuals are based on an authors' reclassification of ISCO groups (high: 1–2–3; medium: 4–5–6; low: 7–8–9). Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2). Data for the 2021 Census and the 2035 baseline are obtained from Eurostat. For education and labour market status, due to the lack of NUTS-2 level projections, baseline values were calculated assuming that the shares of each category remained constant at their 2021 Census levels

Finally, an additional piece of information is derived from the results of the Delphi survey. Participants were asked to indicate, for each scenario, the **variation in average earnings** for workers in the following categories: high-skilled employees, mid-skilled employees, low-skilled employees, and high-skilled self-employed individuals. Due to technical constraints, this information cannot be directly included as a constraint in the model; instead, it is incorporated in a subsequent step by directly applying the estimated variation for each category to the earnings in the synthetic dataset produced by the microsimulation. The earnings variations for each scenario are reported in Table 3.

**Table 3: Projected Percentage Changes in Average Earnings Relative to the 2035 Baseline by Scenario**

		<b>Leapfrog</b>	<b>Lion's Den</b>	<b>Snail's pace</b>	<b>Dark Horse</b>
<b>Castilla-La Mancha</b>	High-skilled employee	9,5	4,1	3,0	7,8
	Mid-skilled employee	11,7	3,0	4,4	9,4
	Low-skilled employee	3,9	-0,5	-1,9	5,5
	High-skilled self-employed	2,3	-2,4	-2,5	4,4
<b>Central Macedonia</b>	High-skilled employee	13,1	-8,5	-3,2	12,0
	Mid-skilled employee	10,9	-7,3	-3,2	10,0
	Low-skilled employee	1,7	-5,5	-4,2	2,7
	High-skilled self-employed	-3,0	-5,5	-5,0	-4,2
<b>Groningen</b>	High-skilled employee	16,0	-9,8	4,0	10,7
	Mid-skilled employee	11,9	-8,9	6,1	11,3
	Low-skilled employee	9,3	-2,0	5,3	8,2
	High-skilled self-employed	11,4	-1,2	8,6	7,7
<b>Lombardy</b>	High-skilled employee	10,0	-1,1	-4,1	7,1
	Mid-skilled employee	10,0	0,1	-2,9	7,1
	Low-skilled employee	5,9	-0,4	-3,1	5,1
	High-skilled self-employed	5,6	0,3	-1,0	3,7
<b>North &amp; East Finland</b>	High-skilled employee	8,7	-3,1	3,7	11,0
	Mid-skilled employee	9,1	2,4	1,9	10,1
	Low-skilled employee	8,0	1,3	2,6	5,7
	High-skilled self-	8,0	2,6	2,7	6,3

	employed				
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**Note:** Tables report projected percentage changes relative to the 2035 baseline. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2).

## 2.2 SPATIAL MICROSIMULATION

The totals obtained from the processing of the Delphi survey results were then used as constraint input for the spatial microsimulation. Specifically, the process relied on data from the EU Statistics on Income and Living Conditions (EU-SILC), a detailed survey providing microdata on income, social inclusion, and living conditions.

EU-SILC was chosen for two main reasons. First, it is a rich dataset containing detailed information on the living conditions and income of European households, with numerous variables that allow for a comprehensive description of household circumstances. The survey is harmonized across all EU Member States, enabling cross-country comparison, including the MOBI-TWIN pilot regions. Its sample size is sufficient to allow for regional (NUTS-2) representativeness in all pilot regions, with the exception of Groningen, where regional-level data were not available; in this case, the entire Netherlands dataset was used. Nonetheless, for the Netherlands, where regional microdata were unavailable and the national dataset was employed, representativeness is still ensured through calibration against the regional aggregate data, and the near-perfect internal validation indicates that the estimates remain robust and reliable, even when derived from units at a higher level of aggregation. Second, using SILC allows for the integration of tax-benefit microsimulation, as SILC represents the standard input for EUROMOD—the EU tax-benefit microsimulation model. Although EUROMOD is flexible regarding input data, it is optimized for SILC, and many of its variables are essential for proper model functioning. For this work, we used the most recent SILC microdata available (SILC 2022), selecting the regional detail relevant for each pilot region. Final sample sizes for the pilot regions are as follows: Castilla-La Mancha N = 2,633; Central Macedonia N = 3,273; Groningen N = 30,329 (entire Netherlands dataset used); Lombardy N = 4,270; North & East Finland N = 5,092.

With regard to the choice of constraint variables, we aligned our calibration for each region and scenario with the information collected through the Delphi survey. The constraint variables (i.e., the aggregate population totals used to recalibrate the microdata to ensure representativeness at the regional level under each scenario) were therefore derived from those provided by the Delphi survey in Task 3.2. Accordingly, the calibration focuses on age groups, gender, labour market status, and educational attainment. These variables are well established in the literature as key correlates of disposable income and other outcomes of interest, and their use thus supports the production of realistic simulation results.

The SILC microdata were recalibrated using standard spatial microsimulation methodology (reweighting approach). Through an iterative proportional fitting algorithm, the original

weights were adjusted so that the totals of each target variable matched the desired totals from the matrix created previously. This technique assigns a weight to each individual by iteratively adjusting the initial weight for each constraint variable, ensuring convergence with the aggregate totals. We also applied integrative calibration at both the individual and household levels, ensuring consistency between household and individual weights within the same household. This procedure generates new weights that guarantee representativeness and coherence at both levels, in line with the original SILC survey weights.

In operational terms, the spatial microsimulation was conducted using the STATA command *sreweight* (Pacifco, 2014). This command implements the methodology proposed by Deville and Särndal (1992), where the reweighting algorithm solves a minimization problem—minimizing the distance between old and new weights—subject to the constraint that the marginal distributions of the constraint variables match the census data vector. The command allows customization, including the choice of distance function. In our model, we used the modified chi-square distance function proposed by Deville and Särndal (1992), which limits the ratio between new and original weights within a specified interval (set to 0.01–8 in our simulations). The command also allows setting a convergence tolerance, i.e., the acceptable deviation between the constraint variable distribution in the reweighted dataset and the census vector. Full convergence is preferred, and in our work the tolerance was progressively reduced to achieve near-full convergence (tolerance < 10) for all scenarios and regions. This procedure was repeated for each of the five pilot regions under the four scenarios and the baseline, resulting in a total of 25 synthetic populations (5 regions × 5 scenarios).

The synthetic datasets are finally adjusted by applying the percentage variations in earnings for specific worker categories across the different scenarios, as reported in Table 3.

## 2.3 TAX-BENEFIT MICROSIMULATION

In a further step, the synthetic datasets generated through spatial microsimulation were enriched by calculating individual-level taxes and benefits, i.e., conducting a tax-benefit microsimulation. Specifically, the reweighted EU-SILC microdata were used as input in **EUROMOD**, the European Union tax-benefit microsimulation model (Sutherland and Figari, 2013). Developed since the 1990s, EUROMOD is currently maintained and funded by the European Commission and is freely available as open-source software. It is a static tax-benefit microsimulation model that, starting from EU-SILC-based microdata, calculates individual tax liabilities and social benefit entitlements according to the rules in place in each of the 27 EU Member States, within a coherent framework that allows for cross-country comparison.

EUROMOD enables the simulation of taxes, social insurance contributions, and non-contributory benefits by applying the policy rules currently in force in each country. Many of these variables are not present in the original SILC dataset (e.g. child benefits, poverty subsidies, consumption taxes, etc.); thus, EUROMOD significantly enriches the informational content of the data. The

model covers most direct taxes, social contributions, and non-contributory benefits, and more recently has also incorporated in-kind transfers and indirect taxes (e.g., consumption taxes). Transfers that cannot be simulated due to missing information in the input data (e.g., contributory benefits) are included as recorded in the survey whenever available, providing the most realistic estimate of each individual's disposable income. EUROMOD is widely used in academic research and by governments across EU countries to assess the redistributive and fiscal effects of existing tax-benefit policies or to simulate potential reforms. A dedicated community of researchers continuously updates the model to ensure it accurately reflects current policy rules in each country.

Typically, EUROMOD is used to compare alternative scenarios against a baseline, allowing ex ante assessment of redistributive and fiscal impacts of potential reforms or changes in labour market or population characteristics. In our simulation, the baseline for each country was set according to the 2035 base projection, while the four hypothetical scenarios (Leapfrog, Dark Horse, Snail's Pace, and Lion's Den) were treated as counterfactuals. Operationally, we processed our 25 synthetic datasets (baseline + four scenarios × five pilot regions) in EUROMOD. The program applies the tax and benefit rules currently in force in each respective country (Spain, Greece, the Netherlands, Italy, and Finland). At the end of the process, each observation in the datasets is enriched with new variables representing simulated taxes, social contributions, and benefits.

Two points should be noted regarding the use of EUROMOD for our simulations. First, taxes and benefits were calculated using the policy rules currently in place for each pilot region, as coded in the EUROMOD 2025 tax-benefit systems. These rules, developed and annually updated by national teams, ensure that the model provides a credible representation of state intervention in each country (see EUROMOD Country Reports: Flevotomou et al., 2025; Recio Alcaide et al., 2025; Räsänen & Simanainen, 2025; Figari & Fiorio, 2025; Cuelenaere et al., 2025). However, no adjustments were made to account for potential future policy changes; therefore, results should be interpreted as “policy-invariant”. In other words, while the analysis captures the structural and demographic dynamics underlying the Twin Transition, any actual changes in policies could substantially alter the outcomes. This may include both adverse and favourable effects, depending on the policy choices implemented, highlighting the crucial role of policymakers in shaping the trajectory of the twin transition over the ten-year horizon considered. Second, EUROMOD determines entitlements based on the observed characteristics of households and individuals. However, actual take-up of benefits is sometimes incomplete, and tax evasion can result in differences between simulated and actual taxes paid. EUROMOD assumes full take-up of benefits and no tax evasion by default, so the simulated impact represents the “desired” effect of the tax-benefit system rather than the realized one. Partial exceptions apply for Greece and Italy, where adjustments for tax evasion are implemented by default (see country reports for details).

At the end of the process, the new variables generated by EUROMOD support a more comprehensive impact assessment. In particular, they enable the calculation of household- and individual-level disposable income, as well as aggregated figures for key public finance variables. These outputs are crucial for assessing the impact of different scenarios on public budgets and the distribution of disposable income. The resulting data constitute the core output of this task, and descriptive statistics and other indicators for each region under the baseline and alternative scenarios are presented in the following sections.

## 3 RESULTS

This section presents the main results of the microsimulations for each region across the alternative scenarios, illustrating different trajectories through which regions may respond to mobility dynamics linked to the twin green and digital transition in the coming years. For each region, we also provide a brief overview of the key characteristics of the scenarios to support interpretation of the results, while a more detailed description of the scenario-building process and methodology is available in Deliverable D3.2.

### 3.1 CASTILLA-LA MANCHA (ES)

#### 3.1.1 REGION OVERVIEW

The demographic outlook for Castilla-La Mancha in 2035, based on projections from Eurostat, points to a context of sustained demographic contraction combined with pronounced population ageing. The region is expected to experience an overall population decline of approximately 5.5%, largely driven by persistently low birth rates and the outmigration of younger cohorts. At the same time, the number of residents aged over 65 is projected to increase by 37%, intensifying demand for healthcare, social services, and age-friendly infrastructure while reducing the available labour force.

These demographic dynamics risk reinforcing existing structural challenges, including rural depopulation, uneven access to services, and the limited diversification of economic activities. Yet in the same period the accelerating Twin Transition introduces a wide range of opportunities for innovation, productivity gains, and territorial regeneration. The extent to which Castilla-La

Mancha is able to leverage these opportunities will depend on investment continuity, institutional coordination, and its capacity to attract and retain population and skills.

On this basis, regional experts—engaged through interviews and dedicated workshops within Task 3.2 of the MOBI-TWIN project—developed four alternative scenarios describing how Castilla-La Mancha might evolve. The full methodology and results are reported in Deliverable D3.2 – Scenarios for assessing the effects of spatial mobility on EU regions during the Twin Transition; the following paragraphs provide a concise summary of the main findings.

### **Leapfrog - Strategic Transformation and Balanced Growth**

In the Leapfrog scenario, Castilla-La Mancha manages to overcome structural vulnerabilities and reposition itself as a dynamic and resilient region. Rather than relying solely on its proximity to Madrid, the region adopts a **proactive development strategy** centred on rural revitalisation, digital infrastructure, and renewable energy deployment. Investments in regional transport networks and social infrastructure reduce territorial isolation, while modernisation in agriculture and logistics enhances productivity and environmental sustainability.

The emergence of “smart villages” enables smaller municipalities to provide high-quality services through digital platforms, remote working opportunities, and community-led innovation. Sustainable tourism, local energy communities, and collaborative governance models strengthen the regional economy and attract new residents seeking quality of life and affordability. Under this scenario, population decline stabilises and gradually reverses, supported by improved living conditions and diversified employment opportunities.

However, this trajectory remains contingent on continued political consensus, stable funding streams, and the region’s capacity to adapt to climate-related pressures. If these enabling conditions are maintained, Castilla-La Mancha evolves into a model of balanced territorial development that combines green growth with social cohesion.

### **Dark Horse - An Unexpected Green and Digital Success**

The Dark Horse scenario describes a trajectory in which Castilla-La Mancha emerges as an unexpected leader in the Twin Transition. Through **targeted investments** in wind and solar energy, digital farming technologies, and improved connectivity, the region becomes a testing ground for innovative rural development models. Enhanced transport links and the diffusion of remote working practices allow professionals and entrepreneurs to relocate from larger cities while maintaining access to national and international markets.

Newcomers—often young, highly educated, and environmentally conscious—bring skills and entrepreneurial capacity that revitalise local economies. The region develops strong interdependencies with neighbouring metropolitan areas, especially Madrid, while also strengthening internal cohesion through improved mobility and digital services. Agricultural

practices become more data-driven and sustainable, and renewable energy production supports both local consumption and export markets.

Nevertheless, the scenario remains fragile. Growth is partly dependent on project-based funding cycles and exposed to competition from other regions pursuing similar strategies. Without long-term political stability and deeper economic diversification, Castilla-La Mancha risks losing momentum. If these challenges are addressed, however, the region could become a reference point for rural innovation and climate-neutral development in Southern Europe.

### **Snail's Pace: Slow Adaptation and Persistent Imbalances**

In the Snail's Pace scenario, Castilla-La Mancha continues to adapt, but only gradually and unevenly. Population ageing accelerates, and younger residents continue to migrate towards larger urban centres in search of education and employment opportunities. Rural municipalities face mounting difficulties in maintaining services and infrastructure, while provincial capitals grow slowly but without sufficient dynamism to absorb demographic decline.

Technological adoption proceeds at a limited pace, constrained by insufficient investment, skills shortages, and institutional fragmentation. As a result, innovation remains concentrated in a few sectors and locations, and productivity gains are modest. The rollout of sustainable energy and digital solutions occurs, but without the scale required to transform the regional economy.

Over time, the region risks becoming locked into a cycle of **demographic contraction** and **limited growth**. While not facing acute crisis, Castilla-La Mancha struggles to attract investment and talent, and disparities between urban and rural areas widen. Breaking out of this trajectory would require coordinated policies to accelerate digitalisation, support entrepreneurship, and create incentives for young people and skilled workers to remain in or relocate to the region.

### **Lion's Den - Structural Decline and Social Strain**

The Lion's Den scenario depicts a more severe trajectory in which **demographic and economic pressures** reinforce each other. Strong outmigration, particularly toward Madrid, weakens local labour markets and reduces the viability of traditional sectors. As ageing accelerates, demand for healthcare and social services rises sharply, placing significant strain on public budgets and administrative capacity.

Although some investments in transport, renewable energy, and digital infrastructure are made, their impact remains limited due to delayed implementation, fragmented governance, or resistance to change. Rural areas experience increasing isolation, while inequality between territories grows. Economic stagnation discourages private investment and reinforces negative demographic trends.

Under this scenario, Castilla-La Mancha risks losing competitiveness and social cohesion unless decisive action is taken. Comprehensive strategies to modernise the economy, invest in human capital, and foster innovation become essential to avoid long-term marginalisation.

### **Relative Likelihood of Scenarios**

Based on the expert assessments, the most probable trajectory is the Snail's Pace scenario (44%), followed by the Lion's Den scenario (36%), while the Leapfrog (13%) and Dark Horse (8%) scenarios are considered less likely. This distribution reflects a cautious outlook in which gradual change and structural inertia are perceived as more plausible than rapid transformation, although targeted policy interventions and sustained investment could still shift the region toward more favourable outcomes.

Taken together, the scenarios highlight how demographic trends, technological change, environmental policy, and regional governance choices will interact to shape Castilla-La Mancha's future. While population decline and ageing present structural constraints, the Twin Transition also offers a window of opportunity to reconfigure the regional economy, strengthen territorial cohesion, and enhance resilience. Strategic coordination between public institutions, local communities, and private actors will be decisive in determining whether Castilla-La Mancha can transform demographic challenge into sustainable development by 2035.

The next sections are devoted to presenting the results of the microsimulation exercises built upon the scenario narrative developed for Castilla-La Mancha, including a set of indicators to assess their potential socio-economic and territorial impacts.

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## **3.1.2 POPULATION DYNAMICS AND CHARACTERISTICS**

Across all scenarios, the dominant trend for Castilla-La Mancha is a decline in total population relative to the 2021 census benchmark (dashed line in the figures), confirming the structural demographic challenges described in the scenario narratives. The only exception is Dark Horse, where population slightly increases, consistent with the scenario's assumption that targeted investments in digital infrastructure and renewable energy attract new residents. In Leapfrog, population remains slightly below the 2021 census level but above the 2035 baseline, stabilising above two million inhabitants—reflecting the scenario's focus on rural revitalisation and improved services.

By contrast, the more pessimistic trajectories—Lion's Den and Snail's Pace—show a substantial loss of more than 200,000 inhabitants each. These scenarios are particularly concerning due to the pronounced decline in the young population (0–24), amounting to –88,683 in Lion's Den and –53,024 in Snail's Pace relative to baseline, and in the working-age population (25–64), with decreases of –116,683 and –87,961 respectively. At the same time, the elderly population (65+)

increases by 93,410 in Lion's Den and 51,084 in Snail's Pace, strongly altering the region's demographic structure and reflecting the social strain described in these scenarios.

In the more positive scenarios, Leapfrog and Dark Horse, Castilla-La Mancha is able to attract skilled individuals, as evidenced by notable increases in the population with secondary and tertiary education. Population with primary education remains relatively stable across scenarios. In Leapfrog, the employed population grows mainly among high-skilled workers (+36,773 compared to baseline), though increases in mid- and low-skilled employment are also observed. Dark Horse shows a more balanced increase in employment across skill categories. Conversely, Lion's Den and Snail's Pace are characterized by net job losses, particularly among low-skilled workers, reinforcing the challenges of structural decline and slow adaptation of these scenarios.

**Figure 2: Castilla-La Mancha – Population characteristics by scenario (2035)**

**Note:** Projected levels of total population and key population and labour market variables by scenario. Dashed line = 2021 Census. Values are shown for the 2035 baseline and alternative scenarios. Educational attainment follows ISCED 2011 (primary: 0–1; secondary: 2–3–4; tertiary: 5–6–7–8). Skill levels for employed individuals are based on an authors' reclassification of ISCO groups (high: 1–2–3; medium: 4–5–6; low: 7–8–9). Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2). Data for the 2035 baseline are obtained from Eurostat projections.

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### 3.1.3 LABOUR MARKET OUTCOMES

Employment rates in Castilla-La Mancha for the 15–64 population show a modest increase relative to the 2021 census, likely reflecting the compositional effects of demographic change. However, differences across scenarios are pronounced, with a spread of over 8.5 percentage points between Lion's Den and Dark Horse, highlighting the impact of scenario-specific factors on regional employment dynamics. Similar patterns emerge for participation rates, though variability between census, baseline, and scenarios is more limited.

Unemployment rates show significant improvements compared to the 2021 census, decreasing by more than three percentage points, again likely reflecting demographic effects. The most optimistic scenarios—Leapfrog and Dark Horse—exhibit further reductions, while Lion's Den and Snail's Pace show only modest improvement (around –2 percentage points). Youth unemployment mirrors these dynamics, indicating that the benefits of digitalisation, rural revitalisation, and green growth are evident in the more proactive scenarios.

**Figure 3: Castilla-La Mancha – Labour market indicators (2035)**

**Note:** The dashed line denotes the 2021 level. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC.

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### 3.1.4 POVERTY AND INEQUALITY

Relative poverty rate, measured using a fixed national poverty line on equivalised household disposable income, shows an overall improvement in Castilla-La Mancha across all scenarios compared to the 2021 census. This likely reflects both demographic adjustments and better labour market outcomes. The decline in poverty is particularly pronounced in Leapfrog and Dark Horse, consistent with their emphasis on balanced growth, human capital development, and rural revitalisation.

The average gap with the 60% median income poverty line improves, while the average gap measured at 40% of the median remains largely stable, with a slight increase in Lion's Den and Snail's Pace. Income inequality, as measured by the Gini coefficient, shows minor reductions, with variations confined within 0.5 percentage points, and the S80/S20 ratio remains largely unchanged across scenarios. Overall, these results suggest that positive demographic and labour market dynamics in the more optimistic scenarios contribute to modest reductions in poverty and inequality.

**Figure 4: Castilla-La Mancha – Poverty and inequality indicators (2035)**

**Note:** The dashed line denotes the 2021 level. National poverty thresholds fixed at baseline levels; OECD-modified equivalence scale. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income simulated using EUROMOD.

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### 3.1.5 PUBLIC FINANCE AGGREGATES

As expected, public spending on pensions in Castilla-La Mancha increases in all scenarios due to demographic ageing, with particularly pronounced pressure in Lion's Den, reflecting both the notable persistence of population and the ageing structure. Social benefit expenditures decrease slightly, likely due to the combined effect of population decline and improvements in labour market and poverty indicators.

Tax revenues, however, show greater variability across scenarios. In the more optimistic trajectories (Leapfrog and Dark Horse), tax receipts from direct taxes increase significantly, reflecting higher employment and better economic performance. These findings reinforce the link between scenario-specific growth policies and fiscal sustainability.

**Figure 5: Castilla-La Mancha – Public finance aggregates (2035)**

**Note:** The dashed line denotes the 2021 level. Bars represent the 2035 baseline and alternative scenarios. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Public finance aggregates—total annual expenditure on public pensions and social benefits, total annual direct taxes, and total annual revenues (direct taxes plus social insurance contributions)—are simulated using EUROMOD.

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### 3.1.6 URBAN-RURAL DIVIDE

Castilla-La Mancha continues to exhibit significant urban-rural disparities. Most of the population resides in suburban and rural areas, yet absolute fiscal contributions are higher in urban centres. Cities also display higher employment rates but greater income inequality. These patterns persist across scenarios, although differences emerge in population dynamics and economic outcomes.

Suburban populations decline relative to the 2021 census in all scenarios. Urban populations are stable in Leapfrog and increase by 20,931 individuals in Dark Horse, while rural populations remain relatively stable in these two scenarios. Employment rate variations mirror the scenario trajectories, with larger changes in cities compared to rural areas. Similarly, direct tax revenues in Dark Horse and Snail's Pace increase almost twice as much in urban areas compared to rural

ones. These results highlight the importance of targeted regional cohesion measures to prevent an exacerbation of the urban-rural divide under differing transition trajectories.

**Figure 6: Castilla-La Mancha – Main indicators by degree of urbanization (2035)**

**Note:** Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income and total annual tax revenue are calculated using EUROMOD.

## 3.2 CENTRAL MACEDONIA (EL)

### 3.2.1 REGION OVERVIEW

Central Macedonia is one of Greece's most economically significant regions, centred on Thessaloniki, which functions as a major logistics, industrial, and services hub for Southeast Europe. Despite this strategic position, Eurostat projections indicate that by 2035 the region may experience a substantial **population decline** (–7.5% from 2021), driven primarily by falling birth rates and a negative migration balance. At the same time, demographic **ageing** is expected to intensify, with the share of residents aged 65+ increasing by 15%, causing pressure on labour supply, public finances, and social services.

These trends highlight the structural challenges facing Central Macedonia in the context of the Twin Transition. The region's ability to combine digital transformation with green innovation—modernising agriculture and manufacturing, strengthening renewable energy deployment, improving public services, and supporting skills development—will be crucial in determining

whether demographic decline can be mitigated. The scenarios analysed in this project therefore explore alternative pathways through which Central Macedonia might respond to demographic pressures, economic restructuring, and climate-related challenges.

Below we summarise the four region-specific scenarios developed by regional experts under Task 3.2 (full results are reported in Deliverable D3.2).

### **Leapfrog - Central Macedonia's Digital Revolution: Driving Progress through Innovation**

In this scenario, Central Macedonia rapidly overcomes structural bottlenecks and positions itself as a digitally driven and diversified regional economy. Smart agriculture, automation, and digitalised public services boost productivity in tourism, exports, and logistics, while improvements in housing, education, healthcare, and local entrepreneurship enhance quality of life and help retain families and attract newcomers.

This trajectory aligns closely with an ambitious Twin Transition strategy, combining digitalisation with sustainable economic growth. However, it depends on sustained policy support, stable funding, and resilience to global economic shifts.

### **Dark Horse- Unlocking Digital and Green Growth Potential**

Here, Central Macedonia emerges as an unexpected national success story. Investments in renewable energy, healthcare, and high-tech sectors—supported by EU programmes and public-private partnerships—turn Thessaloniki into a regional tech-finance hub. The region attracts skilled workers and families, revitalising local economies and strengthening intersectoral innovation in agriculture and services.

This scenario reflects a rapid and externally supported Twin Transition, but remains vulnerable to reliance on external investment, workforce adaptation challenges, and ongoing demographic pressures.

### **Snail's Pace - Central Macedonia's Journey, Overcoming Demographic and Economic Challenges**

Under this trajectory, the region progresses cautiously, guided by EU sustainability and digitalisation policies but constrained by slow implementation, skills mismatches, and labour mobility barriers. Community participation and incremental reforms support gradual improvements, yet demographic decline and labour shortages persist.

Central Macedonia continues to adapt, but without the scale or speed required to fully capture the opportunities of the Twin Transition, risking a widening gap with more dynamic regions.

### **Lion's Den - Central Macedonia's Fight for Revitalization by 2030**

In this pessimistic scenario, economic stagnation, demographic decline, and environmental pressures reinforce one another. Traditional sectors weaken, youth outmigration accelerates, and the ageing population strains public services. Limited investment in digital and renewable sectors leaves the region ill-prepared for structural change, while depopulation and land degradation intensify.

According to this scenario, without decisive policy intervention and investment in human capital and innovation, Central Macedonia risks long-term marginalisation.

### **Relative Likelihood of Scenarios**

The expert survey assigns the highest probability to Snail's Pace (46%), followed by Lion's Den (26%), Dark Horse (17%), and Leapfrog (10%). This distribution reflects cautious expectations among regional stakeholders: incremental adaptation is considered the most likely outcome, while rapid transformation appears less probable without strong and sustained policy action. At the same time, the non-negligible probability of the optimistic scenarios suggests that targeted investment in digitalisation, renewable energy, and skills development could still shift the region toward a more dynamic trajectory.

The following sections present the results of region-specific microsimulations under these four scenarios, focusing on population dynamics, poverty and inequality, public finance aggregates, and the urban–rural divide, in order to assess the socio-economic implications of alternative Twin Transition pathways for Central Macedonia.

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## **3.2.2 POPULATION DYNAMICS AND CHARACTERISTICS**

Central Macedonia experiences a pronounced demographic contraction across most scenarios, in line with Eurostat projections and the structural challenges highlighted in the region overview. Total population falls below the 2021 census benchmark (dashed line in the figures) in all scenarios except Dark Horse, where population stabilises at approximately 2021 levels. This resilience reflects the scenario's narrative of successful digital and green investments centred around Thessaloniki, which attract new residents and partially offset natural decline.

Relative to the baseline, Dark Horse shows balanced demographic resilience across age groups, with a particularly strong increase in the 25–64 cohort accompanied by a modest recovery in births, although still slightly below 2021 levels. Leapfrog also attenuates negative demographic trends, driven almost entirely by a large increase in the adult population (+128,000 compared to baseline), signalling renewed regional attractiveness consistent with its digitalisation and smart-economy narrative.

All scenarios point to an increase in the elderly population, reflecting structural ageing pressures. This is especially pronounced in Lion's Den, where the strongest increase in the 65+ group coincides with the sharpest decline among younger cohorts, significantly worsening the

demographic balance and reinforcing the scenario's depiction of economic stagnation and youth outmigration.

These demographic shifts translate into labour market status outcomes. Lion's Den records the lowest number of employed individuals, consistent with declining industries and workforce shrinkage. At the opposite extreme, Dark Horse shows a substantial increase in employment, led by high-skilled workers but extending across all skill categories. Leapfrog shows a similar pattern, though job growth is concentrated among high- and mid-skilled workers, with low-skilled employment remaining broadly stable. Snail's Pace presents an intermediate outcome, with employment declining across all skill levels, mirroring the overall demographic contraction.

In terms of educational attainment, populations with lower education levels vary little across scenarios, while those with tertiary education show much greater variability. Higher shares of tertiary-educated residents in Leapfrog and Dark Horse reflect increased regional attractiveness under innovation-driven growth trajectories.

**Figure 7: Central Macedonia – Population characteristics by scenario (2035)**

**Note:** Projected levels of total population and key population and labour market variables by scenario. Dashed line = 2021 Census. Values are shown for the 2035 baseline and alternative scenarios. Educational attainment follows ISCED 2011 (primary: 0–1; secondary: 2–3–4; tertiary: 5–6–7–8). Skill levels for employed individuals are based on an authors' reclassification of ISCO groups (high: 1–2–3; medium: 4–5–6; low: 7–8–9). Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2). Data for the 2035 baseline are obtained from Eurostat projections.

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### 3.2.3 LABOUR MARKET OUTCOMES

Employment rates and labour force participation remain relatively stable between 2021 and 2035 in Central Macedonia, with a modest improvements suggesting that demographic decline partly facilitates labour market matching by reducing pressure on available jobs. However, differences between scenarios are significant. The strongest improvements occur in Leapfrog and especially Dark Horse, where economic expansion and inflows of skilled workers increase employment rates—up to six percentage points above baseline in the latter. These results align with scenario assumptions about digital innovation, green investment, and entrepreneurship.

Unemployment rates decline overall compared to 2021, likely due to demographic restructuring also. The reduction is particularly strong in the growth-oriented scenarios, with Dark Horse showing a decrease of about seven percentage points relative to 2021. In contrast, Lion's Den and Snail's Pace record smaller improvements (around one to two percentage points) still remaining above baseline levels. Youth unemployment follows similar dynamics, indicating a better integration of the younger cohorts into the labour market under the Twin Transition.

**Figure 8: Central Macedonia – Labour market indicators (2035)**

**Note:** The dashed line denotes the 2021 level. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC.

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### 3.2.4 POVERTY AND INEQUALITY

Considering a fixed national poverty line set at 60% of median income, poverty levels in Central Macedonia show limited variability across scenarios, though modest improvements are observed overall. Reductions in the poverty rate and poverty gap are more pronounced in Leapfrog and Dark Horse, reflecting stronger regional growth, higher shares of tertiary-educated and high-skilled workers, and overall improved labour market outcomes.

For more extreme poverty (40% threshold), there is a general improvement across scenarios, most evident in Dark Horse, where employment growth extends to low-skilled workers as well. Income inequality indicators show slight improvements overall but limited variation between scenarios: the Gini coefficient fluctuates within  $\pm 0.3$  points around baseline, and the S80/S20 ratio remains largely unchanged. This suggests that demographic and labour market improvements are not sufficient on their own to significantly reshape income distribution patterns.

**Figure 9: Central Macedonia – Poverty and inequality indicators (2035)**

**Note:** The dashed line denotes the 2021 level. National poverty thresholds fixed at baseline levels; OECD-modified equivalence scale. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income simulated using EUROMOD.

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### 3.2.5 PUBLIC FINANCE AGGREGATES

Demographic trends strongly influence public finance aggregates of Central Macedonia. Social benefit expenditure declines relative to 2021 levels, partly due to population decline in baseline, Lion's Den, and Snail's Pace, and partly due to improved labour market and poverty outcomes in Leapfrog and Dark Horse, where population levels are more stable. The combination of these effects can explain differences across scenarios.

Conversely, pension expenditure increases in all scenarios due to ageing, particularly in Lion's Den and Snail's Pace, where demographic imbalance is most severe. In the more optimistic scenarios, population growth is supported by younger and working-age cohorts, moderating - but not eliminating - the increase in pension spending.

As expected, fiscal revenues are highest in Leapfrog and Dark Horse, exceeding both the 2035 baseline and 2021 levels in absolute terms. Stronger employment, higher productivity, and a more skilled workforce underpin this result, illustrating how successful Twin Transition strategies can enhance fiscal sustainability.

**Figure 10: Central Macedonia – Public finance aggregates (2035)**

**Note::** The dashed line denotes the 2021 level. Bars represent the 2035 baseline and alternative scenarios. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Public finance aggregates—total annual expenditure on public pensions and social benefits, total annual direct taxes, and total annual revenues (direct taxes plus social insurance contributions)—are simulated using EUROMOD.

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### 3.2.6 URBAN-RURAL DIVIDE

Population in Central Macedonia is almost evenly distributed across cities, towns/suburbs, and rural areas. Under Leapfrog, population growth relative to baseline occurs primarily in urban areas and, to a lesser extent, suburban zones, while rural population remains broadly stable. Dark Horse shows a similar pattern, with urban growth driven by the expansion of Thessaloniki

as a digital and financial hub. At the opposite extreme, Lion's Den records a marked decline in urban population, while suburban and rural populations remain close to baseline levels.

Despite this tripartite distribution, cities contribute disproportionately to fiscal revenues, a pattern that becomes even more pronounced in Leapfrog and Dark Horse, where urban economic growth accelerates. Contributions from suburban and rural areas remain broadly unchanged across scenarios.

Interestingly, employment rates are slightly higher in rural areas, followed by cities and then towns/suburbs, though variability is limited. Scenario dynamics affect all three areas proportionally, reflecting the interaction between demographic change and labour market conditions. Rural areas also exhibit higher inequality (higher Gini index) than suburban zones, with cities in an intermediate position. This pattern persists across scenarios, though inequality increases in rural areas under Leapfrog and Dark Horse, highlighting the need for targeted redistributive and cohesion policies to ensure that the benefits of the digital and green transition are distributed across all territories.

**Figure 11: Central Macedonia – Main indicators by degree of urbanization (2035)**

**Note:** Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income and total annual tax revenue are calculated using EUROMOD.

## 3.3 GRONINGEN (NL)

### 3.3.1 REGION OVERVIEW

The region of Groningen in the Netherlands includes the city of Groningen and a relatively dispersed settlement structure with several suburban and rural municipalities. Eurostat projections to 2035 point to a **moderate decline** in total population (–3.5% relative to 2021), suggesting that the region retains a certain degree of attractiveness compared with other peripheral European regions. However, changes in the demographic structure are more concerning: the population aged 65+ is expected to increase sharply (+24.6%), while the adult population (25–64) declines modestly (–8.2%) and the youth cohort (0–24) falls more substantially (–15.2%).

These dynamics indicate a combination of **declining fertility and ageing** - factors that could affect labour supply, fiscal sustainability, and regional cohesion. At the same time, Groningen's strong university sector, research capacity, and emerging green-energy industries mean that the region is not necessarily on a path of structural decline. The way in which the Twin Transition unfolds - particularly the shift from traditional energy production to renewables, digital innovation in agriculture and services, and investments in skills and mobility - could play a decisive role in shaping demographic and economic outcomes. Successful green and digital strategies could attract skilled workers and stabilise population trends, while delays in structural transformation could accelerate ageing and youth outmigration.

Below we summarise the four region-specific scenario narratives developed by regional experts within Task 3.2 (full details in Deliverable D4.2), describing alternative trajectories for Groningen as it navigates the Twin Transition.

#### **Leapfrog - Groningen on the Rise: Driving Innovation, Sustainability, and Economic Mobility**

In the Leapfrog scenario, Groningen leverages its educational and research strengths to attract skilled workers and foster innovation. Investments in mobility, partnerships between universities and industry, and inclusive social policies support economic diversification and sustainable energy development. The region strengthens infrastructure and labour market outcomes while maintaining environmental balance.

This scenario represents an ambitious Twin Transition pathway in which digitalisation and green innovation reinforce one another. Its success depends on sustained investment, stable energy markets, and the region's ability to attract and retain skilled workers.

#### **Dark Horse - Groningen's Emerging Hub: Preparing for the Future**

Here, Groningen becomes an unexpected success story. Its strong academic reputation, lower living costs, and high quality of life attract international talent, while green industries and technology start-ups expand rapidly. Climate-driven relocation from vulnerable coastal areas may also increase inward migration, bringing younger populations and new entrepreneurial energy.

This scenario highlights how external shocks and strategic positioning within the Twin Transition could accelerate regional growth. However, it also depends on continued diversification and long-term sustainability of key sectors.

### **Snail's Pace - Groningen's Slow Burn: Navigating Sustainable Economy, Mobility, and Quality of Life**

In this trajectory, Groningen progresses cautiously. Investments in digital access, mobility, and community development improve quality of life, but slow implementation and cautious business adaptation limit rapid transformation. Demographic ageing continues, and economic change remains gradual.

This scenario reflects a moderate Twin Transition pathway, where incremental improvements occur but may not be sufficient to counteract demographic decline or fully exploit innovation potential.

### **Lion's Den - Groningen's Crossroads: Navigating Depopulation and Economic Transformation**

In the pessimistic scenario, Groningen faces population shrinkage and economic instability. Youth outmigration intensifies, rural areas lose services, and traditional sectors fail to transition toward digital and green industries. Economic stagnation and widening urban-rural disparities threaten social cohesion.

Without decisive action in renewable energy, digital infrastructure, and skills development, the region risks entering a cycle of depopulation and structural decline.

### **Relative Likelihood of Scenarios**

The regional expert survey indicates that Snail's Pace is the most likely trajectory (40%), followed by Lion's Den (26%), Leapfrog (19%), and Dark Horse (15%). This distribution reflects cautious expectations: stakeholders consider gradual adaptation more probable than rapid transformation, while still recognising a significant risk of stagnation if demographic and economic pressures are not addressed.

From a policy perspective, these probabilities indicate that facilitate the Twin Transition will be crucial. Incremental change alone may not be enough to offset ageing and population decline. Only sustained investment in green energy, digital skills, innovation ecosystems, and inclusive

regional mobility - core elements of the Leapfrog and Dark Horse scenarios - can significantly reshape Groningen's demographic and economic trajectory.

The following sections present the results of region-specific microsimulations, analysing population dynamics, poverty and inequality, public finance aggregates, and urban-rural disparities under each scenario, in order to assess how different Twin Transition pathways may affect Groningen's long-term socio-economic outlook.

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### 3.3.2 POPULATION DYNAMICS AND CHARACTERISTICS

The 2035 baseline projection shows a modest decline in total population relative to the 2021 census (-20,781 inhabitants) in Groningen. However, the experts' assessment suggests that an effective Twin Transition through green energy innovation, digitalisation, and talent attraction could reverse this trend. Population increases are observed in Dark Horse (+69,778), Leapfrog (+22,390), and Snail's Pace (+17,573), while Lion's Den, where the region fails to adapt to structural change, shows a much larger decline of over 75,000 inhabitants compared with 2021.

Relative to the 2035 baseline, the three growth-oriented scenarios show resilience across all demographic groups, including youth and working-age populations, not only the elderly. The strongest effect appears in Dark Horse, reflecting the scenario narrative in which the region attracts international talent and new residents through university-driven innovation and green industries centred on Groningen. Leapfrog and Snail's Pace also mitigate negative demographic trends, though to a lesser extent. By contrast, Lion's Den shows contraction across all demographic groups, including an additional loss of more than 26,000 adult residents (25 to 64 years old) compared to baseline scenario.

These demographic dynamics translate into labour market status outcomes. Lion's Den records the largest loss in employment (-54,506 employed relative to baseline), more than half of which are high-skilled jobs, consistent with youth outmigration and weak transition in the energy and digital sectors. Dark Horse shows the largest increase in employment (+46,539 high-skilled workers relative to baseline), with positive spillovers across all skill categories, reflecting strong attraction of talent and expansion of green-tech industries. Leapfrog and Snail's Pace lie in between, showing moderate employment growth. Consistent with the qualitative scenario narratives, the growth scenarios - especially Dark Horse, and to a lesser extent Leapfrog - attract tertiary-educated residents, while Lion's Den sees a sharp decline in this group, reflecting outmigration of young skilled workers.

**Figure 12: Groningen – Population characteristics by scenario (2035)**

**Note:** Projected levels of total population and key population and labour market variables by scenario. Dashed line = 2021 Census. Values are shown for the 2035 baseline and alternative scenarios. Educational attainment follows ISCED 2011 (primary: 0–1; secondary: 2–3–4; tertiary: 5–6–7–8). Skill levels for employed individuals are based on an authors' reclassification of ISCO groups (high: 1–2–3; medium: 4–5–6; low: 7–8–9). Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2). Data for the 2035 baseline are obtained from Eurostat projections.

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### 3.3.3 LABOUR MARKET OUTCOMES

Groningen starts from a relatively favourable labour market position, with high employment and participation rates and very low unemployment. These strengths are broadly maintained

across scenarios. Employment and participation rates remain stable between 2021 and 2035, reflecting both strong labour market fundamentals and the demographic contraction that reduces labour supply pressures.

Further improvements are observed in the growth scenarios (Leapfrog, Snail's Pace, and especially Dark Horse), where green innovation, university-industry partnerships, and digital sectors expand employment opportunities. Only in Lion's Den labour market conditions deteriorate, with a moderate increase in unemployment. Youth unemployment rises only slightly, partly because demographic decline is concentrated among younger cohorts. Employment and participation rates in this scenario remain close to 2021 levels, indicating missed opportunities from the Twin Transition due to delayed investment and weak economic diversification.

**Figure 13: Groningen – Labour market indicators (2035)**

**Note:** The dashed line denotes the 2021 level. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC.

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### 3.3.4 POVERTY AND INEQUALITY

Initial poverty levels in the Groningen region are relatively low, and projections indicate further improvements toward 2035. Using a fixed poverty line at 60% of median national income, the poverty rate declines by between 3.0 and 5.5 percentage points depending on the scenario,

reflecting favourable labour market dynamics and effective welfare systems. The largest reductions occur in Dark Horse and Leapfrog, where innovation-led growth, higher shares of skilled workers, and increased employment reduce the risk of poverty. Lion's Den shows smaller improvements, consistent with weaker economic performance.

Extreme poverty (below 40% of the median) remains very low across all scenarios, reflecting strong social protection systems. The poverty gap (i.e., the average distance between poor households' income and the poverty threshold) shows little variation across scenarios. Income inequality indicators also change only marginally: the Gini coefficient varies little between scenarios, though a slight increase (+0.7 percentage points) in Leapfrog suggests that rapid innovation-led growth may require targeted redistributive policies to ensure inclusive benefits. The S80/S20 ratio remains largely unchanged.

**Figure 14: Groningen – Poverty and inequality indicators (2035)**

**Note:** The dashed line denotes the 2021 level. National poverty thresholds fixed at baseline levels; OECD-modified equivalence scale. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income simulated using EUROMOD.

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### 3.3.5 PUBLIC FINANCE AGGREGATES

Demographic ageing leads to an increase in pension expenditure in all scenarios compared with 2021 levels. Differences between scenarios are moderate, reflecting relatively limited variations in the size of the elderly population, although Lion's Den shows a somewhat larger increase due to more pronounced ageing dynamics.

Public spending on social benefits declines relative to 2021 levels, particularly in the growth scenarios (Leapfrog, Snail's Pace, and Dark Horse), despite population increases. This reflects improved labour market outcomes and lower poverty rates. By contrast, social benefits remain above baseline in Lion's Den, indicating greater reliance on income support under economic stagnation. From a policy perspective, this warning signal highlights the risks associated with failing to capture the growth opportunities generated by the Twin Transition.

Fiscal revenues show greater variability across scenarios. Revenues remain close to current levels in the baseline and Snail's Pace, increase clearly in Dark Horse and Leapfrog due to higher employment and productivity, and fall sharply in Lion's Den, where direct tax revenues decline by roughly one-third. These results underline how success in the Twin Transition can strengthen fiscal sustainability, while delayed structural change can weaken it.

**Figure 15: Groningen – Public finance aggregates (2035)**

**Note:** The dashed line denotes the 2021 level. Bars represent the 2035 baseline and alternative scenarios. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Public finance aggregates—total annual expenditure on public pensions and social benefits, total annual direct taxes, and total annual revenues (direct taxes plus social insurance contributions)—are simulated using EUROMOD.

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### 3.3.6 URBAN-RURAL DIVIDE

More than half of Groningen province's population lives in the capital city, with most of the remainder in towns and suburbs, and only around 11.5% in rural areas. These proportions remain stable between the 2021 census, the baseline, and the scenario outcomes, suggesting that demographic trends affect the region relatively uniformly across different territories.

Employment rates are slightly higher in suburban and rural areas than in cities, likely reflecting a large presence of students in the working-age population within the city of Groningen. However, the urban–rural gap narrows in the growth scenarios (Leapfrog, Snail's Pace, and Dark Horse), indicating that innovation-driven growth and improved mobility can spread opportunities across the region.

The city exhibits higher income inequality (about two percentage points higher Gini index than rural areas in the baseline), a pattern that persists across scenarios. Urban areas also contribute disproportionately to fiscal revenues, and this contribution grows further in Dark Horse and Leapfrog, confirming that the economic core of the Twin Transition remains concentrated in the regional capital. Rural areas see more moderate revenue growth,

highlighting the need for cohesion policies to ensure that the benefits of the Twin Transition are shared across the entire region.

**Figure 16: Groningen – Main indicators by degree of urbanization (2035)**

**Note:** Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income and total annual tax revenue are calculated using EUROMOD.

## 3.4 LOMBARDY (IT)

### 3.4.1 REGION OVERVIEW

Eurostat 2035 projections suggest comparatively favourable prospects for Lombardy, which remains the most dynamic and attractive economic area in Italy. Population is expected to grow by about 4.3% compared with 2021, bucking the national trend of demographic decline. This reflects the region's strong labour market, diversified industrial base, and continued attractiveness to both domestic and international workers, particularly around Milan, its main economic and innovation hub.

However, underlying demographic imbalances persist. Low fertility rates continue to reduce younger cohorts, with projected declines in the under-25 population (–4.4%) and working-age population aged 25–64 (–2.1%). Population growth is instead driven primarily by a sharp increase in individuals aged 65 and over (+27.8%). This ageing trend raises concerns about long-

term labour supply, healthcare and pension sustainability, productivity growth, and the capacity to maintain Lombardy's economic dynamism.

These trends place Lombardy at a critical juncture in the context of the Twin Transition. The region has strong assets - advanced manufacturing clusters, leading universities, global finance and design sectors, and a well-developed innovation ecosystem - that could position it at the forefront of Europe's green and digital transformation. Opportunities include accelerating renewable energy deployment, modernising industrial supply chains through automation and AI, investing in sustainable mobility and circular economy models, and strengthening lifelong learning to reskill an ageing workforce. At the same time, key challenges include skills shortages, rising energy costs, uneven territorial development between metropolitan and rural areas, and the need to integrate migrant workers while maintaining social cohesion. How Lombardy navigates these trade-offs will determine whether demographic pressures translate into decline or are offset by productivity gains and innovation.

The four scenarios presented below outline alternative pathways through which Lombardy could respond to demographic pressures while navigating the opportunities and risks associated with the Twin Transition. They reflect the perspectives of regional stakeholders gathered through surveys and workshops under Task 3.2 and illustrate how different combinations of policy ambition, investment capacity, and socio-economic dynamics may shape the region's trajectory toward 2035. Full results and detailed scenario descriptions are available in Deliverable D3.2).

### **Leapfrog - Lombardy at the Brink: Facing Economic Diversification and Green Industry Growth**

In this scenario, Lombardy succeeds in overcoming structural constraints and consolidates its position as Italy's most competitive and innovative region. Building on the strength of the ecosystem centred around Milan, the region accelerates economic diversification through digitalisation, advanced manufacturing, and green technologies. Investments in renewable energy, sustainable agriculture, and modern infrastructure improve connectivity between metropolitan areas and smaller towns, helping to reduce territorial imbalances. Public-private partnerships, research centres, and technology hubs attract skilled workers and stimulate entrepreneurship. Here, the Twin Transition becomes a catalyst for productivity growth and social cohesion. Nonetheless, this pathway depends on sustained political commitment and faces risks related to high energy costs, climate change impacts, and reliance on continuous investment flows.

### **Dark Horse - Lombardy's Unexpected Shift: Embracing Change in Milan and Beyond**

The Dark Horse scenario envisions an unexpected but dynamic transformation. Following recovery from recent economic shocks, Lombardy capitalises on structural changes in work and

mobility patterns. Remote working, combined with improved transport systems, reshapes development beyond Milan's urban core, encouraging suburban and secondary city growth. Green energy and digital sectors expand rapidly, attracting national and international talent. Inclusive policies ensure that innovation-driven growth is accompanied by social cohesion and improved access to opportunities across the region. In this trajectory, the Twin Transition fosters both competitiveness and inclusivity. However, the model risks over-dependence on emerging sectors and could generate uneven territorial benefits if governance mechanisms fail to keep pace with rapid change.

### **Snail's Pace - Lombardy's Olympic Opportunity: Leveraging the Games to Drive Progress**

In this scenario, change unfolds gradually. Major international events such as the Winter Olympics act as a temporary accelerator, stimulating investment in transport infrastructure, housing, digital networks, renewable energy, and agri-food systems. These developments provide short-term employment and tourism gains, but their long-term impact depends on continued reforms and skills upgrading. Without sustained strategic vision, growth slows after the initial boost, and structural challenges related to ageing and labour shortages re-emerge. The Twin Transition advances incrementally, with improvements in digital services and green infrastructure, yet not at a scale sufficient to transform the region's economic model. Governance quality, community engagement, and long-term upskilling efforts become decisive in determining whether incremental change can consolidate into structural progress.

### **Lion's Den - Lombardy on the Edge: Facing Demographic and Economic Pressures**

The Lion's Den scenario depicts a more adverse pathway in which Lombardy struggles to adapt to demographic and technological shifts. Accelerating population ageing and youth outmigration reduce labour supply and strain healthcare and social protection systems. At the same time, limited progress in digital innovation and green industrial transformation weakens manufacturing competitiveness and slows productivity growth. Rural depopulation intensifies, urban-rural divides widen, and job insecurity fuels social tensions. In this context, failure to fully engage with the Twin Transition exacerbates structural vulnerabilities, leading to stagnation and declining attractiveness. The scenario highlights the risks associated with insufficient investment in skills, innovation, and sustainable infrastructure.

### **Relative Likelihood of Scenarios**

Regional experts assign the highest likelihood to Snail's Pace (43%), followed by Lion's Den (33%), Dark Horse (13%), and Leapfrog (10%). This distribution suggests that stakeholders expect Lombardy to remain resilient but not transformative: incremental progress driven by existing strengths is seen as more plausible than a rapid structural shift toward a fully realised Twin Transition.

At the same time, the relatively high probability assigned to the pessimistic Lion's Den scenario signals concern about demographic ageing, labour shortages, and uneven territorial development. Without sustained investment in skills, innovation, and green infrastructure, Lombardy risks losing competitiveness despite its strong starting position.

These likelihoods point to a cautious outlook: Lombardy is expected to remain a leading Italian region, but its ability to lead Europe in Twin Transition-driven growth will depend on proactive policies that address demographic change, promote inclusive innovation, and ensure that digital and green investments translate into productivity gains across both urban and rural areas. The most plausible vision for the region is therefore one of steady adaptation rather than dramatic transformation—unless targeted interventions shift the trajectory toward the more ambitious scenarios.

Overall, the four scenarios illustrate that Lombardy's future hinges on its capacity to transform demographic pressure into an incentive for innovation, ensuring that digitalisation and decarbonisation reinforce long-term competitiveness while maintaining social and territorial cohesion.

The following sections present the results of region-specific microsimulation results under the four scenarios, analysing implications for population dynamics, inequality and poverty, labour market, public finances, and territorial disparities, to assess the socio-economic consequences of alternative Twin Transition pathways for Lombardy.

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### 3.4.2 POPULATION DYNAMICS AND CHARACTERISTICS

The microsimulations for Lombardy broadly confirm the demographic outlook already highlighted in the scenario narratives. A modest population increase relative to 2021 is observed in all scenarios except Snail's Pace, where the population essentially stabilises at current levels. Growth is particularly pronounced in Leapfrog, the only scenario in which Lombardy surpasses 11 million residents, reflecting strong attractiveness driven by successful digitalisation, green investment, and regional innovation networks centred around Milan.

Across all scenarios, the elderly population (65+ years old) increases significantly, confirming the structural and largely irreversible ageing trend already discussed in the region overview. However, in the more optimistic scenarios (Leapfrog and, to a lesser extent, Dark Horse), ageing is partially offset by growth in both younger cohorts (0–24) and working-age populations (25–64). These outcomes are consistent with narratives in which Lombardy leverages the Twin Transition to attract skilled workers and retain younger cohorts through better jobs, infrastructure, and innovation ecosystems.

By contrast, Snail's Pace and Lion's Den show declining fertility and reduced inflows of young people, with the under-25 population falling noticeably relative to the baseline. These

trajectories reflect the risks described in those scenarios: insufficient structural transformation leads to demographic stagnation and, eventually, slower economic growth.

Educational composition varies significantly across scenarios. Populations with secondary and tertiary education grow most in Leapfrog and Dark Horse, reflecting successful attraction of talent and expansion of high-skill sectors linked to digitalisation and green industries. These scenarios also show spillover effects into medium- and low-skill employment through broader economic expansion. In contrast, Snail's Pace raises concerns, with a large decline in employment - especially in low-skill occupations - highlighting how missing the opportunities of the Twin Transition could translate into both labour market contraction and demographic decline.

Overall, demographic outcomes are tightly linked to the region's ability to remain competitive and innovative. Where the Twin Transition is successfully leveraged, Lombardy sustains population growth; where transformation stalls, ageing accelerates and the working-age population shrinks.

**Figure 17: Lombardy – Population characteristics by scenario (2035)**

**Note:** Projected levels of total population and key population and labour market variables by scenario. Dashed line = 2021 Census. Values are shown for the 2035 baseline and alternative scenarios. Educational attainment follows ISCED 2011 (primary: 0–1; secondary: 2–3–4; tertiary: 5–6–7–8). Skill levels for employed individuals are based on an authors' reclassification of ISCO groups (high: 1–2–3; medium: 4–5–6; low: 7–8–9). Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2). Data for the 2035 baseline are obtained from Eurostat projections.

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### 3.4.3 LABOUR MARKET OUTCOMES

Our microsimulations suggest labour market resilience across scenarios, reflecting Lombardy's already strong starting position. In the baseline projection, both employment and participation rates increase slightly relative to 2021 levels. These gains become more pronounced in growth scenarios, with the employment rate reaching nearly 79% in Leapfrog.. Even in the Snail's Pace scenario, employment indicators remain broadly stable at 2021 levels. This stability, however,

masks a missed opportunity: the region maintains employment levels but fails to benefit fully from Twin Transition-driven productivity growth and job creation. In Lion's Den, employment and participation rates show slight improvements despite economic stagnation, likely reflecting demographic shrinkage in working-age cohorts rather than real job creation - consistent with the scenario's narrative of youth outmigration and limited innovation.

Unemployment declines modestly across all scenarios, with more substantial reductions in Leapfrog and Dark Horse. Youth unemployment follows similar trends, although improvements partly reflect demographic decline in younger cohorts (except in Leapfrog, where new job opportunities created by digital and green sectors support genuine labour market expansion).

Overall, labour market outcomes highlight the importance of the Twin Transition not just for employment quantity but for employment quality. Successful transformation produces more high-skill jobs and stronger labour participation, while failure to adapt results in stagnation masked by demographic effects.

**Figure 18: Lombardy – Labour market indicators (2035)**

**Note:** The dashed line denotes the 2021 level. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC.

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### 3.4.4 POVERTY AND INEQUALITY

Poverty rates show modest improvements relative to 2021 levels across all scenarios in Lombardy. The magnitude of improvement varies slightly following labour market performance, with a stronger effect in the Leapfrog and Dark Horse scenarios. Even in lower-growth scenarios such as Snail's Pace and Lion's Den, poverty indicators remain stable, suggesting a resilient social safety net.

There are no significant changes in the average poverty gap, and similarly inequality indicators such as the Gini index and S80/S20 ratio vary only marginally across scenarios. This suggests that current redistributive mechanisms remain effective regardless of economic trajectory. However, it also implies that even growth driven by the Twin Transition does not automatically reduce inequality without targeted policies - a point highlighted in the Leapfrog scenario, where inclusive policies are needed to distribute the benefits of innovation.

**Figure 19: Lombardy – Poverty and inequality indicators (2035)**

**Note:** The dashed line denotes the 2021 level. National poverty thresholds fixed at baseline levels; OECD-modified equivalence scale. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income simulated using EUROMOD.

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### 3.4.5 PUBLIC FINANCE AGGREGATES

Public finance outcomes reveal several structural pressures linked to demographic change in Lombardy. Social benefit expenditure varies modestly across scenarios but rises noticeably in Leapfrog due to higher population. Interestingly, spending is higher in growth scenarios despite stronger labour markets, suggesting that Lombardy's welfare system is relatively universal rather than narrowly targeted.

A major concern is the sharp increase in pension expenditure across all scenarios, rising by €12-19 billion relative to 2021 levels, depending on the scenario. This reflects the ageing population discussed earlier and highlights the fiscal implications of demographic change.

Tax revenues vary significantly across scenarios. Optimistic scenarios (Leapfrog and Dark Horse) generate substantial additional revenue from direct taxes—€13 and €9 billion respectively—thanks to higher employment and productivity. Snail's Pace shows declining revenues, while Lion's Den maintains current levels through moderate economic expansion despite adverse demographic trends. These results underline how Twin Transition success can strengthen fiscal sustainability by expanding the tax base and enhancing productivity.

**Figure 20: Lombardy – Public finance aggregates (2035)**

**Note:** The dashed line denotes the 2021 level. Bars represent the 2035 baseline and alternative scenarios. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Public finance aggregates—total annual expenditure on public pensions and social benefits, total annual direct taxes, and total annual revenues (direct taxes plus social insurance contributions)—are simulated using EUROMOD.

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### 3.4.6 URBAN-RURAL DIVIDE

Lombardy's population remains concentrated in urban and suburban areas, with only about 10% living in rural zones. These proportions remain largely unchanged across scenarios, although growth scenarios (Leapfrog and Dark Horse) show a slight increase in urban population share, consistent with narratives of innovation clusters and talent attraction centred around metropolitan areas such as Milan.

Cities exhibit higher inequality than towns or rural areas, with Gini coefficient values substantially higher, and this pattern persists across scenarios. Urban areas also generate a disproportionately large share of tax revenue, particularly in Leapfrog and Dark Horse, confirming their role as economic engines of the Twin Transition. Growth driven by digitalisation and green innovation is therefore spatially concentrated, although benefits may spill over to suburban and rural areas through employment and supply chains.

Employment rates remain relatively strong across territories, with only small differences between urban and rural areas. Scenario trajectories are broadly transmitted across space, although Snail's Pace slightly widens urban-rural gaps, while Dark Horse produces more balanced improvements in the region. This suggests that successful Twin Transition policies can support regional cohesion, while delayed transformation risks reinforcing territorial inequalities.

**Figure 21: Lombardy – Main indicators by degree of urbanization (2035)**

**Note:** Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income and total annual tax revenue are calculated using EUROMOD.

Overall the results consistently show that Lombardy's demographic resilience, labour market performance, and fiscal sustainability are closely tied to its ability to harness the Twin Transition. Scenarios that successfully combine digital innovation, green investment, and inclusive policies lead to population growth, stronger labour markets, and higher fiscal revenues. Conversely, scenarios characterised by slow adaptation or structural inertia risk demographic stagnation, lost economic opportunities, and growing fiscal pressure from ageing. Lombardy's future depends on policy choices that determine whether the Twin Transition becomes a driver of inclusive regional growth or a missed opportunity.

## 3.5 NORTH & EAST FINLAND (FI)

### 3.5.1 REGION OVERVIEW

Eurostat projections point to significant demographic challenges for North & East Finland, with the region expected to lose about 6.3% of its population by 2035 compared with 2021. The decline is particularly concentrated among young people (-18.8%), signalling persistently low fertility and continued out-migration of students and early-career workers. At the same time, longer life expectancy leads to a 12.8% increase in the 65+ population, while the working-age cohort (25–64) is projected to shrink by 9.3%. Together, these trends suggest rising dependency ratios, labour shortages, and increasing pressure on public services across a region already characterised by low population density and large distances.

In this context, the Twin Transition could significantly reshape the outlook. North & East Finland's evolution towards renewable energy, sustainable mining, forestry, and remote digital services may provide opportunities to offset demographic decline through productivity gains and new high-skill jobs. Expanded digital infrastructure, telework, and AI-enabled public services could maintain service provision in remote areas and attract remote workers or return migrants. Conversely, delays in adopting green technologies or modernising industry could accelerate out-migration and economic stagnation, reinforcing the demographic spiral suggested by baseline projections. These alternative pathways are captured in the four scenarios developed by regional experts within task 3.2 (the full descriptions are reported in deliverable D3.4).

#### **Leapfrog - North & East Finland at the Forefront: Driving community building for technological and economic growth**

In this trajectory, the region becomes a model for overcoming demographic and mobility challenges through strong community initiatives and sustained EU and national support. Investments in **green industry**, **AI-powered public services**, and **incentives** for families and remote workers improve quality of life and economic prospects. The Twin Transition helps stabilise the labour force and attract talent, showing how innovation combined with local resilience can mitigate demographic decline.

#### **Dark Horse - North & East Finland's Transformation: Shaping a digital and sustainable future**

Here the region experiences an unexpected revival, emerging as a competitive hub for green technology and digital innovation. Affordable housing, high **quality of life**, and improved connectivity **attract international talent** and **remote workers**. Cooperation within the EU and with neighbouring countries strengthens economic diversification. In this scenario, the Twin

Transition becomes a catalyst for demographic renewal, reversing population loss and generating new growth sectors.

### **Snail's Pace - North & East Finland's Strengths: Driving progressive evolution**

This scenario reflects **gradual adaptation** under persistent structural and geopolitical constraints. Investments in renewable energy, digitalisation, and trade diversification support incremental progress, but **skills mismatches**, brain drain, and slow institutional change limit the region's capacity to fully benefit from the Twin Transition. Population decline slows but does not reverse, and economic change remains uneven across territories.

### **Lion's Den - North & East Finland at the Crossroads: Striving for stability by 2030**

In the pessimistic trajectory, **industrial decline**, **geopolitical pressures**, and **labour shortages** combine with ageing and youth out-migration. Without sufficient progress in digital and green sectors, the region risks losing competitiveness and struggling to maintain services. Missing out on the Twin Transition amplifies demographic decline, creating a vicious cycle of depopulation and economic fragility.

### **Relative Likelihood of Scenarios**

According to the Delphi survey of regional experts, Snail's Pace (about 40%) and Lion's Den (around 32%) are considered the most likely futures, while Leapfrog (13%) and Dark Horse (15%) are less probable. This distribution reflects cautious expectations about the region's ability to fully exploit Twin Transition opportunities. Experts anticipate gradual change rather than rapid transformation, given challenges such as remoteness, skills shortages, and geopolitical uncertainty. Still, the non-negligible probability of the more optimistic scenarios suggests that targeted policies - especially investments in digital infrastructure, green industries, and talent attraction - could shift the region toward a more dynamic and resilient path.

The following sections present the results of microsimulations for these scenarios, illustrating how demographic trends, labour markets, inequality, public finances, and territorial disparities may evolve depending on how North & East Finland navigates the Twin Transition.

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## **3.5.2 POPULATION DYNAMICS AND CHARACTERISTICS**

Across all simulations for the region, demographic decline emerges as a structural trend, already visible in the baseline and amplified in the more adverse trajectories. In the 2035 baseline, total population continues to fall steadily from the 2021 census benchmark (shown as the dashed line in the figures). This contraction becomes dramatically sharper in the Lion's Den scenario, where population approaches one million inhabitants - more than 200,000 fewer residents compared with 2021. This reflects the core narrative of that scenario: weak regional attractiveness, talent outflows, and limited capacity to adapt to the twin transition.

By contrast, the other scenarios show much stronger demographic resilience. Snail's Pace broadly tracks the baseline trajectory, while Leapfrog stabilizes population levels and Dark Horse even records a modest increase, consistent with a region capable of reinventing itself through innovation, remote working opportunities, and renewed attractiveness.

Youth dynamics are particularly telling. Dark Horse and Leapfrog are the only scenarios where the ongoing reduction of young people - driven by declining birth rates - is somewhat mitigated. Although still below 2021 levels, youth populations remain close to baseline projections. The situation is more worrying in Lion's Den and Snail's Pace, which lose respectively an additional 63,558 and 27,421 individuals under 26 years old. These losses are coherent with the structural narratives of stagnation and low innovation capacity that characterize these scenarios.

For the working-age population (25–64), Dark Horse and Leapfrog again stand out. Both scenarios show increases of 30,000–40,000 adults compared with the baseline, indicating renewed regional attractiveness for workers and families. This partially offsets demographic decline and reflects successful adaptation to green and digital transformations. However, all scenarios show a steady increase in the elderly population. This aging trend, highlighted repeatedly during the Delphi survey, remains unavoidable regardless of economic trajectory.

Employment dynamics also differ sharply across scenarios. Snail's Pace remains aligned with baseline projections, while growth-oriented scenarios (Leapfrog and especially Dark Horse) show strong expansion in employment, largely driven by high-skilled workers. In Dark Horse, high-skilled employment rises by 50,000 jobs above baseline, reflecting innovation-led growth. The opposite occurs in Lion's Den, which loses about 50,000 high-skilled jobs, reflecting talents outflow and weak economic dynamism.

Educational attainment varies less dramatically across scenarios, yet meaningful differences remain. The Dark Horse and Leapfrog scenarios both see significant increases in secondary and especially tertiary-educated populations. This indicates the North & East Finland may attract new residents through remote work and developing innovation ecosystem that could reverse ongoing trends.

**Figure 22: North & East Finland – Population characteristics by scenario (2035)**

**Note:** Projected levels of total population and key population and labour market variables by scenario. Dashed line = 2021 Census. Values are shown for the 2035 baseline and alternative scenarios. Educational attainment follows ISCED 2011 (primary: 0–1; secondary: 2–3–4; tertiary: 5–6–7–8). Skill levels for employed individuals are based on an authors' reclassification of ISCO groups (high: 1–2–3; medium: 4–5–6; low: 7–8–9). Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2). Data for the 2035 baseline are obtained from Eurostat projections.

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### 3.5.3 LABOUR MARKET OUTCOMES

North & East Finland labour market indicators show modest improvement in the baseline, where employment rate rises by 2 percentage points compared with the 2021 level (dashed line in the figure). However, the gains are much stronger in the optimistic scenarios. In Dark Horse

and Leapfrog, employment rate increases by up to 10 percentage points compared with 2011, reflecting the successful attraction of workers and effective management of the twin transition.

In contrast, the Lion's Den scenario sees employment rates fall below 2021 levels despite population decline, indicating structural stagnation. This scenario also shows a significant rise in the unemployment rate, approaching 12% overall and 13% for youth unemployment, reinforcing the narrative of declining competitiveness and weak economic dynamism. If the region instead manages to harness digitalization and decarbonization effectively, as assumed in the Dark Horse and Leapfrog scenarios, unemployment could fall below 5%, turning Twin Transition into a major source of job creation.

**Figure 23: North & East Finland – Labour market indicators (2035)**

**Note:** The dashed line denotes the 2021 level. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC.

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### 3.5.4 POVERTY AND INEQUALITY

Microsimulation results indicate a moderate improvement in poverty indicators through 2035 in North & East Finland. Considering the standard threshold of 60% of national median income,

poverty declines further in Dark Horse, Leapfrog, and even Snail's Pace scenario, as growth or stability supports household incomes. In the Lion's Den scenario, poverty levels instead remain broadly stable relative to today, with no meaningful improvement, reflecting economic stagnation and weak labour market performance. The average poverty gap shows limited variation across scenarios.

Extreme poverty rate (here defined at 40% of national median income) remains very low in all scenarios. This indicates that existing welfare tools are effective in preventing severe deprivation. Dynamics across scenarios mirror those of overall poverty, but with smaller variation. Measures of inequality also show little change between the 2021 census, the baseline, and alternative scenarios. This suggests that the Twin Transition, while affecting employment and sectoral structures, does not radically reshape the structure of household income distribution.

**Figure 24: North & East Finland – Poverty and inequality indicators (2035)**

**Note:** The dashed line denotes the 2021 level. National poverty thresholds fixed at baseline levels; OECD-modified equivalence scale. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income simulated using EUROMOD.

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### 3.5.5 PUBLIC FINANCE AGGREGATES

Public finance projections for North & East Finland reflect the ongoing demographic trend. Pension expenditure rises moderately in all scenarios, driven by population aging, a constant identified by regional experts in all scenarios. Conversely, spending on other social benefit (primarily targeted to younger and working-age groups) declines. This may reflect both demographic contraction and improved labour market outcomes in the more optimistic scenarios, reducing the number of eligible beneficiaries.

Fiscal revenue patterns show greater variability. Direct tax revenues decline slightly in the Baseline relative to 2021 and fall by roughly €1 billion in Lion's Den, reflecting demographic contraction and economic stagnation. The Snail's Pace scenario shows resilience, with revenues remaining near current levels. In Dark Horse and Leapfrog, the stronger economic performance of the region generates substantial revenue gains.

**Figure 25: North & East Finland – Public finance aggregates (2035)**

**Note:** The dashed line denotes the 2021 level. Bars represent the 2035 baseline and alternative scenarios. Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Public finance aggregates—total annual expenditure on public pensions and social benefits, total annual direct taxes, and total annual revenues (direct taxes plus social insurance contributions)—are simulated using EUROMOD.

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### 3.5.6 URBAN-RURAL DIVIDE

Approximately one quarter of the population of North & East Finland lives in cities, with the remainder split between towns/suburbs and rural areas. These proportions remain remarkably stable across all scenarios, indicating that Twin-Transition-related demographic changes do not fundamentally alter settlement patterns.

Cities show slightly lower employment rates, likely because the 15–64 age group includes students concentrated in urban centres. This gap widens in Lion's Den, consistent with the youth outflows described in the scenario narrative. Cities also display higher inequality, with a Gini coefficient higher by 5 percentage points, though this gap shows an ongoing narrowing trend, preserved in all scenarios.

Suburban areas generate the largest absolute direct tax revenues, while cities contribute more per capita. These patterns remain stable across scenarios, reflecting a regional productive structure distributed across medium-sized towns rather than concentrated solely in major urban centres. This also suggests that development opportunities linked with the Twin Transition can benefit also rural and remote areas.

**Figure 26: North & East Finland – Main indicators by degree of urbanization (2035)**

**Note:** Results are based on authors' own calculations using data collected within the MOBI-TWIN project (Task 3.2) and EU-SILC. Household disposable income and total annual tax revenue are calculated using EUROMOD.

Overall, the microsimulation results indicate that North & East Finland will continue to face demographic decline and aging, but the economic and social impact of these trends depends strongly on how the region manages the Twin Transition. In pessimistic pathways such as Lion's Den, population loss, industrial slowdown, and talent outflows weaken labour markets and fiscal capacity, while more dynamic scenarios like Leapfrog and Dark Horse show that investments in digital infrastructure, green industries, remote work, and community resilience can stabilise the working-age population, expand high-skill employment, and sustain regional attractiveness despite shrinking cohorts. Human capital, targeted policy support, and territorial cohesion emerge as decisive factors, suggesting that demographic trends are not destiny and that effective governance can turn the twin transition into an opportunity rather than a constraint for North & East Finland's long-term development.

## 4 INTEGRATION OF RELEVANT RRI PILLARS

MOBI-TWIN places the societal dimension of spatial mobility at the core of its research activities. It aligns the project's activities with the pillars of Responsible Research and Innovation (RRI) — science education, gender equality, governance, open science, public engagement and ethics —

to ensure that outcomes, outputs and impacts meet as much as possible the needs of society ([MOBI-TWIN D4.1](#)).

The RRI pillars mainstreamed into the activities described in this report are gender equality, open science and ethics.

#### *The integration of the gender dimension*

The integration of the gender dimension was systematically implemented throughout all stages of Task 3.3. Population trends, socio-economic indicators, and labour-market outcomes were disaggregated by gender alongside age and educational attainment, with categories including age groups 0–24, 25–64, and 65+, educational attainment levels from primary or below to tertiary, and labour-market status distinguishing high-, mid-, and low-skilled employees, self-employed individuals, and those not in employment.

By embedding gender into the analysis, the results move beyond socially neutral aggregates to reflect the underlying processes of gendered demographic structures, offering policymakers nuanced insights into potential disparities, vulnerabilities, and the differentiated impacts of spatial mobility across scenarios.

#### *The integration of open science*

The analyses rely on EU-SILC microdata produced by Eurostat, which provide detailed information on income, social inclusion, and living conditions for households across the EU. These data were processed in full compliance with GDPR requirements and Eurostat's researcher use agreement, ensuring anonymization and responsible handling of personal information.

The spatial microsimulation methodology applied to these data, using the STATA command *sreweight*, generated synthetic populations for each scenario and pilot region, enabling geographically detailed projections without compromising privacy. These synthetic datasets were then processed through the EUROMOD tax-benefit microsimulation model, maintained by the European Commission and freely available as open-source software, to calculate individual-level taxes, social contributions, and benefits. The combination of EU-SILC and EUROMOD ensures transparency, reproducibility, and the possibility for other researchers to replicate the analyses, while producing results that are directly relevant to regional stakeholders and policymakers.

Accessibility was further enhanced through the production of standardized maps, tables, and scenario summaries, which are designed to support both academic interpretation and public engagement.

#### *The integration of ethics*

Ethical considerations were carefully integrated at all stages of the analysis. The work relies exclusively on aggregated regional and subregional data, and all operations involving microdata are conducted in strict compliance with the ethical standards set out in GA Article 14 (Ethics and Values) and detailed in Annex 5.

The use of synthetic populations ensures that individual identities remain fully protected, while all procedures adhere to GDPR requirements and Eurostat’s rules for researcher use. Central to the analysis is the use of the EUROMOD microsimulation model, developed and maintained by the European Commission, which is open-source and ensures transparency, replicability, and reproducibility of results. The EUROMOD simulations are “policy-invariant,” applying current tax–benefit rules without assuming future changes, which provides a responsible and transparent framework for interpreting the outputs. All results are disseminated in ways that safeguard privacy while enabling stakeholders to assess potential impacts on welfare, inequality, and regional demographic and labour-market dynamics.

## 5 CONCLUSIONS AND NEXT STEPS

The paper presents a new spatial microsimulation model (*EUROMOD-spatial*) for five EU regions: Central Macedonia (Greece), Groningen (Netherlands), Castilla–La Mancha (Spain), North and East Finland (Finland) and Lombardy (Italy). We use the model to investigate the fiscal and distributional effects of four different scenarios for how new mobility patterns shape the future of the five regions: (*leapfrog*, *dark horse*, *at snail’s pace*, and *lion’s den*). We assess what the four scenarios imply in terms of employment, earnings, inequality, social spending, and public revenue, relative to a baseline of current population projections for the year 2035.

Our work builds on previous contributions by economic geographers and others, while our model has been externally and internally validated. Still, this is work in progress, continually corrected and improved as we go along. In view of that, our results ought to be seen as tentative. Having said that, we believe that our results illustrate the potential of spatial microsimulation for the analysis of public policies at local level, compared with the alternatives of increasing the sample size of EU-SILC (highly unlikely), and/or relying on registry data (vulnerable to incomplete coverage, missing socio-demographic variables, privacy concerns, and limited access). As our instrument is refined, its usefulness in assessing the local impact of policy changes, and possibly assisting in their optimal design, is likely to grow.

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