inspire
SMART VILLAGE LABS

D2.3 Business models typology of rural social entrepreneurship: facts, strengths, limitations

University of Groningen (RUG)

28/11/2025

Funded by
the European Union

Document Information

Issued by:	University of Groningen
Issue date:	28/11/2025
Due date:	30/11/2025
Work package leader:	Social Economy Europe
Dissemination level:	Public

Document History

Version	Date	Modifications made by
0.1	20/11/2025	Draft version for quality review by RUG
0.2	27/11/2025	Finaly quality check by WR
1.0	28/11/2025	Final version by RUG

Authors

Name(s)	Beneficiary
Franziska Bay	RUG
Georgios Papapanagiotou	RUG
Thanasis Ziogas	RUG
Richard Rijnks	RUG
Dimitris Ballas	RUG

In case you want any additional information, or you want to consult with the authors of this document, please send your inquiries to: r.h.rijnks@rug.nl or f.bay@rug.nl

Quality Reviewers

Name(s)	Beneficiary
Chiara Lipari	SEE
Paula De Diego	SEE
Yiannis Konstas	Q-PLAN
Elli Roma-Athanasiadou	Q-PLAN
Thomas Bakratsas	WR

Disclaimer

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them

Executive Summary

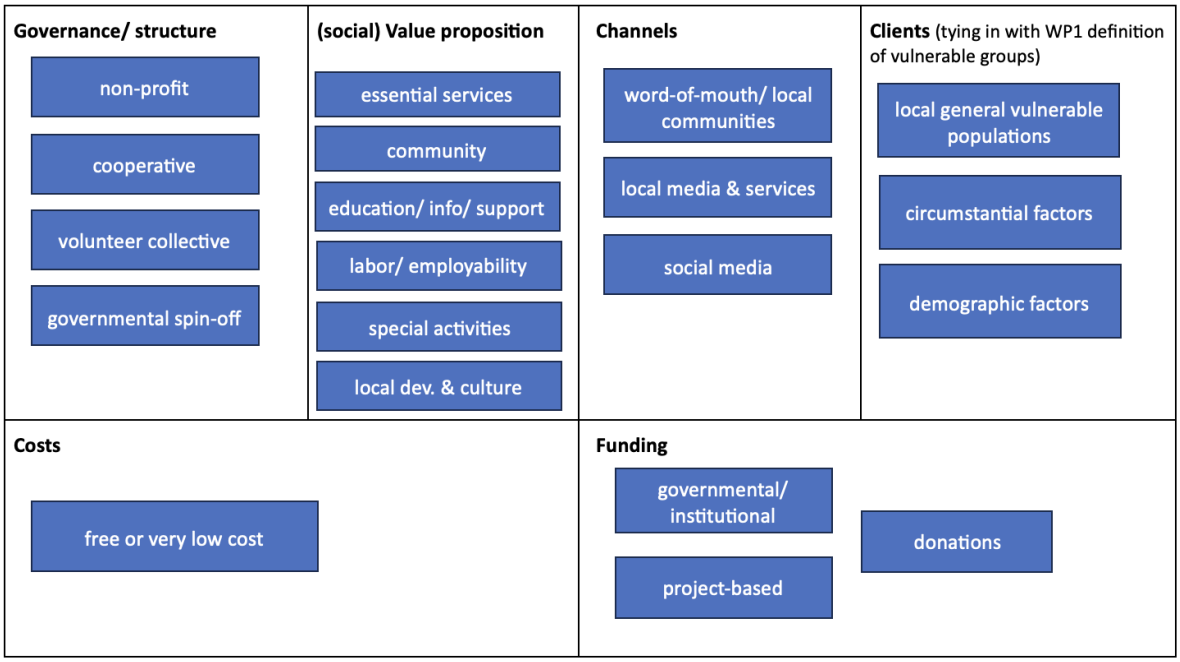
This report (deliverable D2.3) is part of the INSPIRE HORIZON project and focuses on the "Bottom-up mapping of social economy and entrepreneurship in rural Europe" within Task 2.3. The main objective of this task is to categorise the main types of business models (business model typology) for rural social enterprises (SEs) and other actors in the social economy, based on their key characteristics. This deliverable employs a novel integration of three cutting-edge methodologies: digital ethnography, spatial microsimulations, and agent-based models (ABMs). The deliverable builds upon previous work in the project, particularly the conceptualisation of social inclusion from WP1 (D1.1 – Measuring social inclusion and wellbeing in European rural areas: a systematic review) and survey data (D1.2 – Drivers and factors of social exclusion in rural areas: macro-, meso-, and micro-level). The findings will contribute to the Services and Social Economy Atlas on Rural Empowerment (T2.4 – Development of Services and Social Economy Atlas on Rural Empowerment), enhancing understanding of rural social economy dynamics. Furthermore, the findings will support the technical and business incubation of the SE-based solutions for social services, which will be deployed in the 7 pilot areas of the project under WP4, by informing which are the optimal SE business models upon which the pilot solutions can be designed.

Business Model Canvas

The business model canvas provides documentation of business models (Osterwalder and Pigneur, 2010). It contains information on customer segments, channels, relationships, value propositions, key activities, resources, cost structures, and revenue streams. It has been widely employed both by entrepreneurs and business managers as a tool for understanding their business and value proposition, and by academics to structure analyses. To populate the business model canvas, this study employs a digital ethnography of social enterprises and other actors in the social economy in the pilot regions.

Digital ethnography

To identify how actors in the social economy operate in the pilot regions in France, Greece, Ireland, Poland, Romania and Slovakia, we relied on online information. Particularly, we collected data from the organisations' websites, social media accounts, and links to partner organisations. These data formed the basis for the description in a detailed business model canvas, which was subsequently thematically summarised to provide the overview canvas presented below.



Business model canvas: outcome of the study

The canvas presents an overview of the dominant categories found in the pilot regions. Here we present the key elements per value proposition and the linkages across categories. A detailed description of the full business model canvas is presented at the end of the report.

Essential services include healthcare, transportation, and housing, and are generally region-specific examples where vulnerable groups or individuals are unable to rely on government or government-adjacent actors to provide essential services. As a result, the target audience and channels of communication differ across regions. Services tend to be offered for free or at a very low cost, and the organisations can usually rely on funding from local governments

Community services are generally run by local volunteer collectives. Again, their target audiences are region-specific, for instance rural women, migrants, or newcomers. However, most collectives in this study were open to interested individuals joining regardless. A key distinction in the context of this study is that they directly aim to provide social inclusion. They offer their low to no cost and operate requiring very little to no funding as they are mainly volunteer run.

Educational, information, and support organisations and labour and employability organisations appear very closely related but differ in their organisational structure. Educational social enterprises tend to be volunteer-led and can rely on freely available educational resources online, whereas labour and employability social services and enterprises tend to be government run. The broader funding base allows labour and employability social enterprises to offer special services, such as protected workplaces.

Local development and cultural organisations are usually non-governmental cooperatives. Their target audiences are generally the broader local population, although some involve tourists as well.

Particularly when tourists are involved, the social enterprises may charge a small fee to fund their activities.

Finally, we identify a group called special activities which contains social enterprises that deliver a specific service, e.g., transportation for those with disabilities, where these services are absent. As a result, these are very region-specific, and their organisation and value propositions vary substantially. They tend to provide for a necessary service that might otherwise be provided by the government, so external funding is generally involved.

Supporting methodologies and what-if scenarios

Apart from the Business Model Canvas which was the main outcome to be presented in this deliverable, several what-if scenarios are considered; to examine how different types of additional social enterprises could contribute in each pilot area.

For each pilot region, we conducted Spatial Microsimulations. We constructed a population with detailed characteristics that approximate the actual population. The demographic characteristics and social inclusion metrics for this synthetic population were based on data from the survey which was conducted as part of WP1 (State-of-art research on drivers, patterns, trajectories of social inclusion and wellbeing in European rural areas). The synthetic population and the business model patterns were combined in agent-based models. These models simulate the interaction between individuals in the population and social enterprises. The outcome of these models is less the single use case presented here, but rather the ability to replicate these what-if scenarios for other regions (using the broader synthetic populations generated through the spatial microsimulations).

Conclusion

Social enterprises are an important part of rural quality of life (Steiner et al., 2019). They can substitute where government services do not provide sufficient reach and are best placed to identify local communities' needs and optimised solutions (Steinerowski and Steinerowska-Streb, 2012). As a result, idiosyncrasy appears to be baked into social enterprises. Studying how social enterprises are set up, their ecosystem, and business models are therefore substantially reliant on case studies, nested within regions (or countries) or targeting specific value propositions. In this report, we describe a cross-national study of social enterprises targeting social inclusion, involving a variety of value propositions, and very diverse business models.

The present study identifies common themes from these social enterprises and provides a framework to assess the potential impact of new social enterprises. We summarise our findings in the business model canvas, which shows that, despite the inherent idiosyncrasies, some common themes in value propositions, structure, funding, and target audiences can be identified. This general canvas can serve as a tool for both potential social entrepreneurs as well as local policy makers; to help structure discussions around how social enterprises may address local issues.

The integration of digital ethnographies, spatial microsimulations, and ABMs offers a comprehensive framework for understanding and enhancing the role of social enterprises in rural social inclusion.

This approach not only identifies business models currently in use but also informs strategies to better engage vulnerable populations through tailored scenario studies.

Keywords: Social exclusion, social inclusion, rural areas, European Union, social enterprises, social economy business models, digital ethnography, spatial microsimulation, agent-based modelling.

Table of Contents

List of Figures

List of Tables

List of Terms and Definitions

Table 1. Terms and Definitions

Abbreviation	Definition
ABM	Agent-Based Model
BMC	Business Model Canvas
EU	European Union
EU-SILC	EU Statistics on Income and Living Conditions
IPF	Iterative Proportional Fitting
Micro-MaPPS	Microsimulation Modelling and Predictive Policy Analysis System
NUTS3	Nomenclature of Units for Territorial Statistics. Level 3
SE	Social Enterprise

1. Introduction

1.1 Aim and contribution

This report (deliverable D2.3) contains the summary of the main activities undertaken in the task "Bottom-up mapping of social economy and entrepreneurship in rural Europe" (Task 2.3), as part of the INSPIRE Horizon Europe project. The project has the overall goal of understanding social inclusion needs and deficiencies in seven European rural regions in six countries (France, Greece, Ireland, Poland, Romania and Slovakia) and the offer of the social economy and social enterprises that try to combat social exclusion in these areas. The pilot regions are not only set in different countries and cultural contexts; they also are very diverse geographically with some regions being on a small island or in rather inaccessible mountainous areas.

The main output of this task is the present deliverable, which aims to provide a business model typology of rural social enterprises (SEs), discussing facts, strengths, and limitations. We acknowledge that not all actors in the social economy sector are true social enterprises according to very nuanced understandings of the term, such as the one presented in the INSPIRE project report D2.2 – "A common framework on social economy in Europe" (Social Economy Europe, 2025, available at https://inspireprojecteu.eu/deliverables/). Following the definition of the European Commission (n.d.), we broadly classify all organisations that serve a social objective via their main value proposition, that reinvest their profits into their cause towards the social objective, or that are organised with a democratic ownership structure, as social enterprises for the purpose of this report. This term then can include, for instance non-profit organisations, co-operatives and organised collectives.

The exercise undertaken in this work package is based on a novel combination of three cutting edge methodologies. First, we conduct a business model typology, based on a digital ethnography of social economy activities in the pilot regions. Local pilot partners engaged their networks, followed by additional snowballing methods, to provide social enterprises engaged in social inclusion. A detailed thematic analysis of their main characteristics then guided the construction of a business model canvas (BMC, Osterwalder & Pigneur, 2010). Second, to gauge the demand side, i.e. individuals at risk of social exclusion, spatial microsimulations are performed for the pilot countries (within which we find the pilot regions). These spatial microsimulations provide a detailed, individual level dataset, including information on social inclusion and a broad range of other demographic characteristics. Finally, we build a series of agent-based models (ABM, e.g. Broomhead et al., 2019). While the BMC guides this deliverable, to discuss impacts of different social economy business models on social inclusion. ABMs allow the estimation of the impact expected from changes in supply (social enterprises or other social economy actors) on demand (social inclusion of individuals) by creating so-called what-if scenarios. These scenarios inform the discussion on strengths and weaknesses of the social enterprises.

1.2 Short description of the main outcome: the Business Model Canvas

Business model canvases were originally coined by Osterwalder and Pigneur (2010). The central idea is that business and policy makers may map out a holistic picture of a business, including the way it is structured, interacts with its environment, and what values it delivers.

Figure 1 describes the generic BMC as presented in the original work by Osterwalder and Pigneur (2010). Starting on the right of the top row, an organisation can define their customer segment, or target audience. Subsequently, moving to the left, the organisation decides which channels they might use to communicate with their customers, and what they will use as the basis for their consumer relationships. For instance, customer acquisition may require aggressive marketing strategies, whereas customer retention may require a very different approach.

The next main item is the value proposition, which consists of the business' reason for existing. Moving left one more step, and the canvas discusses key activities and key resources, essentially how the product or service is produced, and finally, all the way to the left, is the position of the organisation in the wider ecosystem of colleagues, competitors, and government. The bottom row is somewhat more concise, describing on the left the cost of producing, and on the right the revenues that may be generated.

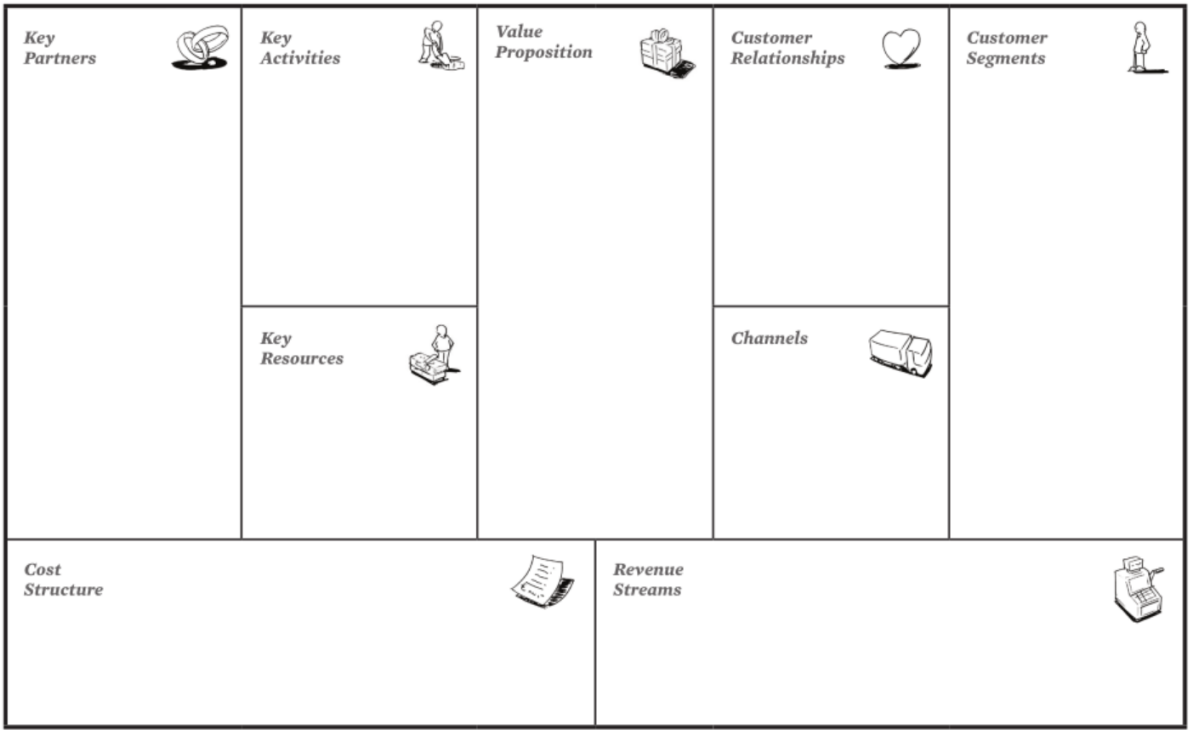


Figure 1: Business model canvas (Osterwalder and Pigneur, 2010)

Several alternative BMC conceptualisations have been proposed, for instance in Joyce and Paquin (2016) and Sparviero (2019). Sparviero (2019) proposes an extension to the conventional model, by including a third row with social and environmental costs, and social and environmental benefits. Joyce and Paquin (2016) propose a more elaborate extension, which incorporates three separate layers: the original layer, an environmental layer (dealing with supplies and outsourcing, production

and materials, functional value, distribution and end of life, and use phase on the top row, and environmental impacts and environmental benefits on the bottom row), and a social layer (which has local communities, governance and employees, social value, societal culture and scale of outreach, and the end user on the top row, and social impacts and social benefits on the bottom row). Both extensions of the original model aim to include a broader set of costs, benefits, and organisation structures. However, they also place a substantially greater demand on the data that must be available and collected to complete the BMC. While we acknowledge the interesting extensions to the model, as this study focuses exclusively on social enterprises, meaning the central value proposition will be to a substantial extent social in nature, and the lower demands on for the data, we choose to follow the conventional model of Osterwalder and Pigneur (2010) for this study.

1.3 Contextualisation within INSPIRE project

This deliverable builds on the work performed so far in the project, notably from WP1, the conceptualisation of social inclusion (D1.1) which guided the data collected as part of the survey in Task 1.3 (previously reported on in D1.2). These survey data are used as the necessary microdata for the spatial microsimulation. Finally, the digital ethnography builds on the conceptualisation of the social economy in Europe in D2.2 (A common conceptual framework on social economy in Europe). The results from the BMC, ABMs, and spatial microsimulations will be included in the Services and Social Economy Atlas on Rural Empowerment (T5.3, to be included on the INSPIRE website D6.3). The remainder of this introduction provides a brief overview of the main points from the previous reports included in the present deliverable.

1.3.1 Social inclusion, background, and conceptualisation

In Europe on average 21.0 per cent of residents are at risk of poverty and social exclusion (EuroStat, 2025). There are substantial differences between countries, with Bulgaria at the higher end (30.3 per cent) and Czechia at the lower end (11.3 per cent). Residents in rural regions are particularly at risk of social exclusion (European Commission, 2021), because of population decline, adverse economic conditions, and peripherality. The European Union vowed to address these adverse conditions and create “stronger, connected, resilient, and prosperous” rural communities. However, at present, neither a broadly agreed upon definition of social exclusion, nor a comprehensive overview of evidence-based interventions exist to date.

The conceptualisation of social exclusion in line with poverty (as done in EuroStat, 2025) is common in the literature. Regional social exclusion, building on D1.1, is a multidimensional concept that includes dimensions of economic exclusion and employment, health and well-being, living conditions, and social participation and engagement (South-Eastern European Research Centre, 2025). The same report identifies nine key drivers that may impact social inclusion:

1. Age
2. Ethnic composition and immigration
3. Criminality and safety
4. Education
5. Digital access
6. Geographic and climate vulnerability
7. Gender
8. Migration

9. Disabilities

For the micro-level analyses in this task, however, it is imperative that these macro-level (following the nomenclature used in this project, macro equates to regional, meso to individual level data collected through surveys and interviews, and micro refers to observational fieldwork) indicators are translated to individual level variables. In the survey, and subsequently in the spatial microsimulations, these indicators of social exclusion are measured using employment, income, and job security; social and political trust; general life satisfaction and self-assessed health; housing situation and accessibility (for a detailed overview see University of Barcelona, 2025).

For the outcome variable, social inclusion, we use the Experiences of Social Inclusion Scale (Leemann et al., 2022; University of Barcelona, 2025). This scale contains a combination of 10 different survey items based on the capability approach (Sen, 1994) to assess whether or not an individual experiences social inclusion, including experiences of usefulness, positive feedback, self-efficacy, and trust. There is an expanding literature on the usefulness of numeric indicators as measures of human experience (Kaiser and Oswald, 2022), and the Experiences of Social Inclusion Scale appears to meet both reliability and validity requirements (Leemann et al., 2022; Nousiainen and Leemann, 2024). A key advantage of the use of subjective indicators of social inclusion is that it allows for the measurement of social inclusion, and the modelling of changes to social inclusion, at the level of the individual. Another advantage is that the measure represents a holistic indication of an individual's experience, which may deviate from the combination of theoretically associated drivers (South-Eastern European Research Centre, 2025).

1.3.2 Social inclusion: key and axes from the survey

In D1.1 - Measuring social inclusion and well-being in European rural areas - and D1.2 - Drivers and factors of social exclusion in rural areas - (South-Eastern European Research Centre, 2025; University of Barcelona, 2025, available at https://inspireprojecteu.eu/deliverables/) we model the dimensions and axes of social inclusion. As we operationalise social inclusion at the individual level as experienced social inclusion, we are able to show how these dimensions and axes of social inclusion are related to the outcome variable. The main results in short are that employment and economic security, and health and well-being are the key dimensions associated with social inclusion. Social participation and living conditions are less strongly linked with experienced social inclusion. Adding the axes of social inclusion to the models added little in terms of explained variance, although gender (males experience less social inclusion) was a significant predictor. Two components of using the internet are also associated with social inclusion: gaming online is positively associated with social inclusion, and using the internet for social interactions is negatively associated with social inclusion. Focusing on rurality specifically, the survey results show that unemployment is a more important factor in explaining rural social inclusion than in larger cities, while poverty is more strongly associated with social inclusion in large towns.

1.3.3 Social economy and social inclusion

Social enterprises are emerging as a key avenue for alleviating rural social exclusion. One reason for this is that social enterprises may be better embedded in their rural contexts and may behave more proactively towards social issues that affect a specific community (Kelly et al., 2019). Within a context of government withdrawal from rural areas (Pumberger and Tobler, 2002) and centralisation of main services and amenities (Christiaanse and Haartsen, 2017), social enterprises can spring up to

alleviate their absence (Steiner et al., 2019). This, combined with a greater attenuation to local needs (Steinerowski and Steinerowska-Streb, 2012), puts social enterprises in an ideal position to alleviate issues around social inclusion. However, there is currently little systematic evidence around best practices, with mainly case study research providing empirical evidence (Steiner et al., 2019). On the one hand, this is to be expected, given the highly idiosyncratic nature of social enterprises, but on the other hand, in this vacuum there is a need for practical tools to complement the local and embedded notions of social enterprises.

1.4 Short introduction to key methods

1.4.1 Digital ethnographies - The supply side

With the end goal of creating a business model typology for rural social enterprises, the first step lies in understanding the landscape of social enterprises in rural regions, how they operate and which services they offer. For this purpose, data needs to be collected from the social enterprises, their organisation of operations, and their services. We do this via a digital ethnography - a relatively new method of ethnographic data collection in an online environment (Kozinets, 1998; Varis, 2015). This is especially appropriate for our project setting as the rural regions that we investigate are spread out across Europe. Collecting data from the online presences of social enterprises in our pilot regions allows us to collect detailed qualitative data, such as the tasks carried out by the social enterprise and the partner and funding organisations that they are connected to, while also being able to get some insights into how social enterprises interact with their target audiences in social media environments that are built for virtual interactions (Delli Paoli and D'Auria, 2021). By gathering information on the main business structures and processes of running social enterprises in the pilot regions, we are able to identify patterns and business models that work well across different geographic contexts and specific value contributions. This can then inform the development of the general business model typologies for rural social enterprises (Sparviero, 2019).

1.4.2 Spatial microsimulations - The demand side

The discussion of social enterprises in Section 1, based on the digital ethnographies, mainly focuses on the "supply" side of practices that aim to reduce the burden of social exclusion. On the "demand" side are the individuals who are willing or likely to engage with these social enterprises and the services and activities they offer. For the purposes of the project, we therefore need to identify these individuals: how many there are, where they are located, and what their main characteristics, needs and attitudes are. In practice, it is often difficult to observe all such individuals directly, especially at a detailed geographical level. For this reason, researchers frequently rely on methods that generate a synthetic population of individuals who resemble the real population as closely as possible. One such method is spatial microsimulation (Ballas, 2004, Morrissey et al, 2008). In simple terms, spatial microsimulation combines rich information from a social survey (in our case, the INSPIRE survey) with small-area data from censuses and administrative sources. By reweighting the survey respondents so that they match the known population totals in each area, the method produces a detailed synthetic population for the pilot regions and surrounding areas (e.g. Ballas et al., 2007; Broomhead et al., 2019). In Section 3 of the report, we describe in detail how we implemented spatial microsimulation in INSPIRE. We explain the data used, the main steps of the method, and how we checked that the results are reliable. We then show how the resulting synthetic population can be

used to map indicators related to social inclusion and vulnerability and, importantly, to provide the demand side input for the agent-based models developed in Section 4.

1.4.3 Agent-based models: interactive analyses

The successful establishment of social enterprises depends to a large extent on the willingness of the population to interact and engage with the social enterprises and receive their services. In the context of an ABM, both the supply side (social enterprises) and the demand side (synthetic population) are represented and behave in a way that mimics the real world (Bonabeau, 2002). Citizen agents employ a cognitive decision approach based on their sociodemographic and sociopsychological characteristics considering how their needs for social inclusion will be satisfied (Gilbert and Terna, 2000 and Jackson et al., 2017). Furthermore, citizens can influence the decision-making process of individuals they feel close to (Rodríguez-Arias et al., 2025). This is done through the construction of a social network (graph) which is updated at the end of each specified period to take into account the current beliefs and status (in terms of social inclusion). The ABM simulations allow us to examine the evolution of public adoption of social enterprises. The results provide useful insights to the social dynamics and individual factors that affect engagement with social enterprises, enabling the evaluation of how to identify the most vulnerable groups in the population and of how to adjust their dissemination channels (i.e., social media, word-of-mouth, etc.) to effectively reach individuals who are eligible for their service.

1.5 Reading guide

The remainder of this document is structured as follows. The first empirical section, Ethnographies, addresses the supply side of the rural social economy, describing how data was collected on the social enterprises identified by pilot project partners and what insights that generated. The second empirical section, Spatial microsimulations, addresses the generation of the synthetic population, and the third empirical section contains the description of the ABMs. Finally, in the last section we present the business model canvas followed by an analysis of the main patterns uncovered.

2. Digital ethnography

2.1 Why digital ethnography?

With the onset of the internet in general, from the 1990s onwards, and particularly since the introduction of web 2.0 and the associated proliferation of social media, individuals increasingly use digital spaces for interacting, searching for information, and finding help and resources (e.g. Delli Paoli and D'Auria, 2021). As could be expected, these new forms of interactions are of interest to researchers in various fields of social sciences (Kozinets, 1998), under the umbrella of a variety of terms (e.g. netnography). In this paper, we will discuss the field under the label digital ethnography, aligning with more recent literature. While we acknowledge that various authors have put forward distinctions and labels for the different subfields that may form a part of digital ethnography (see Delli Paoli and D'Auria, 2021, for an overview), there is at present little consensus over the precise delineation (if at all necessary) within the field. We proceed using digital ethnography as the umbrella term that contains a variety of novel methods for creating thick descriptions using (at least in part) online data. The nascent field of digital ethnography experienced a particular boost during the COVID pandemic, when conventional methods of doing ethnographic research were hampered by limitations on socialising and mobility (Barendregt, 2021). The field is uniquely positioned to use data available on the internet, interactions between users and organisations, users and users, and organisations online, and linkages between all these types of data.

As this is a recent spin-off of conventional ethnography, there is still considerable debate about what digital ethnography specifically entails, and whether it is different from conventional ethnography. Padricelli et al. (2019) provide an overview within the context of tourism studies, where they see differences along a number of main dimensions. First, from a conceptual level, while both methods aim to achieve an in-depth understanding of the social fabric and practices of communities, conventional ethnographies excel in using direct participation as a method of observation. In digital ethnographies, data may be collected without participants' awareness. On the operational level, conventional ethnography relies on observation as the main research action, while digital ethnography allows for the collection of materials (primary and secondary), and as a result the researcher has more agency over the information included than in a conventional ethnography. From a technical point of view, digital ethnographies enable researchers to look back in time over recorded interactions, whereas conventional ethnographies are mainly based on the study period. Finally (although Padricelli et al. (2019) provide more detailed distinctions), digital ethnography does not require a researcher to be in the field for any length of time. To sum up, the main benefits of doing digital ethnographic studies are related to efficiency, cost, and geographic reach, whereas drawbacks, especially in terms of relating to specific communities, include a lack of direct interaction between researcher and community. Other authors, for instance Barendregt (2021) find less of a difference. One particular reason for these diverging views is that digital ethnography is far from a research discipline or paradigm, with a broadly agreed upon set of tools and concepts (Varis, 2015). Rather, it is a very recent and dynamic field of research, where a very broad range of approaches are labelled 'digital ethnography'.

For the purposes of this study, with multiple pilot countries, different communities, and language and embeddedness complications, digital ethnographies allow for the collection of detailed data on a

broad range of services, across a wide geographic spread. More importantly, while the study documented in this deliverable is a one-off, several of the related outputs (the ABMs and the BMC) could be reproduced in different contexts. The outline of the digital ethnography proposed below allows for the current project to be replicated more easily than a conventional ethnographic method might do.

2.1.1 Advantages and limitations of the method

Besides the general advantages of digital ethnography over traditional ethnographic research mentioned in the previous section, there are also noteworthy benefits of using a digital ethnography for the purpose of creating a synthesis of common successful business models for social enterprises. Arguably one of the biggest advantages is the possibility to collect structured data that identifies the same business elements for every social enterprise. In more traditional ethnographic research, the observational data might not yield the same insights with the same degree of comparability between different businesses. While the digital ethnography limits us to data and information that is available on the websites and social media profiles of the social enterprises, all information necessary to understand their business model based on the BMC can typically be found on a company website. Accordingly, the level of depth of the qualitative information might be lower than for data gathered via a traditional ethnography but the main purpose of this study is to find patterns of rural social enterprises' way of organising themselves and working with their respective communities. For this purpose, the digital ethnographic data collection is the most efficient tool.

2.2 Set-up and data collection digital ethnography

2.2.1 Starting point collection from pilot partners and via emails to SEs

As with traditional ethnographic research, a digital ethnography needs to be flexible enough to adapt to the community and environment it seeks to investigate (Pink et al., 2016). The community of interest for the digital ethnography within the INSPIRE project were rural social enterprises and initiatives across seven pilot areas in six different European countries (France, Ireland, Greece, Poland, Slovakia and Romania). To obtain a first point of contact (see Figure 2 for a schematic overview of the digital ethnography) with the local communities that were set to be studied, the pilot partners in the respective regions were asked to provide the researchers with a list of social enterprises or initiatives in the region.

The pilot partners all consulted their professional networks and their personal knowledge of the region and its social entrepreneurial landscape, consulted national registries of social enterprises (for instance, "Conect" for Romania via https://conect.gov.ro/1/harta-interactiva/; the "register of social and solidarity-based economy entities" for Greece via https://www.gov.gr/en/upourgeia/upourgeio-koinonikes-sunokhes-kai-oikogeneias/upourgeio-koinonikes-sunokhes-kai-oikogeneias/metroo-phoreon-koinonikes-kai-allelegguas-oikonomias), or national registers of businesses, filtering for social enterprises, and performed additional broad web searches. The collection of suitable social enterprises and initiatives was expanded via the identification of strategic partner organisations of the already identified social enterprises mentioned on their websites or shared in a snowballing email thread which asked social enterprises to share what other initiatives they were aware of as part of our mapping efforts for T2.3 – "Bottom-up mapping of social economy and entrepreneurship in rural

Europe". The response rate to the snowballing email was expectably low but did generate some new input, especially for the Greek and Irish ecosystem of social enterprises.

The final sample of social enterprise that was generated from these combined sources comprised 65 organisations - 8 from France, 14 from both Greek pilot regions combined, 15 from Ireland, 10 from Poland, 10 from Romania, and 7 from Slovakia.

2.2.2 Integration into business model canvas

As explained in the introduction, the chosen format for the identification of the possible business models for social enterprises in rural regions entails a business model canvas in a simplified form, as the data were mainly collected from online data sources rather than the social enterprises themselves. The choice of which elements of the social enterprises and their operations to include in our business model canvas framework was made based on the considerations of which information is essential for building and analysing a business model and strategy (Osterwalder and Pigneur, 2010), while also taking into account the information that would be freely available on social enterprises' websites and social media. A conventional BMC requires the collection of information on key partners, activities, resources, value proposition, customer relationship, channels, and customer segments. Additionally, some indication of costs and revenues would be interesting, although both are very difficult to ascertain.

The essential elements that were chosen based on these considerations were 1) the governance structure of the social enterprise, which allows us to understand the legal standing of a company as well as give an indication of their internal structure and organisation of their daily operations; 2) the (social) value proposition offered by the business, which gives us insight into the unique selling point and main concern in society that the social enterprise is trying to resolve through which activities; 3) their channels of outreach and communication, helping us understand who the social enterprises communicate with on a regular basis and what their exchanges might look like depending on the channel chosen; 4) their clients (adapted from the original customer segments to reflect a better fit with the social economy) to be able to understand which vulnerable communities are being addressed by the social economy in rural areas and in which ways; 5) the costs for the services; and 6) the funding sources the social enterprises regularly have access to. Especially seeing the costs opposite of the funding obtained helps with evaluating the viability of the business model of the social enterprise. Gathering data from rural social enterprises in this format gives us the necessary information to understand their mission, target market and operations in a structured way. Comparisons across enterprises and regions thereby become possible. This 6-element structure then will also be used to develop the typology of business models that work in certain industries or with certain client groups that they seek to help and implemented as part of the ABMs.

2.2.3 Data collection from websites and social media of SEs

To standardise the process of data collection from the websites and social media profiles of the social enterprises, a spreadsheet was created and all information necessary for the analyses was determined before the start of the data collection. The information to be collected included the main purpose and activities of the social enterprises, their age, their legal form, their target groups, what channels of information they use to attract and communicate with their clients, what sources they obtain funding from, if any, and a number of more quantifiable variables. The costs charged for the services of the social enterprises were classified into categories of "free", "low", "medium", and

"substantial" costs, taking into consideration the local median monthly income. To identify more social enterprises in the respective region, links to external websites were investigated and the number of linked (social) services was counted. A schematic overview of the data collection process can be seen in Figure 2.

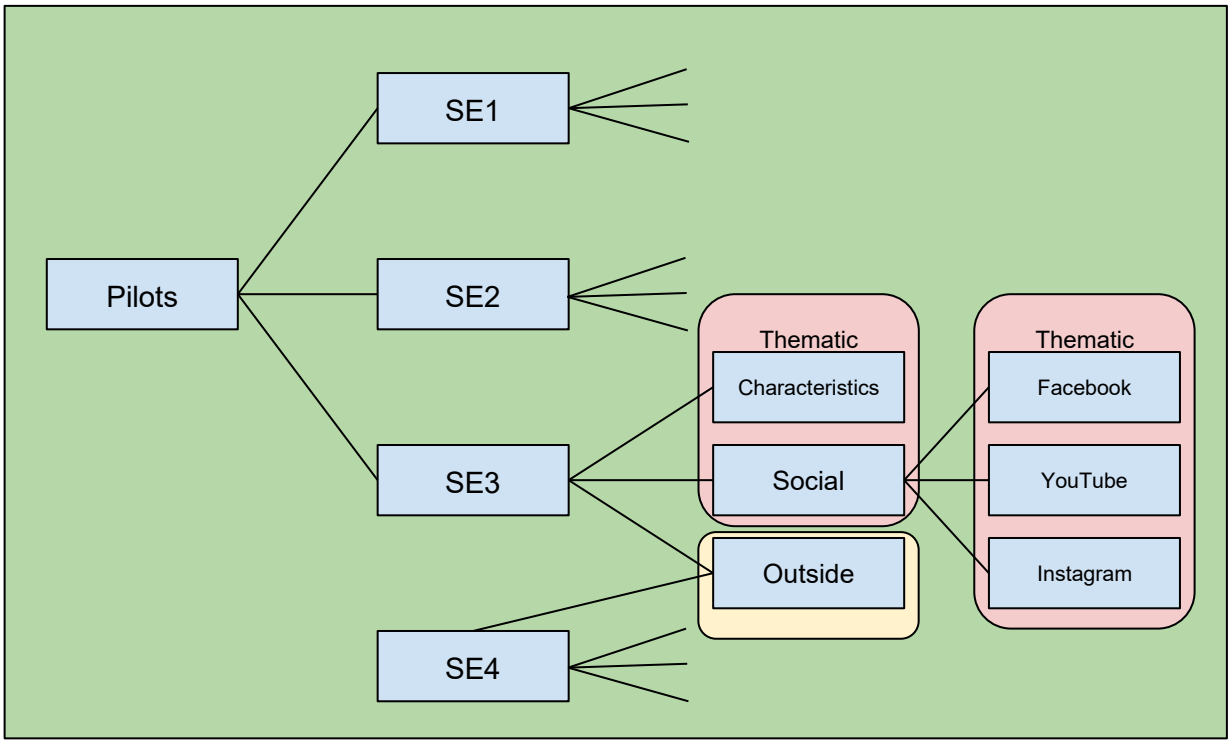


Figure 2: Schematic overview of digital ethnographic methods

In an effort to understand the interactions between the social enterprises and their clients in an online environment, the social media postings of the social enterprises were analysed in terms of frequency of postings, engagement and interactions generated, and the contents and tone of the communication. Not all of the 65 organisations in our sample had social media accounts, five do not host their own websites but have dedicated webpages on the websites of official governmental services. Two thirds of the social enterprises had one or more social media accounts, only one of them has not been actively posting in several years. By far the most frequently used social media channel for social enterprises in our pilot regions was Facebook, which all the organisations with social media accounts were present on. The next most common channels were YouTube - used for showcasing activities and daily work of the SE - and Instagram - mainly used for advertising events and staying connected with the followers/ clients.

The contents and tone of the social media postings and communications were analysed with a focus on concerns and issues experienced by rural communities and the sentiment used to address them directly by a researcher of the university if the contents were in English. For all other languages, the researcher made use of the automatic translation function of the respective social media platforms, supported by Google translations whenever necessary.

2.3 Online communities description (demand side for ABMs)

Considering the lack of geotags on social media such as X (formerly Twitter), Bluesky and Reddit, the social medium of choice for our research were localised Facebook groups in our pilot regions or countries with a direct relationship to rural issues. Relevant Facebook groups were selected by performing several searches using the name of the pilot region and the words “rural communities”, “locals”, “rural”, “villages” and “countryside”. For all regions, except for Konitsa in Greece, two online communities were identified in the form of Facebook groups. The majority of these were publicly accessible groups, only one of the French groups required the researcher to request access by providing information on her interest in the topic of rurality.

The selected Facebook groups were then explored for the sake of understanding the concerns of and online interactions between individuals in rural communities. A minimum of a year’s worth of content shared was considered for all groups which included different amounts of information based on how active the members of the groups are. The main discussion points of each Facebook group were determined, along with the theme most addressed over time and by a large number of members. Finally, the tone of the discourse was evaluated via a sentiment analysis conducted by the RUG team of researchers. A limitation that must be mentioned within the context of sentiment analysis is the language barrier between the original contents of the online communities and the languages spoken by the research team. All English and Greek content was evaluated in the original language. For the other local languages of the pilot regions, Google’s automatic translations to English were used to understand the content and tone of the discussions in the respective online communities.

2.4 Thematic analysis

Thematic analyses were performed for two different contexts within this research effort, one for the information collected from the social enterprises’ websites and social media and the other for the online communities/ Facebook groups of individuals in rural areas. This method was chosen because it allows for an inductive grouping and understanding of the patterns in the qualitative data. For the online communities, the themes of the discussion were identified via a read-through of the last year’s worth of content shared in the Facebook group, including all comments and reactions. The discussion topics were summarised in border themes and the two to three most frequently addressed themes were identified per community.

For the data collected from websites and social media of social enterprises, the thematic analysis was conducted in two steps. Firstly, the information on all essential elements of the SEs found on the websites and social media accounts was summarised and entered into the structured data collection spreadsheet. For all elements, but especially for the value proposition, the original wording used by the organisations themselves was used to ensure that the true values of the SE were captured. Of course, this included translations to English for most of the social enterprises. In the next step, the elements of business of each social enterprise (as defined via the business model canvas framework) were clustered into groups with similar themes or contents. This was done with sticky notes on a large virtual canvas and separately for each element of the business. The clusters were initially formed via similarity between the themes identified for each social enterprise and then further sorted following a

higher-level logic. For instance, sources of funding were grouped together depending on the type of organisation providing the funding and the level of government for governmental funding sources, then, the clusters were sorted according to the financial and future security offered by the different types of funding organisations. Finally, the clusters were analysed in relation to each other and the regions that they represent to develop and inform the business model typology of social enterprises in rural regions. The resulting business model canvas with clustered themes can be found as a Pdf file in the supplementary material to this report.

To create the business model typology involves creating a certain level of abstraction. The method for doing so in this study involves selecting a main business activity and then mapping out the main combinations of the other elements of the business model canvas, e.g. communication channels and funding. The dataset contained a wide variety of organisational structures, meaning that nearly the full set of combinations of each subcategory on the BMC was present in the dataset. The structure provided here represents a thematic map of the main combinations, centred on the main business activity, but we acknowledge that these are not comprehensive.[1]

2.5 Results ethnography

2.5.1 Issues and concerns of rural online communities

To have a first idea of the needs and wants of the target group of the social enterprises that were investigated via a digital ethnography, we are presenting the results of the sentiment analysis of the online communities of rural residents first. Since the online communities investigated as potential clients of SEs within the scope of this project were confined to Facebook groups, the results of the sentiment analysis has to be prefaced by a general observation: Since its peak usage, Facebook has lost not only active users but also much of its interactiveness of the early days of social media (Kay, 2025; Chartr, n.d.). Highly interactive discussions with many engaged members of the community have become the exception rather than the norm in many Facebook groups, but the discussion threads that were observed in the selected communities could still be analysed regarding their most common topics and tone of communication. The results of this are presented in the following paragraphs.

The contents and sentiments in the 13 identified online social communities provided some insights into the topics that are addressed in the online spaces of rural communities and how they are being discussed. Uncovering the issues addressed by rural communities online also provide us with an idea of what challenges the clients of local rural social enterprises experience. The main theme of the discussions varied between the groups as they had slightly different target groups for membership. The most common theme across all regions was the promotion of local events and developments. One of the Irish Facebook groups (“Westmeath County council”, circa 13,000 members) was mainly concerned with providing information that would be of use to local residents, often in the form of announcements for regional events or projects aiming to improve the liveability of the region. The posts regarding the sharing of information were as neutral and objective as possible, while discourse of the members commenting on the news updates and shared information ranged from caring and

[1] A full overview of the different elements and specifications for all SEs can be found in the complete BMC used for the thematic analysis in the supplementary information to this report.

supportive to critically cynical. One of the Facebook groups identified in the Greek Kythera region ("ΚΥΘΗΡΑΪΚΑ ΝΕΑ - Η ΟΜΑΔΑ", circa 5,800 members) similarly covers local news with the discourse of the members ranging from being generally supportive to some providing critical and cynical views on the local governmental decisions. The other regions had similar online communities addressing local happenings, "Lublin forum of Rural Women's and Farmers' circles" is one example from Poland (2,387 members), "Bons plans Auxerre" (3,190 members) is a French one, "Kosice City Page" (circa 43,000 members) is a Slovak one. All these online communities have in common that they function as platforms for local people to share events, invite the community and report back on successfully conducted community events. The general discourse in these online communities is rather informative and mostly supportive with the occasional critical voices which often occur in relation to (funding) decisions taken by local governments.

In one Irish and both Romanian groups, local agriculture was the most important topic with local farmers sharing their personal experiences and updates from their farms or developments in the industry of agriculture and livestock farming. The main difference between the Irish Facebook group ("Saving Rural Ireland Official") and the Romanian ones ("Eco Ruralis" and "EconomieRurala.ro - rural producers and village entrepreneurship") was the tone of the discourse within the group. In the Romanian community, information was shared in a neutral, almost educational way, eliciting supportive reactions from the community. The sentiment in the Irish online community ranged from factual over being critical of big corporations interfering in the local economy to members being concerned and very protective of their local rural communities. Based on the number of members, this Irish online community is a very small but active group of 64 individuals, the Romanian communities were both larger with more than 600 members in one and more than 5,000 members in the other group. The only private Facebook group in our sample ("Tous ensemble, nous sommes la ruralité" from France, around 3,100 members) had a similar focus of discussion topics, mainly revolving around rural livelihoods, hunting, fishing, agriculture and the politics affecting these activities. Somewhat similar to the Irish community, the tone of discussion here was nostalgic and several members expressed their frustration with and distrust of the European Union.

Another important theme across several online communities was the nature and environment of the local regions and the enjoyment thereof; this was especially true for the Greek Facebook groups ("Εξερευνώντας τα Κύθηρα", circa 31,000 members, and "ΦΟΥΡΚΑ ΚΟΝΙΤΣΗΣ- FOURKA KONITSIS!!!", circa 1,600 members. In those and one of the Slovak ones ("Spoznávame Slovensko" 22,644 members), the online community space was used to share photos of local nature, greenery or interesting landmarks to inform and inspire the community to explore and enjoy the respective regions. These communities were characterised by the frequent use of poetic language and very little substantial interaction between the members of the community.

2.5.2 Target group and channels of communication

When it comes to websites and social media accounts of social enterprises, the choice of a communication channel and the target group it reaches are inextricably linked. Therefore, they are addressed together in this section. The choice of media selected for the digital ethnography must be taken into consideration when analysing and reflecting on the data collected. As the main source of information consisted of the websites and social media presences of the social enterprises, all information processed throughout the analyses involves an element of selective self-presentation, which often is informed by the type of (social) media that the information is provided on. Generally

speaking, company websites have a broad target audience and are created to be mostly formal and informative of all services and offers of the respective enterprise. LinkedIn as a professional network is mainly targeted at potential employees, business partners and investors, whereas Facebook, X and Instagram are more casual social media platforms that people often use privately and socially. In line with these differences in purpose of the social media included in our digital ethnography, the style of communication of the social enterprises was found to differ between the different channels of communication. This held true despite the language differences.

A clear pattern in most countries was that comparably younger social enterprises are more active on social media; this was mainly reflected in a higher frequency of posting content. The reasoning here might be that older social enterprises have been active since before the rise of social media and have therefore established offline channels of communication with their target audience, such as via local news and media, local advertisements or the reliance on word-of-mouth recommendations. The number and frequency of postings and interactions did not seem to be directly related to the number of followers of a social media account.

2.5.3 Client relationships & interactions

Publicly visible interactions between the social enterprises and their (potential) clients mainly appear on Facebook and Instagram but are then limited to comments on content shared by the social enterprises. Due to the sensitive nature of the issues addressed by many of the social enterprises, discussions of the content of their daily work or specific situations with individuals are not found on the publicly available web sources used in this digital ethnography. Regardless, some observations about the interactions between social initiatives and their social media followers could be made. While the content shared on the more interactive social platforms does not differ that much between the social enterprises, the frequency of their posts varies a lot. Most social enterprises mainly share information about their upcoming or past events in the form of photos, posters or invitations; occasionally, employees or clients will be put in the spotlight by introducing them to the online followership. In general, the frequency of companies posting content ranged from daily updates to a few posts when the respective social media account was created and never again.

2.5.4 Key partnerships

As for the connections and interactions between different social enterprises in the same region, the analysis showed that many social enterprises are not well connected in their industry or local environment. In some cases, the reason for this certainly lies in the lack of similar initiatives to create a connection with or the degree of specialisation of the services offered, but in most cases the reason might just be a lack of knowledge of other organisations. It also became clear that social enterprises that work with governmental actors are better connected than organisations that do not have any governmental support. This could suggest that, next to their funding commitments, government agencies also play an important role of facilitating synergies between various initiatives with similar goals for local rural development.

2.5.5 Type of organisation

The legal form of the organisation seems, at least to some extent, to depend upon the country of operation. In Ireland, for example, there are many volunteer collectives contributing to solving local community issues. This could be a consequence of the focus of the Irish pilot partner on the

specifically vulnerable population of recent migrants and refugees in rural areas. In the Greek pilot areas, we mainly observed officially registered social cooperatives with causes that are first and foremost culture and place-based. For the Romanian and Polish pilot areas, a substantial number of the social enterprises consisted of governmental services aimed at supporting the local citizens with social services and employability training and support.

2.5.6 Key activities

The services provided by the social enterprises can be divided into four categories - essential services for physical well-being and baseline social conditions, essential services for social integration, economic services and services for non-material well-being. The services falling into the first category concern themselves with the delivery of essential services such as transportation to ease accessibility of, for instance, health care facilities, healthcare itself, housing and daycare facilities as well as primary and secondary education. While historically, these services were often provided by governmental or public actors, due to increasing privatisation of formerly governmental services, services that are not profitable in rural regions often disappear from them (as has previously been showcased in our project deliverable D1.3, Typology on social wellbeing, resilience and exclusion of European rural areas). This gap is then filled by social enterprises that we are especially interested in in the INSPIRE project which focuses on the successful social inclusion of vulnerable populations in rural regions through the social economy. Across all countries and all pilot regions, we can find essential service providers in the form of non-profit organisations. The services they provide do not differ between countries so much as they all offer support for older adults and individuals with disabilities, both groups who are often less mobile than the average person. Helping vulnerable groups with accessing health care, food or housing are services commonly taken on by non-profit organisations in our pilot regions. This cluster comprises the largest number of services in our sample, closely followed by the economic services cluster. One very concrete example of how a social initiative is trying to counteract the disappearance of medical services in French villages in the Bourgogne is the “Bucobus” - a mobile dental clinic that comes to the villages for the local residents to easily access dental care. Especially students training to be dentists and recent graduates are sought out to be involved in this effort that is facilitated by a French health insurance company.

Essential services for social integration cover the topics of community building, connection and representation, they often address these by organising communal social events for individuals to meet, connect and be part of a social group. In our Irish pilot region, which focuses on migrants and refugees, we observed many services that aim at creating a sense of community. This could be a response to newcomers coming into the Irish rural communities and having a need for connection that cannot be met elsewhere, if the new migrants come to the region as single adults or unaccompanied minors. One such event providing a sense of community to its participants is the weekly Sunday “walk and talk” in Moate’s large local park. Over a walk and a chat, locals and newcomers connect, learn about one another and form lasting friendships. For the local community in general, there are initiatives such as “Moate Tidy Towns” or “Moate Men’s Shed”, where people come together for communal activities, such as a town clean-up or just to have a cup of tea together and brainstorm about a new project to work on. Similar places and initiatives were found in the other countries and pilot regions as well but then for slightly different target groups, for example the “Rural women’s circles” in Poland are very active in organising inclusive community events for young and old, whereas the Greek pilot site appears to have many initiatives that are specifically meant to connect and support women in different areas of their lives.

The economic services identified in the ethnographic data still qualify as social enterprises or initiatives, but they deliver something that is of economic value for the individual using the services. This cluster was the second biggest in terms of the number of services identified across the different pilot regions. An example of an economic service would be a training for job-relevant skills that increase the individual's employability, the offer of paid internships, or support in founding a business and obtaining funding for it. These services are often provided by governmental institutions due to the federal interest in a strong labour market and financially independent residents. Especially in the Polish pilot region, we observed governmental initiatives aimed at fostering employability skills and subsidising employment for long-term unemployed individuals. Next to the many formal services offered by employment agencies and institutions with close links to the regional governments, social enterprises in the more classical sense were also part of our sample in Poland. Two examples are "Emaus Lublin" and "Emaus Leczna" - they provide employment in low-threshold occupations such as cleaning, catering/ a restaurant and simple woodwork for individuals to re-enter the labour market after a period of inactivity. These organisations are funded or supported by formerly homeless and jobless individuals who are now entrepreneurs that seek to support the people in need that they can still identify with. Similar initiatives can be found across most European countries, with slightly different industries they operate in or different target groups that they seek to reintegrate into the labour market. In Slovakia, for instance, "Cafe from the Heart" functions as a place of labour market opportunity for individuals with disabilities and reduced working capacities. What makes these specialised organisations so successful at labour market reintegration is their ability to adapt the tasks of the to the person's abilities and capacities.

Lastly, the services for non-material well-being can be related to cultural activities, hobbies, education and empowerment, and the provision of information in the wider sense as well as the active engagement in local development. While there were initiatives and communities that offer room for different hobbies (such as running, reading, crafting, etc.) in all pilot regions, the largest cluster of cultural activities and services offered was found in the two pilot regions in Greece, Konitsa and Kythera. There, a whole social entrepreneurial ecosystem exists that is concerned with eco- and agritourism, sustainably living off the land and revitalising the rural areas via cultural events and activities that keep the local community engaged. Some noteworthy initiatives in this local ecosystem are "Portokalia", "Kaleidoscopio", "Ecotopia" and "The High Mountains". The French pilot region also showed a strong presence in this cluster of services but in a slightly different way. The French and Irish social enterprises (such as "Club de l'Yonne", "Fédération départementale des foyers ruraux de l'Yonne" and "Moate Town Team") are less concerned with the local culture and more focused on participatory government, bringing all stakeholders together to create an inclusive and sustainable community for the future.

2.5.7 Costs of services

For the costs that are charged to the clients of the social enterprises, the picture was very clear - most services are offered for free or at a tiny cost for the individuals. Based on the general target groups for social enterprises being vulnerable populations, many of which live in precarity, offering services for free allows that target group to benefit fully. The few providers that offer social services at a medium or high price point are often cost-intensive services such as specialised day or health care that might be financially supported by a person's health insurance in most countries, such as "Exwell Athlone" in Ireland, the "Trifylleion foundation of Kyherians" in Greece or the "Association for

Community Care Maramureș" in Romania. The only social enterprises in our sample that charge a substantial fee to their clients offer something of very high value in return. In France that is a professional education that will enable the graduates to obtain a higher salary in all future jobs. In Slovakia that is the possibility to self-fund and self-construct a family home. Of course, that requires a large investment and good financial planning, which the organisation also offers help with.

2.5.8 Funding structure

When it comes to funding of the social enterprises in our sample, the vast majority of services across all countries and regions were funded by local, regional and national governments, often augmented by EU- or project-based funding. A small group of initiatives (two each from Greece and Romania) rely only on private donor funding, which can be much less reliable and less sustainable in the long run compared to consistent government funding and support. However, as discussed in the INSPIRE project deliverable D1.3, many rural regions struggle with the lack of planning security in the governmental funding that they receive based on the agenda of the ruling government at any given time. A somewhat larger group of initiatives - three each from Ireland and Greece, one from France and one from Poland - were found to receive no external funding at all. In the case of the Irish social initiatives ("Moate tidy towns", "Moate Men's Shed" and "Sanctuary Runners") and one of the Greek ones ("Women Association of Konitsa 'Myrtali'") the reason for this is that they are volunteer-run organisations that offer free services or activities and they do not have any costs to run their operations. The same applies to the Polish news website for people with disabilities "wnilublin.pl". The French "Trajectoire formation" and the Greek "Mazzipetti bike shop" and "The High Mountains" all offer a paid service or product that covers the cost of producing the item/ service and therefore, they are not reliant on external funding to run their social enterprises. As these examples illustrate, the funding structure is directly linked to the legal form of the business and the main value proposition of their service.

3. Spatial microsimulations

3.1 Overview

As set out in the INSPIRE proposal, Task 2.3 relies on spatial microsimulation to generate detailed small-area information on social inclusion and related socio-economic characteristics in the project's pilot regions. The approach builds on earlier work by the members of the consortium and co-authors of this deliverable (Ballas et al. 2005a, 2005b), which we draw upon in this introductory section of the spatial microsimulation approach.

Microsimulation models are designed to construct large-scale datasets on the attributes of individual micro-units, typically individuals or households. These models are then used, either independently or in combination with Agent-based models (ABM) to examine how policies or shocks affect these units. The entities represented in such models are often referred to as "synthetic" individuals or households. By that we mean that they resemble real persons in terms of their characteristics, yet they do not correspond to identifiable individuals in the population. Working at this micro level using these synthetic individuals allows us to explore how different policies may have an effect across different types of people, households or any other entity that these individuals may interact with.

Over the past decades, microsimulation has become a standard tool in economics and social policy analysis, with national-level (aspatial) models frequently used to assess the distributional consequences of tax and benefit reforms (i.e., EUROMOD[2]). Microsimulation becomes spatial when we explicitly link the synthetic micro-units to geographical locations. In spatial microsimulation, the aim is to create large-scale microdata sets that are geographically referenced and that reflect, as closely as possible, the real population living in particular localities. Because access to geographically detailed microdata is usually restricted for confidentiality and practical reasons, spatial microsimulation methods are used to reconstruct such data indirectly by combining small-area aggregate data, most often from population censuses or administrative registers, together with rich survey microdata, which provide detailed socio-economic, attitudinal and perception variables. By merging these sources, one can simulate a population of individuals within households for a set of geographical units (for example municipalities or local communities), such that the simulated populations match the official small-area distributions of key variables. In this sense, spatial microsimulation is increasingly recognised as a powerful small-area estimation technique, and it can also serve as a natural starting point for agent-based models, by supplying the synthetic population that will later be "simulated" in the ABM environment.

The work reported in this deliverable builds on a series of previous applications by members of the team in the development of spatial microsimulation models capable of generating small-area microdata using different estimation strategies. These include deterministic reweighting based on Iterative Proportional Fitting (IPF) (e.g. Panori, Ballas and Psycharis, 2017; Lovelace and Ballas, 2013; Ballas, 2004), synthetic reconstruction (Ballas and Clarke, 2000) and combinatorial optimisation methods such as simulated annealing (Kavroudakis, Ballas and Birkin, 2011). Across these various models, the simulation outputs (i.e. the attributes of the synthetic individuals) cover a broad range of

[2] https://euromod-web.jrc.ec.europa.eu/

policy-relevant variables, including income, household composition, socio-economic group, and, more recently, well-being indicators and perceptions related to social inclusion which is the aim of the present deliverable.

An example of spatial microsimulation is the SimBritain model, which combines national survey data with small-area census statistics to generate synthetic microdata for the United Kingdom using a deterministic reweighting approach. In that work, non-census variables (e.g. household income) were estimated at small-area level and used to analyse the socio-economic and spatial consequences of a variety of national social policy changes (Ballas et al., 2007). Another example is the Microsimulation Modelling and Predictive Policy Analysis System (Micro-MaPPAS), an open-source geographical microsimulation framework. More recently, the SimAthens model (Panori, Ballas and Psycharis, 2017) combined Greek census data with the EU-SILC survey, using IPF to derive small-area microdata for the Athens metropolitan area in 2001 and 2011.

In INSPIRE, Task 2.3 adopts a similar philosophy but adapts it to the project's specific focus on rural social inclusion. The models developed here combine:

- Individual-level data from the INSPIRE survey, designed and implemented under Task 1.2, which provides information on socio-demographic characteristics (e.g. age, gender, education, employment, household structure), socio-economic situation (e.g. income sources, employment sector), access to and use of services, participation in social initiatives, and perceptions related to inclusion and well-being and safety; together with
- Small-area aggregate data from national statistical authorities (mainly census or administrative data) in the INSPIRE pilot regions.

By fusing these two data sources, we construct static spatial microsimulation models for each study area. "Static" here indicates that the models create a detailed snapshot of the population at one point in time, without simulating demographic, socio-economic or perception transitions over several years. The resulting intra-regional synthetic microdata sets can be used to estimate small-area distributions of variables that are not directly available from official statistics but are crucial for understanding social inclusion in rural settings. A more dynamic approach which allows us to track perception changes over time is by combining spatial microsimulation with ABM. This is possible by using the output of spatial microsimulation models (i.e. the generated synthetic weights) as input in the ABM models and tracking the changes in the variables of interest (i.e. perceptions of inclusion) in a simulated environment.

The R code and procedures developed under Task 2.3 aim to generate small-area population microdata for the INSPIRE pilot regions (and can, in principle, be adapted to other regions given that suitable aggregated census and individual level survey data is available). As has already been mentioned, operationally, the spatial microsimulation models rely on a social survey microdata set (in this case, the INSPIRE survey developed specifically for the needs of the project) which includes information on key demographic and socio-economic characteristics of individuals and their households. This microdata set is then combined with small-area aggregate information (from the census or administrative data) that provide a description of the socio-demographic profile of the pilot areas. The outcome is a set of synthetic micro-populations that form the basis of further analyses. For a more illustrative understanding of the procedure, we include a fictitious example of an individual social survey below in Table 2.

Table 2. Fictitious survey microdata.

PERSON	AHID	PID	AAGE12	SEX	AJBSTAT	…	AHLLT	AQFVOC	ATENURE	AJLSEG	…
1	1000209	10002251	91	2	4	…	1	1	6	9	…
2	1000381	10004491	28	1	3	…	2	0	7	-8	…
3	1000381	10004521	26	1	3	…	2	0	7	-8	…
4	1000667	10007857	58	2	2	…	2	1	7	-8	…
5	1001221	10014578	54	2	1	…	2	0	2	-8	…
6	1001221	10014608	57	1	2	…	2	1	2	-8	…
7	1001418	10016813	36	1	1	…	2	1	3	-8	…
8	1001418	10016848	32	2	-7	…	2	-7	3	-7	…
9	1001418	10016872	10	1	-8	…	-8	-8	3	-8	…
10	1001507	10017933	49	2	1	…	2	0	2	-8	…
11	1001507	10017968	46	1	2	…	2	0	2	-8	…
12	1001507	10017992	12	2	-8	…	-8	-8	2	-8	…

Where:

Person	person number
AHID	household identifier (number of household to which the listed individual belongs)
PID	person identifier (a unique number to identify the individual)
AAGE12	Age
SEX	Sex
AJBSTAT	Current labour force status (e.g. self-employed, in paid employment, unemployed, family care etc.) in 1991
AHLLT	Health status
AQFVOC	Vocational qualifications
ATENURE	Tenure status
AJLSEG	Socio-economic group: last job

For the analyses in this deliverable, we use the INSPIRE survey developed under T1.3. Conceptually, a typical survey file can be viewed as a list of individuals with associated identifiers and attributes (age, sex, employment status, health status, socio-economic group etc.), as illustrated in earlier blueprint work by Ballas et al. (2005b) using data from the BHPS. Spatial microsimulation techniques use such microdata in combination with small-area tables to simulate populations that are statistically consistent with known area-level distributions.

The type of spatial microsimulation implemented in INSPIRE is commonly described as static reweighting-based microsimulation. The starting point is a microdata sample which is representative at higher geographical levels but not directly at the fine spatial scale of interest (e.g., municipalities or local communities in the pilot regions). The goal is to adjust this sample so that, in each small area, the simulated population matches the known marginal distributions from the census or other official sources. This is achieved through reweighting: each survey record is assigned a weight that indicates how many people in a given small area it represents. Reweighting methods search for the set of weights that best describe the microdata with a series of "constraint" variables describing the small areas. These constraint variables summarise the composition of each area in terms of variables such as age group, gender, labour market status, education level or marital status etc.

To illustrate the logic, Table 3 presents a simplified example of the type of small-area constraint tables used in the spatial microsimulation models. For each geographical unit we typically know, from census or administrative sources, how many residents fall into broad age groups, how many are men and women, and how many have low, medium or high levels of education among other constraint variables. These one-dimensional distributions form three of the constraints in our model. The task of the spatial microsimulation procedure is to select and weight records from the individual survey micro-dataset so that, for every geographical unit, the synthetic population reproduces these marginal distributions as closely as possible. In practice there are many different combinations of survey records that could satisfy the constraints, and a range of algorithms can be used to search for a good solution (see, for example, Williamson et al., 1998; Ballas et al., 2005a, 2005b). In INSPIRE we use an Iterative Proportional Fitting (IPF)–based reweighting approach to achieve this alignment.

Table 3. Examples of small area constraints.

Small area table 1 (Age group)	**Small area table 2 (Biological sex)**	**Small area table 3 (Highest attained education)**
Area 1	Area 1	Area 1
200 persons aged 0–17	400 men	250 low education
500 persons aged 18–64	420 women	350 medium education
120 persons aged 65+		220 high education
Area 2	Area 2	Area 2
150 persons aged 0–17	270 men	220 low education
320 persons aged 18–64	280 women	220 medium education
80 persons aged 65+	30 other	110 high education

The INSPIRE model follows the line of work developed in earlier models such as SimBritain, Micro-MaPPAS and SimAthens, as well as in other European Union's Horizon Europe Research and Innovation Programmes such as RISKADAPT[3] and MOBI-TWIN[4]. As a result, it relies on an IPF-based deterministic reweighting procedure implemented in R. Through an iterative process, IPF

[3] https://riskadapt.eu/
[4] https://mobi-twin-project.eu/

adjusts the weights attached to survey records so that the synthetic small-area distributions of the constraint variables converge towards the official totals. The resulting synthetic micro-population for each area provides the foundation for the subsequent analyses of social inclusion and for the ABM. The R code that accompanies this deliverable is designed to be adjustable to facilitate reproducibility. By changing the input survey microdata and the small-area constraint variables (i.e. census data), the same framework can be applied to different regions or countries, and to a range of policy questions. In the context of INSPIRE, the immediate focus is on the six pilot territories (in Slovakia, Poland, Greece, France, Ireland and Romania) and on the variables most relevant to rural social inclusion.

3.2 Constraint variables and model diagnostics

In this subsection we summarise the constraint variables used in the spatial microsimulation models. Across all INSPIRE pilot areas we adopt a common conceptual set of constraints in which we aim to reflect country-specific data availability. The constraint variables used capture basic demographic structure, labour-market position and educational attainment, which are related to the analysis of rural social inclusion.

Below we list the core constraint variables and their typical categorisation. In some pilot areas the exact range between categories (e.g. age groups or education levels) differ slightly in order to align with the national census or administrative sources. These adaptations do not change the underlying logic of the models.

- Age group (0-19, 20-29, 30-39, … , 70-79, 80+)
- Biological sex (male, female)
- Educational level (primary, lower-secondary, upper secondary, tertiary)
- Employment status (employed, unemployed, student, retired, other)
- Marital status (single, married, divorced, widowed)

The constraint variables identified in the census and administrative data are then matched to the corresponding variables in the INSPIRE survey. In cases where the categories of a variable differ between the two sources, we harmonise them by merging either some survey categories or some census categories so that both datasets share the same set of categories before the matching and reweighting procedures. For example, suppose the census reports educational attainment in five categories*:* no education, primary education, lower-secondary education, upper-secondary education, and tertiary education. The survey data used for the microsimulation, by contrast, distinguishes tertiary education into bachelor, master (or equivalent)*,* and PhD (or equivalent)*.* In this case, we collapse these three survey categories into a single “tertiary education” category so that the education variable in the survey is fully aligned with the census classification.

Once the spatial microsimulation models had been run for all INSPIRE pilot areas, we examined whether the IPF procedure converged to their “true” values. To do so, we produced a set of convergence plots that track how the weights attached to selected survey respondents evolve across different iterations of the algorithm. In all pilots the reweighting routine was allowed to run for up to 10 or 20 iterations, depending on the resulting patterns. In practice, the adjustment of the weights stabilised well before this upper limit.

Figure 3 provides an example for a randomly selected individual for all pilot regions. Each graph traces the sequence of weights for a given survey record across iterations. At the beginning of the process, the weights change relatively sharply as the algorithm brings the synthetic distributions closer to the small-area constraint totals. After the first few iterations, these changes become smaller and the lines become almost horizontal, indicating that the weights have reached values that are consistent with the marginal distributions and do not require further iterations. A similar pattern is observed for the other pilots, which suggests that the IPF routine is behaving as expected and that the resulting weights are suitable for generating the synthetic microdata. These visual checks are useful both as a diagnostic tool and as a way of documenting model behaviour in an easy-to-understand manner.

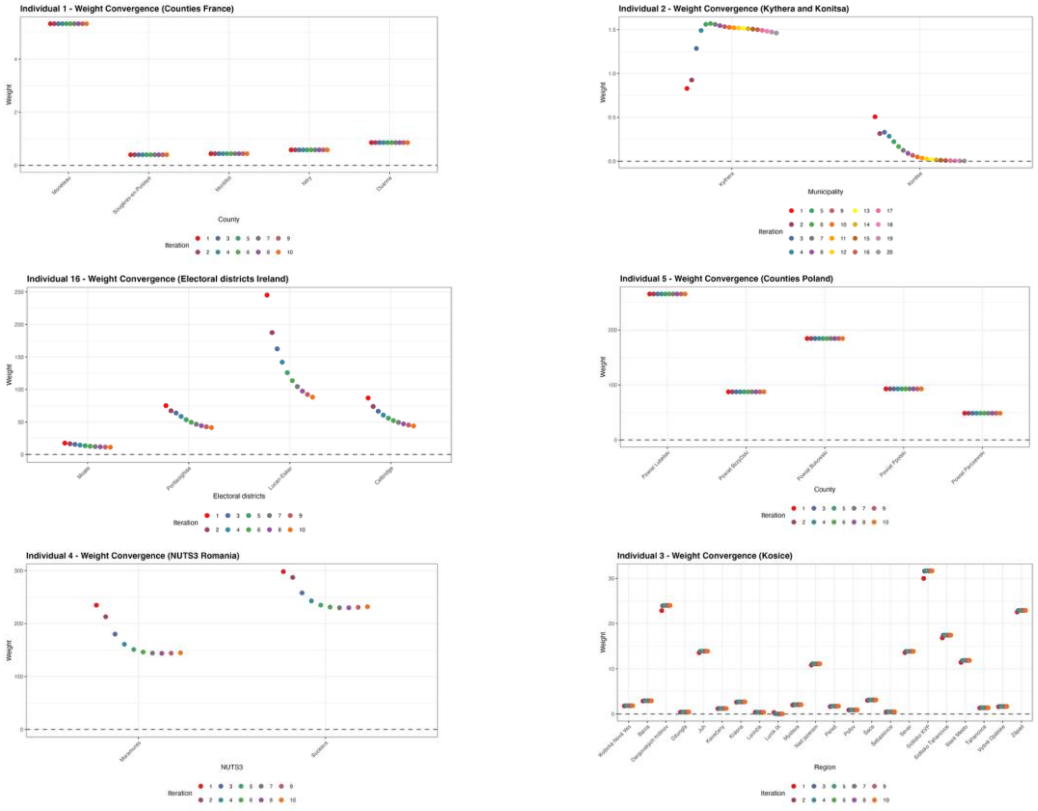


Figure 3: Convergence graphs of spatial microsimulation weights.

Before turning to the analysis based on the synthetic microdata, we first examine how well the spatial microsimulation models perform through internal validation. Internal validation focuses on variables that were already used as constraints in the reweighting procedure and checks to what extent the synthetic populations can reproduce the corresponding official totals at small-area level. Put differently, we use the microsimulation weights to re-estimate the distributions of selected constraint variables and compare these estimates with the observed values from the census or administrative sources for the same geographical units.

For each pilot region, we select at least one constraint variable that is available in both the INSPIRE survey and the small-area statistics (for example, the number of unemployed residents, the number of people in a given age group, or the number of individuals with a specific marital status). Using the spatial microsimulation weights, we calculate the synthetic count of individuals in the chosen category for every spatial unit and compare it with the corresponding actual count from the official data. These

comparisons are presented in the form of scatterplots (Figure 4), one per pilot, where the horizontal axis shows the observed number of individuals and the vertical axis shows the synthetic number produced by the model. Each graph includes a 45-degree reference line, representing perfect agreement between observed and simulated values.

In all pilots, the majority of the points lie very close to this 45-degree line, indicating that the models reproduce the constraint distributions with high accuracy at the small-area level. These diagnostics suggest that the synthetic populations generated for the INSPIRE pilot areas provide a reliable representation of the official small-area marginals and thus form a reliable basis for the subsequent mapping and analysis of social inclusion through the Agent-Based Modelling.

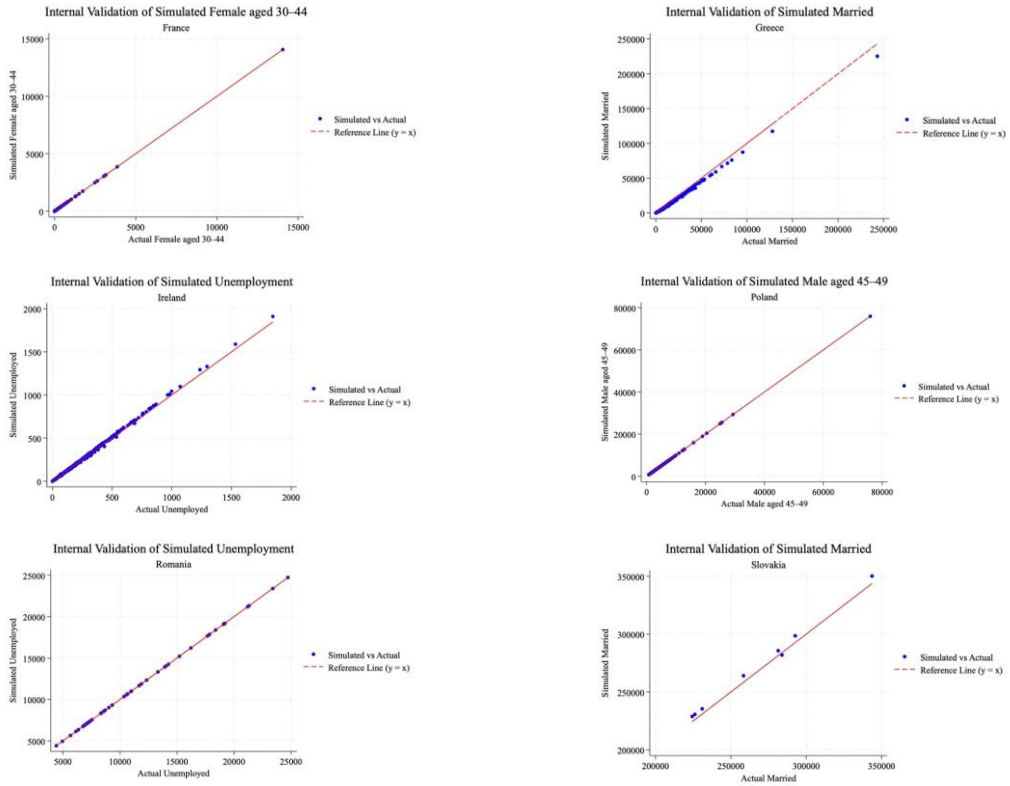


Figure 4: Internal validation per pilot area.

3.3 Mapping of spatial microsimulation output

The results from the spatial microsimulation models can be used to produce maps for the INSPIRE pilot areas. This shows the usefulness of the method, because it allows us to add geography to an otherwise aspatial social survey. By combining the INSPIRE survey with census and administrative data, we are able to estimate how different types of individuals are distributed across different spatial units. Using the synthetic population, we can identify variables related to social inclusion (or exclusion) and vulnerability, such as the absolute number and the share of people reporting low physical or mental health, low-income individuals, older people, individuals with low education, or widowed individuals. Importantly, we can not only estimate how many such individuals there are and their share of the total population but also identify the areas where they are concentrated.

In this report, as an illustration of the method, we present maps based only on the absolute number and the share of people reporting low physical health. We focus on this indicator because it is relatively easy to observe, more objectively measured, and an important factor related to being or feeling socially excluded. Of course, the same type of analysis can be carried out for all other variables mentioned above, but including all of them here would make the report unnecessarily long. By mapping these variables for each pilot area, as well as for neighbouring or broader spatial units such as municipalities, electoral districts or NUTS 3 regions in the countries where the pilots are located, we can identify spatial units where groups at risk of social exclusion are more likely to live. This information can help policy makers and local stakeholders to target interventions, plan services and decide where Smart Village Labs and other actions could have the greatest impact.

In Figure 5, we present maps that show the location of the pilot areas within the country or the broader regional context. This orientation step is useful for readers, as it allows them to locate the areas of interest before examining the more detailed maps of the absolute number and share of people reporting low physical health in the next figures.

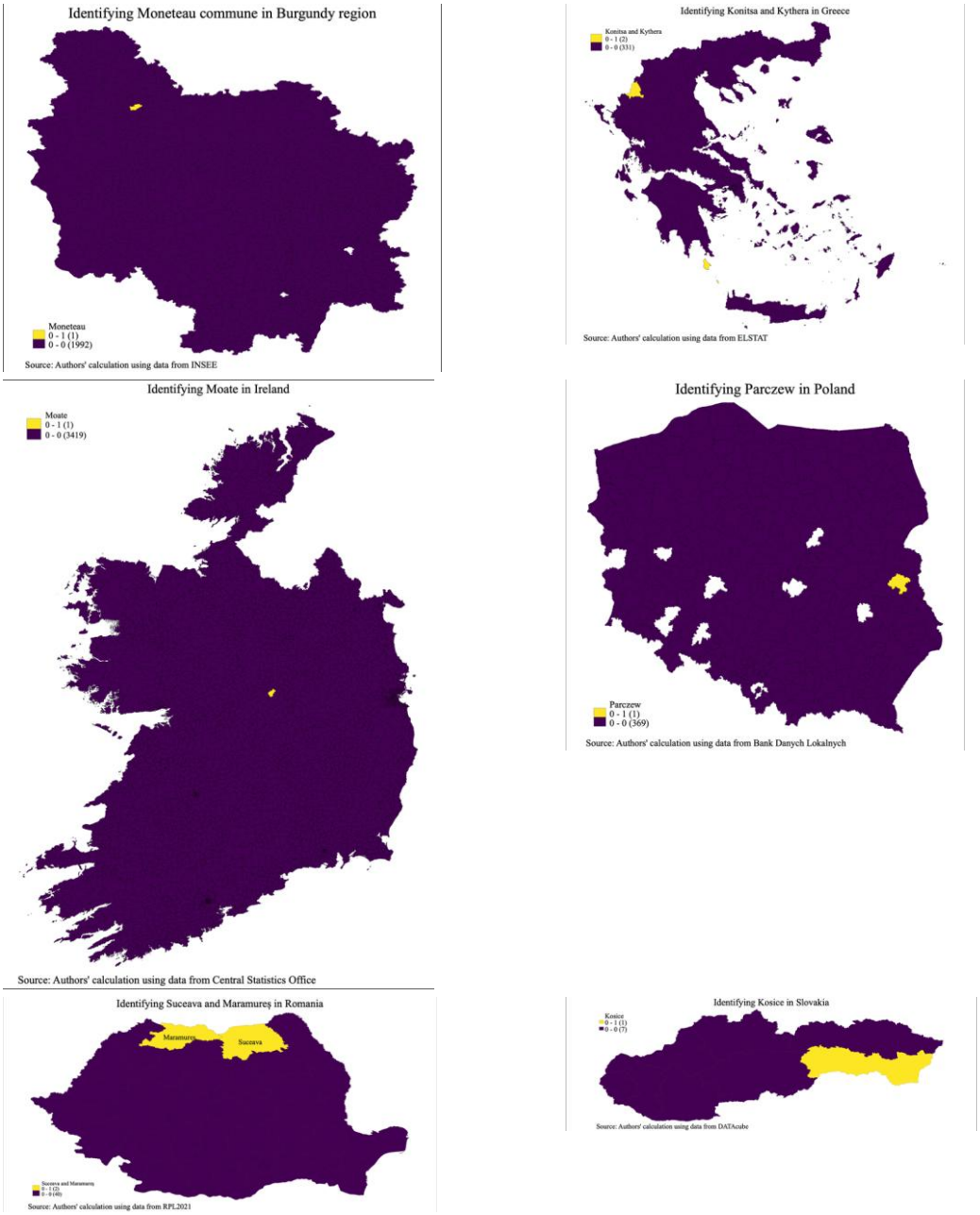


Figure 5: Identifying pilot areas within broader geographical regions.

In the final part of the spatial microsimulation section, we present maps based on four variables derived from the self-reported physical health question in the INSPIRE survey (Q27_1). Respondents were asked*:* "In general, would you say your physical health is: 1) Poor, 2) Fair, 3) Good, 4) Very good, 5) Excellent?". Using this question and the spatial microsimulation weights for all spatial units, we construct two groups of interest:

- Low physical health**:** individuals who reported their physical health as either poor (1) or fair (2).
- Lowest physical health**:** individuals who reported their physical health only as poor (1).

For each small area (e.g. municipality, electoral district or similar unit), we then estimate:

- The absolute number of people with low physical health (poor or fair);
- The share of people with low physical health, obtained by dividing this absolute number by the total population of the area;
- The absolute number of people with lowest physical health (poor); and
- The share of people with lowest physical health, again expressed as a proportion of the total population of the area.

We then present these variables, in Figures 6-11, at the highest available aggregated level per country. This layout allows the reader to see, for each country, both the size of the population reporting low or very poor physical health and the relative intensity of these problems in each area. In other words, it shows not only where many people with low physical health live in absolute terms, but also where they represent a particularly large share of the local population. Across the six countries, these maps help us identify spatial units where people with low or lowest physical health are more likely to live and where potential risks of social exclusion may be higher. In some areas, the absolute number of people with low physical health is high mainly because the municipality is large, whereas in other, smaller rural areas the share of people in poor or fair health is relatively high even if the absolute numbers are modest. This is also evident from the different geographical patterns that emerge when we compare the maps based on absolute numbers with those based on shares of the total population. This distinction is important for policy as both types of areas may require attention, but the nature and scale of interventions may differ. In general, these maps provide an accessible way to visualise how physical health, which is considered as a key factor of social inclusion or exclusion, is distributed within and around the INSPIRE pilot territories.

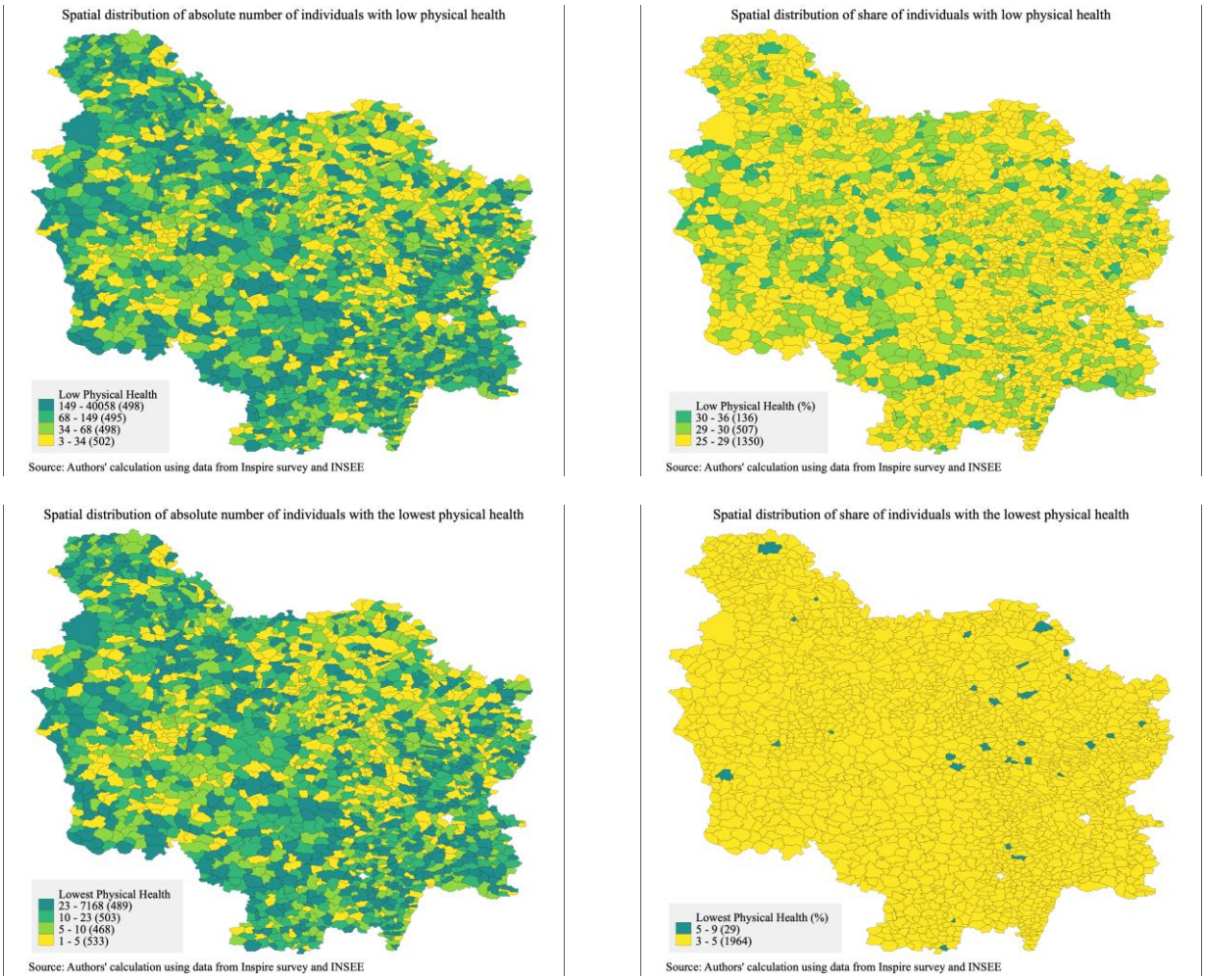


Figure 6: Spatial distribution of physical health in Burgundy region.

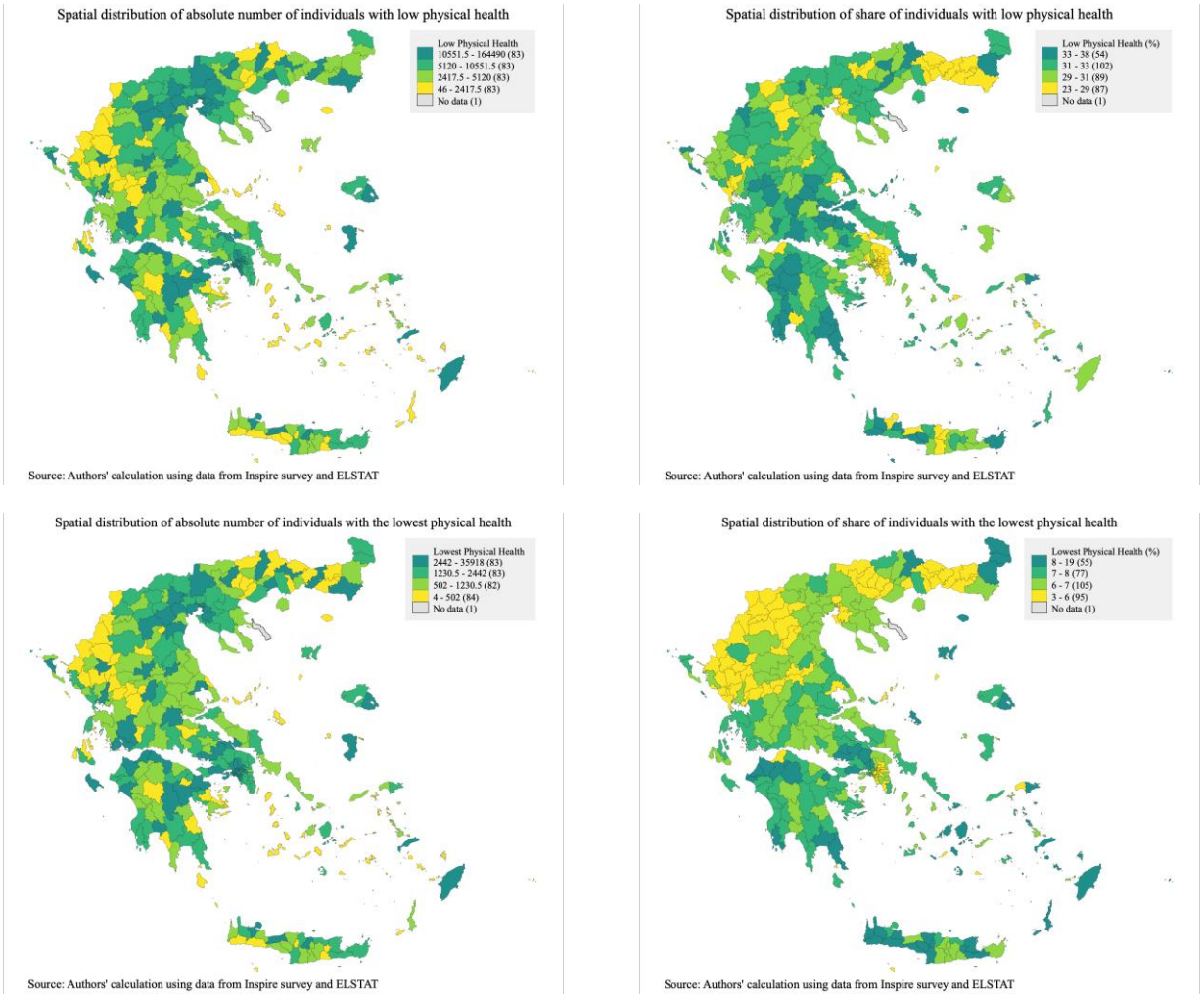


Figure 7: Spatial distribution of physical health in Greece.

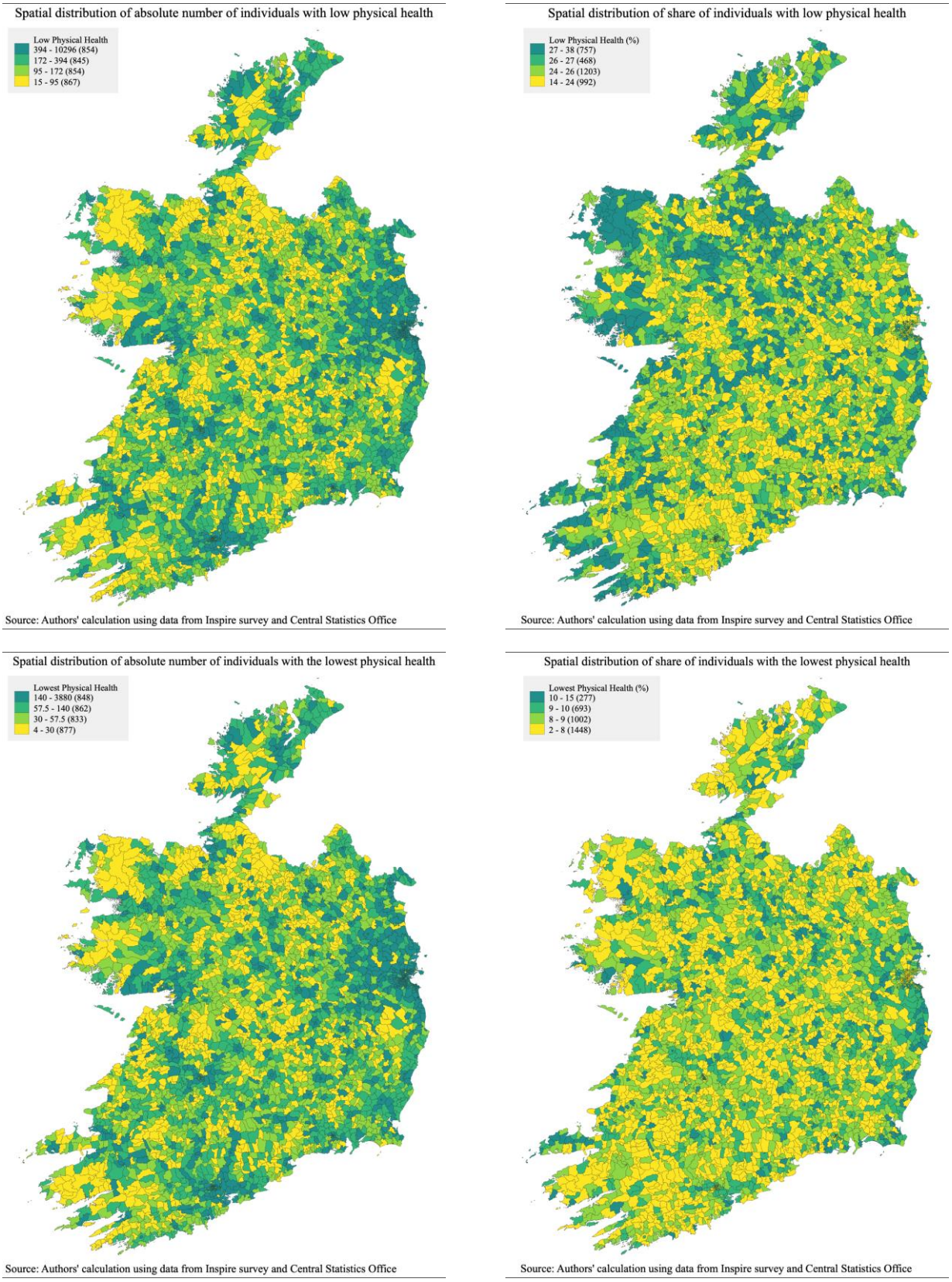


Figure 8: Spatial distribution of physical health in Ireland.

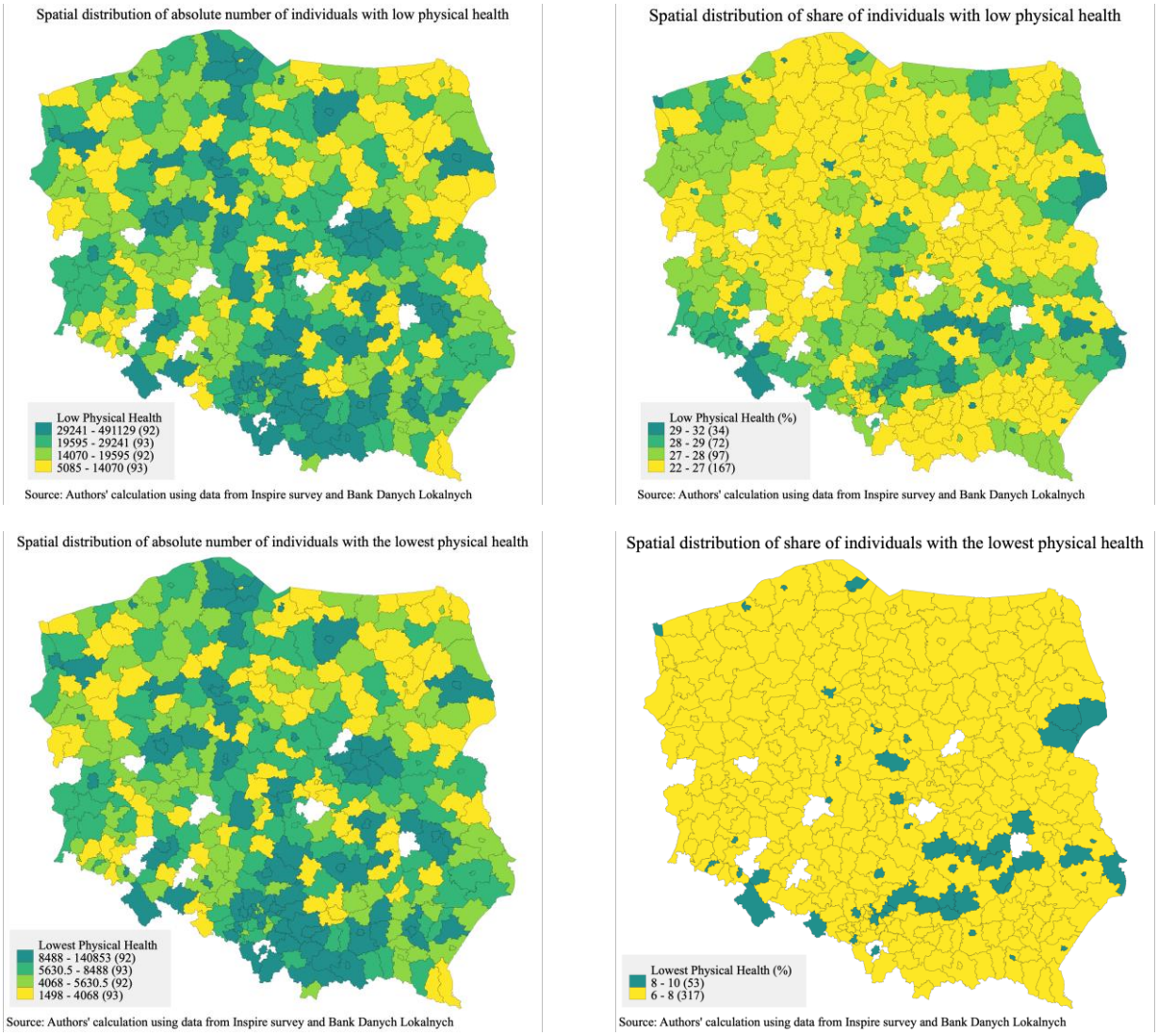


Figure 9: Spatial distribution of physical health in Poland.

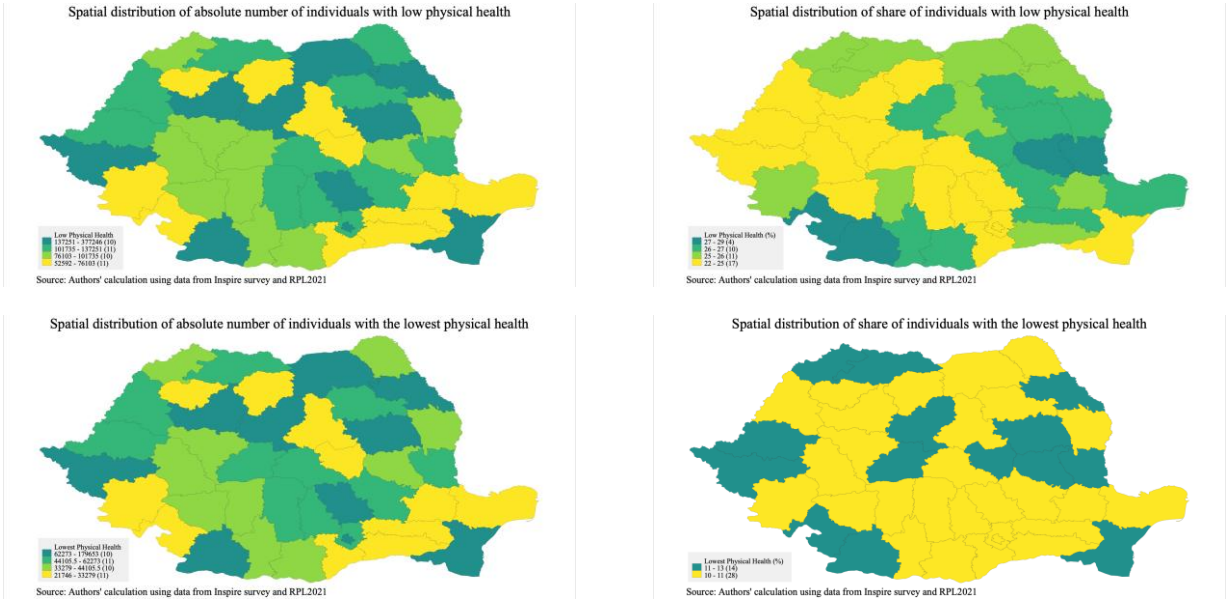


Figure 10: Spatial distribution of physical health in Romania.

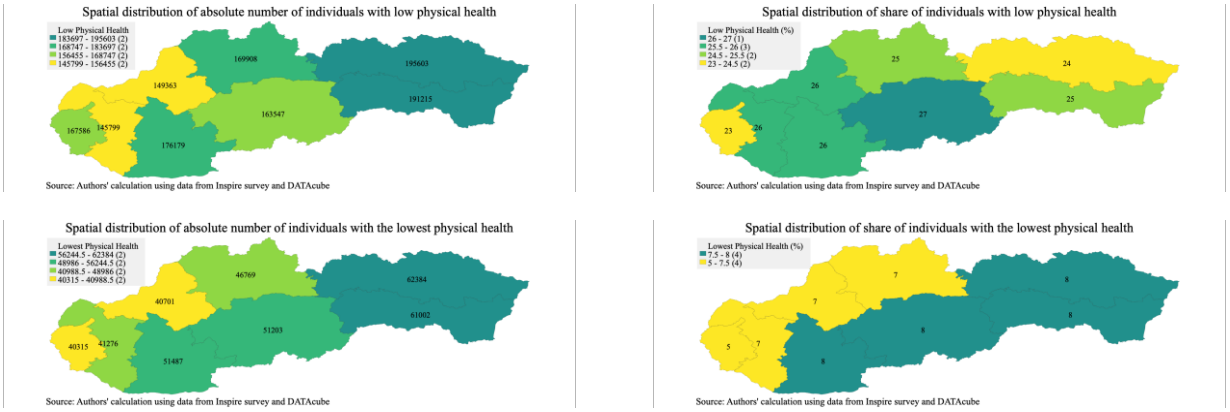


Figure 11: Spatial distribution of physical health in Slovakia.

3.4 Limitations of spatial microsimulations

Spatial microsimulation is a very useful tool for the INSPIRE project because it allows us to create a detailed picture of the population in and around the INSPIRE pilot areas, even when direct information at that level is limited. Once the models have been estimated, we can not only derive a wide range of indicators related to social inclusion and vulnerability for the small areas under investigation, but we can do so across different countries in a consistent way. Hence, it allows us to compare places and to identify spatial units that are not visible in more aggregated statistics. However, there are some limitations that need to be acknowledged. A key requirement for spatial microsimulation is the availability of good-quality small-area data. Official statistical authorities need to provide sufficiently detailed information on the socio-demographic structure of small spatial units (municipalities, postal

code areas, neighbourhoods, etc.). For this project, our models make full use of the small-area information that is currently available. However, access to a richer set of constraints would allow an even more detailed and robust estimation of the synthetic populations. Another limitation concerns validation of the model. In this report, we carry out internal validation, i.e. we check how well the models reproduce the variables that are directly used in the microsimulation. Ideally, one would also like to perform external validation. That is to compare synthetic estimates of variables that were not used as constraints with the actual data for these variables. This would provide another test of how well the models predict characteristics of the population. Given, however, the often-limited number of constraint variables available at small-area level, it is not very practical to keep many potentially useful variables outside the microsimulation framework and reserve them only for external validation. In most cases, it is more useful to include these variables as constraints in the model so that they directly contribute to improving the synthetic populations.

3.4.1 Synthetic populations and ABMs

The synthetic populations produced in the spatial microsimulations will next be used to estimate ABMs. The maps presented in the previous section provide an interesting illustration of the ability of spatial microsimulations to provide individual level micro-data for variables that are not generally available. However, for the purposes of this project the main aim of estimating synthetic populations is to construct individual level agents for the agent-based models which will be introduced in the next section.

4. Agent-based models

4.1 Introduction to agent-based models

An agent-based model (ABM) is a simulated system where entities (called agents) interact with each other and exhibit behaviour that mimics the real world over a specified horizon (Bonabeau, 2002). We build a general ABM structure which is then employed separately in each pilot area. Our model comprises two kinds of agents, citizens (individuals) and social enterprises. Our purpose is to examine how social enterprises can effectively reach out to potential new clients and how individuals can reduce the risk of exclusion by engaging with different kinds of social enterprises. As such, the ABMs allow for the estimation of a wide variety of what-if scenarios, which can help guide policymakers and prospective entrepreneurs to estimate the potential impact based on their envisaged enterprise. Examples of such ABMs include Broomhead et al. (2021), which analyses changes to the healthy food environment and associations with tooth decay, or Bradburd et al. (2006), which analyses the complex interplay between renter types and availability of rental properties under rent controls.

4.2 A very short outline of ABMs

ABM is a broad umbrella term that encompasses a variety of models ranging from the flight of starlings, economic behaviour of agents, traffic simulations, and social simulations such as the one presented in this study. As such, it is not feasible to give a comprehensive overview of what ABMs entail, but for those not familiar, this short paragraph provides a very brief overview.

ABMs generally consist of different types of agents, in our case citizens and social enterprises, an environment in which they interact, in our case the neighbourhood, and an element of time, generally referred to as ticks. The simplest procedure involves setting a certain variable, e.g. number of social connections, for each citizen agent, the probability of interacting with another citizen agent in each tick and then updating the variable for the number of connections for our citizen agent ready for the start of the next tick. As such, our model could run solely with citizen agents, and a canvas on which their interactions take place.

A model like that would have a simple increasing number of connections per agent, provided that the probability of connecting with any other agent is non-zero. As this is unrealistic, we could include a probability of a connection being lost which would run concurrently with the rest of the model. With each addition, a model becomes more complicated, perhaps more realistic, and the outcomes most likely become less tractable. However, this simple example shows the basic logic of ABMs. Fortunately, we can build on existing models, which balance the trade-offs between complexity and realism.

4.3 Agents

4.3.1 Citizens (individuals)

The first type of agent is the citizen. Each citizen is represented as an individual entity so that the heterogeneity of the population is reflected in the model. For a given pilot area, the number of citizens

simulated for the model corresponds to the actual population through the spatial microsimulations used in the previous step. Citizens must decide whether they are engaging with a social enterprise to receive some benefit that reflects their needs. Their decision whether to engage or not is based on their demographic and social characteristics as well as their needs (in terms of social inclusion). The variables characterising each citizen are obtained from their responses to surveys conducted in WP1, Task 1.3. All variables are transformed such as they range from 0 to 1. Certain variables such as age, gender, and education level are used without any further changes, whereas some are used to construct indices that better reflect the model's assumptions. For example, we average the responses to the survey questions/variables measuring how easily one can access i) services, ii) public transport facilities, iii) cultural venues and centres, iv) grocery stores or supermarkets, and v) green and recreational spaces to create an index of overall accessibility (Q26_1-5). Table 4 presents the new constructed indices and the variables used to estimate each index.

Table 4. Indices constructed from the survey variables.

Index	Questions used to construct the index
Inclusion index	Q18_1-4, Q23, Q24
Perceived inclusion	Q41_4, Q41_9, Q48, Q49_1, Q49_2, Q51_6, Q41_5, Q51_1, Q51_2, Q41_1, Q41_2, Q41_7, Q41_6, Q51_8
General trust	Q35_1, Q35_2, Q35_3, Q35_4, Q35_5, Q41_9
Health	Q27_1, Q27_2, Q28
Access	Q26_1, Q26_2, Q26_3, Q26_4, Q26_5
Need for affiliation	Q41_4, Q41_9
Need for autonomy	Q51_1, Q51_2, Q51_6
Need for achievement	Q41_2, Q41_6, Q41_7
Need for security	Q49_1, Q49_2

4.3.2 Network - HUMAT

The individual citizens are analysed based on their sociodemographic and psychometric characteristics by applying a HUMAT-type model (Antosz et al., 2019). An important element of the citizens is that they can interact with each other and affect one's decision on whether to engage with a social enterprise or not. Given the lack of spatial data for the citizens, we can only partially account for physical proximity by considering one's feeling of closeness to people in their local area. Even so, for the purposes of this analysis we posit that the nature of human connections within regions is driven more by shared interests, trust, and social dynamics than by simple physical proximity. To this end, we built a network where the relations are established based on homophily characteristics, habits, and inclusion sentiment. We consider homophily in age, education level, and ethnicity. Habits are measured based on whether a citizen meets socially with friends and relatives, how often they participate in social activities, and how often they volunteer for a charitable or not-for-profit organisation. An individual's experienced inclusion is proxied by the perceived inclusion index which we constructed as an average of the responses to questions focusing on the participants' personal experiences (see Table 3), in line with previous work in this project (University of Barcelona, 2025).

For each individual citizen j we define a triad:

$$B_j = \{AgeGroup, EducationGroup, EthnicityGroup\}_j.$$

We consider three age groups, young (0-34), middle (35-65), and elderly (over 65) and three education levels, low, middle, and high. Ethnicity consists of two groups, natives and migrants. Each citizen is represented as a node in the network. The number of ties (edges) one has is a function of their habits (i.e., meet socially, participate in social activities, and volunteer in charitable organisations). The sum of edges for all citizens must be an even number. To configure the network structure, we employ a stub matching method. At first, each node j has k_j half-edges (stubs), such that

$\sum_{j=1}^{N} \quad k_j = 2m$, where N is the population of the respective pilot area.

In the standard stub-matching approach, these $2m$ stubs would be paired uniformly at random to form m full edges. Here, we deviate from the standard approach for two reasons. First, this approach allows for self-loops and multiple edges which can not be conceptually explained in terms of a social network. By rejecting the cases of self-loops and multiple edges, the outcome is a simple graph. Second, the random construction of full edges does not take into account the homophily characteristics and habits of each individual which are crucial in the formation of social networks. Here, we deviate from perfect uniformity to include homophily traits, habits, and inclusion sentiment of each citizen.

Let a be a stub belonging to node j. To create a full edge, we identify all available stubs b that do not belong to node j (exclude self-loops) and ranked them based on the similarity of the the triads B_j and B_i (where stub b belongs to node i). The top ranked stub b forms a pair with a unless an edge between the nodes j and i already exists (exclude multiple edges). Our approach also encourages triangle formation (clustering). That is, for a node i, the algorithm may connect two of the node's neighbours (friend of a friend). The probability of a triangle formatting is given by

$$p_v = p_{base} + \gamma(aff_v - 0.5),$$

where p_{base} controls baseline clustering and γ controls the sensitivity to place attachment (for a discussion of the concept of social circles, see also, Hamill and Gilbert, 2009). Once a social tie is formed between two citizens, it bears a strength degree. The strength of each tie is a weighted average of all the aforementioned characteristics. Figure 12 is an example of a social network for a population of 50 people.

For all pilot areas, the analyses were performed at a low level of spatial aggregation, except for Romania. For the case of Romania, spatial microsimulations were performed at the NUTS3 regional level as the constraint variables were not available for smaller regional specifications. However, the four pilot areas in Romania are located in two different regions (two pilots in the Suceava county and two pilots in the Maramures county), meaning that we have to dive into a lower regional level to perform the analysis. Due to the lack of suitable small-area data, we proceed in two steps. First, we generate a synthetic population for each of the two NUTS3 regions (through spatial microsimulations, in the previous step). Second, for each pilot area, we draw a simple random sample of individuals from the corresponding county-level synthetic population, with the sample size set equal to the actual population of the pilot area. In doing so, we assume that the socio-economic and demographic structure of each pilot area mirrors that of its parent NUTS3 region. While we acknowledge that this is a strong assumption, we are limited by the nature of the available data. These four random samples are used as citizen-type agents in the model. This approach allows us to approximate the population of the pilots, while acknowledging that any within-county heterogeneity not captured by available data cannot be explicitly modelled.

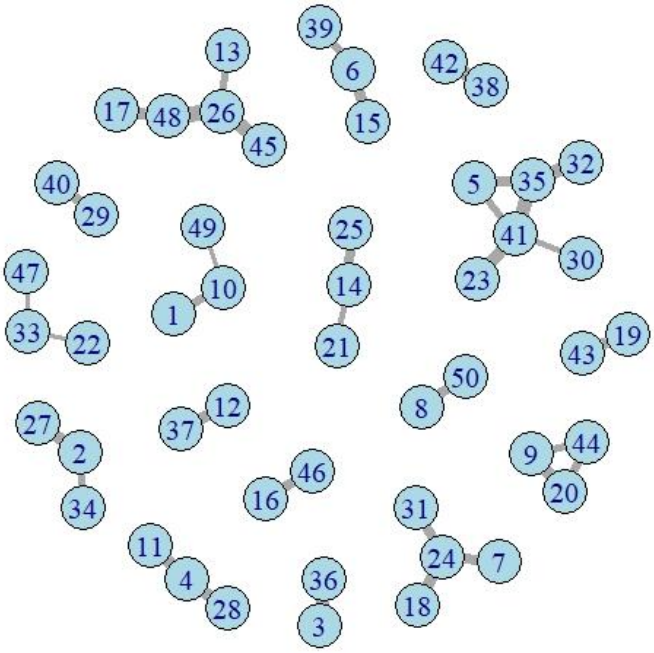


Figure 12: Illustration of a social network.

4.3.3 Social enterprises

The second type of agent is the social enterprise. Each social enterprise is characterised by the type of service it provides, the population group that it targets, whether it charges a fee or not, whether it is subsidised or not, their capacity (number of people they can serve), and their communication strategy. Each social enterprise reaches the target audience through online platforms, word of mouth, and partners (other social enterprises or companies). Service types are categorised in 5 broad groups, inclusion, training, access, health, and athletic, based on the specific aspect of social inclusion that the social enterprise aims to improve. Each service type benefits specific social inclusion needs at a different degree. Moreover, engaging with a social enterprise comes at a cost of money, time, and stigma.

To quantify the received benefit (per need), received effect, and cost we rely on the related literature and meta-analysis studies. Table 5 summarises the selected values. Following the agent-based model setup, the values range from 0 to 1 and we employ a cut-off for values outside this interval. Panel A presents how each service type benefits specific aspects (that match the needs) of one's life. Panel B shows the cost of each service type. The cost of the fee each multiplied by the binary fee variable characterising each social enterprise. The last panel, Panel C, shows the probability of a citizen receiving some benefit from their engagement with a social enterprise. We consider two cases. In the first case, the full benefit is received and in the second case, no benefit is received, and the individual terminates their interaction with the social enterprise.

For social enterprises that provide training services, aiming to increase the employability of the participants, the choice of values is based on meta-analysis studies that evaluate active labour market policies. Card et al. (2010) argue that training programmes appear ineffective in the short run but they

are associated with positive medium-term impacts. These findings are also supported by Card et al. (2017) who find negligible impacts in the short-run and positive impacts after the completion of the programme. Their findings also suggest a degree of heterogeneity across the participants (i.e., training appears to be more beneficial for females and long term unemployed). The latter is contradicted by Kemper et al. (2025) who find no evidence of programme heterogeneity by gender (or age).

O'Sullivan et al. (2024) evaluate the effectiveness of social prescribing interventions in the management of long-term conditions for adults and find that they contribute to improvements in quality of life and physical activity.1 However, they find no evidence related to general psychological well-being. Spanos et al. (2025) focus on social prescribing aimed at addressing mental health issues and psychosocial needs and find moderate positive outcomes in social interactions and sense of purpose.

Physical activity and sports are associated with favourable health outcomes. Furthermore, team sports provide more potent health and additional benefits for mental and social outcomes Eather et al. (2023). Studies focusing on the effects of physical activities on mental health reveal a substantial positive effect, especially in middle- aged and older people (Schuch et al., 2016; Noetel et al., 2024; Zhang et al., 2025).

It is established that greater social inclusion requires greater accessibility (Farrington and Farrington, 2005). Accessibility in terms of car ownership, public transport access, commute times, and job accessibility levels is positively associated with employment outcomes (Bastiaanssen et al., 2020). However, these findings stem from empirical studies focused on the greater metropolitan areas. Bastiaanssen et al. (2022) focus on rural areas and finds that better accessibility improves individual employment probabilities for individuals without vehicle ownership, lower educated individuals and younger individuals.

Table 5. Selected values of the variables characterising each service type.

Service type:	Inclusion	Training	Access	Health	Athletic
Panel A: Effect (positive)					
PI	0.045	0.015	0.015	0.025	0.030
Affiliation	0.035	0.010	0.010	0.015	0.045
Employability	0.000	0.055	0.010	0.005	0.000
Income stability	0.000	0.030	0.010	0.005	0.000
Health	0.010	0.000	0.005	0.055	0.050
Access	0.010	0.005	0.045	0.010	0.005
Autonomy	0.030	0.020	0.020	0.015	0.015
Panel B: Cost (negative)					
Fee	0.200	0.500	0.150	0.250	0.200

Time	0.250	0.450	0.200	0.250	0.200
Stigma	0.150	0.100	0.050	0.200	0.100
Panel C: Received benefit					
Full	0.880	0.800	0.920	0.850	0.900
None	0.080	0.150	0.050	0.100	0.060

4.3.4 Execution loop

After the creation of the initial network, the ABM executes a loop for a simulated evolution of the system over a selected time horizon (12 months). At the start of each period (tick), for each social enterprise, the model first determines the subset of the population which is eligible for the service that the social enterprise provides. Citizens that are eligible for a given social enterprise if their attributes (i.e., age, gender, ethnicity, employment status, health status, and income status) satisfy the social enterprise's target rule. Target rules can be combined consecutively or disjunctively. For example, a target group might consist of unemployed women (combining the gender and employment status characteristics) and another target group might consist of either young or elderly individuals.

Eligible citizens are ranked by a priority score that centres on need and overall inclusion. For citizen j, priority score is calculated as

$$P_J = 1 - InclusionIndex_j + \mu_{type,j}$$

where $\mu_{type,j}$, is a small service-type specific term to ensure that priority reflects both broad inclusion risk and the service's mission.

Eligible candidates (based on their priority score) are exposed to an offer by the social enterprise. The number of candidates that are exposed to an offer is based on the capacity of the social enterprise. Exposure to an offer depends on the three channels of communication, word-of-mouth, social media reach, and partners' channel. A citizen's total exposure is estimated as a linear combination of the signal strength of each channel. If the offer is effectively delivered, based on an independent Bernoulli draw with probability equal to the total exposure, capacity is reduced by one. For citizen j, the word-of-mouth signal is calculated as the sum of the weights of those neighbours who engaged with the social enterprise in the previous period.

An individual j that is effectively exposed to an offer calculates the net utility as a function of the received benefit, cost, and a social term, $U_j = B_j - C_j + S_j$. The decision on the whether one engages with the social enterprise is a stochastic logit process:

$$Pr(adopt_j) = 1 \,/\, (1 + exp(-\beta U_j),$$

where $\beta > 0$ is a decision sensitivity parameter.

Benefits reflect the degree at which the service, provided by the social enterprise, addresses the individual's deficits and needs. We define deficit for the attributes of personal inclusion, health, income, employment status, and accessibility. We quantify as deficit as $d_x = 1 - x$, where x is one of the 5 aforementioned attributes. Each service supplies a base effect and a scale that increases with

the relevant deficit(s). The cost component comprises three penalties: fees (scaled more heavily for lower-income individuals), time/effort (higher when access is poor), and stigma (a small constant). The social term component is a sum of the citizen's general trust and a word-of-mouth boost, to link engagement propensity to both personal attitudes and peers' recent behaviour.

If individual j engages with a social enterprise or social service, the service delivers stochastic outcomes governed by completion/dropout probabilities. Realised effects update the individual's state based on the information in Table 4 (for example, perceived inclusion is increased by all services whereas income level is not affected by athletic/sports services). For each individual that received some benefit, the inclusion index is re-estimated from the updated values of the affected characteristics (i.e., perceived inclusion, health, etc.) and the weighted average of their neighbours' recent outcome changes (to capture both personal experience and social learning).

At the end of each period, the network is updated in two steps to reflect changing relationships and maintain realism. In the first step, edge weights in the graph are updated through the dynamic covariates in the weight function (current place attachment, general trust, volunteering, and social-activity frequency). In the second step, we introduce the probability of an existing edge dissolving. The probability of the edge between nodes a and b breaking is given by:

$$p_{ab} = p_0 + m(1 - w_{ab}) + ndiv_{ab},$$

where p_0 is a baseline component, the term $(1 - w_{ab})$ penalises weak ties, and div_{ab} is a divergent component of perceived inclusion and health between connected individuals. Once the network is updated, the model moves to the next period. This loop is repeated until the end of the model's horizon.

The ABM is particularly suited to analysing interactions between individuals and social enterprises in the context of social inclusion (Melchior et al., 2024). By combining detailed sociodemographic information with psychometric indices such as perceived inclusion, general trust, needs for affiliation, autonomy, achievement, and security, the model treats "soft" social characteristics as explicit state variables rather than unobserved background factors (Boshuijzen-van Burken et al., 2020). Engagement decisions depend both on objective constraints (fees, time, accessibility) and on subjective perceptions and social influence transmitted through the network. As a result, the model can trace how similar individuals cluster, how information about services spreads, and how changes in service provision or communication strategies translate into different inclusion trajectories across groups. Social inclusion is thus modelled as an emergent outcome of the joint evolution of individual characteristics and social ties, rather than as an exogenous input.

Several modelling choices are likely to affect the quantitative results and therefore deserve explicit acknowledgement. First, the use of spatial microsimulation and, in the case of the Romanian pilots, sampling from county-level synthetic populations assumes that each pilot mirrors the socio-economic structure of its parent NUTS3 region (Campbell and Ballas, 2016). This is a strong but necessary assumption given data constraints and implies that within-county heterogeneity not captured in available statistics cannot be fully represented. Second, social inclusion and related concepts are operationalised using composite indices scaled to the [0,1] interval, and thresholds such as the at-risk cut-off are inevitably somewhat arbitrary. Different normalisations or cut-offs would change levels, but the underlying mechanisms remain unchanged. Third, the social network is generated via homophily-based stub matching and clustering in the absence of detailed spatial coordinates,

emphasising similarity in socio-demographic and attitudinal traits over physical distance (McPherson et al., 2001). This reflects the focus on social rather than purely geographic proximity, but may under-represent very local, place-based ties. Fourth, effect sizes, costs, completion probabilities, and communication strengths are calibrated from the literature and stylised evidence, so the model is intended primarily for comparative "what-if" analysis rather than precise forecasting (Fagiolo et al., 2007). Finally, social enterprises are represented as organisations with fixed capacity and mission which abstracts from organisational learning and strategic adaptation. These simplifications are deliberate and make the model transparent and tractable, while still capturing the main channels through which social enterprises can reduce the risk of exclusion in rural settings.

4.4 Results argent-based models

4.4.1 Structure of results

For each pilot area we consider two ABMs. The first, baseline model, uses the existing social enterprises, identified in the previous steps. In the second, hypothetical scenario, model, we introduce one additional social enterprise. To introduce the new social enterprise, we identify the largest vulnerable group in the population and define this as their target group. Table 6 reports the service type and the target population for each of the newly introduced social enterprises. In most pilots, unemployment arises as the most important issue, however, the subpopulation groups that are mostly affected by unemployment differ between the pilot areas. The capacity of the new social enterprise equals the mean capacity of the social enterprise already existing in the area. Likewise, its three dissemination channel weights equal the average across existing social enterprises. Figure 13 presents the share of the population that is at risk of exclusion at each tick of the model. An individual is said to be at risk of exclusion if their respective inclusion index is less than 0.4. For each pilot area, the solid line represents the baseline results and the dashed line the results from the hypothetical scenario.

Table 6. Service type and group target of the additional (hypothetical) social enterprise.

Pilot area	Service type	Target group
Monéteau, France	Training	Woman or elderly
Konitsa, Greece	Training	Unemployed
Kythera, Greece	Inclusion	Elderly
Moate, Ireland	Health	All
Parcew, Poland	Training	Low income or unemployed
Botiza, Romania	Training	All
Ocna, Romania	Migrants	All
Panaci, Romania	Training	Low income or unemployed
Poiana Stampei, Romania	Training	All

Kosice, Slovakia	Training	Unemployed women

Across the ten pilot areas the share of residents at risk of exclusion declines over the 12-month horizon in both the baseline and the hypothetical scenario. Introducing one additional, targeted social enterprise generally produces a further reduction in risk. The magnitude of the decrease varies between the pilot areas. In areas such as Kythera (Greece), Monéteau (France), Kosice (Slovakia), and Parczew (Poland) where the baseline share of population at risk is higher, the effect of an additional social enterprise is evident. In Moate (Ireland) and Panaci (Romania) we observe negligible differences in the short run but there appears to be a substantial effect from the newly introduced social enterprise during the last periods. In the four remaining cases, the share at risk is the same for both the baseline and the hypothetical scenario.

Each histogram in Figure 14 shows the difference in perceived inclusion between the first and last month of the model horizon. Each row corresponds to a pilot area. In all cases, the perceived inclusion remains unchanged for the majority of the population, regardless of the scenario (baseline or hypothetical). This reflects the limited total capacity of the entire set of existing social enterprises in each pilot area. Even if citizens are willing to adopt, each social enterprise can only serve a fixed number of customers. It also highlights the need for additional social enterprises that effectively identify the most vulnerable groups of the population. Even in the hypothetical scenario models, where a new specialised social enterprise is introduced, the increase in perceived inclusion is feeble overall.

Across pilots, the scenario typically thickens the right tail of the distribution of change in perceived inclusion, people with no change in the baseline scenario experience small positive gains in the hypothetical scenario. The clearest improvements occur in Konitsa (Greece), Kosice (Slovakia), and Moate (Ireland) where the number of individuals that experienced an increase in their perceived inclusion is greater than the rest of the pilot areas. This finding also mirrors the strong decline in the share of at-risk population in these particular pilot areas. In Moneteau (France), Kythera (Greece), Parczew (Poland), and Poiana Stampei (Romania) the scenario effect is present but feeble. Distributions are only slightly more right skewed than baseline. The rest of the pilot areas show almost identical results in the two scenarios. The lack of improvement could stem from limited capacity or ineffective communication strategy given the characteristics of a pilot area.

Figure 15 focuses on the vulnerable group that the new, hypothetical social enterprise targets. Specifically, it compares, using violin charts, the distribution of change in perceived inclusion for the specified target group in the two scenarios (baseline and hypothetical). This allows us to clearly observe the positive effect of a new social enterprise being established in an area. In all pilot cases, the maximum change is greater in the hypothetical scenario. For example, in Kythera (Greece), the largest increase in perceived inclusion is 0.075 in the hypothetical scenario while in the baseline scenario is 0.062. In addition, we observe that for all baseline models, the violin charts are wider in the near zero (no change in perceived inclusion for the majority of the population). In the hypothetical scenarios, the band around zero is substantially smaller. Furthermore, the upper part of each shape is now wider, indicating that the addition of a new social enterprise contributes to the reduction of risk of social exclusion. In each plot, the black dot indicates the average change in the perceived inclusion for the specified target group. In all pilot areas, we observe an, albeit small, upward shift of the average value. While the hypothetical scenarios suggest that the introduction of a new social enterprise yields

an increase in inclusion indices, issues such as overall limited capacity or ineffective communication strategy given could undermine the performance of the said social enterprise.

The results are in line with the model's ABM's mechanics. First, only a finite number of residents is effectively exposed to an offer and not all of them necessarily adopt. The addition of a single social enterprise improves social inclusion only incrementally, given the enterprises limited available openings. Second, the monthly realised benefit received is small (based on the related literature). Furthermore, the benefits depend on completion probabilities and service-type effect sizes. Larger gains are concentrated among individuals whose dominant deficits are directly addressed. Second, dose and completion keep most realised gains small: effects depend on completion probabilities and service-type effect sizes, with larger gains concentrated among individuals whose dominant deficits are directly addressed. Third, network diffusion (word-of-mouth) amplifies impact unevenly. Where the targeted group sits in denser, homophilous networks, recent adoptions raise neighbours' exposure probabilities, thickening the right tail under the scenario; where networks are sparse or fragmented, the added capacity leaves little distributional footprint. Together, these mechanisms explain why some sites exhibit visible rightward shifts while others show limited change despite the introduction of a new SE. Third, dissemination channels are an important factor of success. The word-of-mouth amplifies impact unevenly. Eligible individuals belonging in a denser group are more likely to adopt to a social enterprise. However, being part of a dense social network group suggests a relatively high inclusion index. On the contrary, individuals at the risk of exclusion are unlikely to participate in social events and thus form sparse network groups. As a result, they are invulnerable from the word-of-mouth channel which decreases their probability of engaging with a social enterprise and increasing their inclusion index. The combination of these mechanisms explains why some pilot areas exhibit visible rightward shifts while others show limited change despite the introduction of a new social enterprise.

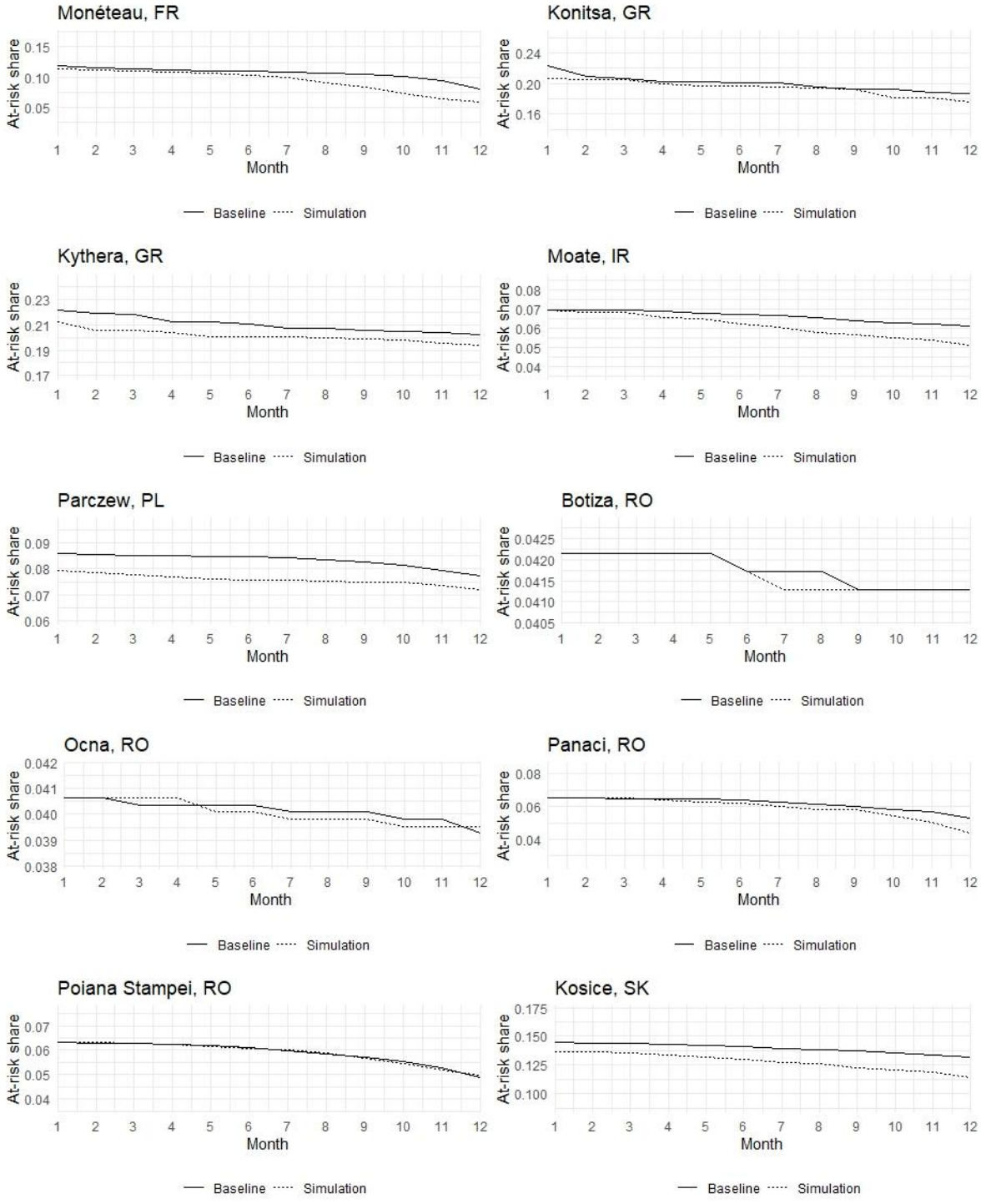


Figure 13: Share of population at risk of exclusion at each period.

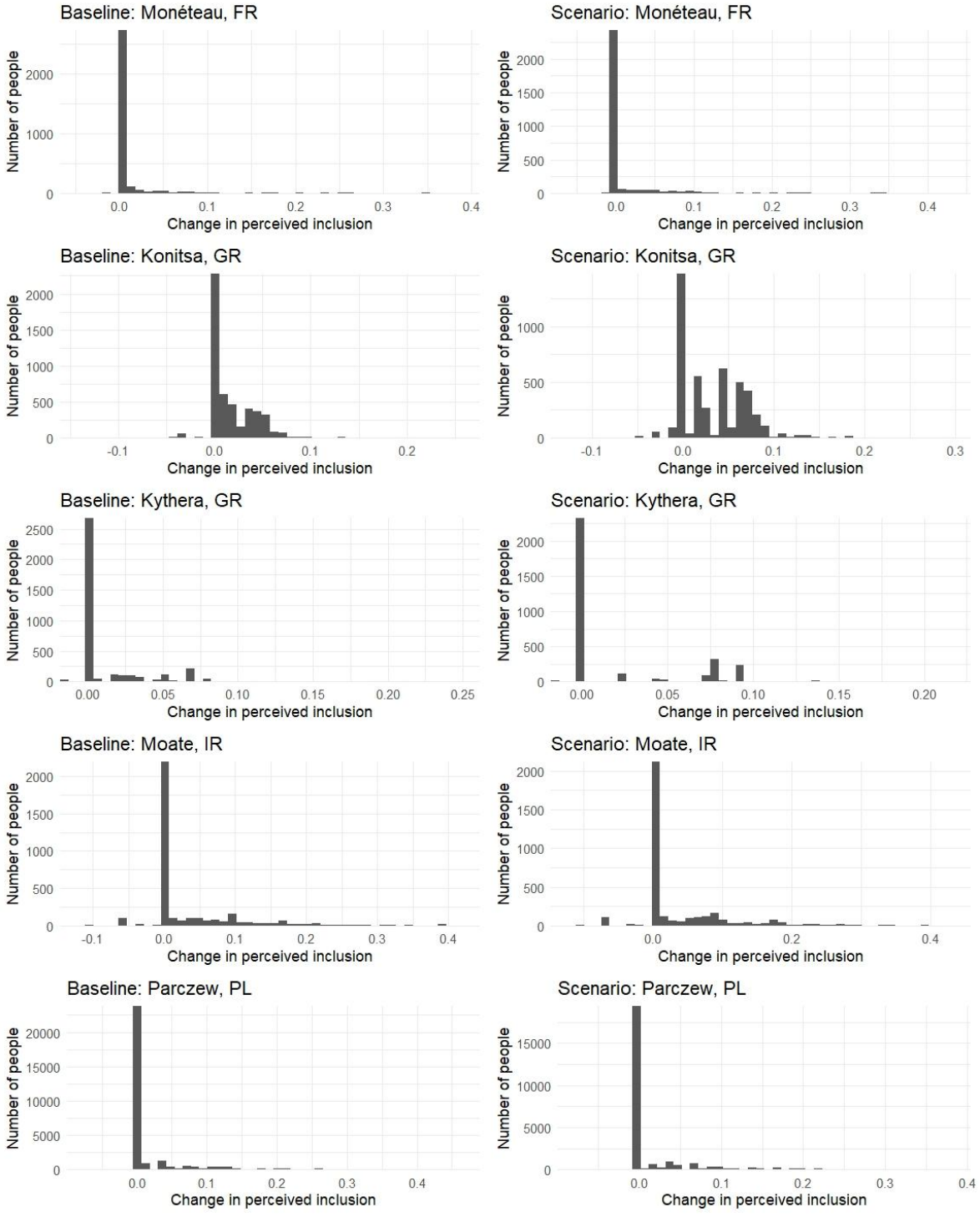


Figure 14: Change in perceived inclusion.

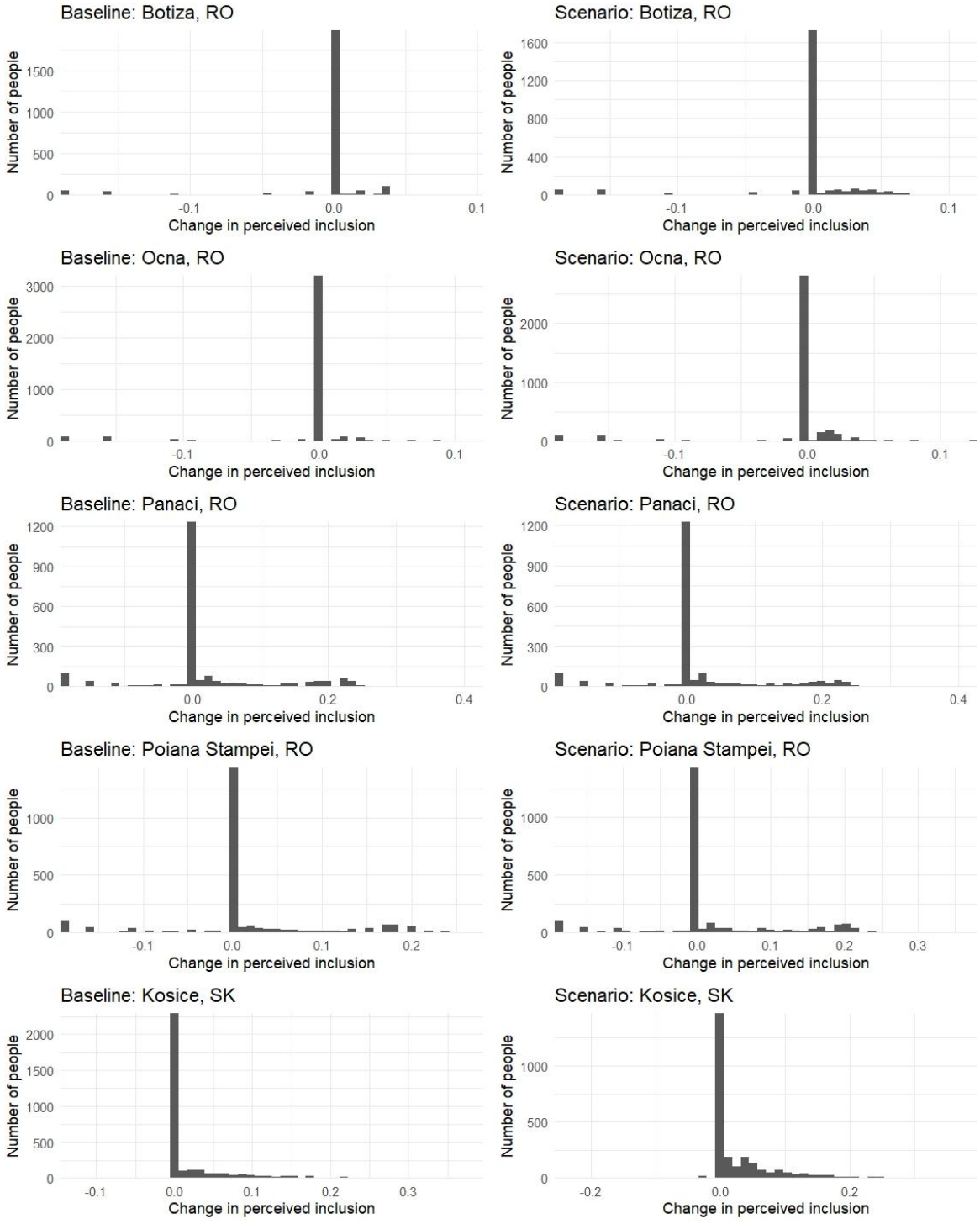


Figure 14: Change in perceived inclusion, continued.

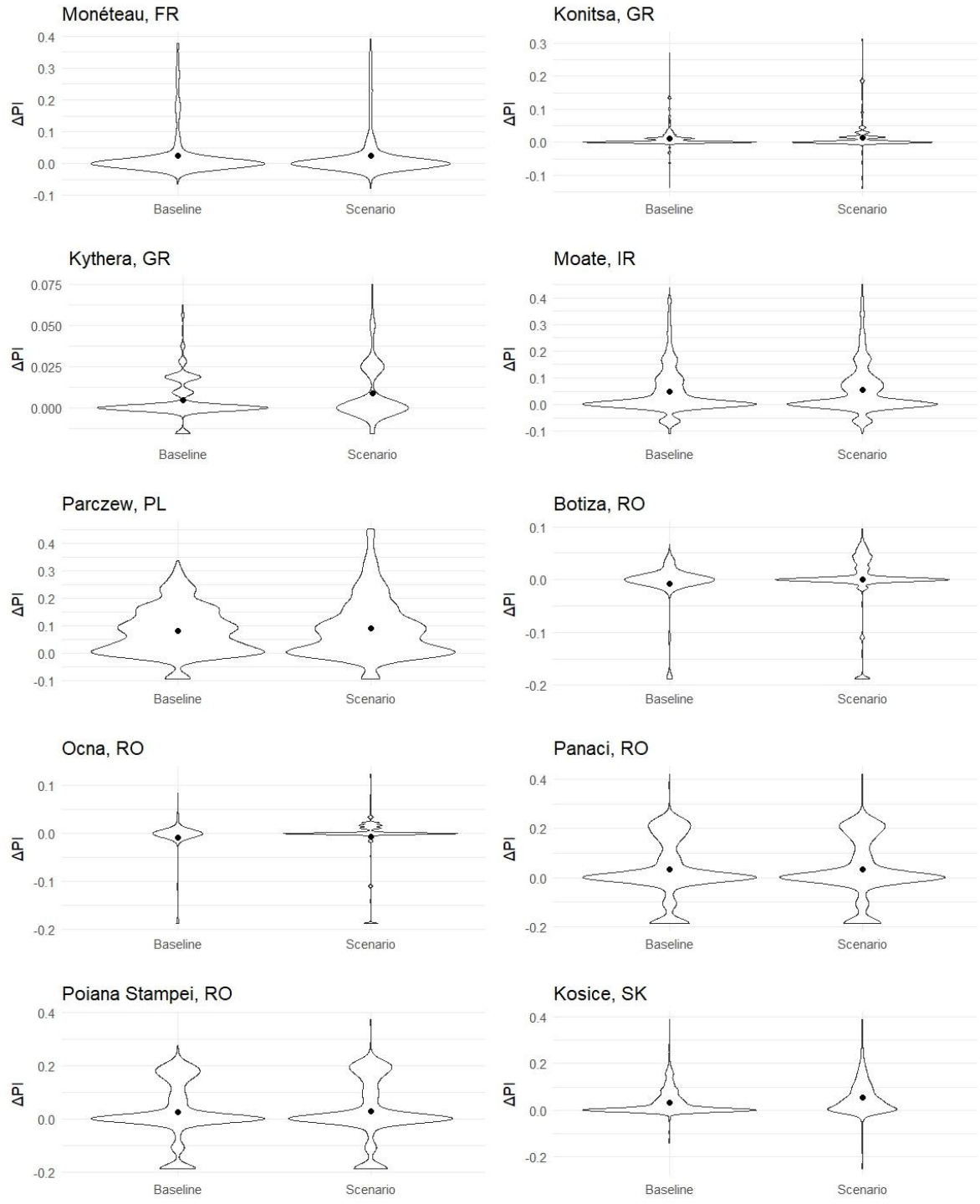


Figure 15: Change in perceived inclusion for the largest group of vulnerable individuals.

5. Business models typology

Creating a business model typology for social enterprises targeting social inclusion in rural Europe was the main concern of the research efforts within this task of the INSPIRE project. The typology presented in the following sections is based on the simplified version of the business model canvas and the clusters of themes that emerged from the digital ethnography of websites and social media of local, rural social enterprises in our pilot regions. An overview of the most important themes per business element can be seen below in Figure 16. Based on the most common themes of all business elements and their most common combinations, the typology describes most probable successful business models for different areas and target groups. The selection bias of only investigating social enterprises that are still running and successfully providing their services to their clients, rather than looking at all social enterprises that get founded and enter the regional social economies, works in our favour in this context. Relying on the information obtained from successful SEs allows us to reasonably expect that the developed business models would work under the suggested circumstances.

Due to the multifaceted structure of the data processed in the business model canvas framework, the business models are developed and described from one central starting point in the model canvas. In the first instance, the SEs are divided by their core social value proposition, which also forms the core of their business mission and values. For each category identified in the value proposition of the social enterprises, the most common specifications of all business elements are explored and presented in the typology. The strengths, weaknesses, challenges and opportunities of the individual business models are discussed in the following section.

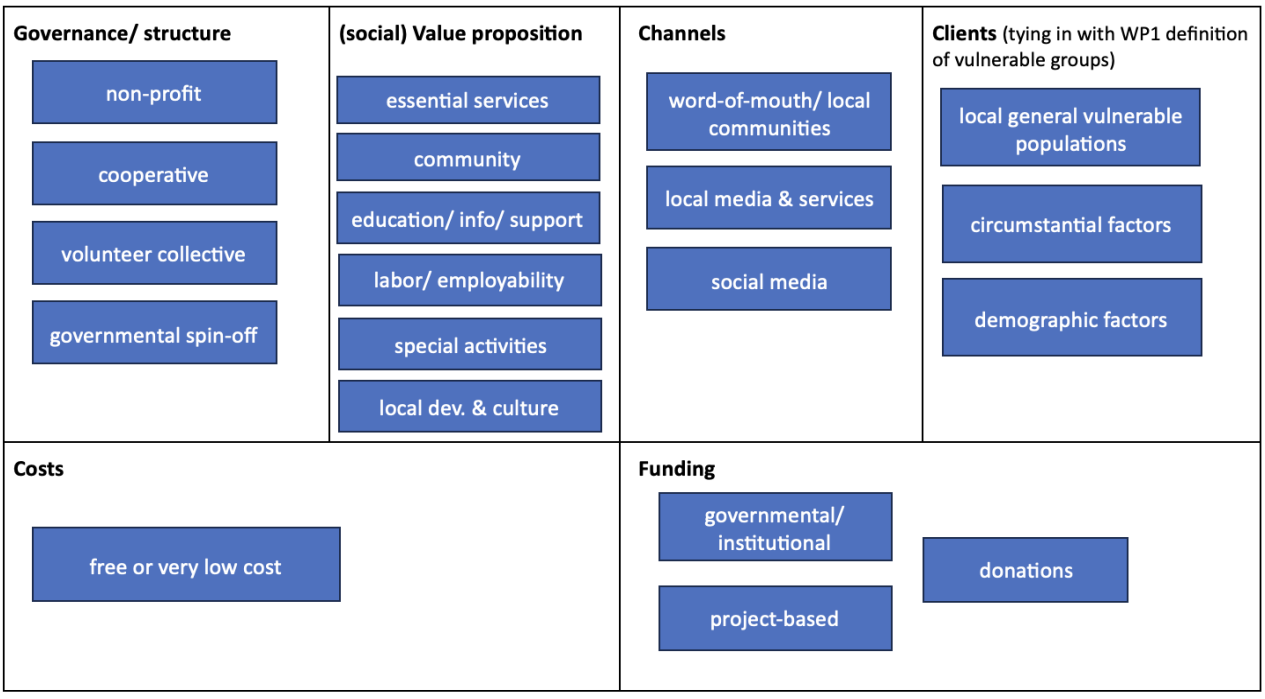


Figure 16: Business model canvas with the most common themes identified per element of business on the sample cases in the project.

5.1 Essential services SEs

Social enterprises with a social value proposition centred around providing care and essential services most often operate in the form of governmental actors or non-profit organisations that work together closely with the local authorities. National legislation and policy often regulate what care and services are provided to residents by local and national governments (Pumberger and Tobler, 2002). If the governmental services are not sufficient and some communities or regions fall through the cracks of the official system, social enterprises take over the task to help these people (Steiner et al., 2019). While specific target groups for certain strictly governmental services might be defined per country, the target group for essential services SE can vary depending on their specific niche of the market that gets left behind by the general governmental services. Some focus on providing food and household essentials to families and individuals living in precarity, while others focus on the provision of basic health care in areas where all local health care providers have disappeared. In general, the target group for essential services SEs can be summarised as any person or group lacking financial means or regions lacking essential amenities. The main value added by this type of social enterprise can further be described as essential service provision as a complementary service to governmental services that serve the same function and expand upon the free state-offered services, although they may be specifically tailored to local circumstances (Kelly et al., 2019). Therefore, their services also should be and mostly are offered for free. They work with governmental funding and, in the case of long-term or day care facilities, the (public) health insurances. For the communication and advertisement of their services, they also rely on the local authorities and service providers to spread awareness of their services.

Strong points include the close ties with and consistent funding and support from local authorities and governments, which creates synergies between existing formal support systems for vulnerable populations and less formal social enterprises or initiatives and financial security for the operations of the social enterprise. A weakness that certainly affects more types of SEs but especially the ones operating in essential businesses is that providing essential items for individuals in precarity or essential amenities on demand for shrinking or ageing places does not address the root of the problem as it does not help lift individuals out of poverty or counteract the rural exodus. Based on current trends in rural-to-urban migration and economic development in most regions (Haartsen and Venhorst, 2010), the challenge will be managing an increasing demand for the essential services provided by the SEs without an increase in the funding provided by the local and regional governments (Steiner et al, 2019).

5.2 Community services SEs

Social enterprises with a social value proposition centred around creating and maintaining a sense of community in a population or a place most often appear to be volunteer collectives or existing communities of very engaged individuals who foster and grow the communities. This form of organisation seems to support the organic formation of social communities that local individuals would like to join based on shared values or interests as they are started and run by local individuals and people from the target populations of the community. The specific target group depends on the focus and composition of the community, but the ones observed in our sample mostly are open for anyone to join with some being aimed more at rural women, some more at men and some at migrants and newcomers to a community. Still, it seems likely that a community services SE is only successful if it is open for a broad range of people willing to be a part of the community. Then, their main contribution

to society is that, through their community services, they provide willing members of the community with a sense of belonging, therefore directly counteracting social exclusion. As their services are usually offered for free and the organisers are all volunteering their time, community services SE do not need much funding to function. Their outreach and communication channels are as diverse as the communities themselves and include social media, local media and word-of-mouth recommendations.

The biggest strength of community services SEs is that they are from the people for the people - as part of the target population, the members of the communities often know best what the community needs and what will be appreciated by its members, making it a very impactful venture just based on its form of organisation. A potential weakness lies in the often-informal organisation of the collectives which could heavily rely on the initiative of only a few strongly engaged individuals. If these people drop out or leave the community, there can be an issue with keeping the community services running and finding new strongly engaged members to take over the tasks of initiating and organising events and activities. Challenges in social communities especially arise when members who are taking charge have different visions for the community and a middle ground or a shared future vision have to be found. An opportunity lies in the possibility for external collaborations and project-based support to professionalise the organisation of the communities and improve existing skills among their members to grow the number of engaged and skilled members.

5.3 Education, information & support SEs

Social enterprises with a social value proposition centred around providing education, information and support are mostly organised as non-profits or volunteer collectives, as they target populations that are not typically covered by the general public education or public services systems in a country. Their target groups often include migrants, refugees, and newcomers to a country or region who might need additional guidance on finding their way around a new location and system. The educational part that is being taken over by SEs in the form of non-profits mainly concerns special needs education and integrative language classes for migrants. Relying on public sources of information and bundling them for the benefit of their clients, as well as providing support with finding the right sources of information and how to read them on a volunteer basis is the main value added by these SEs and the reason that they can offer their services for free or an extremely low cost. Because their services add a real value to the local community, they often receive funding from local and regional governments but also accept donations from private persons and organisations to increase their offer of services for their target populations. While providing valuable information and education to individuals in need of them can often be done at a low cost with simple methods (except for the case of special needs education which is often expensive but supported by governmental funding), reaching the correct population requires collaboration with local authorities and local service providers which can guide clients towards the education, information and support SEs.

The strength of SEs in education, information and support lies in the abundance of freely available resources and information online, meaning that no large amounts of time need to be spent on preparing educational or informative materials, which makes it easy for the SEs to only focus on the interaction and personal support for the individuals in need. A weak spot would be that information about local customs and services is often only available in the local language and not at a simple level for early learners. Then, language skills and easy versions of any relevant documents should be prioritised. Especially when working with migrants or refugees the language barrier can be a

complicating factor. Individuals who speak the native language of the newcomers can be of great value in SEs dealing with migrant populations. Often, people who went through the system themselves take the opportunity to get engaged in these types of social enterprises, giving back to the community that supported them in their early days of adapting to a new place. In the case of special needs education SEs, it is almost equally important to have the right way of understanding and communicating with the target group. There are, however, fewer opportunities for individuals who went through the system to get involved and contribute to the continued operations of SEs in special needs education.

5.4 Labour and employability SEs

Social enterprises with a social value proposition centred around providing skills for employability and finding employment most often operate in the form of governmental actors or foundations that work together closely with the local authorities. They most generally are focused on individuals that are unemployed due to a range of circumstances. Some of these SEs further specialise on individuals with disabilities or of a certain age group and offer not only training but also subsidised employment opportunities at the level that matches the skills and capabilities of the individual. The funding for these services typically comes from local, regional and national governments who have an interest in improving the labour market for individuals with disabilities and raising the employment rate to ensure that as many individuals as possible are able to financially support themselves. The value added by these SEs lies in the support provided to the individuals seeking employment and the potential employers that might be willing to work with the individuals seeking out the SE's services. Local authorities such as governmental employment agencies are often already in contact with unemployed individuals, so that these contacts also function as the communication channels for the services that offer help with labour market integration. As these services are government funded, they are provided free of charge to the individuals and potential employers.

The strength in the labour and employability SEs lies in their well-contestedness operating at the intersection of governmental employment agencies and the local labour market. Constantly being in contact with the individuals seeking employment and the local enterprises that seek workers, subsidies for protected workplaces and information on needs and requirements easily reach the correct target group. Additionally, directly working with the unemployed individuals ensures that the SEs know their special needs for their employment but also are aware of the skills and motivation that they can bring to a workplace, making it easier for them to advocate for their employment. The same is true for social enterprises that employ individuals with disabilities or with a distance from the labour market as their main business model. A potential weakness can be found in the concessions that many employers might be unwilling to make in order to adapt a workplace to a worker with reduced working capabilities. The reliance on an employer's willingness to accept this underlines the need for social enterprises to fill the gap of labour market opportunities for individuals with disabilities or reduced working capabilities.

5.5 Special activities SEs

Social enterprises concerned with organising special activities for a specific target group do not appear to have a common form of organisation, instead they seem to choose a legal form that most supports their purpose. Some of these SEs operate as non-profits, others as associations or even

governmental initiatives and spin-offs. Their target groups are rather specific, ranging from female entrepreneurs over individuals with disabilities to older adults and individuals with limited mobility. Their core value proposition mainly lies in the empowerment and increase of autonomy and social participation of their target group of clients. As the services offered are typically very localised, the main channels of communication of their services are the local communities themselves via word-of-mouth recommendations, local advertisements or, to some extent, social media. As diverse as the target audience of the special activities SEs are, so are their funding sources with most social enterprises receiving a mix of local, regional, national, EU and private funding. While a large share of these SEs charges a fee for their services, thanks to the governmental subsidies they receive, the costs can be kept comparably low.

The strengths of specialised service SEs generally lie in the targeted provision of a service or activity that is needed in the community but not offered by governmental actors or commercial providers at a rate that is accessible to vulnerable populations. A typical example for this would be transportation services for people with limited mobility or lacking access to public or private transportation. A weakness lies in the reliance on external funding in order to provide services which are often needed but not profitable in the location and therefore not operated by the government or commercial providers. Wherever these targeted services exist, the opportunity arises to create and maintain an active rural community in which people from different vulnerable populations can continue to live and retain access to necessary amenities, services and social activities.

5.6 Local development and culture SEs

Social enterprises focusing on local development and culture appear to be mostly organised as non-profit organisations or cooperatives. Additionally, in our sample they were mainly prevalent in France and Greece. Even if local development and culture do not seem directly related at first sight, their overlapping core contribution to society consists of ensuring that a rural place remains liveable and attractive for current and future generations of residents. In some cases, their declared target group also included tourists. While many services in this segment, such as participatory governments, are organised for free based on their nature, some service providers are charging a fee, especially when targeting tourists. These paid services could take the form of a tour and education about the local customs and culture of the crafting of traditional clothing, decorations and artworks. SEs that do not receive any kind of external funding are very common in this field of work. They are forced to charge a fee for their services but often manage to keep the costs affordable for local residents. The local development initiatives and cultural SEs that do receive funding are supported by national governments or individual projects that are backed by the EU and regional governments.

Strengths of local developmental SEs are the fairly uncomplicated engagement of members of the local communities in the local government and their participation in the decision-making process, making solutions more acceptable but also potentially more inclusive due to the consideration of various perspectives of representatives of different (vulnerable) populations. A challenge often lies in the first step of finding members of the community willing to engage in participatory governments. For cultural heritage SEs, the main challenge might be finding individuals that are knowledgeable about the traditional crafts and customs of a region who are also willing to help keep them alive and teach their knowledge to younger generations. The biggest opportunity for these SEs consists of bringing members from different communities together to shape the current rural region to fulfil the needs and

wants of the community as well as to cocreate a future that is attractive to current and future generations.

6. Final remarks

6.1 Conclusions

The business typology generated under Task 2.3 provides a unique view of social enterprises that target social inclusion and spans six countries. The general idea behind social enterprises and their regional embeddedness is that they are highly idiosyncratic. Nevertheless, the study presented above uncovers interesting patterns which hint that there may be patterns to the way social enterprises are set up, given a value proposition. Generally speaking, the successful SEs investigated in the study all found their niche in the market, a social inclusion need that was not met among the local communities. With the help of a steady stream of funding and/or highly engaged individuals the rural social enterprises build and maintain a sense of community while also empowering and supporting individuals in their own agency. All general conclusions have to be drawn with caution as this study only included successful social enterprises, and we cannot say with certainty what factors determine whether an SE will be successful compared to the ones that are not.

Further, the business model canvas should not be treated as prescriptive, but rather, a starting point of the discussion on how a social enterprise targeting social inclusion may be set up. The detailed description provides an indication of the reasoning behind the choices made but leaves room for prospective entrepreneurs to adapt to their own circumstances. By adding in the agent-based modelling and potential to explore what-if scenarios, prospective entrepreneurs can see which combination of organisational elements may yield a higher return on social inclusion. We provide the low-level information for the business model canvas through the INSPIRE repository, and the code required to run an agent-based model as part of this deliverable. As a result, both the business model canvas and the agent-based models provide a flexible framework that may be tailored to local circumstances.

6.2 Next steps

Apart from the intrinsic value of the insight that this report offers to researchers and policymakers active in the field of social economy in rural areas, the findings generated within T2.3 will feed into the next stages of INSPIRE project. Some of these findings are expected to contribute to the Services and Social Economy Atlas on Rural Empowerment under T2.4 – “Development of Services and Social Economy Atlas on Rural Empowerment”, which will improve the understanding of social economy dynamics with social services provided in the rural context.

Moreover, under the deployment of pilot solutions that aim to improve existing social services (or introduce novel ones) in the 7 pilot ecosystems of the project, the findings from this report are expected to be used for the introduction of SE business models upon which these solutions will be designed. In particular, D2.3 findings on business models typology will be considered during the technical and business incubation of the SE-based solutions that will be provided to entrepreneurs and stakeholders in the seven pilot areas, helping them select the optimal SE business models upon which the pilot solutions can be designed. Solutions that are carefully crafted in terms of their funding and operational model are expected to survive and thrive during the post-grant phase, and to become lighthouse examples of how social economy business models can be used for enhancing social services in the rural microcosm.

References

Antosz, P., Jager, W., Polhill, G., Salt, D., Alonso-Betanzos, A., Sánchez-Maroño, N., Guijarro-Berdiñas, B., & Rodríguez, A. (2019). Simulation model implementing different relevant layers of social innovation, human choice behaviour and habitual structures. https://local-social-innovation.eu/resources/deliverables/.

Ballas, D. (2004) Simulating trends in poverty and income inequality on the basis of 1991 and 2001 census data: a tale of two cities, *Area* 36.2, 146-163.

Ballas, D. & Clarke, G. P. (2000), GIS and microsimulation for local labour market policy analysis, *Computers, Environment and Urban Systems*, vol. 24, pp. 305-330.

Ballas, D, Clarke, G P (2009), Spatial Microsimulation, in A.S Fotheringham and Peter A Rogerson (eds.) *Handbook of Spatial Analysis*, Sage, pp. 277-298

Ballas, D., Clarke, G P, Dorling D, Rossiter, D. (2007), Using SimBritain to Model the Geographical Impact of National Government Policies, *Geographical Analysis* 39 (1), pp. 44-77.

Ballas, D., Clarke, G.P., Dorling, D., Eyre, H. and Rossiter, D., Thomas, B (2005a) SimBritain: a spatial microsimulation approach to population dynamics, *Population, Space and Place*, 11, 13–34.

Ballas, D., Kingston, R., Stillwell, J., Jin, J. (2007) Building a spatial microsimulation-based planning support system for local policy making, *Environment and Planning A*, 39(10), 2482 – 2499.

Ballas, D., Rossiter, D., Thomas, B., Clarke, G., & Dorling, D. (2005b). Geography matters: Simulating the local impacts of national social policies. *Geography matters: Simulating the local impacts of national social policies*.

Barendregt, B. (2021) "Digital Ethnography, or `Deep Hanging out' in the Age of Big Data," in C. Grasseni, B. Barendregt, E. de Maaker, F. De Musso, A. Littlejohn, M. Maeckelbergh, … M. Westmoreland (Eds.), Audiovisual and Digital Ethnography. 1st ed. London: Routledge, pp. 168–190. Available at: https://doi.org/10.4324/9781003132417-8.

Bastiaanssen, J., Johnson, D., and Lucas, K. (2020). Does transport help people to gain employment? a systematic review and meta-analysis of the empirical evidence. Transport Reviews, 40:1–22.

Bastiaanssen, J., Johnson, D., and Lucas, K. (2022). Does better job accessibility help people gain employment? The role of public transport in Great Britain. Urban Studies, 59(2):301–322.

Bradburd, R. Sheppard, S., Bergeron, J., Engler, E. (2006) "The Impact of Rent Controls in Non-Walrasian Markets: An Agent-Based Modeling Approach," Journal of Regional Science, 46(3), pp. 455–491. Available at: https://doi.org/10.1111/j.1467-9787.2006.00481.x.

Bonabeau, E. (2002). Agent-based modeling: Methods and techniques for simulating human systems. Proceedings of the National Academy of Sciences, 99: 7280–7287.

Boshuijzen-van Burken, C.G., et al. (2020), Agent-Based Modelling of Values, Journal of Artificial Societies and Social Simulation, 23(4):6.

Broomhead, T., Ballas, D. and Baker, S.R. (2019) "Application of geographic information systems and simulation modelling to dental public health: Where next?," Community Dentistry and Oral Epidemiology, 47(1), pp. 1–11. Available at: https://doi.org/10.1111/cdoe.12437.

Campbell, M. and Ballas, D. (2016), SimAlba: A spatial microsimulation approach to the analysis of health inequalities, *Frontiers in Public Health*, 4:230.

Card, D., Kluve, J., and Weber, A. (2010). Active labour market policy evaluations: A meta-analysis. The Economic Journal, 120(548):F452–F477.

Card, D., Kluve, J., and Weber, A. (2017). What works? a meta analysis of recent active labor market program evaluations. Journal of the European Economic Association, 16(3):894–931.

Chartr. (n.d.). *When Each Social Media Platform Was Generating Its Peak "Buzz" On Google [OC] : r/dataisbeautiful*. https://www.reddit.com/r/dataisbeautiful/comments/lie3yw/comment/gn2k6uk/

Christiaanse, S. and Haartsen, T. (2017) "The Influence of Symbolic and Emotional Meanings of Rural Facilities on Reactions to Closure: The Case of the Village Supermarket," Journal of Rural Studies, 54, pp. 326–336. Available at: https://doi.org/10.1016/j.jrurstud.2017.07.005.

Delli Paoli, A. and D'Auria, V. (2021) "Digital Ethnography: A Systematic Literature Review," Italian Sociological Review, Vol 11, p. 243 Pages. Available at: https://doi.org/10.13136/ISR.V11I4S.434.

Eather, N., Wade, L., Pankowiak, A., and Rochelle, E. (2023). The impact of sports participation on mental health and social outcomes in adults: a systematic review and the 'mental health through sport' conceptual model. Systematic Reviews, 12(102).

European Commission (2021) "A Long-Term Vision for the EU's Rural Areas - Towards Stronger, Connected, Resilient and Prosperous Rural Areas by 2040." European Commission.

European Commission (n.d.). Internal Market, Industry, Entrepreneurship and SMEs - Social enterprises. https://single-market-economy.ec.europa.eu/sectors/proximity-and-social-economy/social-economy-eu/social-enterprises_en

EuroStat (2025) "Living Conditions in Europe - Poverty and Social Exclusion," EuroStat - Statistics Explained.

Fagiolo, G., Moneta, A. and Windrum, P. (2007), A critical guide to empirical validation of agent-based models in economics: Methodologies, procedures, and open problems, *Computational Economics*, 30(3):95–226.

Farrington, J. and Farrington, C. (2005). Rural accessibility, social inclusion and social justice: towards conceptualisation. Journal of Transport Geography, 13(1):1–12.

Gilbert, N., andTerna, P. (2000). How to build and use agent-based models in social science. Mind & Society, 1:57–72.

Haartsen, T. and Venhorst, V. (2010) "Planning for Decline: Anticipating on Population Decline in the Netherlands," Tijdschrift voor Economische en Sociale Geografie, 101(2), pp. 218–227. Available at: https://doi.org/10.1111/j.1467-9663.2010.00597.x.

Hamill, L., & Gilbert, G. (2009). Social circles: A simple structure for agent-based social network models. Journal of Artificial Societies and Social Simulation, 12(2):3–26.

Jackson, J. C., Rand, D., Lewis, K., Norton, M. I., and Gray, K. (2017). Agent-based modeling: A guide for social psychologists. Social Psychological and Personality Science, 8(4):38–395.

Joyce, A. and Paquin, R.L. (2016) "The Triple Layered Business Model Canvas: A Tool to Design More Sustainable Business Models," Journal of Cleaner Production, 135, pp. 1474–1486. Available at: https://doi.org/10.1016/j.jclepro.2016.06.067.

Kaiser, C. and Oswald, A.J. (2022) "The Scientific Value of Numerical Measures of Human Feelings," PNAS, 119(42). Available at: https://doi.org/10.1073/pnas.2210412119.

Kay, K. (2025, July 23). Why did our friends stop posting on social media? https://www.bbc.com/worklife/article/20250722-social-media-user-changes-kyle-chayka-katty-kay-interview

Kavroudakis, D, Ballas, D, Birkin, M, (2013), A spatial microsimulation approach to the analysis of social and spatial inequalities in Higher Education attainment, *Applied Spatial Analysis and Policy*, vol. 3, pp. 1-23.

Kelly, D. Steiner, A., Mazzei, M., Baker, R. (2019) “Filling a Void? The Role of Social Enterprise in Addressing Social Isolation and Loneliness in Rural Communities,” Journal of Rural Studies, 70, pp. 225–236. Available at: https://doi.org/10.1016/j.jrurstud.2019.01.024.

Kemper, J., Au Yong Lyn, A., McDonald, P., and Renold, U. (2025). Labor market outcomes of formal vocational education and training: a meta-analysis. Education Economics, 0(0):1–25.

Kozinets, R.V. (1998) “On Netnography: Initial Reflections on Consumer Research Investigations of Cyberculture.,” Advances in Consumer Research, 25(1), pp. 366–371.

Leemann, L. Martelin, T., Koskinen, S., Harkanen, T., Isola, A.M. (2022) “Development and Psychometric Evaluation of the Experiences of Social Inclusion Scale,” Journal of Human Development and Capabilities, 23(3), pp. 400–424. Available at: https://doi.org/10.1080/19452829.2021.1985440.

Lovelace, R, Ballas, D (2013), `Truncate, replicate, sample': A method for creating integer weights for spatial microsimulation, *Computers, Environment and Urban Systems*, volume 41, pp. 1-11.

McCann, P. (2013). *Modern Urban and Regional Economics*. Oxford University Press.

McPherson, M., Smith-Lovin, L. and Cook, J.M. (2001). Birds of a feather: Homophily in social networks, *Annual Review of Sociology*, 27, pp. 415--444.

Melchior, A., Dignum, F. and Yolum, P. (2024). Policy Development for Societal Challenges: The Collaborative Agent Based Modelling Policy Framework, Advances in Social Simulation: Proceedings of the 18th Social Simulation Conference, 235–248.

Morrissey, K. Clarke, G., Ballas, D., Hynes, S., O’Donohue, C. (2008) “Examining Access to GP Services in Rural Ireland Using Microsimulation Analysis,” Area, 40(3), pp. 354–364. Available at: https://doi.org/10.1111/j.1475-4762.2008.00844.x.

Noetel, M., Sanders, T., Gallardo-Gómez, D., Taylor, P., del Pozo Cruz, B., van den Hoek, D., Smith, J. J., Mahoney, J., Spathis, J., Moresi, M., Pagano, R., Pagano, L., Vasconcellos, R., Arnott, H., Varley, B., Parker, P., Biddle, S., and Lonsdale, C. (2024). Effect of exercise for depression: systematic review and network meta-analysis of randomised controlled trials. The BMJ, 384:e075847.

Nousiainen, M. and Leemann, L. (2024) “Realistic Evaluation of Social Inclusion,” Evaluation, 30(2), pp. 288–305. Available at: https://doi.org/10.1177/13563890231210328.

Osterwalder, A. (2004). *The Business Model Ontology: A Proposition In A Design Science Approach* (PDF) (Ph.D. thesis). Lausanne: University of Lausanne. OCLC 717647749.

Osterwalder, A. and Pigneur, Y. (2010) Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley & Sons.

O’Sullivan, D., Bearne, L., Harrington, J., Cardoso, J., and McVeigh, J. (2024). The effectiveness of social prescribing in the management of long-term conditions in community-based adults: A systematic review and meta-analysis. Clinical Rehabilitation, 38(10).

Padricelli, G.M., Punziano, G. and Saracino, B. (2021) “Virtual vs Digital: Examples of Netnography and Digital Ethnography in Tourism Studies for a Comparison between Methods.” Available at: https://doi.org/10.30958/ajss.8-4-4.

Pink, S., Ardevol, E., Lanzeni, D. (2016), Digital materialities: Design and anthropology, London, Bloomsbury Academic.

Pumberger, M.G. and Tobler, M.E. (2002) “The Problems of Europe’s Countryside,” Congress of Local and Regional Authorities of Europe [Preprint].

Rodríguez-Arias, A., Sánchez-Maroño, N., Guijarro-Berdiñas, B., Alonso-Betanzos, A., Lema-Blanco, I., and Dumitru, A. (2025). An agent-based model to simulate the public acceptability of social innovations. Expert Systems, 42(2): e13731.

Schuch, F., Vancampfort, D., Richards, J., Rosenbaum, S., Ward, P., and Stubbs, B. (2016). Exercise as a treatment for depression: A meta-analysis adjusting for publication bias. Journal of Psychiatric Research, 77:42–51.

Sen, A.K. (1994) "Well-Being, Capability and Public Policy," Giornale degli Economisti e Annali di Economia, 53(7/9), pp. 333–347.

Social Economy Europe (2025) D2.2 A common framework on social economy in Europe.

South-Eastern European Research Centre (2025) D1.1 Measuring social inclusion and wellbeing in European rural areas: a systematic review.

Spanos, S., Wijekulasuriya, S., Ellis, L., Saba, M., Schroeder, T., Charlotte, O., and Zurynski, Y. (2025). Integrating non-clinical supports into care: A systematic review of social prescribing referral pathways for mental health, wellbeing, and psychosocial improvement. International Journal of Integrated Care, 25(3).

Sparviero, S. (2019) "The Case for a Socially Oriented Business Model Canvas: The Social Enterprise Model Canvas," Journal of Social Entrepreneurship, 10(2), pp. 232–251. Available at: https://doi.org/10.1080/19420676.2018.1541011.

Steiner, A., Farmer, J. and Bosworth, G. (2019) "Rural social enterprise – Evidence to date, and a research agenda," Journal of Rural Studies, 70, pp. 139–143. Available at: https://doi.org/10.1016/j.jrurstud.2019.08.008.

Steinerowski, A.A. and Steinerowska-Streb, I. (2012) "Can social enterprise contribute to creating sustainable rural communities? Using the lens of structuration theory to analyse the emergence of rural social enterprise," Local Economy, 27(2), pp. 167–182. Available at: https://doi.org/10.1177/0269094211429650.

University of Barcelona (2025) D1.2 Drivers and factors of social exclusion in rural areas: macro-, meso-, and micro-level.

Varis, P. (2015) "Digital Ethnography," in The Routledge Handbook of Language and Digital Communication. 1st ed. Routledge.

Williamson, P., Birkin, M. and Rees, P. (1998) 'The estimation of population microdata by using data from small area statistics and samples of anonymised records', *Environment and Planning A*, Vol. 30, pp. 785–816

Zhang, Z., Liu, J.-Y., Zhu, K.-T., and Huo, G.-Q. (2025). A META analysis and systematic review of the effects of exercise interventions on middle-aged and elderly patients with depression. PLoS ONE, 20:e0303594.

Appendix

Figure A1: User defined function in R for the estimation of the agent-based model.

```
run_se_one_tick = function(se_row, clean, g, adoption_log, type_tbl,
current_tick) {
  # Determine eligibility set
  ids = 1:nrow(clean)
  eligible = ids[vapply(ids, is_eligible, logical(1), se_row = se_row, clean =
clean)]
  if (!length(eligible)) {
    return(list(offered_ids = integer(0), adopted_ids = integer(0),
                clean = clean, dPI = rep(0, nrow(clean))))
  }
  # Offers
  offered = allocate_offers(se_row, eligible, clean, g, adoption_log,
current_tick = current_tick)
  if (!length(offered)) {
    return(list(offered_ids = integer(0), adopted_ids = integer(0),
                clean = clean, dPI = rep(0, nrow(clean))))
  }

  # Get type row
  trow = type_tbl %>% filter(.data$type == se_row$type)
  if (!nrow(trow)) stop(sprintf("Service type '%s' not found in type_tbl",
se_row$type))
  trow = trow[1, , drop = FALSE]

  adopted = integer(0)
  dPI_vec = rep(0, nrow(clean))

  for (i in offered) {
    p = p_adopt(i, se_row, trow, clean, g, adoption_log, current_tick =
current_tick)
    if (is.na(p)) next
    if (adopt_draw(p) == 1L) {
      adopted = c(adopted, i)
      eff = apply_service_effects(i, se_row, trow, clean)
      clean = eff$clean
      dPI_vec[i] = dPI_vec[i] + (eff$dPI %||% 0)
      # Trust updates
      peer_d = peer_outcome_delta(i, g, dPI_vec)
      clean = update_trust(i, se_row, outcome_delta = dPI_vec[i], peer_delta =
peer_d, clean = clean)
    }
```

```
  }

  list(offered_ids = offered, adopted_ids = adopted, clean = clean, dPI =
dPI_vec)
}


# First reweights edges, then applies churn. Returns the updated graph.
update_network = function(
    g, clean,
    p_break_base = 0.005,
    alpha_weak = 0.5,
    beta_div = 0.3,
    max_churn_frac = 0.03,
    reform_frac = 0.75,
    triadic_closure_prob = 0.6,
    within_weight = 3.0,
    seed = NULL
) {
  g = recompute_edge_weights(g, clean)
  g = network_churn(
    g, clean,
    p_break_base = p_break_base,
    alpha_weak = alpha_weak,
    beta_div = beta_div,
    max_churn_frac = max_churn_frac,
    reform_frac = reform_frac,
    triadic_closure_prob = triadic_closure_prob,
    within_weight = within_weight,
    seed = seed
  )
  g
}


recompute_edge_weights = function(g, clean) {
  if (ecount(g) == 0) return(g)

  # Static group labels stored on graph
  ga = V(g)$group_age
  ge = V(g)$group_edu
  gm = V(g)$group_migrant

  # Dynamic person covariates (safe defaults)
  feel = (clean$feel_close_area %||% rep(0.5, vcount(g)))
```

```
  trust = (clean$trust_general %||% rep(0.5, vcount(g)))
  vol = (clean$volunteered %||% rep(0, vcount(g)))
  act = (clean$social_activity_freq %||% rep(0.5, vcount(g)))

  em = ends(g, E(g))
  v1 = as.integer(em[,1]); v2 = as.integer(em[,2])

  sim_age = as.numeric(ga[v1] == ga[v2])
  sim_edu = as.numeric(ge[v1] == ge[v2])
  sim_mig = as.numeric(gm[v1] == gm[v2])
  w_sim   = (sim_age + sim_edu + sim_mig)/3

  aff_pair = (feel[v1] + feel[v2]) / 2
  tr_pair  = (trust[v1] + trust[v2]) / 2
  w_affil  = clamp01(0.5*aff_pair + 0.5*tr_pair)

  vol_pair = (vol[v1] + vol[v2]) / 2
  act_pair = (act[v1] + act[v2]) / 2
  w_activity = clamp01(0.5*vol_pair + 0.5*act_pair)

  # Combine (same recipe as initial build)
  w_comb = clamp01(0.5*w_sim + 0.3*w_affil + 0.2*w_activity)

  E(g)$w_sim = w_sim
  E(g)$w_affil = w_affil
  E(g)$w_activity = w_activity
  E(g)$weight = w_comb

  g
}

network_churn = function(
    g, clean,
    p_break_base = 0.005,
    alpha_weak = 0.5,
    beta_div = 0.3,
    max_churn_frac = 0.03,
    reform_frac = 0.75,
    triadic_closure_prob = 0.6,
    within_weight = 3.0,
    seed = NULL
) {
  if (!is.null(seed)) set.seed(seed)
  m = ecount(g); n = vcount(g)
  if (m == 0 || n < 2) return(g)
```

```
# Divergence proxy (PI + health)
PI = clean$PI %||% rep(0.5, n)
phys = clean$physical_health %||% rep(NA_real_, n)
ment = clean$mental_health %||% rep(NA_real_, n)
health = ifelse(is.na(phys) | is.na(ment), NA_real_, (phys + ment)/2)
health[is.na(health)] = 0.5

em = ends(g, E(g))
v1 = as.integer(em[,1]); v2 = as.integer(em[,2])
w  = E(g)$weight %||% rep(0.5, m)

dPI = abs(PI[v1] - PI[v2])
dH  = abs(health[v1] - health[v2])
divergence = clamp01(0.5*dPI + 0.5*dH)

# Break probability per edge
p_break = p_break_base + alpha_weak * (1 - w) + beta_div * divergence
p_break = pmin(p_break, 0.05) # local cap
# Global cap by sampling
max_remove = max(1L, floor(max_churn_frac * m))
to_remove = which(runif(m) < p_break)
if (length(to_remove) > max_remove) {
  # Keep the highest-probability candidates
  ord = order(p_break[to_remove], decreasing = TRUE)
  to_remove = to_remove[ord[seq_len(max_remove)]]
}

if (!length(to_remove)) return(g)

# Collect endpoints for potential re-formation
rm_pairs = em[to_remove, , drop = FALSE]
g = delete_edges(g, to_remove)

# Decide how many new edges to add back
add_edges_n = floor(nrow(rm_pairs) * reform_frac)
if (add_edges_n <= 0) return(g)

# Precompute homophily groups for formation
ga = V(g)$group_age; ge = V(g)$group_edu; gm = V(g)$group_migrant
block_id = paste(ga, ge, gm, sep = "|")
# Helper: add a single edge if valid
add_if_valid = function(g, a, b) {
  if (a == b) return(g)
  if (!are.connected(g, a, b)) g = add_edges(g, c(a, b))
```

```
    g
  }

  # Candidate selection functions
  # 1) Triadic closure: connect to friend-of-friend (prefer same block)
  form_triad = function(g, u) {
    neigh = neighbors(g, u)
    if (length(neigh) == 0) return(NA_integer_)
    fof = unique(unlist(neighborhood(g, order = 2, nodes = u)) )
    fof = setdiff(fof, c(u, as.integer(neigh)))
    if (!length(fof)) return(NA_integer_)
    same = block_id[fof] == block_id[u]
    w = ifelse(same, within_weight, 1)
    if (length(fof) > 1) {
      return(sample(as.integer(fof), size = 1, prob = w))
    } else {
      return(fof)
    }
  }
  # 2) Homophily-biased random match over all nodes
  form_homophily = function(g, u) {
    cand = setdiff(seq_len(vcount(g)), c(u, as.integer(neighbors(g, u))))
    if (!length(cand)) return(NA_integer_)
    same = block_id[cand] == block_id[u]
    w = ifelse(same, within_weight, 1)
    sample(as.integer(cand), size = 1, prob = w)
  }

  # Build list of endpoints to try reconnecting (one endpoint per removed edge)
  endpoints = as.integer(rm_pairs[, sample(1:2, nrow(rm_pairs), replace =
TRUE)])
  endpoints = endpoints[seq_len(add_edges_n)]

  for (u in endpoints) {
    v = if (runif(1) < triadic_closure_prob) form_triad(g, u) else
form_homophily(g, u)
    if (!is.na(v)) g = add_if_valid(g, u, v)
  }

  # Optional: refresh simple diagnostics
  graph_attr(g, "avg_degree") = mean(degree(g))
  graph_attr(g, "transitivity") = transitivity(g, type = "globalundirected")

  g
}
```

inspire

SMART VILLAGE LABS

GA 101136592

PARTNERS

WHITE

university of groningen

UNIVERSITAT DE BARCELONA

SEERC SOUTH-EAST EUROPEAN RESEARCH CENTRE

CZU Czech University of Life Sciences Prague

KOÇ ÜNİVERSİTESİ

Social Economy Europe

EASPD

European Social Network

EUROPEAN NETWORK OF MIGRANT WOMEN

PEDAL CONSULTING

EUROPEAN RURAL DEVELOPMENT NETWORK www.erdn.eu

MedINA

LADAPT

the wheel Stronger Charities. Stronger Communities.

ROMONTANA.org

Q-PLAN INTERNATIONAL

arx.net MOBILE INNOVATIONS

Funded by the European Union