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A Major Uplift – Recent Developments in REGION

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REGION has undergone various improvements over the last eight months. In January 2022, I took over as a managing editor of REGION and we appointed four associate editors in March. Since then, we have been committed to increase the visibility, quality and reduce the processing time of submissions to REGION. To develop a plan, we analysed the performance of the journal and published a first performance report. We analysed data on submissions, citations, processing times, views, downloads, authorship and readership. The report is published on our website. Overall, all indicators reflect a positive upward trend of success, attracting a sustainable number of submissions, recording an increasing number of citations and displaying a wide readership and authorship.

REGION is registered with all major indices, except for Web of Science (WoS). In May, we submitted an application to register REGION with WoS. If the application is successful, papers published in REGION will be indexed in WoS. WoS is a key platform as it provides the well know *Impact Factor (IF)* which tends to drive publication, recruitment, funding and promoting decision, despite calls for the responsible and ethical use of academic indicators for evaluating performance (DORA 2022), and recognition of the limitations of such indicators capturing other areas of academic life (The PLoS Medicine Editors 2006). We hope that the registration of REGION in WoS will further increase the number and quality of submission as the journal builds a strong *IF*.

We have also installed a plugin to integrate ORCID identifiers into our online Open Journal Systems (OJS), the open-source software we use for managing REGION. This addition facilitates registration of REGION publications with ORCID which uniquely identifies authors and contributors with the ORCID website increasing the visibility of their academic outputs. Additionally, we added a Public Knowledge Project (PKP) Preservation Network (PN) plugin into OJS. This plugin digitally preserves OJS journals by offering long-term archiving of articles published in REGION. Copies of published articles are stored in a decentralised way distributed across various servers, and warranties perpetual access and preservation of original published articles even if the journal is discontinued. Though, of course, this is not our expectation. We expect REGION to continue to build a strong academic profile.

An additional key development is the integration of iThenticate into REGION's OJS. iThenticate is a plagiarism detection software package and ensures automatic plagiarism checking for all submissions. Finally, we have changed our publication license to comply with the United Kingdom Research and Innovation (UKRI) (UKRI 2022). REGION

switched from a CC BY-NC license, which requires non-commercial use of all material published, to CC BY. The latter has become the de-facto standard in open access publishing. This removes any potential disputes about open access publishing which is often a requirement from funding bodies. The change in license also contributes to enhancing the pioneer role of REGION as open access journal in Regional Science, offering an opportunity to publish at no cost for authors.

The developments described above adds to those reported in Koster, Rowe (2020). We are convinced that these enhancements will contribute to the long-term vision of increasing the visibility and quality submissions to REGION.

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Your Air Pollution Makes Me Sick! Estimating the Spatial Spillover Effects of $PM_{2.5}$ Emissions on Emergency Room Visits Due to Respiratory Diseases in Chile

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Abstract. This study quantifies the spillover effects of $PM_{2.5}$ emissions on emergency room visits due to respiratory diseases in Chile. We use several spatial panel methods and models controlling also for the potential endogeneity of air quality. Our estimates show that the spillover effects are downward biased when this endogeneity is ignored. Furthermore, using the estimates from our preferred model, we find that about 65 per cent of the total emergency room visits in Chile are due to $PM_{2.5}$ emissions generated in the same municipality, whereas the remaining 35 per cent can be attributed to pollutants emitted in a different spatial unit. In economic terms, increasing $PM_{2.5}$ emissions in one thousand tonnes yields to an increase of USD 98,010 of annual costs for ER health facilities due to spillover effects, whereas the total costs (considering indirect and direct effects) amounts to USD 283,855.

Key words: Air pollution, $PM_{2.5}$ emissions, Spatial spillover effect, Public health, Instrumental variable, Spatial panel models

1 Introduction

Several studies across different fields have shown that air quality is highly associated with mortality and hospital admissions for respiratory and cardiovascular diseases (Brunekreef, Holgate 2002, Bernstein et al. 2004, Cohen et al. 2005, Kampa, Castanas 2008). This relationship has gained more attention with accelerating urban development, especially in developing countries where the negative impacts of air pollution on health are greater and public resources for health are scarcer compared to developed countries. Most of the recent studies have focused on atmospheric particulate matter with 2.5 micrometers in diameter ($PM_{2.5}$), which is considered one of the most dangerous pollutants for health due to its capacity to penetrate deeply into the lungs and bloodstream (Pope III et al. 2002, Xing et al. 2016). According to Brauer et al. (2015), $PM_{2.5}$ is the most frequent cause of environment-related deaths worldwide causing approximately 3.1 millions premature deaths globally in 2010 and 2.1 millions in 2013. Previous studies also suggest that long-term exposure to $PM_{2.5}$ increases the prevalence rate of respiratory diseases (Abbey et al. 1995, Pope III et al. 2002, 2004, Cohen et al. 2005), which in turn increases hospitalization rates (Ward 2015, Ostro et al. 2008) and household healthcare expenditure (Yang, Zhang 2018); whereas short-term exposures increase susceptibility to respiratory

infections (Analitis et al. 2006), heart attack (Dominici et al. 2006, Madrigano et al. 2012), asthma attacks (Zanobetti et al. 2009, Hua et al. 2014, Fan et al. 2016) and acute bronchitis (Yang et al. 2019).

Most of these studies assume that air pollution has negative impacts only at the same spatial location. However, geographical units are interrelated resulting in an interregional diffusion of pollutants to other areas. This is supported by studies showing that pollutants can travel long distances (Bergin et al. 2005, Fang et al. 2019), and even continents (Hatakeyama et al. 2001), generating important unintended spatial spillover effects. In terms of $PM_{2.5}$, Li et al. (2018) show that this pollutant is the second pollutant component with the highest level of spatial interdependency in China, whereas Chen et al. (2017), Chen, Ye (2019), Hao, Liu (2016) and Ma et al. (2016) show that $PM_{2.5}$ emissions have significant diffusion effects between neighboring regions.

Given the potential externalities exerted by air pollutants, researchers have tried to estimate the spatial spillovers of air pollution on public health. For example, Zhang et al. (2017) estimates that about 73% of the total premature deaths in the world due to $PM_{2.5}$ are attributable to production activities in the same spatial unit, whereas the remaining percentage is due to air pollutants emitted in a different region. In China, Chen et al. (2017) find that an increase of ten thousand tonnes of industrial sulfur dioxide emissions in a particular city will lead, on average, to an increase in local mortalities from lung cancer and respiratory diseases of 0.035 and 0.030 per ten thousand persons, respectively, and a total spillover effect of 0.217 and 1.543 per ten thousand persons in mortalities of all its neighbors. These results imply that air pollution and its associated effects on health are a strong motivation to establish more effective air quality regulation. For example, policies aimed at reducing air pollutants in target regions might decrease emissions in neighboring regions, exerting unintended but beneficial spillover effects on public health (Fang et al. 2019).

In this context, this study tries to empirically assess the potential spillover effects of $PM_{2.5}$ emissions on emergency room (ER) visits due to respiratory diseases in Chile. In particular, the questions we try to answer are: is there a strong relationship between $PM_{2.5}$ emissions and public health? Is there evidence of spatial spillover effects? If they do exist, are they substantially large? To answer these questions, we estimate several spatial panel models for yearly data on ER visits and $PM_{2.5}$ emissions for 337 municipalities, controlling for the potential endogeneity of $PM_{2.5}$ emissions.

We focus on Chile for two reasons. First, air pollution in Chile has reached worrying levels in the Latin American context. According to the World Health Organization (WHO), the average level of $PM_{2.5}$ concentration in Chile is approximately 25 ug/m^3 (15 points greater than the recommended air quality standard of 10 ug/m^3 annual mean), placing Chile seventh out of the 33 most polluted countries in America. Furthermore, according to the 2018 World Air Quality report, Chile has 9 of the 10 most polluted cities in South America. Although these figures have led the Chilean Government to implement several prevention and decontamination plans, the air quality in many cities of the country still exceeds levels established by the WHO. Second, most of the studies documenting the detrimental effects of air pollution on Chileans' health have focused on the most polluted cities located in the central and southern regions of the country. For example, Ostro et al. (1996) find that a 10-ug/m^3 change in daily mean PM_{10} is associated with a 1% increase in total daily mortality in Santiago. Sanhueza et al. (2006), focusing in Temuco which is one of the most highly polluted cities in Chile, find that PM_{10} and $PM_{2.5}$ are statistically correlated with the daily number of deaths, hospital admissions, and ER visits for cardiovascular, respiratory, and acute respiratory infection diseases.

This work makes two potential contributions. First, and unlike previous studies in Chile, this study uses ER visits data for the entire country, which allows us to generalize our results to whole population. Moreover, it is the first study (to our knowledge) that analyzes the potential spatial spillover effects of air pollution on Chileans' health. Second, we use a spatial panel approach controlling simultaneously for the endogeneity of the spatial lag of ER visits and $PM_{2.5}$ emissions. As instruments for $PM_{2.5}$ emissions, we use the number of vehicles in each municipality and its higher-order spatial lags.

2 Methods

2.1 Model formulation and spatial mechanisms

To analyze the spillover effects of air pollution on ER visits, we propose the following spatial panel data model:

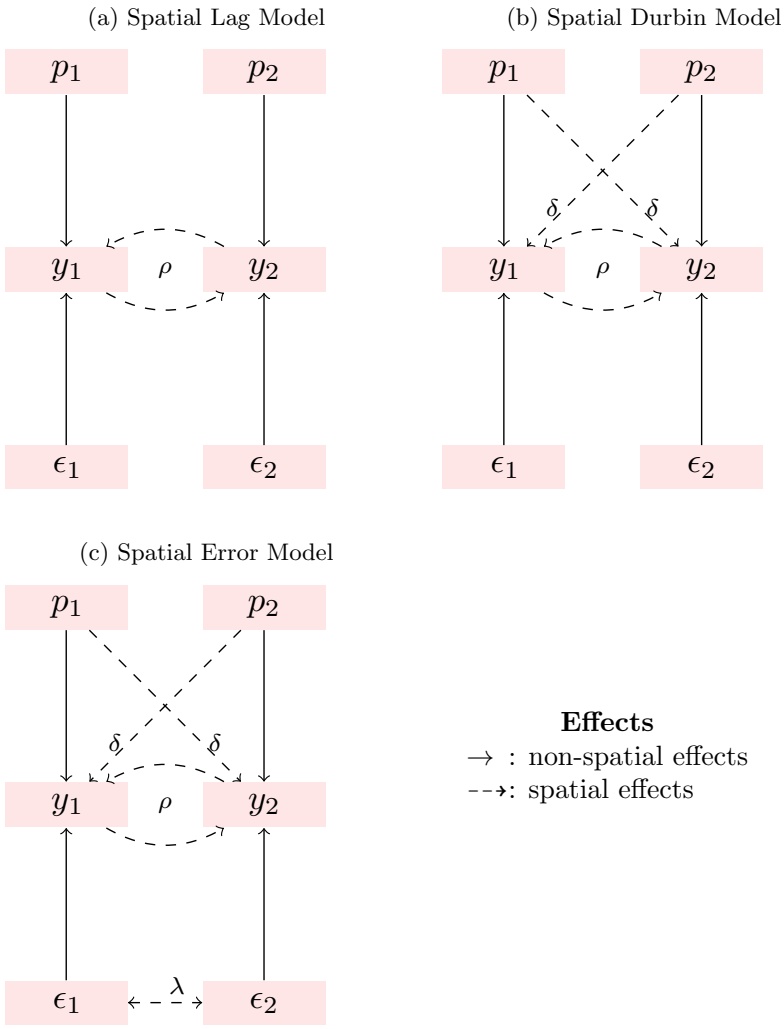
$$
\begin{aligned}
y_{it} &= \rho \sum_{j=1}^{N} w_{ij} y_{jt} + \gamma p_{it} + \delta \sum_{j=1}^{N} w_{ij} p_{jt} + \mathbf{x}_{it}' \boldsymbol{\beta} + \sum_{j=1}^{N} w_{ij} \mathbf{x}_{it}' \boldsymbol{\theta} + \mu_i + \tau_t + u_{it}, \\
u_{it} &= \lambda \sum_{j=1}^{N} w_{ij} u_{jt} + \epsilon_{it}, \\
& i = 1, ..., N; t = 1, ..., T.
\end{aligned} \tag{1}
$$

where y_{it} denotes the number ER visits due to respiratory diseases in municipality i in time t; p_{it} is the amount of $PM_{2.5}$ emissions, which we presume is endogenous; $\mathbf{x}_{it}$ is a $K \times 1$ vector of exogenous variables whose values vary over both municipalities and time; μ_i is a municipality-fixed effect which is meant to control for time-invariant variables whose omission could bias the estimates; τ_t is a time-fixed effect which eliminates omitted variable bias caused by excluding unobserved variables that evolve over time but are constant across municipalities; w_{ij} is an element of the $(N \times N)$ spatial weight matrix $\mathbf{W}$ reflecting the spatial interdependent relationship between different municipalities, so that $\sum_{j=1}^{N} w_{ij} y_{jt}$ captures the number of ER visits for respiratory diseases for i's neighbors, whereas $\sum_{j=1}^{N} w_{ij} u_{jt}$ captures the potential spatial autocorrelation in omitted variables that vary over both municipalities and time; $\sum_{j=1}^{N} w_{ij} p_{jt}$ and $\sum_{j=1}^{N} w_{ij} \mathbf{x}_{it}'$ capture air pollution and other covariates of i's neighbors, respectively. Finally, it is assumed that $\epsilon_{it} \sim iid(0, \sigma_\epsilon^2)$.

Different restrictions on the model (1) give raise to different taxonomies of the spatial relationships between ER visits and air pollution. Setting $\delta = \lambda = 0$ and $\boldsymbol{\theta} = \mathbf{0}$, we obtain the Spatial Lag Model (SLM). This model is displayed in Panel (a) of Figure 1, which considers two municipalities. Under this model, it is assumed that ER visits in municipality 1, (y_1), exerts a spatial externality on the number of ER visits in municipality 2, (y_2). If $\rho > 0$ $(\rho < 0)$, then this spatial externality is positive (negative); that is, the increase in admissions in emergency rooms due to respiratory problems in municipality 1 generates an increase (decrease) in admissions in municipality 2. ER visits might spread from municipality to municipality by a variety of mechanisms. First, there exists a vast literature in epidemiology indicating that disease transmission is inherently spatial, especially for respiratory diseases such as flu, common cold and pneumonia (Kuebart, Stabler 2020). For example, individuals have complex spatial routines in their everyday lives. Thus, it has to be considered that people tend to pass through a variety of places over time, which increase the likelihood of being infected and/or spread the disease to distant places (Kulldorff, Nagarwalla 1995, Li et al. 2003). If the transmission follows a spatial pattern and both the contagion rate and commuting is high, then we should observe spatial clusters in ER visits, especially in seasons of extreme temperatures.

Another mechanism which is observationally equivalent is the overcrowding effect. Emergency departments prioritize patients according to their severity such that low-urgency patients have a longer waiting time. Therefore, waiting times act as an implicit price ensuring that only patients who are willing to bear the cost will be treated (Sivey 2018). Thus, medical centers facing a situation of high demand or operating at or near full capacity could cause individuals with high waiting time elasticity to choose medical centers in neighboring municipalities for urgent treatment, other things equal. According to Salway et al. (2017) another potential mechanism is ambulance diversion. Ambulance diversion is a tactic used by hospitals and emergency medical services to solve the problem of overcrowded emergency departments. For example, if a given municipality is experiencing high demand for urgent treatment, nearby medical centers might also experience an increase of demand due to ambulance diversion. These mechanisms are

Figure 1: Spatial Econometric Models



relevant in the context of emergency services in Chile, which have been experiencing problems of congestion for several years (Salway et al. 2017, Becerra et al. 2020). Based on these theoretical mechanisms, we expect a positive ρ, which is consistent with the epidemiological hypothesis of contagion of diseases and/or with a potential congestion effect of emergency room departments.

Setting $\lambda = 0$ in Equation (1), we obtain the Spatial Durbin model (SDM) displayed in Panel (b) of Figure 1. Under this model, air pollution in municipality 1 not only affects municipality 2's ER visits through congestion and/or contagion, but also directly because of the transboundary characteristic of air pollution via δ (Bergin et al. 2005). As we will discuss later, although δ captures the immediate spillover effect of air pollution (local effects), if ρ equals zero, we will not be able to capture the potential spillover effects on more distant municipalities (global effects).

If $\lambda \neq 0$ gives rise to the General Nesting Spatial (GNS) model (Elhorst 2014). This model helps to control for the potential spatial dependence in the error term, which may arise because of omitted variables that are correlated across municipalities, as shown in Panel (c) of Figure 1. Spatial dependence of error terms leads to an inefficiency problem, but no bias in the estimated parameters if the omitted variables are not correlated with the included variables. Therefore, although λ does not enter in the computation of spillover effects, adjusting for spatial dependence in the error term will produce more accurate inference regarding the direct and indirect effects (LeSage 2014). Finally, if all spatial parameters are zero ($\rho, \gamma, \boldsymbol{\theta}$), except for λ, then the model is reduced to the Spatial Error (SEM) model.

2.2 Issues with model estimation

2.2.1 Fixed effect vs random effect

The idiosyncratic effect μ_i in Equation (1) can be estimated by either a fixed (FE) or a random effects (RE) model. Both methods have advantages and disadvantages discussed in detail by Elhorst (2014) and Kopczewska et al. (2017). In this study, we opt for the FE model for two reasons. First, the RE model is not appropriate when space-time data of adjacent spatial units located in unbroken study areas are used, as in our case (Elhorst 2014, p. 86). Second, the assumption of the RE model of no correlation between the municipalities' fixed (μ_i) effects and the explanatory variables is very restrictive. For instance, climate and/or geographical characteristics (or any other omitted variable in our model) may be correlated with emissions: climate may affect heating and cooling needs which in turn affects the probability of having a respiratory illness (Selden, Song 1994).

The main disadvantage of the FE model is that it does not allow to control for time-invariant geographical characteristics such as distance to the sea, elevation, distance to big cities, etc., which are known to be correlated with respiratory diseases. Therefore, we assume that all these characteristics of municipalities are captured by μ_i. In any case, the Hausman tests (displayed later) support our claim that the FE outperforms the RE model.

2.2.2 Instruments and estimation

Consider the spatial model (1) in matrix form:[1]

$$\begin{aligned} \mathbf{y} &= \rho \left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{y} + \mathbf{X}\boldsymbol{\beta}_1 + \mathbf{Y}\boldsymbol{\beta}_2 + \left(\boldsymbol{\iota}_T \otimes \mathbf{I}_N\right) \boldsymbol{\mu} + \mathbf{u}, \\ \mathbf{u} &= \lambda \left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{u} + \boldsymbol{\varepsilon}, \end{aligned} \tag{2}$$

where $\mathbf{y}' = (\mathbf{y}_1', ..., \mathbf{y}_T')$ and $\mathbf{y}_t$ is an $N \times 1$ vector in time period $t = 1, ..., T$; $\mathbf{X}' = (\mathbf{X}_1', ..., \mathbf{X}_T')$ and $\mathbf{X}_t$ is a $N \times K$ matrix of *exogenous variables*, which can also include their spatial lag; $\boldsymbol{\mu}$ is a $N \times 1$ vector of municipality-fixed effects; $\mathbf{Y}' = (\mathbf{Y}_1', ..., \mathbf{Y}_T')$, where $\mathbf{Y}_t, t = 1, ..., T$ is an $N \times H$ matrix of additional endogenous variables, which in this context collects p_{it} and $\sum_{j=1}^{N} w_{ij} p_{jt}$ across municipalities and time; finally $\boldsymbol{\varepsilon}' = (\boldsymbol{\varepsilon}_1', ..., \boldsymbol{\varepsilon}_T')$ is an $NT \times 1$ vector of error terms. $\mathbf{I}_N$ denotes an identity matrix of dimension $(N \times N)$, or dimensions $(T \times T)$ if the subscript T is indicated.

Estimation of model (2) imposes some complications. First, $\left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{y}$ generates endogeneity due to simultaneity. Second, both p_{it} and its spatial lag are potentially endogenous. For example, our measure of $PM_{2.5}$ emissions is based on self-reported emissions which might result in a potential problem of attenuation bias. Furthermore, air quality might be correlated with unobserved variables at the municipality level that affect individuals' health, creating an omitted variable bias. Therefore, we need to instrumentalize both $\left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{y}$ and $\mathbf{Y}$.

For the identification of the effect of air quality on ER visits, we use the number of vehicles in a given municipality as an additional pre-determined variable. According to the Chilean Ministry of Environment, vehicle emissions represent 35-50% of total national emissions. In terms of the exclusion restriction, we claim that, after taking into account the amount of $PM_{2.5}$ emissions, the only way that the number of vehicles can affect ER visits is through air quality.[2]

Following Kelejian, Prucha (1998), we use

$$\left(\mathbf{X}, \left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{X}, \left(\mathbf{I}_T \otimes \mathbf{W}^2\right) \mathbf{X}, ..., \left(\mathbf{I}_T \otimes \mathbf{W}^q\right) \mathbf{X}\right)$$

as instruments for $\left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{y}$, where $\mathbf{X}$ is the set of included exogenous variables. The intuition behind the instruments is the following: since $\mathbf{X}$ determines $\mathbf{y}$, then it must be true that $\left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{X}, \left(\mathbf{I}_T \otimes \mathbf{W}^2\right) \mathbf{X}, ...$ determines $\left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{y}$. Furthermore, since $\mathbf{X}$ is assumed to be uncorrelated with $\boldsymbol{\varepsilon}$, then $\left(\mathbf{I}_T \otimes \mathbf{W}\right) \mathbf{X}$ must be also uncorrelated with $\boldsymbol{\varepsilon}$.

[1] Note that we have dropped the time-fixed effect, τ_t, for simplicity in the exposition.

[2] As suggested by one of the reviewers, the number of vehicles can affect ER visits through other mechanisms like traffic accidents or urbanization. In our robustness checks section, we also allow for such possibilities.

We also assume that $\boldsymbol{\Phi}$ is a $NT \times R$ matrix of additional exogenous instruments for $\mathbf{Y}$, where $\boldsymbol{\Phi}$ consists of the number of vehicles. Setting $\mathbf{X}_f = [\mathbf{X}, \boldsymbol{\Phi}]$, the instruments are given by the linearly independent columns of (Drukker et al. 2013, Kelejian, Piras 2017) $\mathbf{Q} = \left[\mathbf{X}_f, (\mathbf{I}_T \otimes \mathbf{W})\,\mathbf{X}_f, \left(\mathbf{I}_T \otimes \mathbf{W}^2\right)\mathbf{X}_f, ..., \left(\mathbf{I}_T \otimes \mathbf{W}^q\right)\mathbf{X}_f\right]$.

Following the empirical literature we set $q = 2$ (Drukker et al. 2013, Kelejian, Prucha 1998, 2010, Fingleton, Le Gallo 2008), so that the matrix of instruments is given by following subset of $\mathbf{Q}$:

$$\mathbf{Q}_* = \left[\mathbf{X}_f, (\mathbf{I}_T \otimes \mathbf{W})\,\mathbf{X}_f, \left(\mathbf{I}_T \otimes \mathbf{W}^2\right)\mathbf{X}_f\right]_{LI}, \tag{3}$$

where LI indicates linearly independent columns of $\mathbf{Q}_*$. We use different estimation procedures in this work. First, when assuming that air pollution is exogenous, that is $\boldsymbol{\beta}_2 = \mathbf{0}$, we can estimate the GNS spatial model (Equation (2)) by Maximum Likelihood (ML) procedure assuming the full distribution of $\boldsymbol{\varepsilon}$ (Elhorst 2014). When $\boldsymbol{\beta}_2 \neq \mathbf{0}$, the ML no longer delivers consistent estimates, so we rely on GMM procedures. The full GNS model can be estimated via Generalized Spatial Two Stage Least Square (GS2SLS) (see Kelejian, Piras 2017, chapter 15 for technical specifics). The steps are the following: (1) estimate a FE effect model using a S2SLS procedure using (3) as instruments; (2) obtain the residuals from the 2SLS to consistently estimate σ^2_ϵ and λ via Method of Moments using Kapoor et al. (2007)'s equations accordingly; (3) using the consistent estimates of σ^2_ϵ and λ, the model is transformed to account for the spatial correlation in the error term, and more efficient estimates of the parameters are obtained via 2SLS using (3) as instruments. Finally, if $\lambda = 0$ the model is estimated by the traditional S2SLS.

2.3 Computing direct and indirect effects

Since the estimated coefficients are not directly interpretable (LeSage, Pace 2014b), we need to compute the spatial spillover effects of air pollution on ER visits, which is primary objective of this work.

To derive the marginal impacts, we follow LeSage, Pace (2009) and Elhorst (2014). Assuming that $(\mathbf{I}_{NT} - a\,(\mathbf{I}_T \otimes \mathbf{W}))$ is nonsingular for $|a| < 1$, the reduced form of model (2) is given by:

$$\mathbf{y} = \mathbf{S}^{-1}\mathbf{X}\boldsymbol{\beta}_1 + \mathbf{S}^{-1}\mathbf{Y}\boldsymbol{\beta}_2 + \mathbf{S}^{-1}\,(\boldsymbol{\imath}_T \otimes \mathbf{I}_N)\,\boldsymbol{\mu} + \mathbf{S}^{-1}\mathbf{C}^{-1}\boldsymbol{\varepsilon}, \tag{4}$$

where $\mathbf{S} = (\mathbf{I}_{NT} - \rho\,(\mathbf{I}_T \otimes \mathbf{W}))$ and $\mathbf{C} = (\mathbf{I}_{NT} - \lambda\,(\mathbf{I}_T \otimes \mathbf{W}))$. Taking the expectation of (4) yields:

$$\mathbb{E}(\mathbf{y}) = \mathbf{S}^{-1}\mathbf{X}\boldsymbol{\beta}_1 + \mathbf{S}^{-1}\mathbf{Y}\boldsymbol{\beta}_2.$$

Since $\mathbf{Y}$ collects both air pollution and its spatial lag, the impact on the expected value of location j given a change in air pollution in location i, also known as the indirect effects, is:

$$\frac{\partial \mathbb{E}(y_i)}{\partial p_j} = \mathbf{G}_p(\mathbf{W})_{ij}, \quad \forall i \neq j, \tag{5}$$

where $\mathbf{G}_p(\mathbf{W})_{ij}$ is the i,jth element of the following matrix:

$$\begin{aligned}\mathbf{G}_p(\mathbf{W}) &= \begin{pmatrix} \frac{\partial \mathbb{E}(y_1)}{\partial p_1} & \frac{\partial \mathbb{E}(y_1)}{\partial p_2} & \cdots & \frac{\partial \mathbb{E}(y_1)}{\partial p_N} \\ \frac{\partial \mathbb{E}(y_2)}{\partial p_1} & \frac{\partial \mathbb{E}(y_2)}{\partial p_2} & \cdots & \frac{\partial \mathbb{E}(y_2)}{\partial p_N} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial \mathbb{E}(y_n)}{\partial p_1} & \frac{\partial \mathbb{E}(y_n)}{\partial p_2} & \cdots & \frac{\partial \mathbb{E}(y_n)}{\partial p_N} \end{pmatrix}, \\ &= (\mathbf{I}_{NT} - \rho\,(\mathbf{I}_T \otimes \mathbf{W}))^{-1}\,(\mathbf{I}_{NT}\gamma + \delta\,(\mathbf{I}_T \otimes \mathbf{W}))\,.\end{aligned} \tag{6}$$

Note that $\boldsymbol{\beta}_2' = [\gamma, \delta]$, where γ represents the coefficient for air pollution and δ denotes the coefficient for the spatial lag of air pollution in Equation (1).

Equation (5) is known as the indirect effect which reflects that air pollution in a given municipality not only has a direct or spatial-localized effect on its inhabitants' ER visits,

but also in those of neighboring municipalities. It can be noticed from Equation (5) that every off-diagonal element of (6) represents an indirect effect. Therefore, indirect effects do not occur if both $\rho = 0$ and $\delta = 0$ (Elhorst 2014). Furthermore, it is important to distinguish between global and local indirect effects (LeSage, Pace 2009). Local spillovers occurs if $\delta \neq 0$ and represent a situation where the impact of air pollution on individuals' ER visits falls only on immediate neighbors, dying before they impact municipalities that are neighbors to the neighbors. Global spillovers occur when $\rho \neq 0$ and arise when changes in the air quality of one municipality impact all municipalities' ER visits. This applies even to the municipality itself as the impacts of the air pollutants can pass to its neighbors and back to the municipality itself. Thus, the simultaneous interactions produced by global spillovers lead to a scenario where changes in air quality in one municipality set in motion a sequence of adjustments over time in all municipalities in the sample such that a new long-run equilibrium arises (LeSage, Dominguez 2012, LeSage, Pace 2014b).

The impact of the expected value of municipality i's ER visits, given a change in air pollution for the same municipality is given by:

$$\frac{\partial \mathbb{E}(y_i)}{\partial p_i} = \mathbf{G}_p(\mathbf{W})_{ii}, \quad \forall i. \tag{7}$$

The effect on Equation (7) is known as the direct effect and includes the effect of feedback loops where municipality i affects municipality j and municipality j also affects municipality i.

It is important to highlight three important issues. First, if both $\rho = 0$ and $\delta = 0$, both global and local effects cannot be separated from each other (Elhorst 2014). Second, the SLM model has the disadvantage that the ratio between the indirect and direct effects is the same for all variables considered in the model, which might be unrealistic in our application. This shortcoming does not occur in the SDM or GNS model. Third, given that the change of air quality in each municipality implies N^2 potential marginal effects (as shown in Equation (6)), we report the average marginal effects as suggested by LeSage, Pace (2009). Assuming that our instruments are valid, both the average direct and indirect marginal effects represent the effects of $PM_{2.5}$ emissions for the compliers, i.e., those municipalities whose $PM_{2.5}$ is affected by the instruments (in our case, the sub-population of municipalities who would increase their $PM_{2.5}$ emissions because the number of vehicles had increased). This is known as the local average treatment effect (LATE).

2.3.1 Spatial weight matrix

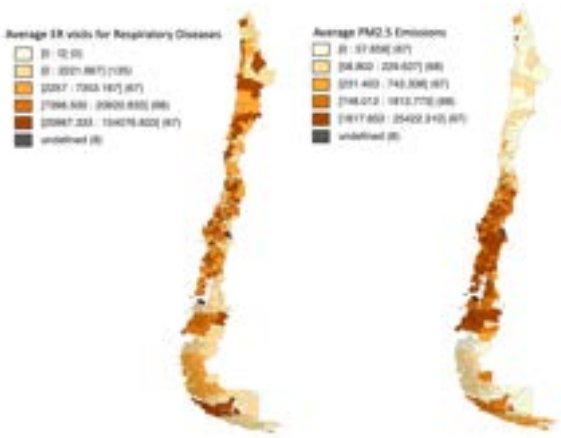
Since pollutants can be transported to geographical locations 1000 kilometers away (Bergin et al. 2005), or even to other continents (Hatakeyama et al. 2001, Liu et al. 2020), in this study we chose an inverse distance weighting scheme. Specifically, we assume that:

$$w_{ij} = \begin{cases} \frac{1}{d_{ij}^2} & i \neq j \\ 0 & i = j \end{cases}, \tag{8}$$

where d_{ij} is the distance between municipality i and j. Thus weights are given by the reciprocal of the distance, such that the larger the distance between municipalities, the lower the spatial connection.

Instead of using the inverse of the distance, as Chen et al. (2017), we use the inverse squared-distance since we expect that the neighboring relationships are nonlinear and decline faster than proportionally to the distance. According to Kopczewska et al. (2017), this weighting scheme allows for both local and global clusters: it is global because it captures interactions between all units under the Chilean territory, and it is local because the spatial links are stronger for closer spatial units. For all the estimations, we use the row-standardized version of $\mathbf{W}$. This ensures that all weights, w_{ij}, are between 0 and 1 and facilitates the interpretation. This also guarantees that the spatial parameters are comparable between models (Anselin 2001).

In the robustness check section, we also consider the following alternative weight matrix: (1) the inverse of the distance, where the weights are given by $1/d_{ij}$, (2) the



Notes: The values represents the average over 2009-2014 period.

Figure 2: Spatial distribution of ER visits and PM2.5 emissions at municipality level.

10- and 7-closest neighbors for each municipality. We do not consider the simple binary geographic unit matrix since it is hard to argue that air pollution only affects first order neighbors. For a similar reasoning see Chen et al. (2017).

3 Data

We use a panel dataset comprising 337 municipalities in Chile over the period 2009-2014. Our main dependent variable is the yearly number of emergency room visits collected from the Statistic and Health Information Department (DEIS in Spanish) of the Health Ministry of Chile. DEIS records daily ER visits in health care facilities of the country that have an emergency service. Since pollutants have been widely associated with various diseases related to the respiratory system, we focus on ER visits due to respiratory diseases coded according to the International Classification of Diseases, 10th Revision (ICD-10).

Panel (a) in Figure (2) shows the spatial distribution of the average number of ER visits due to respiratory diseases for all ages over the 2009-2014 period. A slightly positive spatial autocorrelation can be detected: that is, there is a tendency for municipalities to be surrounded by municipalities with similar numbers of ER visits.

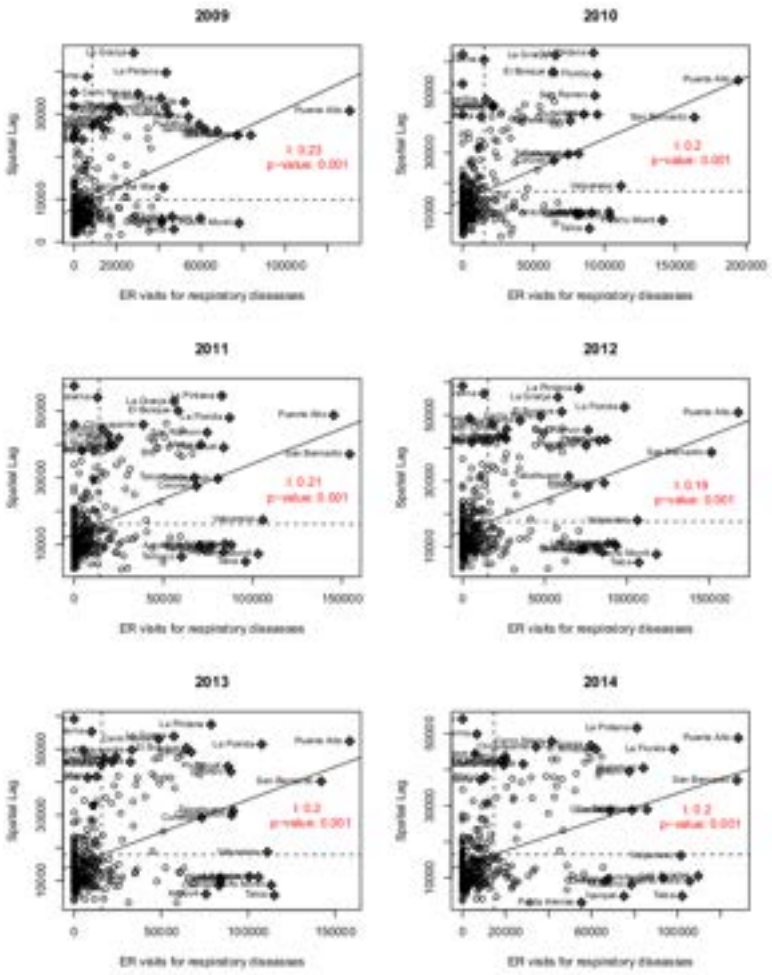
To statistically test this global spatial association, we perform a Moran's test calculated from the following formula:

$$I = \frac{n \sum_{i=1} \sum_{j=1} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{S_0 \sum_i (y_i - \bar{y})^2},$$

where $S_0 = \sum_i \sum_j w_{ij}$. Moran's I values range from -1 (perfect dispersion) to 1 (perfect correlation). Positive values indicate positive spatial autocorrelation; that is municipalities with similar values have a tendency to be spatially clustered; whereas negative values indicate negative spatial autocorrelation, that is municipalities with high (low) values tend to be surrounded by municipalities with low (high) values of y. A zero value indicates a random spatial pattern.

Figure 3, shows the the Moran's scatterplot for ER visits along with the Moran's I and the p-value for the null hypothesis of spatial randomness for each year in the sample.[3] The idea of the Moran's scatterplot is to display the variable for each municipality against the standardized spatial weight average. Therefore, the Moran's I is equivalent to the slope coefficient of a linear regression of $\mathbf{Wy}$ on $\mathbf{y}$ measured as deviation from their mean. The results reveal a moderate degree of positive spatial autocorrelation with a Moran's I fluctuating between 0.19 and 0.23. For all years, the null is rejected at the 5% level.

[3]The p-values are computed using Monte Carlo simulation with 999 rearrangement of spatial configurations.



Notes: p-values for Moran's I statistic are based on Monte Carlo simulation using 999 permutations.

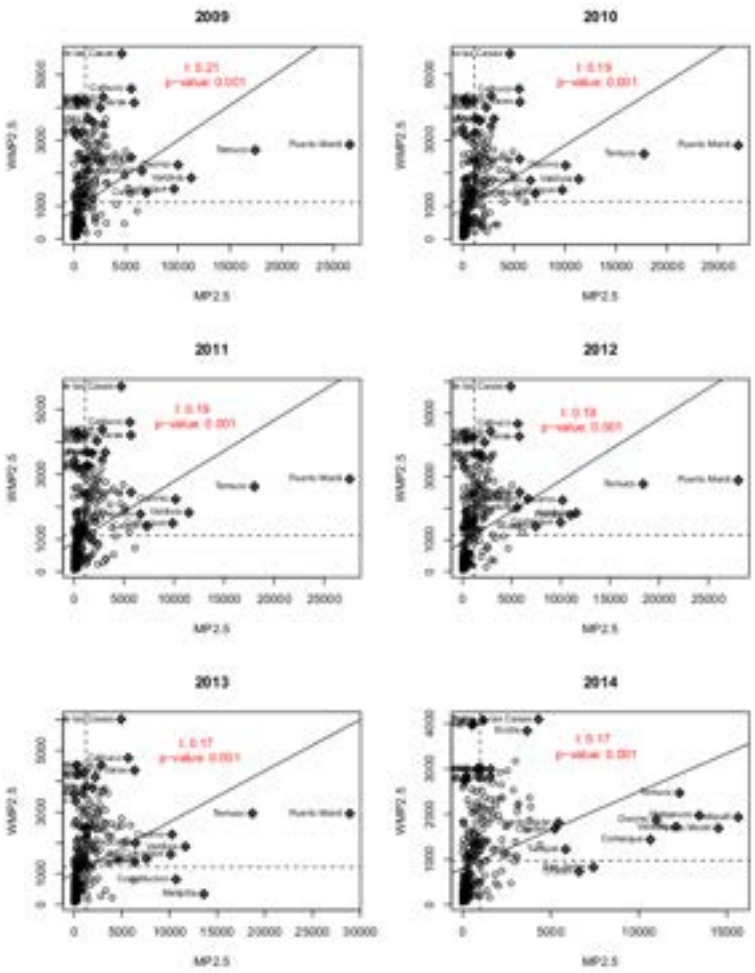
Figure 3: Moran's scatterplots for average ER visits for respiratory diseases: Moran's I test and p-value by year.

These results gives us a first insight on the adequacy of including the spatial lag of ER visits on Equation (1).

$PM_{2.5}$ emissions are obtained from the database of the Record of Emissions and Contaminant Transfer (RETC) from the Chilean Ministry of the Environment. The environmental information associated with each source is collected by different organizations with environmental competence, which in May of each year must be sent to the central node of the RETC. All the information declared through RETC comes from different sectoral systems associated with the self-reporting of point-sources discharges, in addition to the estimation of air emissions from diffuse sources (road transport, agricultural burning, forest and urban fires, and residential firewood), which then are validated and consolidated for each year.

Panel (b) of Figure 2 shows the spatial distribution of $PM_{2.5}$ emissions in tonne averaged over the period 2009-2014. A strong cluster of municipalities high emissions on central and southern part of Chile can be observed. This is further corroborated by Figure 4, which shows a significant positive spatial autocorrelation according to the Moran's I test. Importantly, Puerto Montt, Valdivia, Osorno and Temuco stand out as the municipalities with the highest levels of emissions.

Following the existing literature (e.g. Chen et al. 2017, Analitis et al. 2006, Brunekreef, Holgate 2002, Xing et al. 2016, to mention a few) and the availability of data, we control for the following variables: population, poverty rate, the expenditure on health inversion



Notes: p-values for Moran's I statistic are based on Monte Carlo simulation using 999 permutations.

Figure 4: Moran's scatterplots for average $PM_{2.5}$ emissions: Moran's I test and p-value by year.

and medical human resources, the number of ambulances, medical health facilities and medical laboratories at the municipal level. All these control variables come from the Chilean government's National System of Municipality Indicators (SINIM). The summary statistics are presented in Table 1.

4 Results

4.1 Models and diagnostic test

Although the most preferred model and estimation procedure should be selected on theoretical grounds (see LeSage, Pace 2014b, LeSage 2014, LeSage, Dominguez 2012, Golgher, Voss 2016, for further discussion), we first present several diagnostics and statistical tests for different models and methods, so that we can focus on the estimated spillover effects in the next section. In particular, we test: (1) whether a fixed effect model is more suitable than a model with random effects, 2) what type of spatial structure fits our data better; and finally (3) the ability of the instruments to deal with the potential endogeneity of $PM_{2.5}$ emissions.

Table 2 presents the diagnostic tests for different spatial panel models with FE. Each model (SLM, SDM, and GNS) is estimated by ML and S2SLS/G2SLS. The extended S2SLS/G2SLS additionally controls for the endogeneity of $PM_{2.5}$ emissions (SLM) and its spatial lag (SDM and GNS model).

Table 1: Summary Statistics

Variable	N	Mean	Std. Dev.	Min	Max
Emergency room visits for respiratory disease:					
Children < 1 year	2,022	1,298.532	2,458.911	0	20,961
Children 1-4 years	2,022	3,385.774	6,163.631	0	56,526
Adults 15-64 years	2,022	5,506.554	9,505.077	0	71,311
Adults > 65 years	2,022	890.385	1,418.220	0	8,467
All	2,022	13,964.210	24,049.280	0	194,310
Controls:					
$PM_{2.5}$ (tonne)	2,022	1,130.821	2,331.553	0	28,898.720
Poverty rate	2,022	16.288	8.055	0	50.900
Population / 1000	2,022	508.128	866.759	1.340	9,312.110
Expend. health investment	2,022	0.399	2.287	0	38
Expend. medical human resources	2,022	18.274	9.013	0	82.610
Number of ambulances	2,022	2.202	1.861	0	12
Number of health facilities	2,022	0.790	1.513	0	12
Number of medical laboratories	2,022	0.334	0.521	0	4
Instrument:					
Number of vehicles	2,022	11,172.770	17,798.620	0	118,830

Notes: Expend. ... Expenditures. All variables are computed at municipal level.

To discriminate between the FE and RE model, we performed a Hausman test under the null of no systematic difference between the two set of estimates for the three models considered: SLM, SDM and GNS model. For each of them, we strongly reject the null hypothesis with a χ^2 test statistic equal to 1317, 271 and 704, respectively. Thus, the FE is the preferred model based on both theoretical and statistical reasoning.

We also performed Wald tests for testing whether $\rho = 0$ and/or $\lambda = 0$ across all models and estimation procedures. Looking at Table 2, it can be observed that ρ is positive and highly significant across all models revealing a positive spatial dependency of ER visits and corroborating the Moran's test results, except when the GNS is estimated by ML. According to Elhorst (2014), the GNS model usually tends to overparameterize the spatial relationship, resulting in low z-values of the coefficients. Thus, the lack of statistical significance of λ, together with the erratic behavior of ML estimates, lead us to discard the GNS model in the following sections in pursuit of a more parsimonious model.

Next, we focus on the selection of the spatial structure following the strategy suggested by LeSage, Pace (2009) and Elhorst (2010). Starting with the SDM model, we can apply some restrictions to analyze whether the SLM or SEM model fits our data better. Consider a SDM model by assuming that $\lambda = 0$ in Equation (1), and the following restrictions:

$$\begin{aligned} H_0^1 :&\delta = 0, \\ &\theta_k = 0, \quad \forall k = 1, ..., K, \end{aligned} \tag{9}$$

and

$$\begin{aligned} H_0^2 :&\gamma + \delta\rho = 0, \\ &\theta_k + \beta_k\rho = 0 \quad \forall k. \end{aligned} \tag{10}$$

If (9) is not rejected, then the SDM can be reduced to the SLM. If (10) holds then the SDM can be reduced to the SEM. If both restrictions hold, then the SDM is equivalent to a non-spatial panel model (LeSage, Pace 2009, Elhorst 2010). Table 2 shows that all tests point towards a SDM model: both tests are strongly rejected, except for the extended S2SLS model where H_0^2 is rejected at the 10% level. These results indicate that, in general, the fixed-effect SDM model outperforms the SLM and SEM model, even though we are considering a relatively short period of time.[4]

[4] Elhorst (2014) argues that it is often difficult to reject H_0^1 when using cross-sectional data or panel data over a relatively short period of time.

Table 2: Tests for model specification and instruments

Method:		ML			S2SLS/G2SLS			Extended S2SLS/G2SLS	
Model:	SLM	SDM	GNS	SLM	SDM	GNS	SLM	SDM	GNS
Hausman test: FE vs RE	1316.800	270.700	703.820						
(χ^2 statistic and p-value)	0.000	0.000	0.000						
H_0^1*: SDM vs SLM*		105.010	109.400		119.380	89.084		104.050	96.693
(χ^2 statistic and p-value)		0.000	0.000		0.000	0.000		0.000	0.000
H_0^2*: SDM vs SEM*		163.640			151.210			14.845	
(χ^2 statistic and p-value)		0.000			0.000			0.062	
$\widehat{\rho}$	0.310	0.273	-0.069	0.220	0.201	0.121	0.231	0.203	0.142
Wald test $\rho = 0$	144.080	103.030	1.909	44.993	34.373	7.748	47.095	33.375	9.608
(χ^2 statistic and p-value)	0.000	0.000	0.167	0.000	0.000	0.005	0.000	0.000	0.002
$\widehat{\lambda}$			0.685			0.012			0.022
Wald test $\lambda = 0$			247.530			1.700			1.645
(χ^2 statistic and p-value)			0.000			0.722			0.511
Hausman test of regressors exogeneity							60.300	10.390	10.390
(χ^2 statistic and p-value)							0.000	0.000	0.000
Test of instruments relevance									
$PM_{2.5}$							115.000	31.830	31.830
F statistic and p-value							0.000	0.000	0.000
Spatial lag of $PM_{2.5}$								232.160	232.160
F statistic and p-value								0.000	0.000
Sargan-Hansen test of instrument orthogonality							10.672	22.991	27.982
(χ^2 statistic and p-value)							0.223	0.083	0.083

Notes: The additional pre-determined variables (instruments) for $PM_{2.5}$ and its spatial lag are vehicles and its first and second spatial lag. The Extended S2SLS/G2SLS controls for the endogeneity of $PM_{2.5}$ (SLM) and its spatial lag (SDM and GNS model). The Hausman test of regressors exogeneity and the test of instruments relevance (power of instruments) are the same for the SDM and GNS model. All test where performed under the FE model, except for the Hausman test for the comparison between FE and RE model.

Now we turn our attention to the analysis of models using additional instruments (Extended S2SLS/G2SLS). The over-identifying restrictions tests gives a Hansen-Sargan test statistics equal to $\chi^2_2 = 10.672$, $\chi^2_1 = 22.991$ and $\chi^2_1 = 27.982$ for the SLM, SDM and GNS model, respectively. The p-value for the SLM model (p-value = 0.223) indicates that the orthogonality conditions hold strongly, whereas the results for the SDM and GNS model (p-value = 0.08) indicate that we cannot reject the null at the 5% level. Regarding the power of the additional pre-determined variables (cars, and its first and second order lag), we find that the joint F statistics from the first-stage are sufficiently large in both the SLM and SDM model to reject the null that the instruments are weak. Finally, the Hausman test of regressors exogeneity allows us to reject the null that $PM_{2.5}$ (in the SLM) and both $PM_{2.5}$ and $WPM_{2.5}$ (in the SDM) are not correlated with the error term, suggesting that both variables are indeed endogenous.

In summary, statistical tests cast doubt on the suitability of the GNS model and favor the SDM model. There is also strong evidence that the RE model's estimates are inconsistent. Finally, the tests carried out show that: (1) both $PM_{2.5}$ emissions and their spatial lag are endogenous[5]; (2) the instruments used have sufficient power; and finally (3) there is moderate evidence that the instruments are valid.[6]

4.2 Spillover effects of PM2.5 emissions on ER visits

Given that our main interest is in spatial spillover effects, we report the direct, indirect and total effects of $PM_{2.5}$ emissions on the number of admissions to ERs due to respiratory diseases.[7] The models' point-estimates are presented in Table A.1.

Table 3 shows the average cumulative direct, indirect and total effect of $PM_{2.5}$ for the SLM and SDM models using the spatial panel FE estimator.[8] To show the consistency of the results, we also report the average effects using the ML, S2SLS and the extended S2SLS method. The standard errors in all the specifications and models are computed simulating the distribution of the direct and indirect effects using the estimated asymptotic variance-covariance matrix as proposed by LeSage, Pace (2009). In particular, we use 50,000 simulated parameter drawn from the multivariate normal distribution and compute Equations (5) and (7) using the following Leontief approximation: $(\mathbf{I}_{NT} - \rho(\mathbf{I}_T \otimes \mathbf{W}))^{-1} \approx \sum_{i=0}^{\infty}(\rho\mathbf{W})^i$.

It is important to recall that these average effects should be interpreted as the changes in ER visits that would take place in the long-run as all changes—due to the simultaneous changes in the $PM_{2.5}$ emissions and ER visits—reach a new equilibrium (see Elhorst 2014).[9] These cumulative effects measure the average impact on all municipalities that arise from changes in the $PM_{2.5}$ emissions in each spatial unit.

Considering either the ML or S2SLS estimates, the direct and indirect effects of $PM_{2.5}$ emissions show the expected positive sign when the SLM or SDM model are fitted to our data. Both models show very similar direct effects, whereas the indirect effects are lower when the S2SLS method is used (columns 2 and 3). Another noticeable difference is that the average indirect effect is statistically insignificant when they are obtained from the SLM model.

When endogeneity of $PM_{2.5}$ is taken into account (columns 5 and 6), the results reveal interesting findings. First, the indirect effects of the SDM model become significant at the 10% (p-value = 0.08). Second, the average effects are higher when both $PM_{2.5}$ and its spatial lag are instrumentalized. For example, considering just the total (LATE) effects,

[5]However, this result depends on the validity of our instruments

[6]Since we fit an overidentified model, it is important to highlight that rejection of over-identification tests does not mean that instruments are invalid as all could be valid but give different compliers populations.

[7]The partial changes of the rest of the variables are available upon request

[8]All the estimations were carried out using the splm package in R (Millo, Piras 2012).

[9]As suggested by one of the reviewers, we also estimated a Dynamic SDM with FE assuming that $PM_{2.5}$ is exogenous as in Elhorst (2014). The results (available upon request) show that the point-estimate for ρ is 0.379, which is higher than our estimates in A.1. The point-estimate for $\mathbf{W}\mathbf{y}_{t-1}$ is negative and significant, indicating that an increase in ER visits in neighboring municipalities in the previous year reduces ER visits in each municipality in the current year. The point-estimates for $PM_{2.5}$ and $WPM_{2.5}$ are not significant, which casts doubt as to the exogeneity of air pollution.

Table 3: Effects of $PM_{2.5}$ on ER visits due to respiratory diseases

	ML		S2SLS		Extended S2SLS	
Effects	*SLM*	*SDM*	*SLM*	*SDM*	*SLM*	*SDM*
Direct	1.857	2.164	1.812	2.169	1.837	3.379
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Indirect	0.816	0.875	0.503	0.606	0.543	1.782
	(0.000)	(0.107)	(0.000)	(0.268)	(0.001)	(0.088)
Total	2.673	3.038	2.315	2.775	2.380	5.161
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: These results should be interpreted as the average impact of increasing $PM_{2.5}$ in one tonne on the number of ER visits due to respiratory diseases. The effects are computed using the estimated coefficients from a FE model. The Extended S2SLS method controls for the endogeneity of $PM_{2.5}$ (SLM) and its spatial lag (SDM). The estimated partial effects are computed using the 50,000 draws from the estimated asymptotic variance-covariance matrix of the coefficients as proposed by LeSage, Pace (2009). Simulated p-value in parenthesis.

the SDM estimates under the Extended S2SLS are 86% (5.161 vs 2.775) higher than the S2SLS estimates. Since the emissions are self-reported, this result suggests that a measurement-error problem might exist, implying that ignoring the endogeneity of air quality may lead to underestimating the total effects.

Considering the extended S2SLS estimates, the average estimates imply that increasing $PM_{2.5}$ emissions has a positive direct, indirect and total impact on the ER visits. The positive direct effect indicates that an increase in own-$PM_{2.5}$ emissions is associated with increased ER visits due to respiratory diseases. The magnitude of the effect also indicates that a one tonne increase in $PM_{2.5}$ emissions is associated with an increase of 3.4 ER visits, on average, considering the potential feedback effects. In other words, an increase of about 1000 tonnes (the average of emissions in the sample) would imply that ER visits would increase by about 3,400, on average. Since the coefficient for $PM_{2.5}$ is 3.359 and the direct effect is 3.379, the feedback effect amounts to 0.0204.

The indirect effects are found to be 0.543 (SLM) and 1.782 (SDM), respectively, accounting for approximately 23% and 35% of the total effect. This difference between the SLM and SDM can be explained by two factors. First, the SDM also includes local average effects. Second, the SLM has the restriction that the ratio between the indirect and direct effects is the same for every explanatory variables. Thus, the SLM might be unnecessarily rigid to model spillover effects adequately (Elhorst 2010). The positive indirect effects show that, on average, increasing $PM_{2.5}$ emissions in municipality i leads to higher ER visits not only in that municipality itself but also in that of its neighboring municipalities. Taking into consideration the SDM estimates, an increase of one thousand tonnes in $PM_{2.5}$ emissions in a municipality leads to an increase of 1,728 ER visits of all its neighboring municipalities due to respiratory diseases.

Summarizing, our results show that $PM_{2.5}$ emissions have a significant negative effect on public health. Furthermore, the direct, indirect and total effects of air pollution can be underestimated when endogeneity is not taken into account. Moreover, and unlike Chen et al. (2017), we found that the direct effects are larger than the indirect effects. Using the estimates from our preferred model, we find that about 65% of total PM2.5-related emergency room visits in Chile are due to $PM_{2.5}$ emissions generated in the same municipality, whereas the remaining 35% can be attributed to pollutants emitted in a different spatial unit.

4.3 Policy implications

What are the economic impacts of $PM_{2.5}$ emissions on ER health facilities? Although knowing the impacts of air quality on public health and its spillover effects is useful, it would also be interesting to translate these estimates into terms of monetary costs. Considering that the cost per person in ER services is approximately USD 55, our average estimates from the SDM model imply that an increase of one thousand tonnes in $PM_{2.5}$

emissions in all municipalities would produce an average annual cost of USD 283,855 (approximately 20% of the municipalities' average annual health expenditures), holding other factors constant, from which USD 98,010 (35%) corresponds to spatial spillover effects.

The previous figures represent the expected average effects on monetary costs and ER visits if all municipalities increased their $PM_{2.5}$ emissions by one tonne. However, policy makers might be interested in applying a certain policy to reduce $PM_{2.5}$ emissions in those municipalities with a greater potential impact. A potential solution would be to select the municipality with the greatest total impact, such that resources are spent in the most efficient way after considering both spatial spillover and feedback effects.

To find such municipalities, we compute the total impact from an observation (Kelejian et al. 2006, LeSage, Pace 2009, Anselin, Le Gallo 2006, Golgher, Voss 2016), which is computed as the sum across the jth column of $\mathbf{G}_p$. Each of these j-values represent the total impact over all municipalities' ER visits from increasing the $PM_{2.5}$ emissions by one tonne in the jth municipality.

Figure 5, shows the ranking of the first 20 municipalities with the highest total impact using the estimates from the SDM. Panel (a) and (b) shows the total impact from each municipality assuming that $PM_{2.5}$ emissions are exogenous and endogenous, respectively. The first important result is that the spillover effects emerging from each municipality are larger when we control for the endogeneity of $PM_{2.5}$ emissions, which is in line with the results from the previous section. For example, the effects emanating from San Ramón municipality is approximately 7.4: twice as high as the effects when $PM_{2.5}$ emissions are considered exogenous. This is because the effects depend on the strength of the spatial dependence measured by ρ, and the magnitude of the parameters γ and δ in Equation (1). These parameters are higher when controlled by the potential endogeneity of air pollution; especially γ and δ (see Table A.1).

Considering the cost per person in ER services, reducing $PM_{2.5}$ emissions in San Ramón municipality by about one thousand tonnes would imply an average annual cost reduction of about USD 407,000 considering both the effects in the same municipality and the spillover effects. This cost reduction would be USD 357,500 if the same policy with the same expected result in terms of emissions reduction is applied to the municipality of Cerrillos.

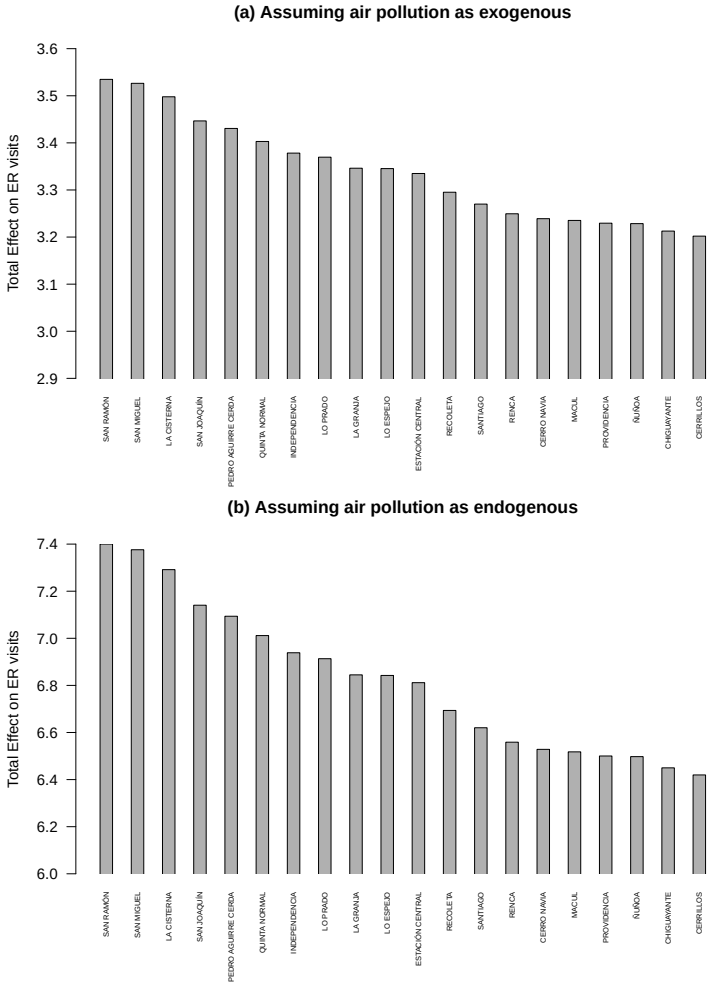
A surprising result is that the municipality with the highest total impact is not that with the highest level of emissions. In fact, all the municipalities in Figure 5 belong to the Metropolitan Region, which captures around 40% of the total Chilean population and is located in the center of the country. However, it should be noted that the magnitude of the spatial spillovers also depend on the position of the municipality in space and the degree of connectivity among municipalities represented by $\mathbf{W}$ (LeSage, Pace 2009).

5 Robustness checks

In this Section, we provide two additional robustness checks to previous results. First, we examine the sensitivity of the marginal impacts to variants of $\mathbf{W}$. Then, we analyze whether heterogeneous effects exist in the relationship between $PM_{2.5}$ and ER visits considering different age-groups. Finally,

Table 4 shows the direct, indirect and total effects using the following spatial weight matrices: (1) inverse-distance, (2) 10-nearest neighbors, and (3) 7-nearest neighbors. Column (4) provides a specification where $\mathbf{WX}$ and $\mathbf{Wy}$ are modeled using the squared-inverse distance (dense) matrix and 10-nearest neighbors (sparse) matrix, respectively. This latest specification is intended to limit the spatial scope of ER visits to municipalities nearby, while at the same time allowing PM2.5 to have more far-reaching local spatial effects. The estimates come from a SDM model with fixed effects using the extended S2SLS method.

The average direct effects are very close among the different spatial connectivity structures, ranging from 2.78 to 3.76, and highly statistically significant. These estimates are also similar to our preferred model (column 6 of Table 3). Thus, the marginal direct impacts are not overly sensitive to alternative weight matrices.



Notes: This graph shows the first 20 municipalities with the highest total impacts using the estimates from the SDM model. The impacts are computed as the sum across the jth column of $\mathbf{G}_p$

Figure 5: Municipalities that generates the higher total impacts.

On the other hand, the indirect effects are more sensitive to spatial structure. The magnitudes are greater when more dense matrices are considered. For example, the average indirect effects using the inverse-distance matrix is 3.074 and statistically significant at 5%, which is greater than the indirect effect using the squared inverse-distance matrix. This result is expected since the inverse matrix does not assume that the neighboring relationship declines faster than proportionally, so that it captures global effects more than local ones. The 10-nearest neighbors matrix produces an average indirect effect closer to the SDM model using the squared-inverse distance, but it is estimated with less precision. Finally, the spillover effects are reduced significantly when the 7-nearest neighbors matrix is assumed. These results agree with the LeSage, Pace (2014a)' results in the sense that the indirect effects for models considering more neighbors are generally higher and that the marginal direct impacts should not be too sensitive to the spatial connectivity imposed.

We also use the J-test proposed by Kelejian, Piras (2016) for panel models. It is important to emphasize that, although informative, the J-test was not developed in the context of spatial models with additional endogenous variables. The model under the H_0 is our SDM-extended S2SLS in Table 3, whereas the alternative models H_1 are those estimated in each column of Table 4. At the 5% level, the J test is not able to reject the model under the null since the Chi-squared variables are lower than the critical value 3.841. These results corroborate previous studies showing that matrices based on

Table 4: Sensitivity of partial effects to different spatial weight matrices

	Inverse distance	10-nearest neighbors	7-nearest neighbors	10-nearest neighbors & squared-inverse distance
Direct	3.222	3.239	3.761	2.777
	(0.000)	(0.000)	(0.000)	(0.000)
Indirect	3.074	1.607	0.479	2.321
	(0.010)	(0.110)	(0.649)	(0.008)
Total	6.295	4.846	4.239	5.098
	(0.000)	(0.000)	(0.000)	(0.000)
J-test (χ^2_1)	2.662	3.342	2.982	3.328

Notes: These results should be interpreted as the average impact of increasing $PM_{2.5}$ in one tonne on the number of ER visits due to respiratory diseases. The effects are computed using the estimated coefficients from a SDM model with fixed effects using the Extended S2SLS method. The estimated partial effects are computed using the 50,000 draws from the estimated asymptotic variance-covariance matrix of the coefficients as proposed by LeSage, Pace (2009). Simulated p-value in parenthesis.

Table 5: Effects of $PM_{2.5}$ on ER visits due to respiratory diseases for age-groups

	$<$ 1 year		1-4 years		15-64 years		$>$ 64 years	
Effects	*SLM*	*SDM*	*SLM*	*SDM*	*SLM*	*SDM*	*SLM*	*SDM*
Direct	0.210	0.455	0.488	1.015	0.594	0.924	0.136	0.241
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Indirect	0.089	-0.013	0.140	0.111	0.162	1.230	0.055	0.031
	(0.001)	(0.936)	(0.001)	(0.695)	(0.003)	(0.002)	(0.000)	(0.667)
Total	0.299	0.442	0.628	1.126	0.755	2.154	0.191	0.272
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: These results should be interpreted as the average impact of increasing $PM_{2.5}$ in one tonne on the number of ER visits due to respiratory diseases. The effects are computed using the estimated coefficients from a SDM-FE model using the Extended S2SLS method. The estimated partial effects are computed using the 50,000 draws from the estimated asymptotic variance-covariance matrix of the coefficients as proposed by LeSage, Pace (2009). Simulated p-value in parenthesis.

distance perform better than more restrictive spatial connectivity matrices when it comes to modeling the spillover effects of air pollution (see for example Cheng et al. 2017, Chen et al. 2017).

The literature shows that the effects of $PM_{2.5}$ on health are heterogeneous. For example, individuals with pre-existing lung or heart disease, as well as elderly people and children are particularly more vulnerable to air pollutants. To analyze the potential heterogeneous effect of $PM_{2.5}$ on ER visits, we re-estimate the SDM model by the extended S2SLS using the ER visits of: infants, children aged 1-4, adults aged 14-64 and adults age 64 and over as the dependent variable.

Looking at Table 5, we can observe that for all age groups, the total average effects are positive and highly significant: a one thousand tonne increase in $PM_{2.5}$ would increase ER visits of infants, children aged 1-4, adults aged 14-64 and adults age 64 and over by about 442, 1126, 2154 and 272, respectively, under the SDM model. These findings corroborate previous findings for Chile (Sanhueza et al. 2009, Cakmak et al. 2007, Ostro et al. 2008). With regards to the average indirect effects, substantial spillover effects are only found for adults aged 14-64 and children aged 1-4, but are only significant for the former. Therefore, the findings from column 6 of Table 3 are mainly driven by adults aged 14-64.[10]

[10]One of the reviewers suggested that our instruments (the number of vehicles and their spatial lag) might be correlated with variables such as car accidents and the level of urbanization. Given this concern, we re-estimated our Extended S2SLS model including the number of ER visits due to car accidents and its spatial lag as additional covariates, along with density (as a proxy for urbanization) and its spatial lag to control for urbanization. The results (available upon request) show that the point-estimates for ρ and $PM_2.5$ are reduced, whereas the estimate for $WPM_{2.5}$ increases and turns out significant.

6 Conclusion

$PM_{2.5}$ has been considered one of the most dangerous pollutants to human health due to its ability to penetrate deeply into lungs and bloodstream, causing various diseases related to the respiratory and circulatory system. Furthermore, the literature has shown that this pollutant has the ability to travel large geographical distances, producing negative effects on public health not only in the city where the pollution is emitted, but also in more distant cities. Not taking into consideration these spillover effects might lead to under- or overestimation of the effects of environmental or economic policies that are spatially blind.

In this paper, we contribute to the empirical literature on the effects of air pollution on public health by quantifying the direct and indirect effects of $PM_{2.5}$ emissions on emergency room visits due to respiratory disease in Chile. To do so, we use different spatial panel models and methods for 337 municipalities over the period 2009-2014. To give more accurate estimates of the effect of air quality on public health, we use an instrumental variables approach using the number of vehicles in each spatial unit as exogenous variability.

Our results provide evidence that the marginal partial effects are downward-biased when not controlling for the potential endogeneity of air pollution. This result supports both that emissions may be measured with error or that there may be omitted variables that are negatively correlated with municipal emissions. According to our results, the bias is higher for the average indirect effects than the direct effects: the average direct and indirect effects are respectively 1.5 and 3 times lower when $PM_{2.5}$ emissions are considered as exogenous. Assuming both that our instruments are valid and that a high proportion of municipalities are compliers, our results suggest that estimates based on traditional spatial panel data are likely to be misleading.

In addition, the magnitude of our preferred model indicates that increasing $PM_{2.5}$ emissions by one thousand tonnes would imply, on average, a total increase of approximately 5161 ER visits due to respiratory diseases, holding time-invariant idiosyncratic effects and other relevant factors constant. Of this total (LATE) change, 1782 ER visits are due to the spillover effects, which represents 35% of the total effect. The robustness checks show that the direct effects are relatively unvarying under different spatial weight specifications, whereas the indirect are higher and statistically significant when spatial connectivity is based on the inverse-distance between municipalities rather than limiting the spatial association to a certain number of neighbors.

When considering age-group specific ER visits, the estimated average impacts reveals that an increase of $PM_{2.5}$ emissions by one thousand tonnes would increase the ER visits of infants, children aged 1-4, adults aged 14-64 and adults age 64 and over by about 442, 1126, 2154 and 272, respectively. However, substantial spillover effects are only found for adults aged 14-64 and children aged 1-4.

Although the indirect effects are proportionally lower than the direct effects, they are still economically significant. For example, the average indirect effects of an increase of one thousand tonnes of $PM_{2.5}$ emissions yield to an increase of USD 98,010 of annual costs for ER health facilities, whereas the total costs (considering indirect and direct effects) amounts to USD 283,855. Furthermore, we show that policies that aim to reduce $PM_{2.5}$ emissions would have a greater impact (considering both direct and spillover effects) if they are applied to municipalities located in the Metropolitan Region. For example, considering the municipality that generates the highest total effects (San Ramón), reducing the $PM_{2.5}$ emissions by one thousand tonnes would imply an average annual cost reduction of about USD 407,000.

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A Appendix:

Table A.1: Spatial panel models with fixed effects

	ML		S2SLS		Extended S2SLS		ML		S2SLS		Extended S2SLS	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
$PM_{2.5}$	1.844***	(0.126)	1.806***	(0.140)	1.830***	(0.328)	2.151***	(0.138)	2.162***	(0.153)	3.359***	(0.462)
Poverty	89.856**	(36.168)	83.115***	(40.000)	82.855**	(42.960)	212.260***	(52.503)	215.940***	(58.093)	235.350***	(59.547)
City size	17.638***	(0.427)	18.054***	(0.469)	17.991***	(0.515)	17.121***	(0.432)	17.304***	(0.473)	16.250***	(0.641)
Investment on health	63.534	(122.840)	83.568	(135.655)	81.540	(135.620)	36.774	(120.370)	45.199	(133.020)	54.047	(136.120)
Investment on medical HR	-62.744*	(32.828)	-74.481***	(36.374)	-72.926***	(36.446)	-71.040**	(33.215)	-75.272***	(36.742)	-60.904	(37.722)
Number of ambulances	1537.977***	(176.516)	1569.781***	(195.263)	1570.723***	(207.288)	1115.400***	(179.460)	1107.700***	(198.500)	1249.900***	(211.470)
Number of health facilities	1129.107***	(224.754)	1216.661***	(249.924)	1204.440***	(251.475)	1276.200***	(224.940)	1322.900***	(249.540)	1141.500***	(268.150)
Number of medical laboratories	381.006	(559.349)	299.931	(618.426)	296.874	(645.975)	879.900	(553.630)	876.190	(612.230)	390.380	(636.520)
Year 2010	6316.011***	(883.623)	6306.715***	(976.726)	6308.921***	(976.008)	6876.500***	(873.340)	6837.900***	(966.000)	7006.600***	(988.270)
Year 2011	6361.261***	(912.359)	6494.853***	(1009.426)	6478.681***	(1008.575)	2424.900*	(1241.000)	2432.000**	(1372.500)	3446.100***	(1431.600)
Year 2012	7678.957***	(911.779)	7804.514***	(1008.574)	7788.076***	(1008.032)	3374.600***	(1222.800)	3400.100***	(1352.500)	4072.700***	(1400.200)
Year 2013	7828.567***	(913.128)	7932.988***	(1009.886)	7916.302***	(1011.228)	3349.800***	(1254.700)	3341.700***	(1387.600)	3911.900***	(1429.200)
Year 2014	6586.191***	(920.687)	6721.775***	(1018.455)	6704.799***	(1017.701)	1247.800	(1307.600)	1269.200	(1446.200)	2096.800	(1497.800)
Spatial Lags												
$PM_{2.5}$							0.059	(0.402)	0.056	(0.443)	0.752	(0.804)
Poverty							-113.130	(90.598)	-119.340	(100.240)	-271.680***	(110.790)
City size							3.233**	(1.649)	4.166***	(1.849)	5.021***	(2.177)
Investment on health investment							-196.900	(588.950)	-180.000	(651.400)	-210.870	(669.560)
Investment on medical HR							215.170**	(109.040)	177.290	(121.400)	165.290	(124.260)
Number of ambulances							2813.900***	(632.330)	2821.100***	(699.340)	3442.400***	(834.700)
Number of health facilities							-3933.300***	(796.370)	-4012.700***	(881.190)	-3236.400***	(916.610)
Number of medical laboratories							-8487.200***	(1996.900)	-8653.000***	(2209.900)	-13059.000***	(2478.200)
ρ	0.310***	(0.026)	0.220***	(0.033)	0.231***	(0.034)	0.273***	(0.027)	0.201***	(0.034)	0.203***	(0.032)

Notes: Robust standard errors in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$.

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Assessing press releases as a data source for spatial research

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Abstract. Describing the distribution and development of socio-economic activities in space is frequently limited due to data availability, as official statistical data sources are often restricted to specific topics and geographical scales. Consequently, new and alternative data sources are needed as complements. This paper presents, discusses, and empirically explores an example of such an alternative data source that promises to give detailed and novel insights into regions' socio-economic structures: press releases. While press releases have seen some use in the literature, they have hardly seen any applications in regional research. Consequently, it is still largely unknown to what extent their information content gives systematic insights into regional socio-economic patterns. The paper closes this gap by assessing the degree to which the content of press releases corresponds to the socio-economic characteristics of regions, by means of an empirical analysis of German NUTS-3 regions. The results confirm that press release content varies systematically between regions, and regional differences in socio-economic characteristics, events, and activities seem to be well-presented by press releases. This suggests that press releases offer substantial potential and might be a useful complementary data source in regional studies.

1 Introduction

Information on economic activities is at the heart of the empirical literature in economic spatial sciences. Unless researchers collect their own primary data, most contemporary studies rely on official secondary data sources. While the primary data collection requires massive efforts and is simply unfeasible in many situations, the use of secondary data sources implies that researchers are restricted to look at socio-economic developments using available data. This may not always give a precise representation of the phenomenon in question. Finding new data sources that capture socio-economic processes in novel ways or from new perspectives is therefore imperative to empirical research.

This imperative motivates the present study, which presents a data source that has seen some applications in the literature, yet has not been discussed nor evaluated with respect to its usefulness for spatial economic research at the sub-national level: press releases. A press release is a written statement about a matter that might be of public interest, written by an organization related to the matter. Organizations issue press releases to inform the public about noteworthy news and recent developments. Press releases contain rich and useful textual information covering a wide range of topics in domains like political (e.g., announcements by local administrations), social (e.g.,

sport and music events), and economic (e.g., updates on new products and firms). Not surprisingly, their value as a data source has been recognized for some time (Johnson, Haythornthwaite 1989, Berger et al. 2019, von Bloh et al. 2020). However, the extent to which they contain systematic information for describing socio-economic structures at the sub-national (regional) level has not been explored so far. The present paper conducts such an assessment and discusses whether press releases represent a useful data source in this context from an empirical basis. More precisely, we argue that the content of press releases is systematically shaped by regions' socio-economic structures, which in consequence allows inferences about the latter by (empirically) observing the former.

We test this argument by assessing the spatial correspondence of information obtained from geo-located press releases of Germany's biggest press release agency to that of regions' general characteristics. At the level of 401 districts (NUTS-3 regions), the study confirms that inter-regional variations in the events reported in these press releases correlate well with general socio-economic characteristics of regions. For instance, population density, income level, and touristic potential of regions are clearly reflected in the content of press releases. As there are little to no reasons for why this correlation should be systematically different for other and more specific content, our findings substantiate the promise that press releases are a complementary data source to official statistics in spatial research at the sub-national level, which is likely to capture socio-economic patterns and processes not covered by these. An example of the latter is the study by von Bloh et al. (2020) that use press releases to capture the entrepreneurial activities and sentiments towards it in regions.

The remainder of the paper is organized as follows. Section 2 discusses why press releases might be a valuable data source in spatial sciences. Section 3 presents the empirical basis for testing press releases' correspondence to regional characteristics. It outlines the data collection and cleaning process and describes the overall structure of the data set. Section 4 discusses the employed empirical set-up of the assessment. Section 5 presents the empirical results and discusses the findings. Section 6 concludes.

2 Press releases: An underutilized data source in spatial studies

In the age of big data, empirical information has been crucial for one's understanding of the world. The analysis of documented and codified facts and narratives is a crucial task in all social sciences independent of the analysis being quantitative or qualitative in nature. Frequently, it is the availability and richness of data that shapes what researchers can investigate and what perspectives they can apply. However, equally true is that all data are "biased" and "incomplete," meaning that each data set only offers a selective and particular view of the world. In sum, high-quality and reliable science requires researchers to utilize and exploit a range of distinct data sets.

This is not any different in spatial sciences, where the interest is frequently to assess, describe, and explain structural differences at the sub-national level, i.e., variations between regions. Doing this requires empirical data that provides comparable and representative pictures of what socio-economic activities are happening within regions. Unfortunately, researchers are frequently limited to the use of official secondary data sources. While the topics covered by this type of data have been greatly expanded in size and improved in quality, they still cover only specific portions of spatial socio-economic structures. For instance, information on the average value-added, unemployment, and investments are usually reliable and available in most countries as part of official statistics. They also usually exist for multiple years and at varying spatial scales. In contrast, processes like entrepreneurship, environmental initiatives, social events, types of sports conducted, etc. are less documented in official statistics (see, e.g., Stuetzer et al. 2018).[1] Yet, such activities are not less relevant. Sport is a major economic factor and this is similarly true for social activities. They both play crucial roles in the emergence and development of social networks and local cultures that facilitate knowledge diffusion, learning, and innovation, which in turn are essential for regions' long-term economic

[1] Further limitations and shortcomings of official statistics are discussed in greater length elsewhere (see, e.g., Pérez 2006, Bean 2016)

development (Hofstede et al. 2010, Gertler 1997, Saxenian 1996). Consequently, it is essential for researchers to seek and explore novel data sources that complement existing ones by either allowing for looking at the same activities and events from an alternative perspective or by capturing aspects completely outside of the scope of official statistics. These may include activities and events that are recent phenomena and hence are not yet captured by such statistics. In this case, it takes unusual approaches and greater efforts by researchers to create empirical information capturing their existence and spatial distribution.

Recent technological developments and improvements in computational methods opened new toolboxes to obtain, structure, and transform data from various alternative sources. Frequently, these sources are not originally intended to be used in this context but provide novel opportunities for spatial research nonetheless (Arribas-Bel 2014). For example, recent studies show that insights on firms' activities and their spatial interactions can be obtained from website data (Kinne, Axenbeck 2018, Kinne, Lenz 2021). Similarly, social media data, such as Twitter, allow researchers to explore topics like well-being and social attitudes. (Mitchell et al. 2013, Lansley, Longley 2016).

The present paper contributes to the literature by discussing a data source that has been around for a long time, but that has hardly seen any utilization in the spatial sciences: press releases. Press releases issued by companies (Ahern, Sosyura 2014, Henry 2008, Dahlin et al. 2006), by political parties (Senninger, Wagner 2015, Klüver, Sagarzazu 2016), by local governments (Boussalis et al. 2018), and by health organizations (Park, Reber 2010) have been valuable information sources for researchers. Although several studies indicated press releases' potential value (Feldman, Lowe 2015, von Bloh et al. 2020), they have not yet been used on a larger basis in spatial sciences.

Press releases provide important information about their issuers and their activities. In some cases, both the issuer and the event have a spatial dimension. The latter motivates the present paper, as the events reported in press releases may give insight into what is happening in specific locations. In other words, there are good reasons to suspect that information in press releases reflect regional events and activities. Given the great variety of issuers and topics, it is more than likely that they contain information on socio-economic issues.

Press releases are public statements created by governments, companies, research organizations and the like, which are delivered to inform the media and targeted audiences. In other words, press releases are *told only to be retold* (Jacobs 1999). By being one of the most important public relation tools, press releases provide journalists with crucial *raw materials*, as they are delivered regularly, reliably, and contain usable information (Walters, Walters 1992, Hong 2008, Turk 1986, Aronoff 1976). Accordingly, mass media and these information sources are in a so-called symbiotic relationship, due to reciprocity of interest and economic necessity (Herman, Chomsky 2010). Not surprisingly, studies show that the reliance of journalists on public relations statements and press releases is extensive (Erjavec 2005, Lewis et al. 2008, O'Neill, O'Connor 2008, Reich 2010, Macnamara 2014). Crucially, press releases are not news. News is a commodity that is shaped by the dynamics of supply and demand (Hamilton 2004). Since all events, people, regions, and discussions cannot be covered daily by the news media, all news outlets, e.g., local newspapers, broadcast television networks, or international news agencies, have to make decisions of what to report and what not to. The primary determinant of which events are reported is their newsworthiness (Shoemaker 2006). Newsworthiness is related to both the inherent characteristics of an event and journalists' assessments (Staab 1990, Kepplinger, Ehmig 2006, Galtung, Ruge 1965, Harcup, O'Neill 2017, Eilders 2006). From a set of potential newsworthy events, media outlets filter what is perceived to be the most newsworthy for their own audience (Boukes, Vliegenthart 2020). Even when a story is considered newsworthy, it is not automatically published. For example, on a slow news day, minor events can become news that wouldn't have been reported on a news-rich day (Gans 2004).

On the other hand, press releases are subject to just a fraction of this selection process. They do not have to be considered relevant or newsworthy for anyone but the issuer. At least in the short run, it is the issuer's urge to supply information rather than their

desire to satisfy demand. Nevertheless, it can be expected that the issuer will invest the efforts of producing a press release only if they expect some demand for it from the press or another kind of audience. In any case, press releases do not go through a similar multi-stage selection, filtering, and editorial processes as news, which is known to induce all sorts of biases (Robinson, Sparkes 1976, Kariel, Rosenvall 1984, Chang et al. 1987, Wu 2003, 2007, Himelboim et al. 2010, Segev 2015). Consequently, in contrast to news, they are much less subject to these biases built into the journalistic system. However, that doesn't mean that they are unbiased. In many instances, an individual press release is more subjective than a news piece that has made it through a more rigorous journalistic process. Crucially, their information content is limited to what the issuer wants to share, and they tend to be written in a positive tone (Maat, de Jong 2013). Not surprisingly, it is known that for press releases to become news, they need to be rewritten to match the (hopefully more objective and rigorous) editorial and stylistic requirements (Walters et al. 1994).

While the subjectivity and a potential positivity bias will translate to the regional level, when press release information is aggregated, at least the degree of subjectivity is likely to "average out" with larger numbers of (heterogeneous) issuers in a location. Indeed, this number will in many cases be larger than the number of news outlets in a region, which frequently are a much smaller and more homogeneous (in terms of education, qualification, and motivation) group, i.e., journalists. Consequently, in many circumstances, and conditional on a large number of issuers, press releases might be a more direct and less-biased information source than news. We also argue that the positivity bias is less of a problem when looking at press releases from a spatial perspective because it would need to have a distinct and systematic inter-regional variance to impact cross-regional analyses. This logic similarly applies to the sentiments of press releases, which are likely to be very positive in general, yet, it is only their inter-regional variance that matters in regional analyses. Nevertheless, they are still subject to specific selection processes implying that they are not useful information sources in all circumstances. They are less likely to give insights into negative events.

While press releases are different from news, they have a similar potential to identify regional particularities and differences. The heterogeneity of issuers and events they deem to be press release-worthy is substantial. The low effort of writing a press release makes it quite likely that events with a relatively minor level of (social) significance will show up in press releases. The non-restrictiveness of what they can inform about gives more room to heterogeneous events and activities being featured. On top of that, it is their textual nature that gives broader possibilities to extract information. In any case, the frequency with which events in specific locations are covered in press releases may give further insights into the observed or unobserved spatial distribution of the underlying events.

The purpose of this study is to unveil the potential of press releases in reflecting regional characteristics based on aggregate numbers of events reported. For this, we adopt a straightforward approach: We expect that specific categories of events found in press releases are related to specific regional characteristics. For instance, events related to economic activities are more likely to occur in regions with plenty of economic actors (banks, insurance); locations attractive to tourists are likely to feature many entertainment events, and so on. Consequently, we seek to assess the empirical fit between the frequency of events of a certain kind reported in press releases in a specific location, and general characteristics of regions obtained from official statistics that should relate to them.

3 Data

We work with a collection of press releases brought together by the *Presseportal*, a subsidiary of DPA (Deutsche Presse Agentur). DPA is Germany's leading press agency (Kleinsteuber, Thomass 2007) and the Presseportal is the largest and most popular press release portal in Germany.[2] Their services are used by more than 12,000 organizations, which are represented with their own newsrooms. The portal attracts around 20 million

[2] https://www.presseportal.de

visitors per month (Presseportal 2021). The agency operates without a clear thematic focus (except for a geographical one on Germany) and provides only minimal professional journalistic editing and selection process. This implies that the press release collection covers a wider variety of topics and events. For example, companies share their financial reports, new product announcements, innovations, new store openings; universities, research institutes, and medical associations share recent findings; local governments share new developments in their regions; local media outlets share recent local events and incidents; sports magazines share information on games and scores; political parties share statements made by their members; cultural venues share upcoming event information. In sum, the portal provides a collection of events and developments which are found worth sharing by their creators. Accordingly, we can expect this data to carry a wealth of up-to-date information on what these organizations do in specific places.

We accessed and downloaded press release data from *Presseportal* for four years (from May 2016 to May 2020). Releases were retrieved daily by using the portal's API service. In total, we downloaded 140,833 press releases. For all press releases, we recorded the title, full text, date, location, name of the issuing organization, and keywords. While this text data is generally of high quality, several steps were necessary before it could be analyzed.

First, some press releases include TV program information published by TV broadcasters. These releases usually review the content of movies and TV series implying that in most cases, they represent fictional information. Consequently, we removed them from our data.

Second, the location given in the press releases refers to the location of its issuer, which might be distinct from the location of content, i.e., where the event described in the release takes place. For example, a press release about an upcoming play in Hamburg might be assigned to Berlin as the location because the entertainment company issuing the release is located there. In the context of the present paper, we are more interested in where the event takes place. For this reason, we applied a two-step procedure to geo-locate the press release content. In the first step, we identified the names of locations mentioned in the press releases using an adapted string-matching approach based on an extensive list of location names in Germany. Given that the location names in Germany can be a combination of multiple words and some names may refer to multiple locations, we had to develop a somewhat more sophisticated string-matching approach including intensive cleaning and the use of additional information, to identify the correct locations. When present in the text, we assigned multiple locations to an individual press release. It implies that press releases are counted multiple times when the press releases are distributed across regions. The multiple counting is reasonable, as multiple locations being named in a press release is most likely due to the underlying event having place in multiple locations or multiple events being referred to. With this approach, we were able to assign 55,776 press releases to at least one location in Germany. In the second step, we assigned all press releases that did not contain location information, to the location of the issuer, as given in the original database. After the two steps, 99,984 press releases were assigned to one or more locations in Germany.[3] The assigned locations were later aggregated to the NUTS-3 level. More than 80% of all press releases were assigned to just one NUTS-3 region. Figure 1 gives a first impression of the spatial distribution of press releases.

The map reveals a strong imbalance in the geographic distribution of press releases. Of 401 districts, only one either had not been covered by press releases, or our approach could not identify any location in the region. 197 districts had been covered in less than fifty press releases, implying that they have been reported on about less than once a month, on average. The most frequently covered region was Berlin; it was mentioned 26,559 times. One-third of all press releases referred to four (of 401) regions; namely Berlin, Dusseldorf, Munich, and Hamburg, which are among the most populous German cities. Other regions shown in dark colors on the map are Cologne, Frankfurt, and Stuttgart,

[3]The remaining press releases were either issued by organizations outside of Germany or did not contain any location name in Germany. Further details on the geolocation procedure can be found in Appendix A.

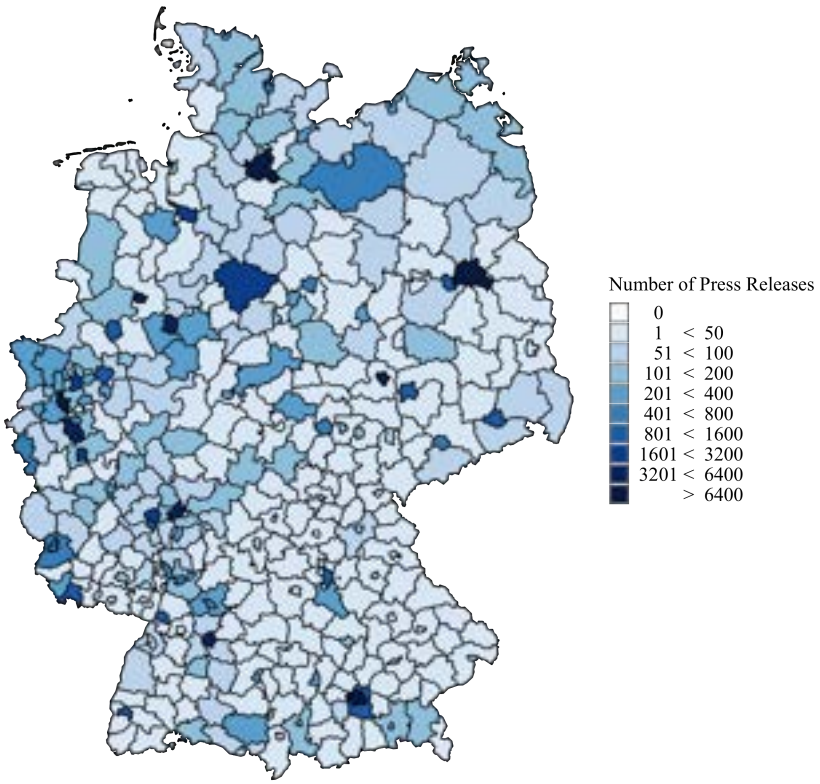

Figure 1: Spatial distribution of press releases

which are also among the largest cities in Germany. This observation does not come as a surprise. Districts with a greater population are usually the ones where larger numbers of events are taking place, and where more issuers are located. Other than this, we do not observe any strong spatial pattern such as spatial clustering, or differences between federal states. Spatial autocorrelation also appears to be largely absent.[4]

Third, there were 12,327 distinct organizations issuing press releases. Unfortunately, for these organizations, we do not have background information other than their (often incomplete) names. To get at least some idea about who they are, we manually classified all issuers with more than 100 releases, which in sum contribute about 50% of all press releases. The majority of them are firms (32%), non-profit associations[5] (25%), and newspapers (25%).[6] Future research might be able to match these names to register data, to learn more about their areas of activity, size, and type.

Fourth, press releases in the data set cover a wide variety of topics. Fortunately, the press release portal associates each press release with one or multiple keywords. In total, there are 283 distinct keywords in the dataset. On average, an article is associated with three keywords. The keywords' frequency distribution is very skewed. One-third of the keywords do not show up in more than ten press releases, i.e., they appear to be very case-specific. In contrast, some keywords are used very frequently, suggesting that the press releases seem to be simultaneously assigned to general and specific keywords. Manual inspection of a randomly selected set of press releases confirmed a good fit between the press releases' content and the assigned keywords. Figure 2 shows the frequency of the most common 20 keywords. Clearly, words associated with politics and the economic situation dominate. However, words related to tourism, health, entertainment, and sports themes are also relatively common.

Figure 3 visualizes the most frequent keyword for each NUTS-3 region to give an idea

[4] A Moran's I test for spatial autocorrelation confirms this with a test statistic −0.01 and p-value 0.67.

[5] As indicated by an "e.V." being part of their name, which applies to all formally registered non-profit organizations / associations in Germany.

[6] The coverage rate and selection of news articles issued as press releases are unknown at this stage.

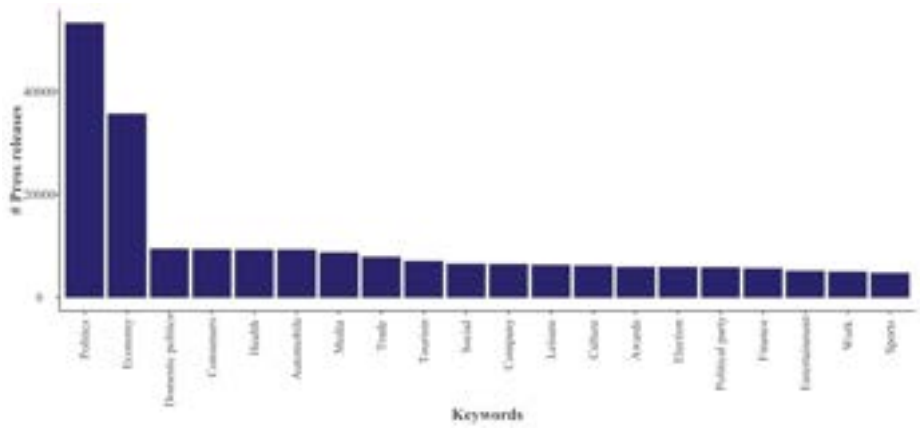

Figure 2: Most common keywords and frequency in press releases

about the keywords' distribution in space. Of 283 keywords, 13 turn out dominate in at least one district, with *economy* and *politics* being dominant in 184 and 132 districts, respectively. The distribution of general keywords does not contain insights into inter-regional differences. However, looking at less frequent keywords gives the first impression of a potential fit between press releases' content and regional characteristics. For example, the majority of press releases referring to the city of *Mönchengladbach* are categorized to the keyword *Sports*. This reflects that the city is strongly associated with its soccer team *Borussia Mönchengladbach*, which plays in the Bundesliga. Another illustrative example is *Saarlouis* for which the most frequent keyword is *Automobile*. Correspondingly, the largest employer in this town is the Ford Motor Company's body and assembly facility. These examples show how the portrayal of regions in press releases varies and how significant events and sectors shape the content of press releases linked to these places. In the following, we will explore this link in a more systematic way.[7]

4 Empirical approach

Our analysis seeks to assess the degree to which the content of press releases corresponds to the socio-economic characteristics of regions. Empirically, we test if regional characteristics explain the frequency with which events are associated with corresponding regions. In our baseline model, the total number of press releases associated with each region, *PRESS*, is the dependent variable, which is related to a set of regional socio-economic factors to assess which of these relate to the quantities of press releases. Afterwards, we estimate four more separate models in which the dependent variables correspond to the number of press releases representing specific topics (i.e., keywords). While the set of explanatory variables, i.e., the set of regional socio-economic factors remains the same in each model, it is usually one of them that is contextually most closely related and hence is expected to show the strongest empirical association with the dependent variable.

The size of regions is approximated by their population, which is denoted by *POP*. We capture urbanization with the variable *POPDENS*, which is the number of resident individuals per square kilometer. The economic success of regions is approximated by the gross domestic product per capita (*GDPC*).[8] All three variables capture the overall frequency with which events take place in regions, in general. That is, larger and more economically successful regions are likely to experience more "press-release" worthy events.

A variable that refers to a more specific regional characteristic is tourism (*TOUR*), which shows the touristic attractiveness of regions, measured by the number of overnight stays in tourist facilities per inhabitant. Straightforwardly, we expect the frequencies of press releases related to tourism and leisure to be empirically associated with this variable.

[7] The anonymized version of the dataset is available at: https://github.com/burcuozgun/grpr.

[8] All data are obtained from the statistical office of the European Union, i.e., Eurostat and *INKAR*, the interactive online atlas of the Federal Institute for Building, Urban Affairs and Spatial Development of Germany (https://www.inkar.de).

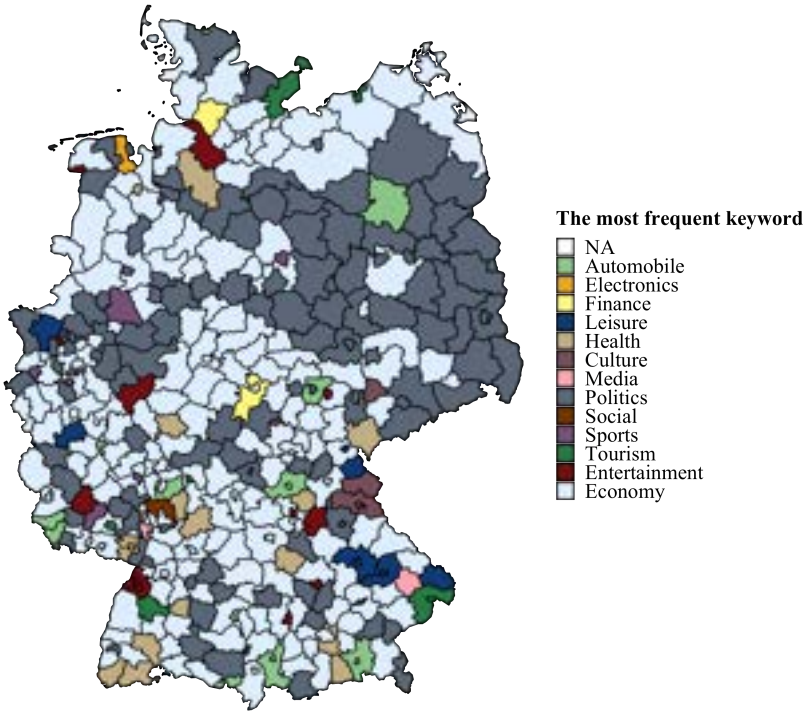

Figure 3: The most frequent keyword in each region

Peoples' interest in politics is captured by voter turnout in regions (*VOTE*). It is defined as the percentage of eligible voters that participated in the federal elections in 2017.[9] As for tourism, this variable represents a specific set of activities and consequently, should be mirrored by the frequency of political events mentioned in press releases. We also test for correspondence of the intensity of regional innovation activities and these types of events being mentioned in press releases. Innovation activities of regions are approximated by the number of patent applications (*PAT*).

To isolate the relationships between these socio-economic characteristics and press release frequencies, we consider several control variables. The first one is the dummy variable *EAST*, which has a value of one for regions in former East Germany or zero otherwise. Given the peculiar history of the two parts of Germany, these differences might be reflected in the general practice of using press releases. While we don't have direct evidence, systematic differences in journalistic activities are still known to exist (Haller 2012) and it is likely that they extend to the practice of press releases.

The German Press Agency (DPA), to which the portal providing the utilized database belongs, has 54 editorial desks distributed across Germany. We suspect that districts in which an editorial desk exists might be over-represented in press releases because they may attract more (local) issuers to utilize the portal's services. In addition, the locations of editorial desks might not be chosen randomly, but rather be proximate to important press release sources such as political agencies or newspapers. In either case, the existence of editorial desks can cause a potential bias that needs to be controlled for. We include the dummy variable *EDESK*, which is one for districts in which the DPA has an editorial desk or zero otherwise. Lastly, we include the number of press release issuing organizations (*ISSUERS*) to correct for some regions having larger numbers due to more organizations being active issuers. Descriptive statistics of these variables are presented in Tables 1 and 2.[10] The bivariate correlations are reported in Table B.1 in Appendix B.

Our dependent variable, the number of press releases (in general, or concerning a

[9]Ideally we would like to have a more direct measure of political engagement, like the number of people being members of political parties. However, such data is currently missing.

[10]The total population count refers to the year 2020; the gross domestic per capita and population density refer to the year 2019; voter turnout is recorded for the federal elections in 2017; and the information on touristic overnight stays is the most recent one available, which is 2015.

Table 1: Descriptive statistics

	PRESS	ISSUERS	POP	POPDEN	GDPC	VOTE	TOUR	PAT
#Obs	401	401	401	401	401	401	398	399
#Null	1	1	0	0	0	0	0	0
#NA	0	0	0	0	0	0	3	2
Min	0	0	3,4193	36	0.02	63.10	0.40	0.58
Max	26,881	2,696	3,669,491	4,767.30	0.18	84.10	43.60	824.38
Mean	340.10	71.86	207,398.28	546.39	0.04	75.08	5.48	56.87
Median	49.00	27.00	154,899	200.60	0.03	75.30	3.40	31.28
Std.dev	1632.02	203.06	245,162.41	723.15	0.02	3.80	6.28	82.69

Table 2: Descriptive statistics for categorical variables

Variable	Levels	# Obs	%
EAST	1	77	19.2
	0	324	80.8
	All	401	100.0
EDESK	1	54	13.5
	0	347	86.5
	All	401	100.0

particular keyword), is a count variable. This suggests the use of generalized linear models. Since the variable is characterized by an over-dispersion, we employ a negative binomial distribution.[11] We do not detect any issues of spatial autocorrelation in our models.[12] In the regression analyses, we include all variables representing shares or rates in their original form. Variables measuring absolute numbers are log-transformed to reduce the effect of potential outliers.

We run separate models for different categories of press releases. These categories are selected among the most frequent keywords, based on the availability of secondary data at the district level for which a fit with the keyword can be expected. The subset of press releases related to economic events is given by the dependent variable *ECON*. It denotes the number of press releases assigned to keyword *Economy*. The second category considered is politics (dependent variable: *POL*), for which press releases are considered that are associated with the keyword *Politics*. In both cases, we expect the population variables and income level to show a significant relation. The third subset is the press releases assigned to the keyword *Tourism*, (dependent variable *TOURM*), which is hypothesized to correlate with the touristic attractiveness of regions. The same is true for the fourth subset that comprises press releases associated with the keyword *Leisure*, (dependent variable *LEISR*). We expect districts with a larger population, higher population density, and larger tourist facilities to host a larger number of events and thus be mentioned with leisure-related press releases. Lastly, in the fifth subset, we consider press releases related to technological events. The dependent variable TECH denotes the number of press releases associated with the keyword *Technology*. We expect a larger number of technology-related press releases in regions where gross domestic product per capita and patent applications are higher, as these are commonly associated with the frequency of science and technology events (Balland et al. 2020).[13]

[11] A χ^2 test based on the models' residual deviance indicates the Poisson distribution does not fit. This is further substantiated with a likelihood ratio test for over-dispersion.

[12] Lagrange multiplier test statistic for the error model is 1.820 with a p-value of 0.177 and the test statistic for the spatial autocorrelation model is 0.407 with a p-value of 0.523.

[13] The correlations between the count of press releases in the given categories and regional socio-economic variables are given in Table C.1 in Appendix C.

Table 3: Determinants of visibility in press releases

	PRESS (1)	ECON (2)	POL (3)	TOURM (4)	LEISR (5)	TECH (6)	TECH (7)	TECH (8)
EDESK	0.851***	0.617***	1.571***	0.002	0.164	-0.443*	-0.456*	-0.456*
	(0.109)	(0.126)	(0.182)	(0.239)	(0.156)	(0.213)	(0.213)	(0.217)
log(ISSUERS)	1.044***	0.950***	1.394***	1.472***	1.120***	0.952***	0.977***	1.029***
	(0.045)	(0.054)	(0.078)	(0.109)	(0.072)	(0.108)	(0.108)	(0.106)
log(POP)	-0.138	0.173	-0.439**	-0.497*	-0.251	0.335	0.193	0.041
	(0.090)	(0.107)	(0.152)	(0.205)	(0.137)	(0.205)	(0.191)	(0.175)
log(POPDEN)	0.132**	0.099*	-0.003	0.133	0.136*	0.119	0.051	0.128
	(0.042)	(0.050)	(0.072)	(0.098)	(0.065)	(0.100)	(0.094)	(0.088)
log(GDPC)	0.304*	0.295*	-0.011	0.321	0.237	0.605*	0.559*	
	(0.124)	(0.145)	(0.209)	(0.279)	(0.185)	(0.257)	(0.255)	
VOTE	-0.031**	-0.010	-0.109***	-0.036	-0.022	0.056*		
	(0.012)	(0.014)	(0.020)	(0.027)	(0.018)	(0.026)		
TOUR	-0.002	-0.016*	-0.016	0.081***	0.025**	-0.006	-0.005	-0.0001
	(0.005)	(0.006)	(0.009)	(0.011)	(0.008)	(0.014)	(0.014)	(0.013)
log(PAT)	0.044	-0.048	0.114	0.086	0.101	0.119	0.287**	0.371***
	(0.057)	(0.068)	(0.096)	(0.132)	(0.089)	(0.137)	(0.110)	(0.104)
EAST	-0.129	-0.343**	-0.067	-0.186	-0.019	0.589**	0.549*	0.465*
	(0.098)	(0.117)	(0.164)	(0.224)	(0.149)	(0.216)	(0.215)	(0.218)
Constant	4.720***	-0.930	10.934***	4.501	1.881	-10.934***	-5.422**	-6.381***
	(1.366)	(1.620)	(2.315)	(3.139)	(2.098)	(3.203)	(1.847)	(1.842)
Observations	396	396	396	396	396	396	396	396
R^2 McFadden	0.208	0.225	0.199	0.172	0.206	0.266	0.262	0.259
R^2(Linear)	0.307	0.312	0.206	0.413	0.446	0.302	0.300	0.298
Max VIF	5.38	5.45	5.46	5.54	5.59	6.01	4.23	3.42
Log Lik.	-1,994.679	-1,536.445	-1,531.040	-1,006.969	-1,059.938	-522.546	-524.914	-527.220
θ	3.122***	2.463***	1.148***	0.733***	1.852***	1.773***	1.753***	1.647***
AIC	4,009.357	3,092.890	3,082.080	2,033.939	2,139.877	1,065.093	1,067.828	1,070.439

Note: Numbers in parentheses are standard errors of coefficients.
*p<0.05; **p<0.01; ***p<0.001

5 Results and Discussion

The regression results are reported in Table 3. Model (1) of Table 3 shows our baseline model that relates the total number of press releases to all regional characteristics. Two of our control variables are strong predictors of the number of press releases. Regions where editorial desks of the press agency (DPA) are located (EDESK) are more likely to appear in press releases. Apparently, they either attract additional press release activities or are in regions where there are more events to report. Since we control for the number of press release issuing organizations (ISSUERS), which also obtains a significantly positive coefficient, EDESK does not capture the presence of many press release issuing organizations. This suggests that editorial desks rather motivate proximate organizations to be more active in this respect. In any case, the findings suggest that the location of editorial desks and the number of press release issuing organizations in the regions as well as the underlying processes need to be taken into consideration when working with press release data in a spatial context.

In addition, we find regions with higher population density, i.e., urban regions, to be mentioned more in press releases. Accordingly, it is urbanization that translates into more events taking place and eventually getting featured in press releases. Crucially, this effect materializes despite the consideration of the number of press release issuers (ISSUERS) and the total population (POP) in the models. It implies that it is not a size, but a (social) density effect that becomes visible in the number of press releases. GDPC also obtains a significantly positive coefficient. It confirms our predictions that more prosperous regions are more likely to host a larger number of events. From this general analysis, it is unclear to what extent the availability of greater economic resources to initiate and organize events drives this finding. We must leave this to future research.

We observe a statistically significant and negative relationship between press release frequency and voter turnout (VOTE), which does not meet our expectations, as we expected voter turnout to be positively correlated to the number of political events taking place in a region which should translate into more press releases. As the subsequent analysis will show, this argumentation seems to be far from reality.

In addition to the variables for which we find a statistically significant relationship, it

is interesting to note that there do not seem to be significant differences between former East and West German regions. Accordingly, variations in the frequency of press releases at the sub-national level do not seem to be strongly impacted by the former division of Germany, at least not when controlling for the other variables.

In sum, our baseline model highlights that there is a strong regional imbalance in the frequency of press releases, which is systematically related to regional characteristics, most notably to the number of press release issuing organizations, presence of the editorial desks, and the degree of urbanization. Consequently, these variables should be included in analyses at this level when using press release information.

Columns (2) to (8) in Table 3 present the findings for the estimations using the frequency of press releases associated with specific keywords as the dependent variable. Other than that, their specifications are identical to that of the baseline model. Note that in these models, the number of press release issuing organizations serves two purposes. First, it controls for inter-regional variation in precisely this number (see discussion above). Second, it accounts for the general tendency of regions to be mentioned in press releases because the variable is highly correlated to the total number of press releases. When including both PRESS and ISSUERS, multicollinearity distorts the estimations ($VIF > 10$). Therefore, we only consider one of the two variables in the models reported here.

The first category of press releases whose spatial distribution is explored is related to the economy (ECON). Besides the control variables discussed above, the model in column (2) shows that economy-related press releases are mostly concentrated in regions with a higher per capita income. While the level of statistical significance is relatively low, it can still be seen as confirmation of our expectations that more economy-related press releases are issued in regions that are economically more successful. The slightly significantly positive relationship with urbanization (POPDEN) adds to this, as more urbanized regions also tend to be more prosperous or at least host a larger number of diverse economic activities. A similar rationale may explain the somewhat stronger significantly negative coefficient of EAST. Given that regions in the Eastern part of the country still lag their Western counterparts in terms of economic prosperity, they appear to be less likely to host economic events that find their expression in press releases. When accounting for inter-regional differences in economic prosperity and urbanization, tourism frequently tends to be over-represented in peripheral and less economically dynamic regions. Consequently, we find a negative relationship between the corresponding variable TOUR and press releases dealing with economic topics. In sum, for this category, our models confirm the idea that press releases' content reflects important economic characteristics of regions. However, while the directions of the coefficients are in full support, a caveat is the relatively low levels of significance of the observed relations.

Our results for politics-related press releases (Model 3) are probably the most surprising. While the control variables are again in line with the expectations and particularly the presence of editorial desks correlates with the spatial distribution, our core explanatory variable for this set of press releases (VOTE) shows a significantly negative relationship with their frequency. This is opposite to our expectations, as high voter turnout (VOTE) was seen as an indication of democratic engagement and consequently, of the frequency of political events taking place. However, the literature on voter turnout suggests that other determinants, such as labor market conditions, domestic political cleavages, the local age composition, and regional attachment are more important determinants in this context (Fiorino et al. 2019, Henderson, McEwen 2010). Consequently, our primary indicator might not seem to correlate to the number of political events that took place, which explains our findings for this variable. This is supported by the size of regions (POP) being observed to have a significantly negative relationship with the number of political press releases as well. Less populous regions are usually rather rural, which in Germany tends to correlate with an on average older population. Older populations are politically more interested and might hence induce comparatively more political events to take place in a locality. These are subsequently mentioned in press releases. Clearly, future research will have to work with alternative indicators to assess this relationship more precisely.

In contrast to the findings for political press releases, our findings concerning tourism

(Model 4) are in line with our expectations. Regions that host a larger number of tourists per inhabitant are associated with a larger number of tourism-related press releases. Clearly, a stronger touristic orientation implies more touristic events taking place which shapes the press releases associated with that region. Apart from tourism, it is the size of the region that is found to have a slightly significant negative relation with TOURISM. Given that tourism matters a lot for smaller and rural regions, this finding strengthens the close link between press releases and touristic activities in the regions.

Model (5) relating the frequency of leisure-related press releases to regional characteristics is basically a mirror of Model (4) concerning tourism. Apparently, the use of the keyword *leisure* is very similar to that of *tourism*, which suggests that they refer to the same overarching category of press releases, which captures touristic and leisure activities.

The last category of press releases of which regional distribution is studied is technology. Here, if we use the same model as for the other categories, we find few and primarily rather weak relations. Technology-related press releases are positively related to GDP per capita, which is likely to be driven by more technologically active and advanced organizations being in regions with higher levels of economic income. However, the link is not very strong. We also observe a positive relationship with VOTE suggesting that regions with higher voter turnout are more likely to be found in press releases about technologies, for which we do not have an explanation. Crucially, our primary indicator to assess the correspondence between regional characteristics and press releases, the number of patents (PAT), is insignificant. However, the results change when excluding GDPC and VOTE variables. In Models 7 and 8, we remove these variables from the analysis. Now, the number of patents (PAT) obtains a strongly significantly positive coefficient, which is very much in line with our expectations. Consequently, it is the consideration of VOTE and GDPC that "hides" the correspondence of press release information with the intensity of innovation activities in regions.

In addition, the analysis of technology-related press releases highlights the link between press releases and the content of newspapers. The coefficient of EAST is significantly positive, signaling that press releases mentioning regions in East Germany tend to feature information on technologies more frequently than those in the Western part. While in general, innovation activities are still less frequent in the former East than in the Western part, the finding matches that of Ozgun, Broekel (2021), who observe the same positive relationship for the content of (regional) newspapers.

Considering our analysis, we find the assessment of press releases as a source of regional data rather promising. For four out of five studied topic categories, we find a strong correspondence between common indicators of regional characteristics and the content of press releases. In particular, for touristic and leisure activities the link appears to be substantial. The spatial distribution of economic activities also seems to be reflected in the content of press releases. The correspondence of press release content and the intensity of innovation activities (as measured by patents) only becomes observable when not controlling for regions' economic situations and voter turnout. However, it must be pointed out that patents are just one indicator for specific kinds of innovations (those that can be patented) and that NUTS-3 regions (used in our analysis) are generally perceived to be not ideal for capturing their spatial distribution (Brenner, Greif 2006). Within the framework of the applied approach and data, we did not manage to validate press releases to follow the same spatial distribution as common statistical indicators in the case of political events. It is likely that our employed indicator is insufficient and hence the finding shouldn't be over-interpreted.

6 Conclusion

As in most social sciences, regional scientists and economic geographers are constantly seeking to advance their available databases. Given the fast-changing and complex nature of contemporary developments, standard official datasets may not include the information required to track and analyze these. In the present study, we discuss press releases as an alternative data source in this context. Despite their use in other literature streams, so far, they have been rarely exploited by spatial scientists. Press releases offer a number

of attractive features, such as being generally widely available, containing rich textual information that includes aspects frequently not covered by official statistics, and, most importantly, being geo-locatable.

Given these promises of press releases, the aim of this paper was to assess the usefulness of press releases as a data source in spatial economic research from an empirical perspective. We argue that press releases seem to be an attractive data source which, however, requires several crucial aspects to be considered. This includes a certain positivity bias, as organizations are less likely to issue press releases on negative events. A more important aspect from a spatial perspective is that press release information is greatly shaped by the distribution and characteristics of the underlying population of press release issuing organizations. For instance, locations with many organizations active in the sports sector are more likely to show up in press releases on sports. Consequently, press releases will primarily reflect the population of issuing organizations. Yet, this is not always a negative thing, as researchers might be explicitly interested in this population which may otherwise be difficult to be observed. Sticking to the example of sports, for countries in which a comprehensive list of sport-organizations at small geographical units does not exist, press releases with reference to sports activities might give a reasonable approximation of their spatial distribution. Although they cannot be used to infer their absolute number or general importance, identifying regions with comparative strength in these activities is feasible.

To be used in such tasks or similar ones, it is important to know if press releases, when aggregated to the regional level, reflect the socio-economic characteristics of regions. To gain insights into this, we empirically assessed the correspondence of a range of regional characteristics and associated events in press releases. To achieve this, we used a novel data set on press releases published by the German news agency DPA covering all 401 German districts (NUTS-3 regions). The analyses revealed that the overall frequency of press releases and that of specific types of events mentioned therein align reasonably well. In particular, aggregated counts of press releases on touristic activities are strongly correlated to the presence of tourists in regions. A similarly strong link was observed for technology press releases and patents when not controlling for regions' economic prosperity and voter turnout. Although weaker, we also detect a relationship between regional economic development and economy-related press releases. Our analysis was unable to confirm a correspondence between press releases on political topics and political engagement (voter turnout) at the regional level, which we suspect is primarily due to voter turnout not being a good proxy for the number of political events taking place in a region.

In sum, in many instances, regional differences in events and activities seem to be well-presented by press releases. This makes press release data a useful data source in spatial studies. However, there are important limitations to press release data that apply to all press releases in general and some that apply to the specific database on press releases used in this study. The latter's relevance in other step-ups depends on how much the data is like the one used in this study. As for the first group of limitations, as pointed out, press releases suffer from a positivity bias and they are shaped by the underlying population of press release issuing organizations. Concerning the latter, the motivations and abilities to produce press releases, as well as the styles thereof, are likely to differ substantially between organizations. So far, it is unknown to what extent these may differ between locations. In addition, press releases are always highly subjective texts, written with a specific purpose, which, unfortunately, is not information to spatial scientists. These may introduce unknown distortions. There is also no information on which events are covered by press releases and which are not. Consequently, as with any other data source, press releases represent incomplete information which must be considered in their interpretation.

As for the data we have used in our study, all these limitations apply. In addition, however, it includes very little information on the issuing organizations. We do not know what fraction of all press releases in a region are covered in the database. For about half of the press releases, no location information was given in the text, which makes assigning them to the correct region in which the event took place very difficult. Even when location

information was included, we faced several challenges. For instance, there are still several ambiguous location names. A prominent example is "Essen". It frequently appears in press releases and may refer to, in this case, the city of Essen or to "food". While manual inspections confirmed a high discriminating power of our geo-location procedure and we are confident about its proper working, there might still be cases in which the location assignment was incorrect. For disambiguation of location names, future studies can use natural language processing tools. In terms of classifying the press releases by topics, we relied on keywords assigned to press releases. Neither do we know who assigned those keywords (either the issuing organization, or the database administrators), nor do we know how reliable they are. Future research may shed light on this by using text classification or clustering techniques. We tried to overcome many of these limitations and in this regard, our empirical study hopefully provides valuable insights for the applied researchers working with press release data and facing similar issues. We also point out a couple of aspects that may help the specification of empirical spatial models based on press release data. For instance, when using their spatial variation, it is essential to consider the location of editorial desks and the number of issuing organizations.

Given the increasing demands for new and rich data sets in regional science, we believe that press releases offer substantial potential and may be very useful in many contexts. For instance, when looking at specific topics, press releases may allow for identifying regional economic specializations that remain hidden in official statistics. Our study is an early step in this direction and might help researchers assess if press releases are useful for their work.

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Appendices

A Geo-locating the press releases

To geo-locate the press releases, we rely on the OpenGeo-database, which contains the names and geo-coordinates of more than 12,000 places in Germany (http://opengeodb.giswiki.org/wiki/OpenGeoDB). Since German location names can include punctuation and stop words, and some location names are words with other meanings, we cannot apply standard text preprocessing and straightforward string-matching techniques. The procedure we apply is summarized in the following.

1. We remove numbers and all punctuation marks from the text, except for periods, commas, parentheses, and dashes, as these are part of some location names. The punctuation marks that are not removed are standardized, e.g., *hyphen*, *en dash*, and *em dash* all become short dash.

2. We transform the abbreviations in location names to their full words so that they can be matched with the original names. For example, *a.M.* is transformed into *am Main*; *a.d.R.* into *an der Ruhr*; and *St.* into *Sankt*.

3. Although press releases are in German, in some cases, English names of German places are used. We translate these into their German originals. For example, *Munich* is translated into *München* and *Nuremberg* into *Nürnberg*.

4. In German, the first letter of location names are normally in capitals, however, sometimes this is not done when articles and prepositions are part of the name. To differentiate location names from other words, such as verbs, we capitalize all the stop words and prepositions that are used in location names. For example, *an der* becomes *An Der*; *vor der* becomes *Vor Der*. Consequently, all words in location names, if mentioned in the press release, begin with a capital letter. After this step, we clean the corpus by removing words that start with lower case letters. This ensures the removal of verbs, and irrelevant prepositions and articles. This step also decreases the size of text data considerably so that pattern matching becomes feasible.

5. Using string-matching we assign latitude and longitude from the OpenGeo-database to press releases. In case multiple location names are identified in the text, we assign all locations mentioned to the respective press release.

6. Since some location names in Germany have special letters that do not exist in all alphabets (ä, ö, ü, and ß) and writing the words including these letters by using only the English alphabet is a common practice, we repeat the previous step once more, by replacing the special letters in the list of location names. For example, *ä* is replaced with *ae*; *ß* with *ss* and so on. At the end of these steps, 51,861 press releases are assigned to a location in Germany.

7. In some cases, the places' full names are not mentioned in the press releases. Although this creates ambiguity in terms of text analysis, it is usually clear for readers from the content of the release which location the text refers to. A well-known example of such is *Frankfurt*. There are two prominent locations in Germany containing *Frankfurt* in their names: (*Frankfurt am Main* and *Frankfurt an der Oder*). Hence, a reference to just *Frankfurt* in the text is insufficient to establish a unique match. Lacking any further information to solve this ambiguity, we match in this case the location with the larger population. We assume that it is more likely that the smaller (and lesser known location) is referred with its full name, i.e. *Frankfurt an der Oder*. Manual checks confirm the appropriateness of this assumption. This allows to assign locations to 3,915 additional press releases.

8. In addition to potential location names in the releases' main text, the database offers location information for all press releases for their issuing organization. If a location is mentioned in the article (and it is identified through in the previous

steps), we assume that it is a more accurate description of the event's or issue's location than the location of the issuer. However, in the lack of the first, it is still the best available information. Consequently, for all locations where the previous steps didn't result in at least one match, the location of the issuer is used to geo-locate the press releases. For these locations, we primarily use an API access to Google Maps to obtain their geo-locations. At the end of this final stage, 99, 984 press releases are assigned to a location in Germany.

B Correlation matrix

Table B.1: Correlation matrix

	PRESS	POP	POPDEN	GDPC	EDESK	VOTE	TOUR	EAST	PAT
POP	0.85***								
POPDEN	0.54***	0.50***							
GDPC	0.21***	0.14**	0.48***						
EDESK	0.39***	0.35***	0.50***	0.30***					
VOTE	0.01	0.09	-0.15*	0.01	-0.06				
TOUR	0.02	-0.03	-0.15*	-0.05	-0.02	0.03			
EAST	0.06	0.01	-0.13*	-0.26***	0.07	-0.45***	0.02		
PAT	0.59***	0.77***	0.49***	0.33***	0.27***	0.32***	-0.07	-0.19**	
ISSUERS	0.92***	0.89***	0.62***	0.25***	0.46***	0.02	0.03	0.04	0.69***

C Correlation between press release frequency in selected topics and regional variables

Table C.1: Correlation between frequency of press releases in economy, politics, tourism, leisure, and technology topics, and regional socio-economic variables

	POP	POPDEN	GDPC	VOTE	TOUR	PAT	EAST
ECON	0.86***	0.56***	0.22***	0.01	0.03	0.63***	0.04
POL	0.72***	0.45***	0.15*	-0.01	-0.01	0.45***	0.08
TOURM	0.82***	0.61***	0.29***	0.01	0.01	0.67***	0.00
LEISR	0.87***	0.61***	0.28***	0.02	0.02	0.67***	0.02
TECH	0.85***	0.55***	0.22***	0.03	0.03	0.71***	0.05

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Academic Tourism in Barcelona (Spain) in the COVID-19 Era

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Abstract. Academic stays at higher education institutions located outside students' usual environment for less than a year have become increasingly popular. The research reported in this article aimed to examine the current situation of international academic tourism in the region of Barcelona (Spain). The main objectives were to profile academic tourists, to analyse the impact of the COVID-19 pandemic on inbound academic tourism flows, and to explore the outcomes of academic travel experiences. Following a mixed-methods approach, two focus groups and three in-depth interviews were conducted to collect data from both a supply and demand perspective, in addition to a survey designed for international students. A total of 132 questionnaires were analysed by means of descriptive statistics and through chi-square and ANOVA tests. Qualitative data was processed by means of categorisation and content analysis using QDA Miner. The main results indicate that academic tourism has positive sustainable impacts and is conducive to transformational experiences. Tourists' profile has been identified and the effects of the pandemic have been pinpointed. Due to COVID-19, academic tourism flows experienced a serious decline and the satisfaction degree with the academic travel experience was lower. Nonetheless, most of the respondents would recommend Barcelona as an academic destination.

1 Introduction

The number of overseas students in higher education has almost tripled in less than 20 years, growing from 1.9 million in 1999 to 5.3 million in 2017 (UNESCO 2020, as cited in Martínez-Roget, Rodríguez 2021). Academic stays abroad rely on a wide range of educational and touristic services and facilities that involve different stakeholders. They also impact the participants and the destinations where they take place. However, academic tourism has not received the attention it deserves from academia (Cerdeira Bento 2021), particularly from an anthropological perspective (Di Giovine, Bodinger de Uriarte 2021).

The need to explore academic tourism has had another turn of the screw with the advent of the COVID-19 pandemic and its unexpected consequences for international mobility worldwide. Spain has seen a decrease in tourism flows because of the lower demand for tourist services as a result of uncertainty, preventive measures, and the mobility restrictions that most destinations are adopting (Ministry of Industry, Trade and Tourism ny).

This has been the main motive underpinning the research reported in this article. The general objective was to study the current situation of inbound academic tourism in the region of Barcelona (Spain), and it comprised three specific objectives. The first one aimed to identify the profile of tourists that come to Barcelona's region for academic purposes. The following research questions were formulated in this respect:

RQ1. Which is the demographic profile of academic tourists that come to Barcelona for academic purposes?

RQ2. Which are the main motivations of academic tourists coming to Barcelona?

The second specific objective sought to analyse the impact of COVID-19 on inbound academic tourism flows in the region of Barcelona, and was related to these questions:

RQ3. What was the influx of academic tourists in Barcelona before the COVID-19 pandemic?

RQ4. What has been the influx of academic tourists in Barcelona during the COVID-19 pandemic?

RQ5. Has the COVID-19 pandemic influenced students' destination choice?

RQ6. What are the major challenges posed by COVID-19 for academic tourism in Barcelona?

Finally, the third specific objective focused on academic tourism stakeholders so as to explore the outcomes of academic travel experiences in the region of Barcelona in the COVID-19 era in reply to the last set of research questions:

RQ7. What are the impacts of academic tourism on Barcelona's academic tourism industry?

RQ8. What are the impacts of academic tourism on Barcelona's host community?

RQ9. Are academic tourists satisfied with their academic stays in Barcelona?

RQ10. What are the main impacts of the academic tourism experience on the academic tourists that stay in Barcelona?

Before providing an account of the methodology and the outcomes of this research, let us contextualise the current academic tourism scenario.

2 Literature review

According to the World Tourism Organization (2019), educational tourism is primarily motivated by the tourist's engagement in learning, self-improvement, intellectual growth, and skills development. It can be linked to study programs, language courses, skill acquisition, or career development sojourns. In simple terms, educational tourism is the combination of traveling and learning.

A micro-niche of educational tourism is academic tourism, which can be referred to as "a distinct type of tourism that would include any stays made in higher education institutions in places outside their usual environment for a period of less than one year" (Rodriguez et al. 2012, p. 1583). Academic travel is closely related with other niches, such as scientific, cultural, or youth (Iglesias 2022). In fact, it can be complemented and even intertwined with several touristic activities, like voluntourism or language tourism, which is in turn another micro-niche of educational tourism (Iglesias 2021). Within academic tourism, two subtypes can be distinguished: domestic and international (Rodriguez et al. 2012).

Thanks to exchange mobility programs, thousands of students pursue their studies in a higher education institution outside their usual place of residence annually. Concerning domestic mobility agreements between Spanish universities, the Sistema de Intercambio

entre Centros Universitarios de España (SICUE) has been operating since 2000. Promoted by the associations Crue-Asuntos Estudiantiles and Crue-Internacionalización y Cooperación, students can go on an exchange program in a higher education institution located in a different geographical region within Spain, with guaranteed adaptation to their curricular profile and academic recognition. This enables students to take part in diverse teaching systems and socio-cultural contexts (Crue Universidades Españolas ny).

On the other hand, the Erasmus program has always been a very popular international mobility scheme in Spain. From its foundation in 1987 by the European Union until 2018, over 4 million higher education students had the opportunity to study, train, volunteer, or gain professional experience abroad. International flows rocketed from over 3,000 students in the academic year 1987-1988 to almost 350,000 students in 2018, and the number of participating countries during this period increased from 12 countries to 33 (Martínez-Roget, Rodríguez 2021). The Erasmus+ program for 2021-2027 aims at enabling the mobility of about 10 million learners and staff with a total budget of €26.2 billion, i.e., nearly twice the budget of the Erasmus+ program for 2014-2020 (European Commission 2021). The main purpose of the Erasmus+ program is to encourage Europe's 2020 strategy for prosperity, jobs, social equity, and inclusion, as well as spreading the concept of sustainability across higher education institutions. It also supports the objectives of the EU Youth Strategy, such as reducing the unemployment rate, promoting adult learning, and supporting innovation and collaboration. Another strand of Erasmus+ is Erasmus Mundus Joint Masters, especially targeted at master's students worldwide (European Commission ny).

The academic tourism micro-niche has some idiosyncratic characteristics which are related to the impacts it produces in terms of economic, socio-cultural, and environmental sustainability, as stated by Rodríguez, Martínez-Roget (2021). These authors maintain that, to begin with, this type of tourism is considered more economically sustainable than mainstream tourism, since students' stays are significantly longer than those of common tourists, so their average expenditure is more substantial. Additionally, students have similar spending patterns to local residents. Academic tourism also helps to counterbalance seasonality, compensating for the decrease of tourist flows in the low season (Rodríguez, Martínez-Roget 2021).

Secondly, when it comes to socio-cultural aspects, exchange students are generally more educated than other types of tourists, and many wish to integrate into the local culture, learn the local language, and build new relationships with residents and people from all around the world. Cultural exchange and open-mindedness are thus enhanced (Rodríguez, Martínez-Roget 2021). Study abroad can be considered an ethical type of tourism that can contribute to global citizenship (Di Giovine, Bodinger de Uriarte 2021).

Lastly, nowadays young people are environmentally concerned and universities are also committed to the conservation of the environment. Higher education institutions usually promote the use of recycled products and alternative energy resources, and they are involved in providing an ecologically oriented education. Innovation and the use of new technologies are frequent in academic tourism. Moreover, it does not require the building of new infrastructures, as is the case with mainstream tourism, since students stay in shared apartments, dorms, with host families, or housing provided by universities. Academic tourism is therefore positive for the destination and it even contributes to its conservation (Rodríguez, Martínez-Roget 2021). Academic tourism activities can also have the power to transform those participants that take part in them (Cruz et al. 2021). Study abroad has a transformational nature, since it offers opportunities for changing attitudes and behaviours (Di Giovine, Bodinger de Uriarte 2021). It is necessary to understand the transformative process of intercultural identities from an interdisciplinary approach that looks at mobile students' realities and listens to their own accounts (Selby 2021).

Transformational tourism experiences can be created anywhere at any time. Nevertheless, according to Pritchard, Morgan (2013) some specific types of travel tend to contribute to enhancing consciousness, like nature-based tourism, eco-travel, cultural and heritage travel, religious trips and pilgrimages, adventure and challenging activities, volunteer trips, or educational travel. The latter results in learning, gaining cultural and global

Table 1: Push factors in international academic tourism

PUSH FACTORS
Professional development goals Doyle et al. 2010, Furukawa et al. 2013, Lam et al. 2011, Larbi, Fu 2017, Lesjak et al. 2015, Li, Bray 2007, Li, Qi 2019
Linguistic and/or cultural development goals Bodycott 2009, Cao et al. 2016, Counsell 2011, Doyle et al. 2010, Iglesias 2017, 2021, Nilsson 2015
Personal growth Cruz et al. 2021, Doyle et al. 2010, Lesjak et al. 2015, Li, Bray 2007, Nilsson 2015
International exposure Bhati, Anderson 2012, Bodycott 2009, Larbi, Fu 2017
Experiencing novelty and excitement abroad Jon et al. 2014, Li, Qi 2019, Llewellyn-Smith, McCabe 2008
Having fun and socializing Cruz et al. 2021, Lesjak et al. 2015, Llewellyn-Smith, McCabe 2008
Low living standards and/or unavailable educational options in home country Bodycott 2009, Cao et al. 2016, Larbi, Fu 2017, Maringe, Carter 2007, Mazzarol, Soutar 2002, Naidoo 2007, Rodriguez et al. 2012, Rodríguez González et al. 2011
Adverse socio-political situation in home country Maringe, Carter 2007, Abubakar et al. 2014
Dissatisfaction with education system in home country Ghazarian 2014, Kim, Zhang 2021, Park 2009

knowledge, intellectual growth, and personality development. Tourists have traditionally been driven by relaxation and leisure. New tourists seek educational and experiential components in their trips. They want to go beyond looking and seeing, they want to feel and sense, and undergo a personal transformation (Reisinger 2015).

Following Martínez-Roget, Rodríguez (2021), the push and pull model has been commonly used to analyse academic travel motivation. Push factors are usually regarded as intrinsic to travellers and related to their background, whereas pull factors are external and often linked to the perceived attributes of the academic destination (Mazzarol, Soutar 2002). Some of the push and pull factors identified by researchers in the last two decades are listed in Tables 1 and 2.

These are some of the aspects that underlie the noticeable growth experienced by academic tourism over the years (Lesjak et al. 2015). The implementation of student exchange programs coupled with the creation and promotion of infrastructures to support mobility have made this possible. International students now represent 2.4% of all higher education students in the world (UNESCO 2020, as cited in Martínez-Roget, Rodríguez 2021).

Regarding academic tourism in Europe, in 2019 a €3.37 billion budget was distributed by means of the Erasmus+ program among almost 940,000 students, around 25,000 projects, and 111,000 participating organisations (European Commission 2020b). As for academic tourism in the region of Barcelona, significant data is reported by two important universities, namely Universitat de Barcelona (UB) and Universitat Autònoma de Barcelona (UAB). In 2019-2020, UB received a total of 1,705 international students through mobility programs and sent 1,392 students abroad. This university had 3,754 agreements with foreign institutions and 68 active Erasmus+ programs (Universitat de Barcelona 2021). In turn, in 2019-2020 UAB welcomed 881 Erasmus+ foreign students, as well as 356 students through their UAB Exchange Programs and 2,179 students through their study abroad programs. As for outbound mobility, 660 students engaged in Erasmus+ studies and 116 in Erasmus+ placements, while 270 took part in UAB exchange programs and 136 in UAB exchange program placements (Universitat Autònoma de Barcelona 2021).

Table 2: Pull factors in international academic tourism

PULL FACTORS
Destination's image or prestige Ahmad et al. 2016, Lesjak et al. 2015
Destination's culture and language Abubakar et al. 2014, Larbi, Fu 2017, Rodríguez González et al. 2011
Destination's climate and weather Cao et al. 2016, Llewellyn-Smith, McCabe 2008, Rodríguez González et al. 2011
Destination's tourist attractions Cruz et al. 2021, Llewellyn-Smith, McCabe 2008
Destination's natural environment Abubakar et al. 2014, Llewellyn-Smith, McCabe 2008
Destination's geographical proximity Beine et al. 2014, Cao et al. 2016, Lee 2017, Mazzarol, Soutar 2002, Moreira, Gomes 2019, Rodríguez González et al. 2011, Shanka et al. 2005, Soo, Elliott 2010
Destination's linguistic or cultural proximity Ahmad, Buchanan 2016, Beine et al. 2014, Counsell 2011, Jon et al. 2014, Lee, Morrish 2012
Destination's perceived safety and/or security Abubakar et al. 2014, Bhati, Anderson 2012, Caruso, De Wit 2015, Chen 2008, Lam et al. 2011, Mazzarol, Soutar 2002, Shanka et al. 2005
Destination's cultural diversity and integration opportunities Abubakar et al. 2014, Ahmad, Buchanan 2016, Chen 2008, Lam et al. 2011, Mazzarol, Soutar 2002
Destination's professional opportunities Abubakar et al. 2014, Cao et al. 2016, Counsell 2011, Eder et al. 2010, Ivy 2010, Mazzarol, Soutar 2002
Destination's educational system and institutions Abubakar et al. 2014, Ahmad et al. 2016, Ahmad, Buchanan 2016, Beine et al. 2014, Cao et al. 2016, Furukawa et al. 2013, Gong et al. 2020, Kim, Zhang 2021, Lam et al. 2011, Larbi, Fu 2017, Mazzarol, Soutar 2002, Nilsson 2015, Park 2009, Petruzzellis, Romanazzi 2010, Rodriguez et al. 2012, Rodríguez González et al. 2011, Shanka et al. 2005, Van Bouwel, Veugelers 2013
Tuition in English in the destination Baláž, Williams 2004, Bodycott 2009, Kim, Zhang 2021, Nilsson 2015, Park 2009
Scholarships and financial support Abubakar et al. 2014, Larbi, Fu 2017
Destination's education costs Abubakar et al. 2014, Ahmad, Buchanan 2016, Bourke 2000, Doyle et al. 2010, Lam et al. 2016, Mazzarol, Soutar 2002, Naidoo 2007, Shanka et al. 2005
Destination's living costs Abubakar et al. 2014, Ahmad, Buchanan 2016, Beine et al. 2014, Bourke 2000, Cruz et al. 2021, Lam et al. 2016, Mazzarol, Soutar 2002, Moreira, Gomes 2019, Nilsson 2015, Rodríguez González et al. 2011, Shanka et al. 2005
Travel costs Cao et al. 2016, Cruz et al. 2021, Mazzarol, Soutar 2002, Moreira, Gomes 2019, Rodriguez et al. 2012
Visa procedures Abubakar et al. 2014, Eder et al. 2010, Urias, Camp Yeakey 2008
Recommendations and social influence of acquaintances Ahmad et al. 2016, Cao et al. 2016, Cheung et al. 2011, Cruz et al. 2021, Ivy 2010, Lee 2014, Li, Qi 2019, Mazzarol, Soutar 2002, McCarthy et al. 2012, Rodriguez et al. 2012, Shanka et al. 2005

International mobility flows started to be dramatically affected worldwide in early 2020 when the COVID-19 virus started to spread, becoming an ongoing pandemic and a global health threat. National governments across the world restricted non-essential business and travel, which resulted in massive economic loss and jobless workers (Williams 2020). The tourism industry experienced a global decline of 60% in international tourism in 2020 (OECD 2020). The destination of Barcelona lost 75.8% of airport arrivals and 82.3% of international commercial flights (Observatori del Turisme a Barcelona 2021). The lockdown, quarantine, social distancing, and closure of universities caused an overall impact on international student mobility of nearly 90% (Marinoni et al. 2020). More specifically, as regards both inbound and outbound mobility programmes, UB reported that the pandemic affected nearly 100% of full-year and autumn semester stays. Whereas one-third of overseas students returned home, the rest stayed in their academic destinations, and most international students had to continue their studies online, regardless of whether they had stayed abroad or not (Universitat de Barcelona 2021).

The European Commission published in 2020 the results of the survey on the impact of COVID-19 on learning mobility activities sent to over 57,000 participants, 40% of which were doing an academic exchange during the outbreak of the pandemic. The study found that 75% of the respondents, i.e., more than 107,000 participants, were affected. Over 42% were able to continue with their academic mobility with some variations like online learning, 22% of the participants had their exchange temporarily suspended, and 36% of the students had it cancelled (European Commission 2020a).

In addition, a factsheet was published by the European Commission (2020c) to provide essential practical advice to participants in the Erasmus+ program during the COVID-19 outbreak and spread. The European Commission monitored the situation in order to implement the necessary measures and adapt the activities to the current context. The main measures were to invoke the force majeure clause in all cases, postpone the deadline of all the activities for 12 months, reschedule Erasmus+ partnerships that were not able to take place in spring 2020, and arrange peer-to-peer support for students abroad in Europe European Commission (2020c). At present, while domestic academic tourism and proximity trips seem to have better recovery prospects, the future of international academic travel is uncertain and will be probably dependent on ensuring travellers' safety (Iglesias 2022).

Pandemic-related research in the tourism and hospitality sector has globally focused on impacts on vulnerable stakeholders, destinations' promotion, tourists' choices, and the role of technology, as well as on resilience and recovery (Utkarsh, Sigala 2021). In view of the lack of studies comparing the specific situation of academic tourism before and after the COVID-19 crisis in the region of Barcelona, the research project presented in this paper aimed at putting this topic under the spotlight.

3 Data and Methodology

This exploratory investigation followed a mixed-methods approach with the purpose of reaching the research objectives mentioned in the Introduction after triangulating different perspectives and methods. Thus, the main primary data collection techniques were a survey to international academic students, interviews with experts from the academic tourism sector, and two focus groups: the first one gathered past and present foreign students and national students, and the second focus group aimed at obtaining information from industry stakeholders. A Google Forms questionnaire was designed for the survey and distributed through social media, while specific scripts were elaborated for the interviews and the focus groups. Virtual zoom meetings were video recorded in the case of the focus groups and one interview. The other interviews took place onsite or via email.

Both descriptive and inferential statistical analyses were conducted using GNU PSPP, a software for quantitative survey results (Free Software Foundation). This programme was considered a very convenient tool since it is a free easy-to-use replacement for SPSS, which is commonly used by researchers (cf. Lesjak et al. 2015, McCarthy et al. 2012, Nilsson 2015). Data was correlated through chi-square and analysis of variance (ANOVA) tests. The whole process is represented in Figure 1.

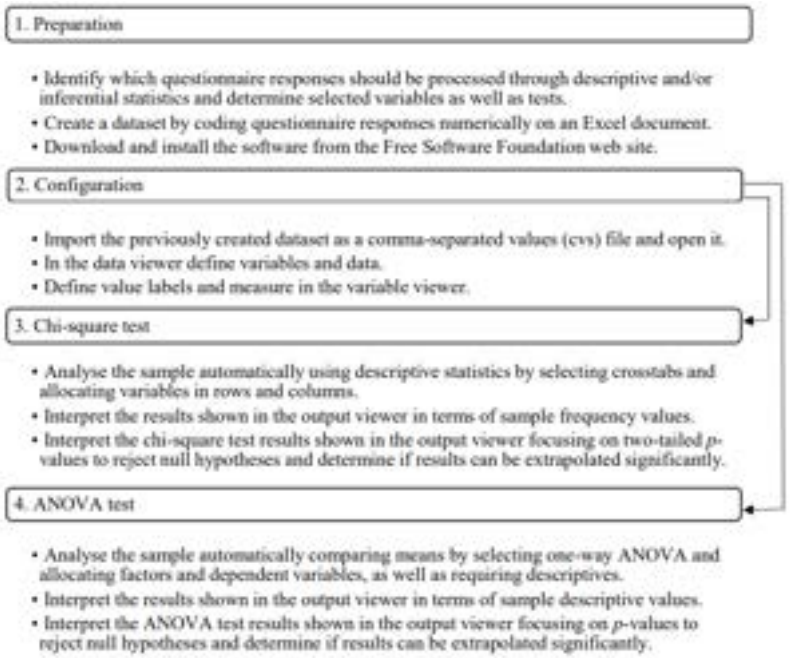


Figure 1: Process for PSPP analysis

On the other hand, qualitative data obtained by interacting with interviewees and focus group participants was processed by means of content analysis and categorisation following the model employed by Cruz et al. (2021). Table 3 shows the categorisation used in this study after reading the information provided by all the respondents.

Transcripts of the responses included in each dataset, i.e., in-depth interviews, students' focus group, and stakeholders' focus group, were analysed using QDA Miner Lite, the free popular version of the qualitative data analysis software QDA Miner (Provalis Research). This was also considered a very useful methodological option, as it enables researchers to code and analyse textual data from large collections of documents to find out co-occurrences reliably. Figure 2 illustrates this process.

Since the scope was the region of Barcelona, the universe consisted of the students that came to this region to take part in an academic exchange experience and the industry stakeholders from local academic tourism organisations. As mentioned in Section 2, an approximate number of exchange students in the academic period 2019-2020 has been publicly reported by UB and UAB. However, it was impossible to determine the exact volume of academic tourists that participate in international mobility programs in the rest of this region's higher education institutions every year.

Having opted for a non-probabilistic convenience sample, 136 responses to the questionnaire were collected, 4 of which were discarded because they were submitted by national students. The valid responses were sent by international students whose academic destination was or had been Barcelona. Moreover, 3 experts based in Barcelona were interviewed in depth, namely the CEO of an academic tourism provider for the Chinese outbound market, the Diversity and Inclusion Officer of another international study abroad provider, and the Co-founder and Head of Product and Marketing of an international student association. Furthermore, the first focus group was composed of a combination of international students from mobility programs in Barcelona before or during the COVID-19 pandemic and local students who participated in Buddy Programs to contribute to their foreign peers' integration. Last but not least, 5 industry stakeholders shared their views in the second focus group: the International Officer of a higher education institution in Barcelona, the Head of the Buddy Program of the same institution, the Sales Manager and Commercial Director of a student residence hall located in this city, and one of the Operations Managers of a local accommodation agency.

Table 3: Categorisation

Technique	Category	Subcategory
Interview (I)	I1. Impacts	I1.1. Economic I1.2. Socio-cultural I1.3. Environmental
	I2. Profile of students	
	I3. Challenges	
	I4. Future expectations	
Focus group students (FGS)	FGS1. Impacts	FGS1.1. Economic FGS1.2. Socio-cultural FGS1.3. Environmental
	FGS2. Profile of students	
	FGS3. Challenges	FGS3.1. Health FGS3.2. Mobility FGS3.3. Integration
	FGS4. Academic experience	FGS4.1. Positive outcomes FGS4.2. Negative outcomes
	FGS5. Barcelona as an academic tourism destination	FGS5.1. International students' perspective FGS5.2. Local students' perspective
Focus group industry (FGI)	FGI1. Impacts	FGI1.1. Economic FGI1.2. Socio-cultural FGI1.3. Environmental
	FGI2. Profile of students	
	FGI3. Challenges	FGI3.1. Academic FGI3.2. Accommodation
	FGI4. Academic tourism data	
	FGI5. Future expectations	

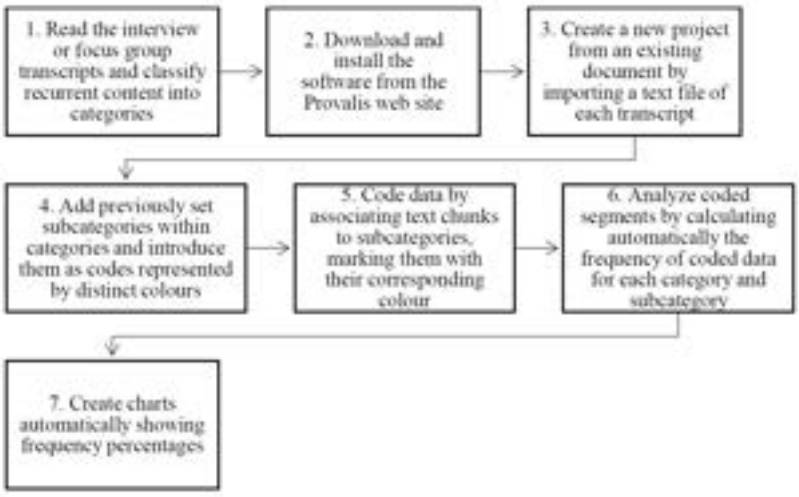


Figure 2: Process for QDA Miner analysis

4 Results

4.1 Survey analysis

The vast majority of the respondents were European students, mostly from France (19.5%), Italy (18.8%), and Germany (12.03%). They were mainly in their early twenties and 70.5% were women. Their main motivation to carry out an academic exchange was personal development (80.15%), as well as professional growth (61.76%), social life (54.4%), and leisure (26.47%). They chose Barcelona as their academic destination because of the climate (21.9%), the local language and culture (17.4%), the tourist attractions (16.62%), and the local cuisine and gastronomy (10.29%). Most of them stayed in this city in the second semester of 2020-2021 (54.5%) or in the first semester of 2019-2020 (23.5%), for a period of 6 months (55.3%) or 3 months (24.2%), and studied at UB (53.68%) and UAB (16.91%). The respondents pursued a Bachelor's degree (83.3%) or a Master's degree (14.4%), in social sciences (56.1%) or in the area of arts and humanities (16.7%), predominantly.

Regarding the touristic services they used in Barcelona, 75% rented an apartment and 19.12% stayed at a student residence hall, whereas the rest opted for other types of accommodation, including host families. Average monthly accommodation expenditures ranged between €301 and €500 for 52.2%, between €501 and €700 for 33.8%, between €701 and €900 for 7.4%, exceeded €900 for 4.4%, and did not reach €300 for 2.2%. Almost everybody (97.06%) travelled around the city by public transport, and 52.94% also did it on foot. The most frequent leisure activities were cultural (77.94%), nightlife (47.06%), gastronomic (42.65%), and sports (27.21%).

Even though most of the respondents interacted with local residents almost constantly (36.03%) or quite often (24.26%), constant interactions with other foreign people were more abundant for the majority (53.68%), and while 42.6% took a Spanish language course during their stay, 57.4% did not. Linguistic gains were actually some of the outcomes of their academic stays reported by the respondents, as well as other aspects related to their individual growth shown in Figure 3.

As for the consequences of COVID-19 on the respondents' academic tourism experience, 68.4% stated that the pandemic affected them, but they stayed in Barcelona and continued with their classes online, while 5.9% had to return to their countries. Conversely, for 25.7% their academic stay took place before the COVID-19 outbreak. All in all, a very significant percentage of the respondents seemed globally satisfied (50%) or even very satisfied (28.68%) with their academic experience, and they would recommend (27.2%) or highly recommend (67.6%) Barcelona as an academic tourism destination.

With respect to the chi-square tests for 132 valid cases, 2 null hypotheses (H_0) were rejected since the results were statistically significant ($p < .05$):

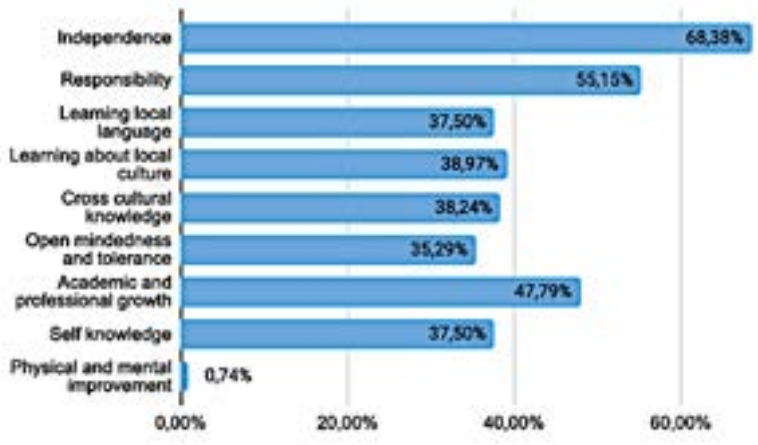


Figure 3: Outcomes of academic stays for international students in Barcelona

Table 4: Chi-square test results

Associations	H_0	Statistic	Value	df	Asymp. Sig. (2-tailed)
Period of stay & motivation for choosing Barcelona	Confirmed. Not related	Pearson Chi-square	1.79	4	.775
		Likelihood Ratio	2.12	4	.714
		Linear-by-Linear Association	.70	1	.401
Country of origin & accommodation expenditure	Rejected. Related	Pearson Chi-square	266.06	136	.000
		Likelihood Ratio	127.82	136	.679
		Linear-by-Linear Association	.59	1	.441
Length of stay & accommodation expenditure	Rejected. Related	Pearson Chi-square	54.04	16	.000
		Likelihood Ratio	42.77	16	.000
		Linear-by-Linear Association	4.83	1	.028
Length of stay & means of transport	Confirmed. Not related	Pearson Chi-square	5.31	8	.724
		Likelihood Ratio	5.34	8	.720
		Linear-by-Linear Association	.33	1	.566
Period of stay & outcomes	Confirmed. Not related	Pearson Chi-square	4.35	4	.361
		Likelihood Ratio	4.92	4	.295
		Linear-by-Linear Association	1.08	1	.298
Length of stay & outcomes	Confirmed. Not related	Pearson Chi-square	5.69	4	.224
		Likelihood Ratio	5.56	4	.235
		Linear-by-Linear Association	.18	1	.670

- For H_0 = There is no significant difference between the country of origin and the accommodation expenditure, the result was $\chi^2(136,\ n\ = 132) = 266.06$, $p\ < .001$. There was a correlation between non-European countries like Ukraine, South Korea, Jordan, or Australia and monthly accommodation expenditure above €900. The respondents who paid €300 a month for their accommodation were mainly from France, Portugal, Italy, and Greece.
- For H_0 = There is no significant difference between the length of stay and the accommodation expenditure, the result was $\chi^2(16,\ n\ = 132) = 54.04$, $p\ < .001$. There was a correlation between longer stays and higher accommodation expenses. The students who stayed between 3 and 6 months were the most likely to spend between €301 and €500 per month on lodging.

On the contrary, no significant correlations were found between other aspects. Full details of the findings are summarised in Table 4.

As regards ANOVA test results, 5 null hypotheses (H_0) were rejected since the results were statistically significant ($p < .05$):

- For H_0 = There is no significant difference between the country of origin and the

Table 5: ANOVA test result

Associations	H_0	Groups	Sum of squares	df	Mean Square	F	Sig
Country of origin & interaction with locals	Rejected. Related	Between gr. Within gr.	69.00 116.33	34 97	2.03 1.20	1.69	.024
Country of origin & interaction with internationals	Rejected. Related	Between gr. Within gr.	53.15 60.73	34 97	1.56 .63	2.50	.000
Period of stay & satisfaction	Confirmed. Not related	Between gr. Within gr.	5.72 88.28	4 127	1.43 .70	2.06	.090
Type of accommodation & interaction with internationals	Confirmed. Not related	Between gr. Within gr.	.16 113.71	2 129	.08 .88	.09	.911
Length of stay & interaction with locals	Rejected. Related	Between gr. Within gr.	18.60 166.74	4 127	4.65 1.31	3.54	.009
Length of stay & interaction with internationals	Rejected. Related	Between gr. Within gr.	8.98 104.89	4 127	2.25 .83	2.72	.033
Affected by COVID-19 & satisfaction	Rejected. Related	Between gr. Within gr.	7.77 86.23	2 129	3.88 .67	5.81	.004
Length of stay & satisfaction	Confirmed. Not related	Between gr. Within gr.	6.25 87.75	4 127	1.56 .69	2.26	.066

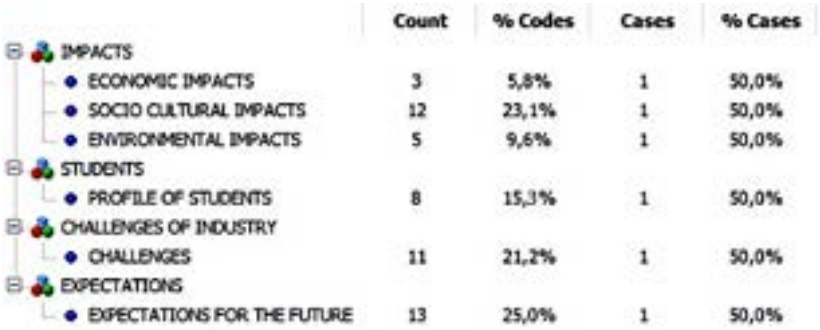
interaction with locals, the result was $F(34, 97) = 1.69$, $p < .024$. Non-European students seemed to interact more frequently with local residents than European students.

- For H_0 = There is no significant difference between the country of origin and the interaction with internationals, the result was $F(34, 97) = 2.50$, $p < .001$. Non-European students also interacted more often with other internationals than European students. Yet, European students' interactions with other international peers were more frequent than with locals.
- For H_0 = There is no significant difference between the length of stay and the interaction with locals, the result was $F(4, 127) = 3.54$, $p < .009$. The students who stayed in Barcelona for longer than 6 months had more interaction with locals than those who stayed for a shorter period.
- For H_0 = There is no significant difference between the length of stay and the interaction with internationals, the result was $F(4, 127) = 2.72$, $p < .033$. Longer stays also correlated with more frequent interactions with other internationals.
- For H_0 = There is no significant difference between the students affected by COVID-19 and the satisfaction with their academic experience, the result was $F(2, 129) = 5.81$, $p < .004$. Those international students who stayed in Barcelona before the COVID-19 outbreak were more satisfied with their academic experience than the ones who were affected by the pandemic.

Table 5 shows all the results in full detail.

4.2 Analysis of interviews

The three most recurrent categories mentioned by interviewees were future expectations (I4 = 25%), socio-cultural impacts (I1.2 = 23.1%), and challenges (I3 = 21.2%). When



	Count	% Codes	Cases	% Cases
IMPACTS				
ECONOMIC IMPACTS	3	5,8%	1	50,0%
SOCIO CULTURAL IMPACTS	12	23,1%	1	50,0%
ENVIRONMENTAL IMPACTS	5	9,6%	1	50,0%
STUDENTS				
PROFILE OF STUDENTS	8	15,3%	1	50,0%
CHALLENGES OF INDUSTRY				
CHALLENGES	11	21,2%	1	50,0%
EXPECTATIONS				
EXPECTATIONS FOR THE FUTURE	13	25,0%	1	50,0%

Figure 4: QDA Miner analysis of interviews

it comes to the impacts generated by academic tourism in the region of Barcelona (I1), international students' most substantial expenditure on rent, tuition, and leisure activities is always a direct economic benefit for the destination (I1.1). With regard to socio-cultural impacts (I1.2), bearing in mind the difficulties that some students face when they have to overcome the language barrier or interact outside of their comfort zone, the pandemic has been an added obstacle for the students to get to know new people and integrate themselves into the local culture. Lastly, concerning environmental impacts (I1.3), all interviewees agreed that academic tourism is more sustainable than other types of tourism, as international students stay longer, use public transport, and have similar consumption patterns to locals, even though the carbon footprint of their trips to neighbouring regions cannot be overlooked.

In relation to academic tourists' profile (I2), due to the strict travel restrictions caused by the pandemic, most students nowadays come from Europe, especially from France. Before the COVID-19 outbreak, a large percentage of American and Chinese students used to choose Barcelona as their academic destination.

One of the main challenges (I3) posed by the coronavirus was indeed the drastic reduction of academic tourists due to restricted mobility, as well as the need to adapt providers' products and services to the new situation, for instance through digitalisation and virtual environments. Promoting Spain as a safe destination was considered a must.

As regards future expectations (I4), there was consensus on the recovery of academic stays in the short term, as international students are eager to travel. More inclusive programs and local trips are forecast.

Figure 4 shows metrics for each one of the above-mentioned categories including number of co-occurrences (Count) and relative frequencies (% Codes).

4.3 Analysis of students' focus group

In relation to the impacts generated by academic tourism on the area (FGS1), students mentioned that they used to shop more in local establishments rather than in shops owned by bigger companies to help local businesses, particularly during the pandemic (FGS1.1). They were aware that living costs would have been higher before the COVID-19 outbreak. Paradoxically, for them it was easier to meet local students online or onsite in this new context, as there were fewer international students, and social interactions were highly appreciated (FGS1.2). They travelled around the city by public transport or on foot (FGS1.3).

As for international students' profile (FGS2), the focus group participants agreed that the majority were around 21 years old and came from European countries, especially France and Germany, since most American students were not traveling abroad during the pandemic. Generally speaking, Erasmus students were considered open-minded, adventurous, and keen to meet new people.

Regarding challenges (FGS3), the fear of being infected by the COVID-19 virus made students' experiences less enjoyable (FGS3.1). Mobility challenges caused by restrictive measures like COVID-19 test requirements to cross borders were perceived as obstacles,

	Count	% Codes	Cases	% Cases
IMPACTS				
ECONOMIC IMPACTS	2	4,9%	1	100,0%
SOCIO-CULTURAL IMPACTS	8	19,5%	1	100,0%
ENVIRONMENTAL IMPACTS	1	2,4%	1	100,0%
PROFILE				
PROFILE OF STUDENTS	5	12,2%	1	100,0%
CHALLENGES				
HEALTH ISSUES	2	4,9%	1	100,0%
MOBILITY CHALLENGES	3	7,3%	1	100,0%
INTEGRATION	5	12,2%	1	100,0%
ACADEMIC EXPERIENCE				
POSITIVE OUTCOMES	6	14,6%	1	100,0%
NEGATIVE OUTCOMES	4	9,8%	1	100,0%
BARCELONA AS ACADEMIC TOURISM DESTINATION				
EXCHANGE STUDENT VISION	3	7,3%	1	100,0%
LOCAL STUDENT PERSPECTIVE	2	4,9%	1	100,0%

Figure 5: QDA Miner analysis of students' focus group

but not as impediments that made academic travel impossible (FGS3.2). International students felt integrated into the host community all the same (FGS3.3). Even though sometimes they had to meet local students virtually through social media instead of face-to-face, they did not find it hard to get along with locals and adapt to the local culture despite the language barriers.

With respect to the academic experience (FGS4), in spite of the pandemic situation, students regarded it as very positive and felt satisfied with it (FGS4.1). However, the limitations in terms of mobility and entertainment opportunities due to the COVID-19 pandemic were seen as negative aspects, particularly for those students who did not speak Spanish (FGS4.2).

Concerning Barcelona as an academic tourism destination (FGS5), both international (FGS5.1) and local students (FGS5.2) agreed that the local people, culture, climate, gastronomy, and tourist attractions were the principal pull factors. Learning Spanish was a push factor for some international students. Moreover, local students believed that academic tourists were also looking to have fun.

To sum up, the most recurrent topics were socio-cultural impacts (FGS1.2 = 19.5%), positive outcomes of the academic experience (FGS4.1 = 14.6%), students' profile (FGS2 = 12.2%), and integration challenges (FGS3.3 = 12.2%), as shown in Figure 5.

4.4 Analysis of industry stakeholders' focus group

Referring to impacts (FGI1), all participants agreed that the economic benefits of academic tourism for the destination are usually very noticeable (FGI1.1), not only for educational institutions but also for the hospitality industry and for local businesses, even in neighbouring geographical areas. Therefore, the drop in inbound travellers due to the pandemic has badly affected the local economy. Socio-culturally speaking (FGI1.2), Barcelona as a diverse, cosmopolitan city with a wide cultural offering facilitates foreign students' cultural development and is in turn enriched by international student flows, so the balance tends to be very positive. In the current situation, restrictive safety policies coupled with some students' reluctance to meet face to face have limited social interactions. Nevertheless, the participation of local students in buddy program activities has increased, since this is nowadays a home-based opportunity for internationalisation. The special emotional bonds that this program creates contributes to all students' linguistic and cultural progress. As for environmental impacts (FGI1.3), there was consensus on considering that academic tourists are more environmentally friendly than mass tourists, since they stay longer, tend to use public transport, and are more akin to local residents' patterns of behaviour. In student residence halls, for instance, cleaning procedures lead to minimising water consumption in comparison to hotels. In addition, students' carbon footprint has been reduced since they cannot travel as much as in pre-pandemic times.

	Count	% Codes	Cases	% Cases
IMPACTS				
ECONOMIC IMPACTS	10	19,6%	1	100,0%
SOCIO-CULTURAL IMPACTS	6	11,8%	1	100,0%
ENVIRONMENTAL IMPACTS	5	9,8%	1	100,0%
PROFILE				
PROFILE OF STUDENTS	11	21,5%	1	100,0%
CHALLENGES				
ACADEMIC CHALLENGES	6	11,8%	1	100,0%
ACCOMMODATION CHALLENGES	3	5,9%	1	100,0%
DATA				
ACADEMIC TOURISM DATA	5	9,8%	1	100,0%
EXPECTATIONS				
FUTURE EXPECTATIONS	5	9,8%	1	100,0%

Figure 6: QDA Miner analysis of industry stakeholders' focus group

Moving on to the profile of international students (FGI2), before the COVID-19 outbreak the majority were non-European, they used to travel in groups, and preferred to live together in apartments. However, nowadays intercontinental travellers are discouraged by mobility restrictions or by the prospect of being locked down and having to take online classes at the host university. Students are mostly European, predominantly from nearby countries, and safety is a concern for them.

In relation to challenges (FGI3), both higher education institutions and students have had to face a number of academic challenges (FGI3.1). Even though digitalisation has been key, adapting to virtual environments or new safety protocols was not easy. Visa procedures have also been a drawback for students which should be addressed by public administrations. On the other hand, accommodation challenges (FGI3.2), like having extended apartment rentals or more limited capacities in common areas and restrictive buffet procedures in residence halls, were not perceived as particularly problematic.

According to the academic tourism data provided by the focus group participants (FGI4), inbound study abroad volumes dropped up to 90% and slumped down completely in the case of summer programs owing to the pandemic.

Lastly, the participants' future expectations (FGI5) were all optimistic and highly positive, forecasting even higher student flows once the pandemic has been stabilised, first from outbound proximity markets and later across continents. Although digitalisation is here to stay, international students are expected to be more motivated than ever to travel.

In conclusion, the most recurrent topics were students' profile (FGI2 = 21.5%), economic impacts (FGI1.1 = 19.6%), socio-cultural impacts (FGI1.2 = 11.8%), and academic challenges (FGI3.1 = 11.8%), as illustrated in Figure 6.

5 Discussion

This research stemmed from a number of research questions that were fundamentally grounded on three main concerns with respect to academic tourism in Barcelona amidst the COVID-19 pandemic, namely tourist profiles, impacts, and outcomes. The triangulation of the results has made it possible to obtain some answers.

Contrary to pre-pandemic tourism flows, the vast majority of international students were European in their early twenties coming from nearby countries due to restricted international mobility. This confirms that proximity travel is indeed a global trend in this new context (Iglesias 2022). In line with the previous research findings listed in the Literature review, the main push factors were personal development (Cruz et al. 2021, Doyle et al. 2010, Lesjak et al. 2015, Li, Bray 2007, Nilsson 2015), professional growth (Doyle et al. 2010, Furukawa et al. 2013, Lam et al. 2011, Larbi, Fu 2017, Lesjak et al. 2015, Li, Bray 2007, Li, Qi 2019), and social life and enjoyment (Cruz et al. 2021, Lesjak et al. 2015, Llewellyn-Smith, McCabe 2008). The major pull factors were the climate (Cao et al. 2016, Llewellyn-Smith, McCabe 2008, Rodríguez González et al. 2011), local

culture and language (Abubakar et al. 2014, Larbi, Fu 2017, Rodríguez González et al. 2011), and tourist attractions (Cruz et al. 2021, Llewellyn-Smith, McCabe 2008). In comparison with intercontinental students, Europeans tend to interact less with locals than with other international peers. However, longer academic stays have been correlated with higher interaction, which in the pandemic context has been facilitated by virtual platforms. Interactive opportunities and behaviour need therefore to be strengthened to enhance academic tourists' integration in the host community and local culture.

Barcelona used to be a consolidated academic tourism destination. Yet, like other studies have reported worldwide (European Commission 2020a, Marinoni et al. 2020), data suggests that the COVID-19 outbreak and spread have had a dramatic effect in this region, as tourism flows have decreased considerably and pre-pandemic international students seemed to be more satisfied with their academic tourism experience. Health concerns and restrictive protocols associated with COVID-19 have been very challenging and have interfered with academic tourists' full enjoyment and integration. In addition, lack of proficiency in Spanish has been a barrier sometimes. Since the majority of the respondents did not take a language course during their academic stay, fostering the acquisition of the local language could contribute to counterbalancing this deficiency. On the other hand, safety is a key aspect that must be taken care of without undermining academic tourists' memorable experiences, so global vaccination and hygiene measures need to be reinforced and promoted.

Admittedly, the traditional outcomes of academic tourism as described by other authors (Cruz et al. 2021, Rodríguez, Martínez-Roget 2021) have been minimised because of the pandemic. Before the COVID-19 outbreak and spread, which entailed a substantial loss in revenues, the economic impact on the destination used to be significant owing to direct and indirect expenditure beyond the educational and hospitality industries. As already mentioned, the interference in the socio-cultural benefits deriving from intercultural contact has also been noticeable. Nevertheless, other compensating alternatives have become more popular, either in virtual environments or through buddy programs, leading to enhanced emotional bonds and cultural development in both visitors and hosts.. The increased participation of local students has thus provided them with more internationalisation opportunities. Concerning environmental impacts, the perception that academic tourism is more sustainable than other types has been corroborated. The results indicate that international students used less-polluting means of transport within the destination and had more similar consumption patterns to those of local students, particularly in longer stays. Furthermore, the pandemic has reduced the carbon footprint produced by less frequent leisure trips to neighbouring regions.

Although satisfaction degrees were higher before the pandemic, more than 75% of the respondents were satisfied with their experience and would recommend Barcelona as an academic tourism destination. Most of them acknowledged some kind of personal growth, as they had become more independent and responsible thanks to their academic sojourns. For some, their academic stays were also conducive to self-discovery and cross-cultural awareness, and had transformed them into more tolerant, open-minded individuals. Moreover, some international students seized the opportunity to learn more about the local language and culture, whereas other reported gains were related to academic and professional development. These findings build on existing evidence of transformational benefits of educational tourism experiences (Di Giovine, Bodinger de Uriarte 2021, Reisinger 2015) and the outcomes seem consistent with the above-mentioned pushfactors.

Table 6 summarizes the reported pre-pandemic and pandemic features of academic tourism in Barcelona. They are related to their corresponding effects, so the table also indicates which traditional outcomes have been undermined and which new aspects have emerged. Therefore, the implications can be regarded as lessons that can be learned, mostly concerning positive and negative economic, socio-cultural, and environmental impacts.

Table 6: Effects of COVID-19 pandemic on academic tourism in Barcelona

Pre-COVID features	COVID features	Implications	Type of impact
Significant socio-economic benefits for Barcelona as a consolidated academic tourism destination and surrounding areas.	Dramatic slump of academic tourism flows.	Loss in revenues experienced by the tourism industry, educational institutions, and local businesses.	Economic (-)
		Fewer tourists and local community members can enjoy the socio-cultural development associated with intercultural contact.	Socio-cultural (-)
Large percentage of inbound transcontinental students.	Mainly inbound European students.	Shorter stays and lower monthly accommodation expenditure.	Economic (-)
		Less diversity and more narrow socio-cultural perspectives.	Socio-cultural (-)
		Less frequent social interaction with local and other international students.	Socio-cultural (-)
		Reduced carbon footprint produced by long-haul transport.	Environmental (+)
		Rebound of proximity travel and rediscovery of European academic destinations.	Global (+)
Weekend breaks and excursions to other regions arranged for academic tourists.	Travel restrictions for complementary trips and limited mobility.	Reduced carbon footprint produced by short-haul transport.	Environmental (+)
		Students stay in their academic destinations, generating more local revenues and the opportunity to socialise and know the host culture better.	Economic (+) and socio-cultural (+)
Significant economic investment made by students during their academic stays.	Lower living costs. Purchase in neighbourhood shops prioritised.	Increased affordability for tourists.	Economic (+)
		Reduced profit margins for local businesses, particularly large stores.	Economic (-)
		Higher revenues for corner shops.	Economic (+)
		More opportunities for immersion in the local community & culture.	Socio-cultural (+)
Some challenges posed by international students' reluctance to leave their comfort zone or by language barriers.	Social distance and increased social media exchanges.	More obstacles for onsite integration in the local community and culture.	Socio-cultural (-)

continued on next page . . .

Table 6: Effects of COVID-19 pandemic on academic tourism in Barcelona (continued)

Pre-COVID features	COVID features	Implications	Type of impact
		Enhanced opportunities for virtual socialisation and online integration approaches.	Socio-cultural (+)
Partial involvement of local students in facilitating academic tourists' integration.	Social interactions highly valued due to lockdowns. More participation of local students in buddy programmes.	Strengthening of emotional bonds conducive to integrative activities as well as to boosted linguistic and cultural development for local and international students.	Socio-cultural (+)
Solid operating procedures aiming to provide immersive academic tourism experiences.	Need to adapt service provision and health protocols.	More limited face-to-face contact.	Socio-cultural (-)
	Introduction of virtual operations and online tuition.	Extra financial and emotional efforts made by supply and demand to meet digitalisation needs and to implement safety measures.	Economic (-) and socio-cultural (-)
		New paths have been opened for future dynamics.	Global (+)
Higher satisfaction with academic tourism experience.	Health concerns and fear of infection. More limited entertainment options.	Less enjoyable stays and lower degrees of satisfaction.	Socio-cultural (-)

6 Conclusion

This research aimed at analysing the effect of the COVID-19 pandemic on academic tourism in the region of Barcelona, as this was an unexplored field to date. The initial specific objectives were met, even though the generalisability of the results is limited by this study's sample size. Finding publicly available updated data on inbound academic tourism in the region of Barcelona was one of the main obstacles, and several higher education institutions were reluctant to cooperate. Similarly, it was difficult to obtain a higher response rate not only from industry stakeholders but also from international students. Nevertheless, in view of the multiple positive impacts of academic travel reported in this and previous investigations, the implications point to the convenience of sustaining this tourism niche in forthcoming post-pandemic scenarios. Public administrations, hand in hand with educational institutions and the hospitality industry, should therefore implement supportive policies, for example in terms of financial aids, promotional campaigns, and the regulation of international mobility.

To counterbalance the negative impacts of the pandemic as regards socio-cultural and economic loss, some compensatory measures have been pointed out in this article. Proximity tourism with longer academic stays ought to be further promoted. They could consist of combined experiences to make them more integrative and significant, for example including internships or volunteering projects. Additionally, to encourage a rebound of international academic tourism an image of a safe destination must be projected thanks to high vaccination rates and sound health procedures. The public and private sectors should undertake alliances across regions, and local authorities must endeavour to involve local stakeholders in academic tourism activities, particularly the host community. Virtual platforms and social media should be considered as engagement opportunities that can complement face-to-face interaction, also reinforced by educational institutions through mentoring and buddy programmes.

This study has established the foundations for further lines of investigation that ought to analyse in more depth expenditure and patterns of behaviour in relation to the consumption of touristic services, i.e., transport, accommodation, catering, and leisure. Cross-cultural development and adjustment experienced by both local community members and sojourners should also be investigated in specific contexts, and viable integration practices should be an object of analysis. There is a need to reflect on how meaningful immersion and authentic encounters can be facilitated for the benefit of all those who engage in them.

As the pandemic evolves, further research will be needed to continue identifying changes in inbound academic tourism flows, profiles, and impacts. Moreover, domestic academic tourism data should be examined, as well as outbound academic tourism indicators. Since new travel choices will be made, it is fundamental to know the effect of COVID-19 on destinations and tourist experiences, to redesign tourism supply accordingly, to take into account the factors that intervene in this changing landscape, and to foster innovation.

Finally, scholarly attention may also focus on academic tourism across different geographical regions through longitudinal contrastive projects. Despite local idiosyncrasies, some of the aspects that have been pinpointed in this study - such as the key role of digitalisation and technological innovation or the need to provide safe travel options to students who are eager to engage in study abroad experiences - will probably be global dynamics and trends. Likewise, the features that characterise the academic tourism micro-niche and its outcomes involve excellent prospects to diversify the socio-economic activities of academic destinations worldwide. How they can contribute to their post-pandemic sustainable development is another area that must be certainly researched.

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Ageing, therefore marginal: demographic trends and institutional capacity in marginal Chilean municipalities

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Abstract. In Global South countries, ageing is an incoming phenomenon with socio-spatial implications that are not much explored yet. Global North countries are already facing ageing trends with significant territorial consequences, such as declining populations that contribute to making certain areas marginal. However, different factors may determine the marginality of a municipality or a region in other settings. Drawing on these premises, the paper discusses whether ageing demographic trends contribute to territorial marginality also in a Global South setting. The paper focuses on the case of Chile, a country characterised by significant territorial inequalities and a population that is becoming older. In doing so, it has a twofold purpose: first, examine census data to define what areas are currently experiencing a demographic decline and if these correspond to the areas that national policies define as marginal; second, examine official documents to consider to what extent both national policies and local development plans define ageing as an element of marginality. The decline of population in Chile defines a geography of marginality that complements and expands the one defined in policy strategies, including more areas. In contrast, institutions at different levels are only partially prepared for dealing with the socio-spatial implications of an increasingly older population.

Key words: ageing, territorial marginality, institutional capacity, Chile

1 Introduction

Ageing is a significant phenomenon that increasingly affects also the Global South. Nowadays, older people are 10% of the world population, and ageing affects mainly Global North countries (United Nations 2019): for example, in 2019, older people were 23.1% of the European population, while in Latin America and the Caribbean, they accounted only for 10% of the overall population. Nonetheless, these proportions are expected to change in the next decades dramatically. While Europe is expected to consolidate as an old continent already in the next few decades (older people will be 39.2% of the population by 2050 and 43.7% by 2100), demographic forecasts indicate that Latin America will experience an even faster ageing process: the elderly population (that is, the amount of people aged 65 years and older) will amount to 23.4% already by 2050 and, at the end of the century, 45.6% of the Latin American population will be 65+ (United Nations 2019). These impressive demographic trends confirm thus that ageing will pose a significant challenge outside the Global North in the next few decades.

Ageing has significant socio-spatial implications for the development of cities and regions that nonetheless seem to have received less attention in Global South countries. For example, in Latin America, more attention has been given to issues such as life expectancy, pensions and welfare services (Bilal et al. 2019, Jeong 2013, Rotarou, Sakellariou 2019), in comparison to the spatial dimensions of ageing (Sánchez González 2015). These involve primarily the need to adapt existing settings to a population that is increasingly old and has different needs, in terms of valued opportunities, available resources and degrees of personal autonomy (Boldy et al. 2011, Chui 2008, Costa-Font et al. 2009). However, another crucial dimension is the impact on general demographic trends and their consequences for territorial development. While ageing is often (and mistakenly) associated with population decline (Jarzebski et al. 2021), the growing presence of older people can be observed in places with both a decreasing or an increasing number of inhabitants, be them shrinking regions or areas that attract retired people. In both cases, the effects on the development patterns, the fiscal autonomy and the overall quality of life of a certain place are significant, determining different 'urban futures' and making ageing a possible cause of territorial vulnerability (McCann 2017). Amongst the several consequences that ageing may have for a certain place, the impact on the 'territorial future' appears thus to be especially relevant in relation to what institutions can do in order to deal with increasingly older places. In fact, emerging demographic trends may not only determine new needs and opportunities of a changing population, but also affect the resources that are available to face them.

The socio-spatial effects of ageing could be thus stronger in areas that are already stagnating and losing inhabitants, appearing marginal. In Latin America, urban areas concentrate not only most of the population but also wealth, especially in the case of extractivist economies. While peripheral areas provide resources, the value they generate is captured by a few cities that act as gateways to the global economy (Atienza et al. 2021). Therefore, the combined concentration of inhabitants and resources determines significant forms of territorial inequality and may easily configure non-urban areas as "places that don't matter" (Rodríguez-Pose 2018), lacking opportunities and quality of life for their inhabitants (Collantes 2019, Vendemmia et al. 2021). Considering the future impact that ageing will also have on Latin American populations, it would be relevant to consider if, together with the concentration of wealth and inhabitants, also ageing acts as an additional factor that marginalises a specific territory.

Drawing on these premises, the paper intends to investigate if ageing demographic trends also contribute to determining a condition of territorial marginality in a Global South setting. The analysis focuses on Chile, a Latin American country that well represents some of the issues related to ageing, marginality and territorial inequality: it is a rapidly ageing country, with the highest presence of elderly inhabitants in the region – currently 10.6% of the population, while by 2050 one third of the Chilean inhabitants are expected to be aged 65+; (United Nations 2017); it is a highly unequal country, where economic activities and wealth show high levels of spatial concentration (Aroca et al. 2018, Badia-Miró 2020); and it is a country prone to marginality, due not only to its peculiar geography but also to the strong institutional centralisation (Orellana et al. 2016). Other Latin American countries have high shares of urban population and also show similar ageing trends, as in the case of Uruguay (14.9% of the population is aged 65+) and Brazil (9.3%) (United Nations 2019); nonetheless, these countries are less centralised than Chile or, as in the case of Uruguay, have undergone decentralisation processes (Ruiz Díaz 2018).

The paper focuses on municipalities where ageing processes have a higher incidence and considers how institutions at different levels currently deal with ageing. In particular, the analysis is based on three steps: (1) determine what municipalities are currently more exposed to ageing and to what extent these correspond to areas that national policies define as marginal; (2) consider if local institutions can deal with the needs of ageing local communities, providing basic services and developing plans that frame public action; (3) examine if their current development plans consider ageing as an issue. We hypothesise that ageing defines a different geography of marginality compared to official definitions, and that local institutions only partially address the ongoing demographic transformation despite its relevance for the development of these places.

2 Ageing: a phenomenon affecting territorial marginality and institutional capacity?

Even if territorial marginality is a fuzzy concept that has received quite different definitions (Moscarelli 2021), most definitions do not seem to consider ageing dynamics when defining a territory as marginal. In general, the relationship between a centre and its periphery defines what areas are marginal: those places that are far from a geographical centre, both in spatial and functional terms, are considered marginal since they are distant, dependent and different from the centre (Ferrão, Lopes 2004). Even from a regional perspective, such distance does not simply refer to a spatial dimension but also involves participation in a particular space's social and economic dynamics. If a territory is far from a centre and does not share its social, economic, and institutional features, it can be considered marginal (Copus 2001). A similar approach can also be found in the European Cohesion Policy, which defines as inner peripheries those areas with scarce access and poor socioeconomic conditions (Moscarelli 2021). The current definitions of territorial marginality tend thus to focus on the location of a specific place and its participation in ongoing socioeconomic dynamics but do not seem to address directly any demographic dimension.

Instead, adverse demographic trends may be observed in areas that were already defined as marginal based on other criteria, such as spatial proximity and access to basic opportunities. This is, for example the case of Italy, a country where national strategies define marginal areas according to their (lack of) access to health, education and mobility: the elements that identify such "institutional periphery" are thus mainly spatial features, even if the resulting marginal areas have in common trends such as population degrowth and increasing ageing (Vendemmia et al. 2021). Similarly, several regions of Spain experience the loss of population and a growing presence of older inhabitants, due to historical trend of migration towards urban, developed areas. These ageing trends are the result of a loss of population that occurred already in the central decades of the twentieth century, affecting especially those rural regions closer to developing urban areas (Pinilla, Sáez 2017).

Nonetheless, ageing is not simply a feature found in areas that are already marginal per se, but rather is a phenomenon that may differently impact the development of a specific place. As McCann (2017) discusses in relation to different urban futures, an ageing population may have different consequences on the development of a specific place. An ageing place may have a growing population, as in the case of coastal or rural areas that become destinations for specific forms of amenity-led migration (Gosnell, Abrams 2011): in this case, the impact of ageing can be positive for the local economic development. Instead, in those places that are losing inhabitants and where the remaining population is increasingly older, differences may be observed between urban, former industrial places and remote areas. In these two cases, different can be the implications on local development and the strategies to contrast the adverse effects of such demographic trends – as the different strategies deployed for shrinking areas (Haase et al. 2016) and inner peripheries (De Toni et al. 2021) demonstrate. The different impact that ageing can have on a territorial setting suggests that an increasingly older population is not necessarily observed in contexts that are marginal by definition. On the contrary, ageing can make a certain territory marginal or, under certain circumstances, avoid such conditions.

Ageing also has significant consequences for the institutions in charge of governing a specific territory and responding to its challenges. Institutional capacity is another slippery concept, generically considered as the ability to perform some of the varied tasks that government bodies are in charge of: for example, providing essential services and dealing with existing assets, such as infrastructures (Alm et al. 2021); manage scarce resources, as in the case of water (De Loë et al. 2002, Pirie et al. 2004), or plan and anticipate future threats, for example implementing policy to reduce disasters (McGregor et al. 2021). At least three levels define the capacity of an institution (Rosas Huerta 2008). At a micro level, crucial is the availability of resources, including financial and human ones. At a meso level, the management ability emerges as the element that determines the possibility to use existing resources to perform specific required tasks. Finally, at a

macro level, the capacity of an institution depends on its ability to interact with other significant actors, institutional or not, effectively. Ageing, mainly when observed in a context that is losing population, potentially negatively affects local institutions' capacity. Having a smaller local working population, the fiscal and financial resources available to local institutions in ageing places diminish, affecting the institutional capacity at a micro level. As a consequence, also their capacity to deal with the challenges of ageing (referring thus to the meso level), for example providing the services necessary for an increasingly older population, decreases.

Finally, ageing could further reduce the institutional capacity to deal with territories whose marginal condition poses specific challenges for the government bodies in charge of them. An example in this sense are the so-called 'places that don't matter', declining areas where local discontent has converged into populist electoral results (Rodríguez-Pose 2018). In these places, experiencing economic crises and population losses, only some inhabitants remain: and in many cases, these are the older, retired citizens whose age and emotional attachment to these places make their relocation unlikely (Rodríguez-Pose 2018, p. 201). The marginal nature of these places can affect the action of institutions in at least two senses. First, when the perceived marginality leads to antagonistic electoral results, the political divide between marginal, populist territories and central, "privileged" places can affect institutional capacity at a macro level, reducing one institution's ability to cooperate with other institutional bodies both horizontally and vertically. Second, these revengeful and antagonistic attitudes can affect the administration of marginal places even when electoral results do not reflect a populist shift. For example, marginal places can adopt an antagonistic attitude also in relation to the definition of their local identity and its consequences for planning decisions and processes (Mattila et al. 2020).

3 The case of Chile: ageing in an unequal, centralised country

Territorial marginality is only partially a policy priority in Chile, although several features of the country – geographically, economically and socio-politically – contribute to determining a marginal condition for several areas of the country. First of all, the geography of Chile is unfavourable, or even "crazy", according to a Chilean essayist (Subercaseaux 2005). The country's northern regions are characterised by deserts, while the southern parts of it have a cold climate and are fragmented into several islands, increasing their isolation. As a result, in a country which is 4.270 km long, 90% of its population lives in cities and especially in the Metropolitan Region, which includes the capital city of Santiago: even if the area covers only 2% of the Chilean territory, 40% of the national population lives there (INE 2018). Moreover, Chile's government has traditionally been centralist, struggling with decentralisation and resisting the transfer of attributions to regional and local governments (Orellana et al. 2016). Also economic activities reflect such centralist attitude, showing extractive mechanisms that favour the capital city and do not benefit the territories where these different activities – such as mining, forestry, intensive cultivations and farming – are realised (Atienza et al. 2021). As a consequence, the relevant socioeconomic inequalities of the country (Agostini, Brown 2007) become even stronger in non-metropolitan territories, leading to several socio-territorial conflicts (Delamaza et al. 2017). The geographical, economic, and political features of Chile contributed thus to marginalise vast parts of the country, determining significant forms of territorial inequality that public investments have not been able to address effectively (Orellana-Ossandon et al. 2020).

In a country where territorial disparities are an important public issue, ageing could become an additional determinant of marginality. The proportion of older people in Latin American countries is increasing (Gietel-Basten et al. 2020). This trend is even more intense in Chile, where older people have been 11.4% of the population in 2017, and will be 33% of the total population by 2050 (United Nations 2017). Here, the neoliberal policies that have characterized the country in the last decades determine that the provision of public welfare services is scarce in terms of quality and availability (Jeong 2013, Kurtz 2002, Wigell 2017), affecting mainly the quality of life of older people and configuring ageing as an additional element of fragility. As a result, pensions became one of the most

mentioned elements during the 2019 protests of Chile's estallido social and one of the most debated social welfare issues during the COVID-19 pandemic (Heiss 2020). The presence of a fragile group such as older people may affect mainly rural areas, where they prevail (INE 2018). However, their presence seems to have a different effect according to the places taken into account (McCann 2017): seaside or lake locations experiencing forms of internal amenity-led migration may benefit from a growing ageing population (Vecchio et al. 2022), while other places may have an increasingly older population due to the internal migration of younger inhabitants (Rodríguez Vignoli 2019). Ageing appears thus to be a potentially significant and partially overlooked phenomenon that could further affect the development of territories that in Chile are already experiencing significant forms of marginality.

Nonetheless, the existing policy on territorial marginality does not consider ageing as a possible issue. In particular, the convergence policy of Chile defines "left behind regions" (zonas rezagadas) according to two criteria: isolation and social gaps. Isolation refers to localities "that have difficulties of accessibility and physical connectivity, have very low population density, present dispersion in the territorial distribution of their inhabitants, and show low presence and coverage of basic and public services, according to the existing relationship between the components of structural isolation and degree of integration" (Ministerio del Interior y de Seguridad Pública 2018). Social gaps instead represent "the distance between communal poverty and regional poverty, which is understood as the difference between the average income poverty rate and the multidimensional poverty rate of each commune, and the regional average of both rates" (Ministerio del Interior y de Seguridad Pública 2018). Other national policies, more generically referred to rural areas (Subsecretaria de Desarrollo Regional 2020), rapidly mention older people as a group that deserves "priority attention" – together with women, youth, indigenous people, disabled people and migrants (Subsecretaria de Desarrollo Regional 2020). Even at a local scale, rural municipalities' local development plans (PlaDeCo) do not mention ageing as a challenge to be addressed, focusing instead on other relevant issues such as vulnerability, social equity and housing (Orellana-Ossandon et al. 2020). In synthesis, Chile presents significant issues of territorial marginality, and ageing is a potentially more fragile condition than in other countries; nonetheless, these two issues – part of the national policy debate – do not seem to dialogue between each other yet.

4 Methodology

To examine whether ageing demographic trends contribute to determine a condition of territorial marginality also in Chile, the paper draws on a three-steps analysis. These are intended to detect the municipalities that are currently facing intense ageing processes, to synthetically assess their institutional capacity, and to examine to what extent they perceive ageing as a policy issue.

4.1 Definition of ageing municipalities

First, census data from the Chilean censuses of 2002 and 2017 (INE 2003, 2018) are examined to detect which municipalities are currently facing relevant ageing processes. The 2012 census was not considered since it has serious issues of representativeness that affects its validity (Neupert 2017). Although data are available also for previous censuses, the analysis focuses on the first two decades of the twenty-first century since this is the moment in which the Chilean demographic pyramid starts to change and the share of older population increases, showing changes in established demographic trends. The analysis considers 345 Chilean municipalities (excluding the municipality of Antártica, which is not recognised internationally) and first selects those municipalities where in the last census the elderly population was above the national average (11.4%), calculating the ratio between older inhabitants (aged 65+) and the overall municipal population. Then, in the selected municipalities the evolution of the population is considered, examining what municipalities have been losing inhabitants in the last years (comparing the 2002 and the 2017 census). In doing so, those municipalities facing a situation of potential demographic decline are selected. Finally, the set of selected municipalities is compared

Table 1: Variables and indicators used for the synthetic index of institutional capacity

Variable	SINIM indicator	Type of item
Fiscal autonomy	Dependency from the Common municipal Fund	Continuous (%)
Socioeconomic conditions of the population	Percentage of inhabitants under the line of poverty	Continuous (%)
Provision of health services	Number of municipal clinics	Continuous (nr)
	Number of municipal rural clinics	Continuous (nr)
Capacity to plan	Existence of a land use plan	Discrete (yes/no)
	Existence of a community development plan	Discrete (yes/no)
	Antiquity of the community development plan	Continuous (nr years)

Source: own elaboration

to the group of municipalities that are officially defined as isolated zones or as zonas rezagadas – that is, lagging areas for which development strategies are a priority. This last step examines how many municipalities previously selected are also officialy defined as lagging or isolated zones.

4.2 Assessment of the municipal institutional capacity

To consider the capacity of local institutions to deal with the needs of their communities – especially in relation to ageing populations – the analysis focuses on the selected municipalities to assess the financial resources available to them and their ability to provide certain essential services. It is important to notice that in Chile, due to profound administrative reforms promoted under Pinochet's military dictatorship, the provision of public services such as health and education is in charge of municipalities. At the same time, the financial resources available to them mainly come from the taxes they can collect. A national fund – Fondo Común Municipal (common municipal fund) – redistributes resources among municipalities so that the dependence from this source is a proxy of the resources (or scarcity of) available to a municipality.

Therefore, a synthetic index of institutional capacity is proposed, considering two dimensions (see Table 1 for a detailed presentation of variables and indicators). On the one hand, the index consideres the resources available to the municipality and its population, considering the dependency on the common municipal fund and the percentage of inhabitants in a condition of poverty. On the other hand, the index considers the services that a municipality can provide, focusing on basic health services that can be important for older people (clinics and rural clinics) as well as the planning tools available to the municipality. These include both normative land use planning tools (Plan Regulador Comunal) and strategic planning tools (Plan de Desarrollo Comunitario, community development plan), and reflect the ability of a municipality to project its action on a longer temporal horizon. Data referred to these items are based on data from the Chilean National System of Municipal Information (SINIM – Sistema Nacional de Información Municipal). Depending on the type of item (Table 1), discrete variables can receive 1 or 0 points (if a plan is available or not), while a 0-1 normalisation is applied to continuous variables. The average score of each municipality in relation to these items determines their final institutional capacity score.

4.3 Analysis of community development plans

To consider if the municipalities consider their ageing condition as a policy priority, a content analysis of their community development plans is performed. Being a strategic tool, these plans are usually easier to update compared to land use planning tools, and they can usefully express to what extent a municipality perceives specific issues as a priority. The analysis is performed on 39 plans, examining the plans that municipalities made publicly available on their websites. First, the analysis examines if plans mention ageing as a phenomenon that is affecting the municipality, estimating if and how the plans conceptualise this demographic trend. Second, the analysis focuses on more specific references to older people and demographic issues, determining what the strategies and actions deployed to deal with the needs of this growing population group are.

5 Results

5.1 Marginal and ageing municipalities in Chile: a partially overlapping geography

In Chile, the current definitions of isolated or lagging areas do not cover most municipalities where ageing can determine a condition of marginality. Examining census data for the 345 Chilean municipalities, the majority of them (243) currently shows a number of older people higher than the national average. These involve very different places, from isolated villages to boroughs of Santiago's metropolitan area. However, only 70 of these municipalities are currently experiencing also population loss, and, among them, 48 are small, rural municipalities (with less than 25.000 inhabitants; here we exclude municipalities with more inhabitants and places that are not rural, as per Berdegué et al. 2010). These places show some differences in relation to the intensity of their demographic decline (Table 2). Some municipalities show a condition of relative stability (-0.6%, Hualañe) of its population over 15 years, while others show a more intense loss of inhabitants (-15.8%, in Lumaco). As for ageing, the incidence of older people ranges from values slightly higher than the national average (12.3%, in Futrono) to a stronger presence (20.5 %, in Curepto). Interestingly, the municipalities where older people are more present are not the places that have lost more inhabitants and vice versa. The preliminary selection of municipalities highlights thus that 14% of Chilean municipalities are currently experiencing demographic trends that may define a potential condition of territorial marginality.

Table 2: Population of the selected ageing municipalities; regions are shown from North to South

Region	Municipality	Inhabitants in 2002	Inhabitants in 2017	Population loss (2002-17)	Older inhabitants (2017)	% of older inhabitants (2017)
Atacama	Canela	9.420	9.093	-3.5%	1.821	20.0%
Atacama	Combarbalá	13.531	13.322	-1.5%	2.521	18.9%
Atacama	Río Hurtado	4.770	4.278	-10.3%	843	19.7%
O'Higgins	Paredones	6.656	6.188	-7.0%	1.179	19.1%
O'Higgins	Pumanque	3.477	3.421	-1.6%	649	19.0%
Maule	Curepto	10.712	9.448	-11.8%	1.934	20.5%
Maule	Empedrado	4.203	4.142	-1.5%	525	12.7%
Maule	Chanco	9.423	8.928	-5.3%	1.394	15.6%
Maule	Hualañe	9.720	9.657	-0.6%	1.602	16.6%
Maule	Licantén	6.732	6.653	-1.2%	984	14.8%
Maule	Vichuquén	4.786	4.322	-9.7%	735	17.0%
Biobío	Florida	10.889	10.624	-2.4%	1.796	16.9%
Biobío	Quilleco	10.327	9.587	-7.2%	1.662	17.3%
Biobío	San Rosendo	3.971	3.412	-14.1%	563	16.5%
Ñuble	Cobquecura	5.579	5.012	-10.2%	1.015	20.3%
Ñuble	El Carmen	12.780	12.044	-5.8%	1.910	15.9%
Ñuble	Ninhue	5.737	5.213	-9.1%	987	18.9%
Ñuble	Ñiquén	11.417	11.152	-2.3%	2.005	18.0%
Ñuble	Pemuco	8.788	8.448	-3.9%	1.175	13.9%

Continued on next page

Table 2 – continued from previous page

Region	Municipality	Inhabitants in 2002	Inhabitants in 2017	Population loss (2002-17)	Older inhabitants (2017)	% of older inhabitants (2017)
Ñuble	Portezuelo	5.362	4.862	-9.3%	845	17.4%
La Araucanía	Carahue	25.575	24.533	-4.1%	3.601	14.7%
La Araucanía	Cunco	18.800	17.526	-6.8%	3.055	17.4%
La Araucanía	Freire	25.163	24.606	-2.2%	3.472	14.1%
La Araucanía	Galvarino	12.635	11.996	-5.1%	1.739	14.5%
La Araucanía	Gorbea	15.215	14.414	-5.3%	2.417	16.8%
La Araucanía	Saavedra	13.995	12.450	-11.0%	2.041	16.4%
La Araucanía	Teodoro Schmidt	15.323	15.045	-1.8%	2.513	16.7%
La Araucanía	Toltén	11.201	9.722	-13.2%	1.533	15.8%
La Araucanía	Ercilla	9.131	7.733	-15.3%	1.072	13.9%
La Araucanía	Los Sauces	7.603	7.265	-4.4%	1.114	15.3%
La Araucanía	Lumaco	11.335	9.548	-15.8%	1.405	14.7%
La Araucanía	Purén	12.965	11.779	-9.1%	1.742	14.8%
La Araucanía	Traiguén	19.179	18.843	-1.8%	2.921	15.5%
Los Ríos	Los Lagos	20.117	19.634	-2.4%	2.525	12.9%
Los Ríos	Máfil	7.147	7.095	-0.7%	995	14.0%
Los Ríos	Futrono	14.899	14.665	-1.6%	1.807	12.3%
Los Ríos	Lago Ranco	10.034	9.896	-1.4%	1.473	14.9%
Los Lagos	Cochamó	4.323	4.023	-6.9%	647	16.1%
Los Lagos	Fresia	12.620	12.261	-2.8%	1.832	14.9%
Los Lagos	Maullín	15.621	14.216	-9.0%	2.339	16.5%
Los Lagos	Puqueldón	4.124	3.921	-4.9%	647	16.5%
Los Lagos	Quemchi	8.553	8.352	-2.4%	1.293	15.5%
Los Lagos	Quinchao	8.932	8.088	-9.4%	1.218	15.1%
Los Lagos	Puerto Octay	10.171	8.999	-11.5%	1.132	12.6%
Los Lagos	Purranque	20.814	20.369	-2.1%	3.038	14.9%
Los Lagos	Río Negro	14.732	14.085	-4.4%	2.159	15.3%
Los Lagos	San Juan De La Costa	8.782	7.512	-14.5%	1.371	18.3%
Los Lagos	San Pablo	10.137	10.030	-1.1%	1.650	16.5%

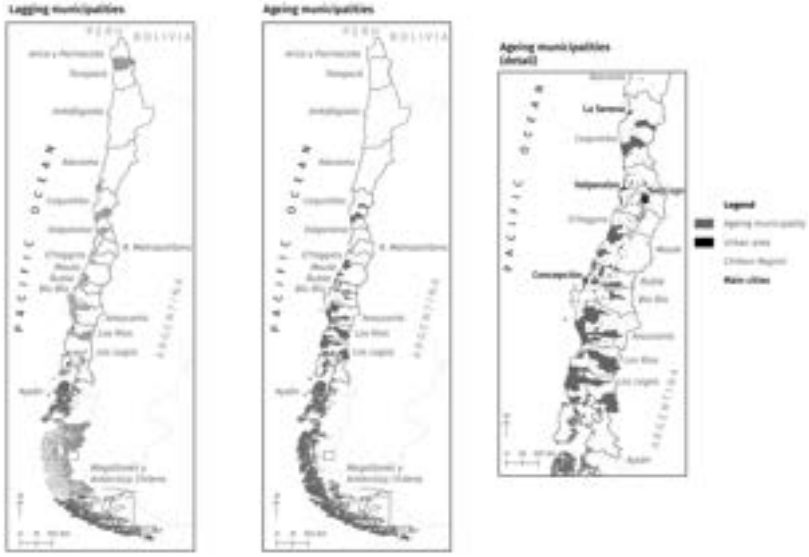
Source: own elaboration on INE, 2003, 2018

These municipalities are concentrated in a relatively limited extension of the Chilean territory, excluding the most extreme regions of the country (Figure 1). These include places ranging from the Region of Coquimbo, in the North, to the Region of Los Lagos, in the South, but some clusters emerge in the central-southern part of Chile: one between the regions of O' Higgins and Maule, another one in La Araucanía (the most deprived region of Chile), and two in the regions of Los Ríos and Los Lagos. While different are the locations of these municipalities, several of them are located between coastal and rural zones. The distribution of these municipalities seems thus to confirm that internal migration does not affect the most extreme regions of the country (Rodríguez Vignoli 2019).

The resulting geography shows some differences with the municipalities that Chilean national policies identify as lagging areas (Figure 1). The Chilean Subsecretariat for Regional Development currently identifies 66 municipalities as lagging areas, based on their isolation and social deprivation. However, only 23 of the ageing municipalities currently belong to lagging areas. The main overlaps can be observed in the rural regions of Maule and La Araucanía, while in other zones there is a partial correspondence: ageing municipalities are part of wider lagging zones, or instead define autonomous clusters. Moreover, lagging areas also include municipalities in extreme regions of Northern and Southern Chile. Therefore, ageing municipalities in Chile define a geography of marginality that is potentially different from that of lagging areas: in some cases, demographic decline adds to an already recognised condition of socio-spatial marginality; in others, the increasingly older remaining population can determine a situation of fragility despite the good physical connectivity and favourable socioeconomic conditions.

5.2 Municipal institutional capacity: different capacities in deprived settings

The examined municipalities show pretty different levels of institutional capacity (Table 3 and Figure 2). The index of institutional capacity shows the existence of different degrees



Source: own elaboration

Figure 1: Lagging and ageing municipalities in Chile

of capacity when comparing ageing municipalities. Some places show low results (such as the municipalities of Galvarino and Teodoro Schmidt, whose score is 0.27), while others score better (for example, the municipality of Gorbea, with a score of 0.70); interestingly, these municipalities are part of the same deprived region, La Araucanía. Comparing the municipalities that are defined as lagging zones or not, the municipalities with lower and higher capacity shows similar results; instead, the average capacity of the two groups is slightly different, being higher in the case of non-lagging areas. As for the spatial distribution of the municipalities with different scores, apparently, no clear patterns emerge (although an analysis of spatial autocorrelation would be relevant if the index of institutional capacity were available for each municipality of the country). While in some cases neighbouring municipalities show similar levels of institutional capacity (as in the regions of Los Ríos and, partially, Los Lagos), even the main clusters of ageing municipalities show different results: the most evident case is that of La Araucanía, where towns with higher and lower scores are close to each other. As represented in the synthetic index proposed, institutional capacity reflects a territorial multiplicity that does not correspond exactly to existing definitions of marginality (based on geographical distance and socioeconomic deprivation), nor new definitions based on demographic variables.

Considering the elements that constitute the institutional capacity, a more nuanced picture emerges. In relation to the financial resources available to a municipality, the levels of autonomy of each town are quite different: the majority of them – except one – depend on the common municipal fund, and more than half of their resources depend on transfers from the national government; however, on average only 20% of the financial resources is raised locally and, in some cases, there is almost a total dependence from the common fund (as in Saavedra, where 95% of the resources derive from national transfers). In relation to the population above the poverty threshold, more than half of the inhabitants belong to this group in each examined municipality, ranging from 63% in Galvarino to 89% in Gorbea, Pumanque and Purranque. As for the health services provided by municipalities, only in 9 out of 48 a clinic is available. While the availability of this service should depend on the number of inhabitants, no direct correspondence is observed between a higher number of inhabitants and the presence of such service. Different is the situation for rural clinics, basic services in charge of responding to the first health needs of the inhabitants and not able to deal with medical emergencies. In the examined municipalities, the number of rural clinics ranges from 0 to 14, which probably depends on the more or less dispersed spatial distribution of the population, rather than on the simple overall number of inhabitants.

Table 3: Institutional capacity of the selected ageing municipalities: synthetic index and indicators (normalized scores)

Region	Comuna	Part of a lagging area	Institutional capacity – synthetic index	Fiscal autonomy	Socioeconomic conditions of the population	Number of municipal clinics	Number of municipal rural clinics	Existence of a land use plan	Existence of a community development plan	Antiquity of the community development plan
Atacama	Canela	yes	0.50	0.56	0.46	0.00	0.64	0.00	1.00	0.80
Atacama	Combarbalá	yes	0.48	0.20	0.79	0.00	0.86	0.00	1.00	0.50
Atacama	Río Hurtado	no	0.37	0.30	0.75	0.00	0.43	0.00	1.00	0.10
O'Higgins	Paredones	yes	0.49	0.07	0.84	0.00	0.21	1.00	1.00	0.30
O'Higgins	Pumanque	yes	0.40	0.35	1.00	0.00	0.21	0.00	1.00	0.20
Maule	Curepto	no	0.57	0.29	0.82	0.00	0.57	1.00	1.00	0.30
Maule	Empedrado	yes	0.38	0.10	0.78	0.00	0.07	0.00	1.00	0.70
Maule	Chanco	yes	0.35	0.18	0.64	0.00	0.50	0.00	1.00	0.10
Maule	Hualañe	no	0.38	0.53	0.60	0.00	0.21	0.00	1.00	0.30
Maule	Licantén	no	0.33	0.28	0.53	0.00	0.29	0.00	1.00	0.20
Maule	Vichuquén	no	0.51	1.00	0.76	0.00	0.29	0.00	1.00	0.50
Biobío	Florida	no	0.46	0.14	0.80	0.00	0.29	1.00	1.00	0.00
Biobío	Quilleco	no	0.36	0.29	0.80	0.00	0.21	0.00	1.00	0.20
Biobío	San Rosendo	no	0.31	0.01	0.62	0.00	0.07	0.00	1.00	0.50
Ñuble	Cobquecura	yes	0.45	0.11	0.12	0.00	0.14	1.00	1.00	0.80
Ñuble	El Carmen	no	0.54	0.23	0.32	0.00	0.71	1.00	1.00	0.50
Ñuble	Ninhue	yes	0.47	0.09	0.45	0.00	0.14	1.00	1.00	0.60
Ñuble	Ñiquén	no	0.50	0.23	0.65	0.00	0.00	1.00	1.00	0.60
Ñuble	Pemuco	no	0.62	0.71	0.51	0.00	0.14	1.00	1.00	1.00
Ñuble	Portezuelo	yes	0.48	0.04	0.70	0.00	0.14	1.00	1.00	0.50
La Araucanía	Carahue	yes	0.55	0.07	0.48	0.00	1.00	1.00	1.00	0.30
La Araucanía	Cunco	no	0.53	0.39	0.66	1.00	0.43	0.00	1.00	0.20
La Araucanía	Freire	no	0.53	0.27	0.50	0.00	0.57	1.00	1.00	0.40
La Araucanía	Galvarino	no	0.27	0.09	0.00	0.00	0.71	0.00	1.00	0.10
La Araucanía	Gorbea	no	0.70	0.24	0.98	1.00	0.36	1.00	1.00	0.30
La Araucanía	Saavedra	yes	0.40	0.00	0.07	0.00	1.00	1.00	0.00	0.70
La Araucanía	Teodoro Schmidt	yes	0.27	0.04	0.37	0.00	0.29	0.00	1.00	0.20
La Araucanía	Toltén	yes	0.44	0.11	0.08	0.00	0.50	1.00	1.00	0.40
La Araucanía	Ercilla	yes	0.51	0.21	0.40	1.00	0.29	0.00	1.00	0.70
La Araucanía	Los Sauces	yes	0.51	0.21	0.50	1.00	0.29	0.00	1.00	0.60

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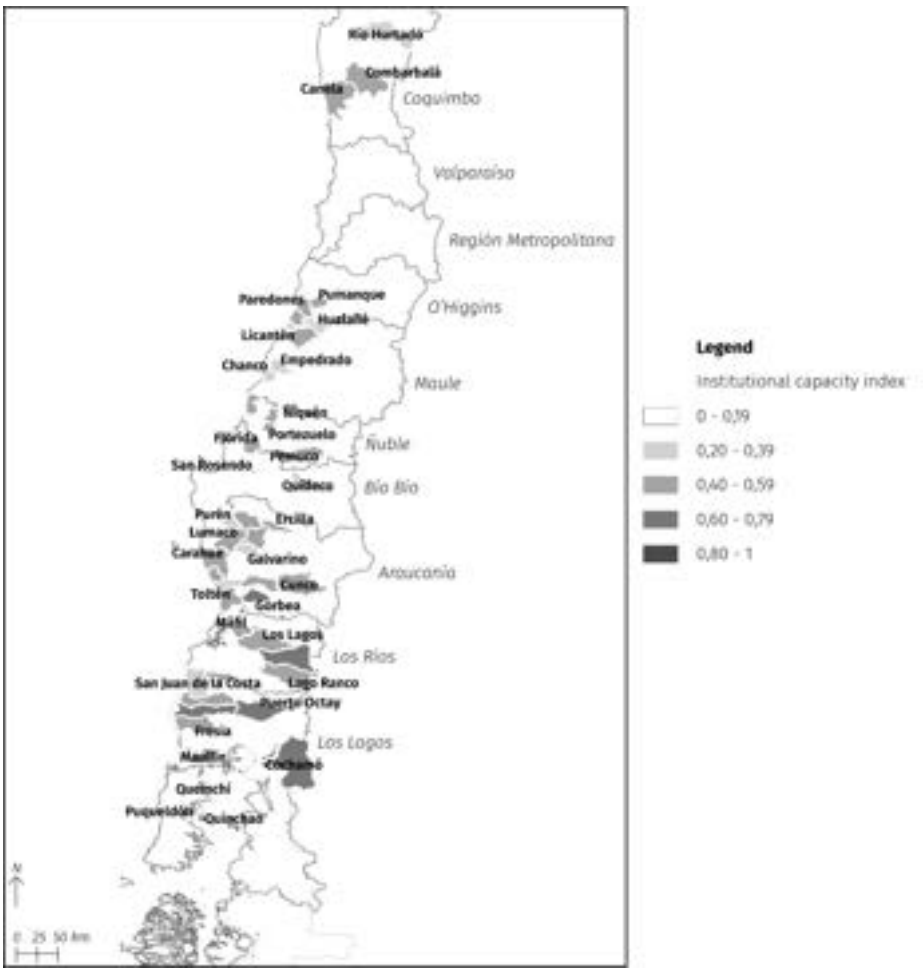
Table 3 – continued from previous page

Region	Comuna	Part of a lagging area	Institutional capacity – synthetic index	Fiscal autonomy	Socioeconomic conditions of the population	Number of municipal clinics	Number of municipal rural clinics	Existence of a land use plan	Existence of a community development plan	Antiquity of the community development plan
La Araucanía	Lumaco	yes	0.40	0.10	0.15	1.00	0.36	0.00	1.00	0.20
La Araucanía	Purén	yes	0.35	0.05	0.74	0.00	0.36	0.00	1.00	0.30
La Araucanía	Traiguén	yes	0.50	0.26	0.60	0.00	0.43	1.00	1.00	0.20
Los Ríos	Los Lagos	no	0.60	0.54	0.82	0.00	0.43	1.00	1.00	0.40
Los Ríos	Máfil	no	0.52	0.32	0.93	0.00	0.07	1.00	1.00	0.30
Los Ríos	Futrono	yes	0.69	0.51	0.87	1.00	0.36	1.00	1.00	0.10
Los Ríos	Lago Ranco	yes	0.57	0.56	0.85	0.00	0.36	1.00	1.00	0.20
Los Lagos	Cochamó	no	0.67	0.33	0.89	1.00	0.57	0.00	1.00	0.90
Los Lagos	Fresia	no	0.56	0.35	0.72	0.00	0.64	1.00	1.00	0.20
Los Lagos	Maullín	no	0.51	0.20	0.79	1.00	0.36	0.00	1.00	0.20
Los Lagos	Puqueldón	yes	0.39	0.25	0.88	0.00	0.29	0.00	1.00	0.30
Los Lagos	Quemchi	yes	0.60	0.38	0.64	1.00	0.57	0.00	1.00	0.60
Los Lagos	Quinchao	yes	0.50	0.35	0.39	0.00	0.57	1.00	1.00	0.20
Los Lagos	Puerto Octay	no	0.66	0.72	0.87	0.00	0.43	1.00	1.00	0.60
Los Lagos	Purranque	no	0.66	0.59	0.98	0.00	0.57	1.00	1.00	0.50
Los Lagos	Río Negro	no	0.57	0.52	0.83	0.00	0.14	1.00	1.00	0.50
Los Lagos	San Juan De La Costa	no	0.36	0.06	0.19	0.00	0.36	0.00	1.00	0.90
Los Lagos	San Pablo	no	0.47	0.52	0.78	0.00	0.00	1.00	1.00	0.00

Source: own elaboration on SINIM, 2021



Source: own elaboration

Figure 2: Institutional capacity of ageing municipalities in Chile

Finally, as for the availability of planning tools, only 25 out of 48 municipalities have a land use plan. Considering that in Chile these tools include urban areas but not rural ones, municipalities with a mainly rural territory may not consider planning as a priority. Different is the case for community development plans, which are available in all municipalities but one. These are quite recent documents, considering that the newest one was adopted in 2021 and the oldest one in 2011. On average, these plans have an antiquity of four years, something coherent with both the duration of a mayor's term (four years) and with the fact that municipal elections took place in the whole Chilean territory in 2021 and, before, in 2017.

5.3 Community development plans: recognising ageing without tackling it

In the examined community development plans, ageing is mainly recognized as affecting these marginal territories. 29 out of 39 examined plans – that is, three out of four – explicitly mention ageing as a significant phenomenon that municipal institutions need to deal with (Table 4). Among them, ageing is considered in two ways. On the one hand, several municipalities consider it simply as an ongoing phenomenon, mentioning that the number of older inhabitants has grown and highlighting similarities with regional or national demographic trends. On the other hand, other municipalities mention ageing as a threat, for example in SWOT analyses: when considered a negative phenomenon, ageing is mentioned together with issues such as loss of population, diminution of youth, and adverse demographic trends that affect mainly rural areas.

Table 4: Contents referred to ageing in the examined local development plans

Region	Comuna	Part of a lagging area	Has a community development plan	Antiquity of the plan	Acknowledges ageing as an issue	Proposes strategies for ageing	Proposes leisure activities	Proposes active ageing	Proposes care services
Atacama	Canela	yes	yes	8	yes	yes	yes	no	yes
Atacama	Combarbalá	yes	yes	5	no	yes	no	no	no
Atacama	Río Hurtado	no	yes	1	plan not available	-	-	-	-
O'Higgins	Paredones	yes	yes	3	yes	no	no	no	yes
O'Higgins	Pumanque	yes	yes	2	plan not available	-	-	-	-
Maule	Curepto	no	yes	3	yes	no	no	no	yes
Maule	Empedrado	yes	yes	7	yes	yes	no	yes	yes
Maule	Chanco	yes	yes	1	yes	no	no	no	yes
Maule	Hualañe	no	yes	3	yes	no	no	no	no
Maule	Licantén	no	yes	2	no	no	yes	no	no
Maule	Vichuquén	no	yes	5	yes	yes	yes	yes	no
Biobío	Florida	no	yes	0	yes	yes	yes	yes	yes
Biobío	Quilleco	no	yes	2	yes	yes	no	no	yes
Biobío	San Rosendo	no	yes	5	yes	yes	yes	yes	yes
Ñuble	Cobquecura	yes	yes	8	plan not available	-	-	-	-
Ñuble	El Carmen	no	yes	5	plan not available	-	-	-	-
Ñuble	Ninhue	yes	yes	6	yes	no	no	no	yes
Ñuble	Ñiquén	no	yes	6	yes	yes	no	no	no
Ñuble	Pemuco	no	yes	10	no	no	no	no	yes
Ñuble	Portezuelo	yes	yes	5	yes	no	no	no	no
La Araucanía	Carahue	yes	yes	3	no	yes	no	yes	yes
La Araucanía	Cunco	no	yes	2	yes	yes	no	yes	no
La Araucanía	Freire	no	yes	4	plan not available	-	-	-	-
La Araucanía	Galvarino	no	yes	1	yes	no	yes	no	yes

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Table 4 – continued from previous page

Region	Comuna	Part of a lagging area	Has a community development plan	Antiquity of the plan	Acknowledges ageing as an issue	Proposes strategies for ageing	Proposes leisure activities	Proposes active ageing	Proposes care services
La Araucanía	Gorbea	no	yes	3	yes	no	no	no	yes
La Araucanía	Saavedra	yes	no	7	plan not available	-	-	-	-
La Araucanía	Teodoro Schmidt	yes	yes	2	yes	yes	no	no	yes
La Araucanía	Toltén	yes	yes	4	yes	no	no	no	yes
La Araucanía	Ercilla	yes	yes	7	yes	yes	no	yes	no
La Araucanía	Los Sauces	yes	yes	6	plan not available	-	-	-	-
La Araucanía	Lumaco	yes	yes	2	yes	yes	no	yes	no
La Araucanía	Purén	yes	yes	3	yes	yes	yes	yes	yes
La Araucanía	Traiguén	yes	yes	2	yes	yes	yes	yes	no
Los Ríos	Los Lagos	no	yes	4	plan not available	-	-	-	-
Los Ríos	Máfil	no	yes	3	no	yes	yes	no	no
Los Ríos	Futrono	yes	yes	1	yes	yes	no	no	yes
Los Ríos	Lago Ranco	yes	yes	2	plan not available	-	-	-	-
Los Lagos	Cochamó	no	yes	9	yes	no	no	yes	no
Los Lagos	Fresia	no	yes	2	yes	yes	yes	yes	yes
Los Lagos	Maullín	no	yes	2	yes	yes	no	no	yes
Los Lagos	Puqueldón	yes	yes	3	no	no	no	no	no
Los Lagos	Quemchi	yes	yes	6	yes	no	no	yes	no
Los Lagos	Quinchao	yes	yes	2	no	no	no	no	no
Los Lagos	Puerto Octay	no	yes	6	yes	no	no	yes	no
Los Lagos	Purranque	no	yes	5	yes	no	no	no	no
Los Lagos	Río Negro	no	yes	5	no	yes	no	no	no
Los Lagos	San Juan De La Costa	no	yes	9	no	no	no	no	yes
Los Lagos	San Pablo	no	yes	-	no	no	no	no	no

Source: own elaboration

Nonetheless, the references to the increasing presence of older people do not necessarily lead to addressing the ongoing demographic decline or the welfare of the elderly population: in fact, 20 municipalities propose measures for their older inhabitants. In doing so, the actions fall into three categories. First, the most common refers to the provision of health care services, including home care, transfer to clinics and medical assistance more in general (found in 20 municipalities). Second, 14 municipalities promote active ageing, proposing measures to prevent or accompany the effects of ageing – for example, programs that focus on older people's physical and mental health. Interestingly, some of the measures for active ageing in rural municipalities also focus on training, so that older inhabitants can continue working in their farms, and in promoting literacy, to facilitate the application of the ageing population to public funds that can support their working activities. Finally, a smaller number of municipalities (10) focuses on leisure activities, promoting trips and other social events to entertain their older inhabitants. However, only four out of 29 examined plans propose actions that refer to these three categories, showing thus partial approaches to the needs of an increasingly older population.

6 Discussion

Considering the current demographic trends of Chile, ageing appears as a condition of potential territorial marginality. In a slowly but increasingly ageing country, the increase in the number of ageing inhabitants and the loss of population affect mainly rural areas. These include places that could be potentially defined as marginal based on spatial proximity and socioeconomic conditions. The selected places are located mainly in the central and southern regions of Chile, excluding the most extreme areas of the country. These places appear to be marginal primarily from a spatial perspective, considering that often they are far from metropolitan areas and from the main longitudinal corridor that connects Chile from North to South. Moreover, these are also excluded from the main socioeconomic processes of the country, that outside the main metropolitan areas are mainly referred to the presence of extractivist industries; as a result, significant flows of internal immigration originate from these regions. It must be noticed that none of the examined municipalities shows more than 30% of older inhabitants, a value that – based on other declining settings (Golini et al. 2000) – can be considered as the threshold determining the possible extinction of a community. Based on these elements, in the case of Chile, ageing seems to reinforce trends of territorial marginalisation that are already ongoing rather than determining new trajectories of development. Moreover, the current demographic trends define ageing as an emerging issue rather than as a structural condition of marginal areas.

Ageing defines a geography of territorial marginality that is different from the institutional one. The institutional definitions, in fact, rely on traditional criteria, focusing on spatial proximity and social deprivation (Ferrão, Lopes 2004, Moscarelli 2021). Moreover, more recent definitions seem to privilege the latter dimension: a 2021 document defines municipalities that could be defined as lagging areas focusing mainly on their socioeconomic condition, leading to the contradictory results of having both rural villages and big cities of the country (such as Valparaíso) within the same category (Subsecretaria de Desarrollo Regional 2021). As a result, the municipalities where ageing is a further determinant of marginality only partially correspond with institutional definitions of lagging areas. More interestingly, ageing municipalities in some cases would expand existing clusters of lagging municipalities. Considering the potential impact of demographic trends on places already left behind (McCann 2017), it would be relevant to include ageing and other demographic dynamics when defining marginal territories, instead of considering ageing simply as an element that characterises areas that are marginal per se.

While the features of demographic decline allow defining an alternative geography of marginality, the institutional capacity does not allow to do so. The institutional capacity of the examined municipalities in fact does not seem to suffer from the ongoing ageing processes, or at least not yet. Despite the lack of a comparison with other, non-ageing places, the selected municipalities show certain differences among them when examining

the resources available to them and the services they can provide (referring thus to the micro and meso level of institutional capacity, according to Rosas Huerta 2008). The scarcity of financial resources is a common issue among the examined areas, even if the level of poverty of their population is different. The provision of health services demonstrates more significant differences that probably are related to the spatial distribution of a population (i.e., more clinics are necessary to spatially cover a sparser population, living in several rural settlements) rather than to the resources available to a municipality or to the number of inhabitants to be served. These differences suggest the importance of considering the accessibility to certain essential services when defining marginal areas. In other settings, the accessibility to basic services – the possibility to access places such as schools, hospitals or stations within a certain spatial or temporal distance – is a criterion used to define what areas are marginal (see for example Vendemmia et al. 2021). Instead, in the case of Chile, this issue is considered only in relation to isolated areas, rather than including also lagging areas.

The examined areas show thus the same fragility that is common to other Chilean municipalities, although ageing can potentially expand the definition of institutional capacity in marginal areas. In Chile, both individuals and institutions can be considered as vulnerable: the former are exposed to the structural inequality of the country and the different opportunities available to them, while for the latter, the resources available to provide several essential services are scarce (Vecchio et al. 2021). Currently, the Chilean Organic Law of Municipalities – a norm that complements the existing Constitution – identifies several fields in which local institutions can or must be active. On the one hand, urban planning (at the local scale) and community development are two functions exclusively in charge of municipalities. On the other hand, municipalities can also develop activities related to several other fields, in which the intervention of other institutions is optional: among them, social welfare, public health, education, social housing, and risk prevention. In settings such as ageing municipalities, the capacity of local institutions can be affected by both the decrease of the available resources and the increase in the needs of the local population, especially in terms of welfare provision. Even if the strengthening of local institutions has been the object of academic and political debate for a long time, local institutions will possibly remain central also in the next decades. For example, the draft for a new Constitution for Chile, elaborated between 2021 and 2022, states that "the basic principle for the municipal government should be the search for harmonious and equitable territorial development, aiming for all people to have equal access to the same level and quality of municipal public services, regardless of where they live" (proposed Chile Const. art. 212, §2).

Right now, ageing does not seem to affect the institutional capacity of the examined municipalities, although an increasingly older population could have a more relevant impact in the following years (McCann 2017). Moreover, the limited possibility of providing certain services at the municipal level probably requires considering what opportunities are available at a higher scale – for example, groups of neighbouring municipalities located within a certain distance. This focus on the spatial availability of certain opportunities would be relevant not only for those services addressing the needs of an increasingly older population (for example, health services), but also for the services that can prevent younger inhabitants from leaving marginal areas: this could be the case for education, considering that the availability of schools can determine the need to migrate to urban areas where these are more easily available.

The approaches of marginal Chilean municipalities to ageing aim to tackle the specific needs of the elderly population but do not seem to include them within broader strategies to address their demographic decline. The examined plans tend to recognise ageing as an existing condition and, in some cases, as a threat to be considered when planning for a municipality's development. However, most measures tend to address ageing as a "static" phenomenon that requires granting health and leisure to older people, but without considering the impacts of an increasingly older population on local communities. Interestingly, the municipalities that propose innovative forms of active ageing are mainly rural ones, where the population is potentially more isolated and requires higher levels of autonomy. Nonetheless, while the local plans address the needs of local older people

– among the subjects that are less likely to relocate elsewhere (Rodríguez-Pose 2018) – less attention is provided to measures that could attract new inhabitants and activities. Therefore, considering that national strategies for ageing areas are being developed but that local institutions are struggling in this sense, the existing gap between lagging, ageing areas and other parts of the country could increase when the share of older inhabitants grows in the next years.

The present study is a first exploration of the relationship between ageing and territorial marginality in Chile with a focus on institutional capacity and, therefore, it suffers from some limitations. First, the analysis focuses simply on municipalities that are currently losing inhabitants and showing an increasingly older population. The assessment of their institutional capacity provides a relative evaluation that does not consider places that are currently experiencing other dynamics – such as an increase of the population thanks to the arrival of older inhabitants, or even the loss of population that occurs in places with younger inhabitants. Expanding the sample of examined municipalities would thus allow providing a more solid comparison between municipalities. Moreover, the same index of institutional capacity is a first, limited assessment that could benefit from the inclusion of other variables available in public databases: these could refer to the resources available to municipalities (in terms of available staff, for example) as well as to the services provided by local institutions (including education and social welfare). Expanding the sample of examined municipalities and the set of indicators would probably allow for more robust data analyses, allowing, for example, correlations and regressions. Moreover, the quantitative results could go together with qualitative analyses focusing on specific, representative cases, and complementing thus the content analysis of community development plans. For example, a possible avenue for future research could consider interviewing local decision makers to understand more in depth their perception of the relationship between ageing, marginality, and the resources available to institutions to face them.

7 Conclusions

This exploratory analysis focused on Chile's ongoing ageing demographic trends to consider if these contribute to determining a condition of territorial marginality also in a Global South setting. The results show that forms of population decline can be observed both in contexts already defined as marginal in national policies and areas that are not yet defined as such. Therefore, ageing seems to define an alternative geography of marginality, thus complementing and expanding official definitions of marginal areas. Moreover, the capacity of local institutions to recognise and address the issues of ageing appears to be limited due to the lack of resources required to provide essential services to an increasingly ageing population, and because of the limited set of strategies proposed to face the ongoing demographic decline.

The proposed analysis shows thus that, in line with peripheral settings in Global North contexts (for example, in Europe), areas that are declining in terms of population are also marginal from a spatial and socioeconomic perspective, at least in the case of Chile. The finding can be a first step towards a more systematic approach to the definition of marginal areas in Global South contexts, where territorial peripheries have been widely examined in relation to centralised institutional schemes, intense urbanisation processes and extractivist economies: ageing, an emerging issue that in the next decades will affect most Latin American countries, can emerge as an additional element determining territorial marginality. Further analyses are required to define more precisely what these marginal territories are and the abilities of their institutions to deal with such conditions. Even if ageing does not appear as a phenomenon that determines marginality per se, it is crucial to consider the additional impact it could generate on places already being left behind.

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Remote and connected. Negotiating marginality in rural coworking spaces and "tiers-lieux" in France

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Abstract. Originally associated to big cities' centres, coworking spaces and "tiers-lieux" ("third-places") have been blooming in rural regions and small towns over the past five years. The development of those places has been critically supported by local and national authorities, with a growing interest from rural localities. Indeed, those places are supposed to provide answers to numerous contemporary territorial challenges, and to tackle several dimensions or rural vulnerability. They are supposed to enhance sustainability by reducing the need to commute and car-dependence, by bringing both workplaces and services closer from home. They are also mobilised to tackle the issue of the digital gap between centres and peripheries, providing digital infrastructures and hardware. Finally, they are supposed to reduce territorial inequalities by strengthening rural entrepreneurship, safeguarding local jobs, facilitating professional retraining and attract new residents by providing an easier access to telework.

Conducted between 2017 and 2019 in the Auvergne-Rhône-Alpes region, our study provides some elements to evaluate the effects of those places on territorial vulnerability and marginality. Based on the study of 17 coworking spaces situated in rural areas, their funders' trajectories and their users' profiles, we discuss the motives and the expected returns of those places, and their actual potentialities and limits.

In this article, we intend to shed light on the actual practices, uses and users of rural coworking spaces and third places, in order to question the territorial change they bring about from a demographical, sociological and territorial point of view. Interrogating the notion of marginality at the light of those places and their users, our study highlights the diversity of lifestyles in the rural areas. Coworkers display particular spatial anchorages, with local resources being valued, though combined with forms of plural and multilocalized belongings. Their relationship with the margin is chosen, controlled and reversible, sometimes even yearned for. Their connectedness is not so much defined by where they live rather than by who they know and where they move, embodying the social dimensions of marginality.

1 Introduction

Coworking spaces have emerged at the beginning of the years 2000 in the San Francisco Bay. They have originally been created by digital workers themselves, in search of a place to work when their status allowed them to work anywhere (Liefooghe 2018). Shared spaces of work also responded to the need of the growing freelance workforce to have access to an affordable workplace, in the context of booming prices on the Californian real estate market (Lallement 2015). Soon attracting the curiosity of the media, they are

now seen as one of the symbols of new ways of living and working, typical of the so-called "collaborative" economy and of digital nomadism (Scaillerez, Tremblay 2017).

During the years 2010, coworking spaces have spread throughout Europe and the world, first in the major cities and more recently in medium-sized towns and even some villages (Besson 2018, Leducq et al. 2019). In France, many non-profit coworking spaces adopt the label of "tiers-lieux" (third-place). In the French context, the "Third place" movement, reuniting diverse collaborative workplaces such as coworking places, fablabs and makerspaces, has emerged at the same time, a proof of both dissemination and differentiation of those shared places of work in different urban environments (Leducq et al. 2019).

Indeed, recent data shows that the biggest increase of such places in the past 5 years was recorded outside the metropolitan areas (Lévy-Waitz 2018, 2021). In 2018, they represented 42 % of all spaces in France and up to 70 % in some regions where special public policies and funding have been implemented (Nouvelle-Aquitaine, Occitanie). Indeed, there is a growing interest from municipal communities for those projects. Following the first report of the Mission on Coworking Places and Third Places commissioned by the Ministry of Economy (Lévy-Waitz 2018), the State has also launched its own funding scheme, with a wide 5-year subsidy programme aiming at creating 300 new third places in particularly vulnerable rural and suburban territories ("Fabriques de territoire"[1]). This territorial dimension aims, on one hand, at operating a "re-balancing" between inner cities and their peripheries (both urban and rural), and on the other hand, at fostering local development. The consistent budget dedicated to this programme (175 million €) highlights the importance of expectations towards those places.

In France, according to the latest classification of the National institute of statistics based on population density, a third of the population lives in rural areas (D'Alessandro et al. 2021). The population living in rural areas faces the increasing scarcity and remoteness of everyday services (Doré 2019), while employment areas are concentrating in the metropolis thus expanding daily commutes (Reynard, Vallès 2019). This reliance on mobility to access diverse resources (work, services, healthcare) has been particularly exposed during the "Yellow Vests" movement, highlighting the acute risk of social exclusion due to the lack of accessibility in rural areas (Farrington, Farrington 2005).

Third-places are supposed to answer some of those challenges. First, they are supposed to allow employees to work closer from home, and to bring back services in remote areas through the functional mixity of those spaces (Lejoux et al. 2019). Third-places are also assumed to build on the digitalisation of the economy to reduce territorial inequalities: the opportunity to provide more and more products and services at distance through the internet is supposed to boost rural entrepreneurship, create new jobs and allow rural entrepreneurs to access distant markets. In addition, third-places could avoid emigration and help attract new residents through telework. Finally, third-places are also expected to counterbalance the territorial effects of the welfare State retrenchement (Courcelle et al. 2017), by offering multiservices hubs while rationalising public spending through the use of digitalisation (Courcelle et al. 2012).

The idea, however, is not new: as early as in the 1990s, the State already saw in telework a potential tool of local development (Salgueiro et al. 2017). The DATAR (Interministerial direction of planning and regional attractivity, suppressed in 2014 and replaced with the General commission of territorial equality) launched in 1990 a programme to set up "telecottages" in order to promote telework in the countryside and address territorial inequalities through the support of remote work in rural areas. But the experience fell short of expectations and never really reached an audience (Crouzet 2002, Moriset 2011, Pouly 2020). In 2005, another call for tender by the Interministerial Direction of Planning and Territorial Competitiveness aimed at implementing 100 telecottages on the national territory. But by the year 2008, there were about 35 of such places in rural areas (Salgueiro et al. 2017), versus about 20 times more coworking spaces and third-places ten years later (Lévy-Waitz 2018).

[1] "Fabriques de territoires" is a national program launched in 2019 by the Ministry of Territorial Cohesion and renewed in 2021, aiming at labelling "Territorial hubs" . It comes with an operating grant of 75 000 to 150 000 € over 3 years (50 000 € per year maximum). See https://www.cohesion-territoires.gouv.fr/labellisation-de-300-fabriques-de-territoire-en-france

The recent success of coworking spaces in the countryside thus comes with a little surprise. We argue that it can be explained by changes in the demography of some rural areas, that have become more and more attractive to "creative classes" that are increasingly sensitive to environmental amenities and to the values and narratives of contemporary "neo-rurality". The multiplication of social innovations in the countryside across the past ten years testifies from a renewed dynamism in those residential flows from the city to the countryside, that was already tangible before the Covid-19 pandemic, but gained new attention since 2020. Indeed, a new research agenda has emerged after the pandemic on the opportunities of coworking spaces to respond to the challenges of the rapid increase of telework, including in rural areas (see, for example, Manzini Ceinar, Mariotti 2021b). In the same time, there has been an increasing interest for the possibility for generalisation of telework to allow for a large-scale relocation of jobs from the urban to more peripheral areas, thus reviving the interest to use telework as a tool for local development (Hölzel, de Vries 2021, Sen 2021, Reuschke et al. 2021), but also to tackle the issue of spatial inequalities (Reuschke 2021). However, not all countrysides benefit from such dynamism, nor all parts of those countrysides.

In this article, we intend to shed light on the actual practices, uses and users of rural coworking spaces and third places, in order to bring out the social and spatial patterns of those places prior to the pandemic. We don't seek to evaluate their effects from an economic point of view (for this, see for example Besson 2018), but rather to highlight the territorial change they bring about from a demographical and sociological point of view, while questioning to what extent marginality can be defined as the property of places, or of people. We will first present the methodology and scope of this study, before revisiting definitions of coworking and third-places and the origin of their recent spread in the rural areas (Section 3). Then, we will present the empirical results of our study. First, we will present the characteristics of those places and their users, by focussing on the users of shared offices (Section 4). Then finally, we will examine the motives and expected benefits of the social and spatial networks derived from those places (Section 5). Third-places, we argue, are not at the origin of the contemporary rural dynamism in the places they establish themselves, but may accelerate it by creating networks of entrepreneurs. In this respect, we will point out some potentialities and limits of this model, including the risk of rural gentrification and deepening of inequalities between territories in the context of State retrenchment.

2 Methodology

In this article, we rely on data gathered between 2017 and 2019 in the Auvergne-Rhône-Alpes region in the framework of a publicly funded research programme called Coworkworlds[2].

The fieldwork, completed before the 2020 lockdown, comprised 4 different phases. We first conducted an inventory of all coworking spaces open at the time of the survey. This census that we expected to be as exhaustive as possible indicated that although 47% of those spaces are located in the centres of big cities, there were also many coworking spaces in the suburbs, medium-sized towns and rural areas, attesting to the geographical spread of coworking (Leducq et al. 2019). Indeed, almost a quarter of those spaces were situated in rural areas of the region (see Table 1). The second phase of the research aimed at characterising the coworker population and a panel of coworking spaces. A quantitative survey was administered to 377 individuals (including 79 in rural areas) in a panel of 54 places, including 12 in small cities and rural areas (mostly in Drôme and Ardèche). Table 1 summarises the geographical scope of the research.

We originally did not include third places in our study, which was focused on coworking spaces exclusively. But the progressive dissemination of this word, especially among rural non-profit shared places of work, coupled with its progressive institutionalisation with the creation of France Tiers Lieux, forced us to re-evaluate this choice and to broaden our sample to all collaborative shared offices.

[2]French National Agency for Research, contract nr. ANR-17-CE22-0004

Table 1: Data collection process according to urban environments

Urban type	Number of registered spaces		Number of investigated places		Number of persons interviewed for the quantitative survey		Semi-structured interviews
	N	%	N	%	N	%	N
Metropolis – centres	72	57.60%	27	50.00%	237	59.70%	12
Metropolis – suburban	24	19.20%	15	27.78%	101	25.44%	1
Rural	29	23.20%	12	22.22%	59	14.86%	19
Total	125	100.00%	54	100.00%	397	100.00%	32

Table 2: Interviewees

Name	Gender	Age	Status	Occupation	Founder or user
Agata	F	36-55	Self-employed	Photographer	Both
Alice	F	36-55	Self-employed	Photographer	User
Baptiste	M	26-35	Salaried employee	Engineer	User
Benoît	M	36-55	Business owner	Informatician	Both
Clément	M	26-35	Salaried employee	Project developer	User
Damien	M	36-55	Self-employed	Ergonomist	User
Gaëlle	F	36-55	Self-employed	Stylist	User
Jeanne	F	36-55	Business owner	Founder and manager	Both
Julien	M	36-55	Self-employed	Web developer	User
Maëlle	F	26-35	Self-employed	Photographer	User
Matthieu	M	26-35	Self-employed	Forest manager	User
Mickaël	M	36-55	Both	Web developer	User
Patrick	M	36-55	Salaried employee	Founder and manager	Both
Paul	M	36-55	Self-employed	Photographer	Both
Quentin	M	36-55	Self-employed	Engineer	User
Rosa	F	36-55	Self-employed	Translator	User
Stéphane	M	36-55	Self-employed	IT consultant	Both
Théo	M	26-35	Self-employed	Music producer	User
Yannick	M	36-55	Both	Multiple businesses	User
Cécile	F	26-35	Self-employed	Naturopath	Founder
Eric	M	36-55	Self-employed	Photographer	Both
Sebastien	M	36-55	Salaried employee	Web developer	Both
Alizée	F	26-35	Salaried employee	Communication	Founder

A third phase of the research has consisted in semi-structured interviews conducted with 32 coworkers who agreed to be contacted after the questionnaire (including 19 in rural areas), and with 20 founders of such places (including 5 in rural areas). For this qualitative part of the project, the researchers sought out a diversity of professional and family situations, as well as a diversity of spaces frequented: interviewees have been recruited in 12 different rural coworking spaces. Table 2 summarises the sample of interviewees. As many founders of those places are also users, some interviewees have been interviewed both as founder and user.

Finally, ethnographic research has been conducted during 2 years in a "third-place" situated in a small city (8,000 inhabitants). A last phase of the research was supposed to be based on collection of GPS tracks of a subsample of voluntary coworkers, but had to be cancelled because of the lockdown.

3 Coworking spaces and third-places in the French context

3.1 From diffusion to differentiation

Coworking is a new form of spatial organization of work that is closely linked with the knowledge and creation economy (Spinuzzi 2012). It is a fee-based service defined by the share of a place with office equipment (typically a high-speed internet connexion, a copy machine and coffee) and a network of individuals (Blein 2016, Gandini 2015). But more importantly, coworking is a practice based on specific references and values that stem from digital culture and the knowledge economy (Berrebi-Hoffmann et al. 2018).

The "third place" movement originates from a wider set of actors. Referring themselves to Ray's Oldenburg concept, they put the local community at the centre of their definition. Ray Oldenburg originally defined third-places as neutral places, opened to the public and ordinary in their appearance, like cafés, cinema, libraries and so forth, and that ensure daily sociality in a given community (Oldenburg, Brissett 1982, Oldenburg 1999). Those places are "third" because they are different from the first place (home) and the second place which is the place of work. In Oldenburg's initial work, the focus was put on ordinary sociality places in the city and on social mixing opportunities they brought about, with the opportunities to bond with individuals that were neither co-workers nor family. A few decades later, the concept of third-place has first been excavated in the French context by public libraries in their strategy of user diversification (Burret 2017).

Indeed, the development of digital nomadism has increased the possibility of working "anywhere, anytime" (Alexander et al. 2011), allowing for a "multilocality" of workplaces (Di Marino, Lapintie 2020). This allowed a growing number of places to become "third places", including coffee shops, librairies, universities, etc. The concept has also expanded to a wide range of activities in the cultural and social sector, which now frequently refer themselves to this notion, including community cafés, cinemas, restaurants, artistic wastelands, etc. The dimension of collaboration and co-operation is frequently at the centre of their "raison d'être" (Akhavan 2021). The development of a broad national grant programme for "third places" in 2019 in France has also contributed to the spread of this label among a diversity of actors. Indeed, the programme aimed at creating a nationwide network with the creation of a national agency "France Tiers Lieux." However, their actual definition remains very lax and focuses more on intentions than actual content: they are defined as "places that reunite diverse activities, participate in the local economic development and animate a community"[3] or "places for doing together (...) that have spread thanks to the digital development on the territory"[4]. More generally, we can define third-places as hybrid non-profit community-based places that provide various services. Their very originality is that they refer to a place (and not to a specific activity or organisation), and they imply some dimension of functional mixing: being both a coworking place and a workshop or a studio, both a community garden and a place of work, both a café and a coworking place, etc.

Third-places now designate a wide range of places and practices, accounting for a progressive differentiation, adaptation and hybridation of the original concept (Liefooghe 2018), in particular in rural areas where multifunctionality is needed because of the low-density context and of the specificities of the local labour force. Since the focus of our study is on the effects of telework, we have included in our study only those "third places" which designates or includes shared office spaces. Indeed, many non-profit coworking spaces prefer to label themselves "third-places", to distinguish themselves from a more business-oriented vision of coworking.

3.2 Third-places and local development policies: Promises and pitfalls

Popular in the social innovation and creative economy sphere, third-places have also attracted the interest of public policy, whether it be at the local or at the national levels. Indeed, those places are in line with the newest forms and precepts of territorial development, since "the search for synergy between actors has been the new alpha and

[3] France Tiers Lieux
[4] Ministry for Territorial Cohesion (Ministère pour la Cohésion des Territoires)

omega of local public action", says André Torre (Torre 2018). By bringing together various local actors in a same physical place, they thus represent the spatial transposition of this ideal of social networking. In addition, they embody a certain vision of the "creative city" or the "smart city" that has been appropriated and promoted way beyond the city, with the idea of a "smart countryside" being more and more trending.

As a result, in many cases those places have been supported, directly or indirectly, by actors of territorial development. In some cases, the support to coworking spaces (CS) has been a continuation of previous policies of telework and telecottage implementation and promotion (Salgueiro 2015), in the framework of digital development policies. In some others, it has come as a complementary tool for policies aiming at attracting migrant entrepreneurs (Sajous 2015). In the Ardèche county, the network of CSs has been partly funded by a scheme of rural youth support, while it has been developed by a scheme of digital economy development support in the Drome county.

Although coworking is mainly an urban phenomenon, the last few years have seen a flouring of CSs in peripheral areas (Capdevila 2021). Different factors can explain this widespread of CSs in rural areas (Mariotti et al. 2021). On the one hand, CSs may operate in rural areas as well as in urban areas because the geography of creative industries is more complex than the simple concentric circle (Felton et al. 2010). On the other hand, more and more knowledge workers tend to work from rural locations because of their benefits: higher general wellbeing, lower congestion, less polluted air, lower cost location, exploiting institutional leeway, etc. These elements show that CSs are expected to become drivers of economic change while retaining the creative class and knowledge workers in the periphery, thereby increasing the competitiveness and performance of rural areas.

But the literature exploring the "indirect" effects of CSs on the local environment is still scant (Leducq, Ananian 2019), especially in rural areas (Knapp, Sawy 2021, Mariotti et al. 2021). The main studies have shown that CSs can have positive effects on rural areas, in different countries and regions. For example, Fuzi has shown that CSs can support entrepreneurship in sparse regions like South Wales (Fuzi 2015) and Capdevila that CSs can be considered as drivers for economic development in rural areas in Catalonia (Capdevila 2018). Heikkilä studied the Finnish case and argued that rural coworking supports local economy by enabling collaboration, subcontracting, joint ventures, and all other forms of shared activities (Heikkilä 2012). In Italy, Mariotti, Akhavan and Di Matteo showed that, on average, CSs in rural areas, compared to those in urban areas: (i) perceived a higher positive impact of the in the urban context; (ii) declared to be more satisfied; (iii) experienced higher social and organizational proximity, and lower institutional proximity; (iv) have created new professional relationships, and had the chance to access new information channels and new training opportunities inside the CS (Mariotti et al. 2021). Recently, Mariotti et al. have also shown that being located in a rural area may represent an economic benefit for coworkers' organizations (Mariotti, Di Matteo 2022). According to their results, if an organization collocates its employees in a CS settled in a rural area, the organizations' incomes would probably be more performative as against the case in which the employees had been placed in a CS located in an urban area. Nevertheless, further research is needed to better understand the diffusion of CSs in rural areas and its effects on socio-economic spatial development. According to Mariotti et al., "Although CSs seem a very attractive instrument for small towns and rural communities, we know very little about their functions, user profiles, their links with socio-economic spatial development, etc" (Mariotti et al. 2021, p. 189)[5].

The COVID-19 crisis has been an accelerator of the knowledge workers' increasing lure for more remote destinations. For example, the share of teleworkers outside metropolitan areas has massively increased in Italy (Mariotti et al. 2021) but also in remote parts of the UK like South West England and Wales (Bosworth et al. 2021). Different factors could foster the implementation of coworking spaces in rural areas: (i) the willingness of companies to downsize their offices by relocating employees in other locations and promoting remote working; (ii) the tendency by freelancers and digital nomads to move to rural areas to experience a higher quality of life (Manzini Ceinar, Mariotti 2021b).

[5]A European research project, funded by the COST Action, and untitled "New working spaces and the impact on the periphery" aims to fill this gap in the literature.

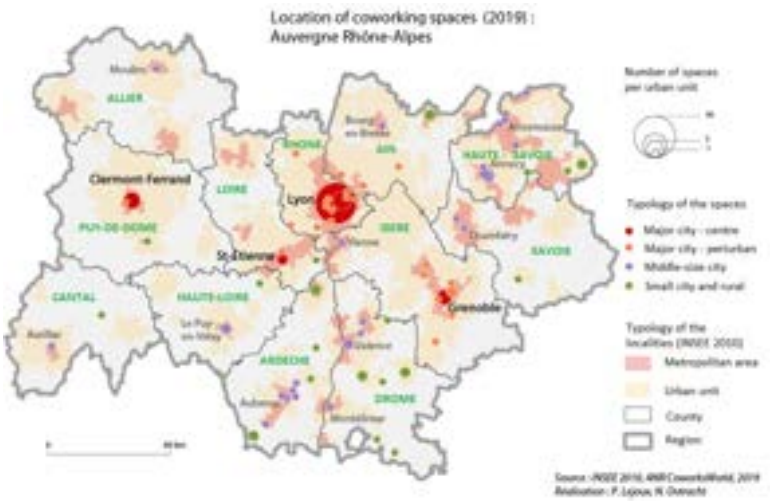

Figure 1: Location of coworking spaces in Auvergne-Rhône-Alpes (2019)

CSs in rural areas could thus provide new opportunities for new network connections and relationships to emerge within rural spaces, by connecting rural people into wider knowledge networks (Thomas 2019) but also by creating new interdependencies between urban and rural areas (Bosworth et al. 2021, Bürgin et al. 2021). In that case, attracting CSs located in urban poles that have been greatly affected by the COVID-19 might be a good strategy for local authorities located in rural areas. But this implies to develop tailored policies and to enlarge the (CS) toolkit for local development in smaller towns and rural areas (Manzini Ceinar, Mariotti 2021b). Local authorities have a key role to play in enabling coworking in such areas in its function as operator and financial supporter (Knapp, Sawy 2021), but, at the same time, they should also respect the spontaneous and flexible aspects of these new working spaces (Fuzi 2015).

3.3 The geographies and demographies of remote working in the Auvergne-Rhone-Alpes region

After having set the general framework of the dissemination of shared places of work in French rural areas, we now turn to the empirical results of our study in the Auvergne-Rhône-Alpes region. The Auvergne-Rhône-Alpes region is known for its economic and cultural dynamism as much as for its numerous environmental amenities. It is amongst the most dynamic French regions and one of its particularities is the high rate of professionals and managers in the population (INSEE 2019). Indeed, it is a region that comprises several big cities and recognised universities and campuses, thus attractive to a highly qualified population.

A first significant fact (Figure 1) that arises from the quantitative data we gathered is that metropolitan areas put aside, shared places of work are not to be found in the countrysides that are closest to the main cities and in the counties that are more polarised by them and most metropolised (Loire, Ain, Rhône and Isère). They are more numerous in Drôme and Ardèche which are further away from the main urban areas and have lower overall density[6] (respectively 78 and 59 inh./km2), and no important city (Valence, the main city, has 62,500 inhabitants and no university of its own, while Aubenas is a very small urban area of 12,000 inhabitants). However, other peripheral rural counties such as Cantal or Allier, that are more remote and less populated, were not affected in the same way.

An interesting parallel emerges when the geographical repartition of coworking spaces throughout the region is confronted with demographic trends at the county-level. Table 3

[6]As a comparison, Rhône has a density of 572 inh./km2, Isère 170, Ain 112, and Cantal which is the less dense county of the region has a density of 25 inh./km2.

Table 3: Evolution of the population between 2008, 2013 and 2018 per county, AURA region

	Population			Annual variation rate of the population (%)					
				total		natural change		migration	
	2008	2013	2018	P1	P2	P1	P2	P1	P2
Ain	581,355	619,497	647,634	1.3	0.9	0.5	0.4	0.8	0.5
Allier	342,807	343,431	337,171	0.0	-0.4	-0.3	-0.4	0.3	0.0
Ardèche	311,452	320,379	326,606	0.6	0.4	0.0	-0.1	0.5	0.5
Cantal	148,737	147,035	144,765	-0.2	-0.3	-0.4	-0.6	0.2	0.3
Drôme	478,069	494,712	514,732	0.7	0.8	0.4	0.2	0.3	0.6
Isère	1,188,660	1,235,387	1,263,563	0.8	0.5	0.6	0.5	0.1	0.0
Loire	742,076	756,715	763,441	0.4	0.2	0.3	0.2	0.1	0.0
Haute-Loire	221,834	226,203	227,552	0.4	0.1	0.0	-0.2	0.4	0.3
Puy-de-Dôme	628,485	640,999	659,048	0.4	0.6	0.1	0.1	0.3	0.5
Rhône	1,690,498	1,779,845	1,859,524	1.0	0.9	0.8	0.8	0.2	0.1
Lyon agglo-meration	1,272,188	1,336,994	1,398,892	1.0	0.9	0.9	0.9	0.1	0.0
Savoie	408,842	423,715	433,724	0.7	0.5	0.4	0.2	0.3	0.2
Haute-Savoie	716,277	769,677	816,699	1.4	1.2	0.6	0.6	0.8	0.6
Auvergne-Rhône-Alpes	7,459,092	7,757,595	7,994,459	0.8	0.6	0.4	0.4	0.3	0.3
France (mainland)	62,134,866	63,697,865	64,844,037	0.5	0.4	0.4	0.3	0.1	0.1

Source: INSEE, population censuses
Notes: **P1**: 2008-2013, **P2**: 2013-2018

highlights the very diverse situations that is to be found in the 5 most rural counties of the AURA region (highlighted in grey)[7].

Indeed, part of the explanation for the uneven spread of coworking is to be found in the changing demography of some French countrysides, especially in the "presential countrysides with residential and touristic attractivity" (Pistre 2012). This typology refers to the theory of presential economy, coined by Davezies (2008), Terrier et al. (2005) and Terrier (2006) to describe the economy of a territory based on consumption, rather than production. In Pistre's typology, presential countrysides where locally consumed services and tourism are dominant are opposed to productive countrysides, where industrial and/or agricultural activities prevail. Based on demographic trends, Pistre's typology shows that presential countrysides with residential and touristic attractivity are affected both by temporary flows of visitors (tourism) and internal residential migration from both active and retired populations. Those categories of countrysides are to be found in the South-Western oceanside and in Southern France, including the Drome and Ardèche counties.

Indeed, those new "lifestyle migrations" (Benson, O'Reilly 2009) or "amenity migrations" (Cadieux, Hurley 2011, Martin et al. 2012, Moss 1987, 1994) are historically particularly important in the south of France. Among them, the proportion of more qualified populations such as professionals, artists, cultural workers and managers is on the rise (Bilella 2019, Charmes 2019) as shows the Table 4.

Independently from those wide demographic trends, the practice of remote working has also been developing in the last ten years, mainly because of the wide precarisation and subcontractualisation of many professions of the knowledge and creation economies, with a bloom of free-lance (Gill, Pratt 2008, Gill et al. 2019). An indication of this increase of the "gig economy" can be found in the number of self-employed persons through micro-enterprises. Unfortunately, statistical data can't be disaggregated both by sectors and by counties. However, data per county shows that Drome and Ardeche have a rate of micro-entreprises that is more than 3 times the national average (respectively 27, 25 and 7 per 1000 inhabitants).

Though still a marginal practice, remote working for salaried workers has also been expanding in the last five years, prior to the pandemic which has obviously been a game

[7]This table is extracted from Bianco E. and Geymond J., "Près de 8 millions d'habitants", INSEE Flash Auvergne-Rhône-Alpes, 2020, https://www.insee.fr/fr/statistiques/5006465#documentation

Table 4: Net internal migration rate per socio-professional status, 2016, per 1000 habitants

	Ardèche	Drôme	AURA Region
Farmers	3,70	7,70	0,70
Entrepreneurs, tradesman and craftsmen	12,80	4,70	-0,10
Professionals and managers	10,90	8,60	2,70
Technicians and associate professionals	5,00	6,60	3,00
Clerks and administrative staff	5,70	4,40	2,80
Blue-collar workers	10,50	4,70	2,30
Retirees	9,90	5,80	0,50
Other inactive	0,50	-2,70	2,50
Total	6,40	3,20	2,10

Source: INSEE RP

changer. In 2017, 3% of the employed workforce reported teleworking regularly, but the number rose to 9% for those who lived more than 50 km away from their workplace. Moving further away from the city centres and teleworking had already been described as a solution for young families to circumvent the housing crisis in the cities and increasing commuting times and costs, though a solution that was (and is still) restricted to highly qualified jobs (Ortar 2009).

Indeed, for the overwhelming majority of our respondents, coworking is linked with residential migration and a project of lifestyle change and establishment in a place of choice – rural in some cases, urban in other (Flipo, Ortar 2020). Being able to pick a lifestyle and an attractive – yet remote – place of living can thus be considered as a privilege for high-demand profiles. As the example of Quentin, a highly qualified engineer with a PhD in environmental biology shows, for some rare and demanded qualifications, remote working can be negotiated even before hiring:

> *At the time, I was in Lyon and I was looking for a job, anywhere really. And a few months before my contract ended, I had not found anything that suited me (...) So I decided to take control of things. I thought: "Let's settle in a place that we like". And so, we decided to settle here, and to find a job after. And that meant there was a 99.9% probability that it would be a job in telework, since my job is pretty specific. (...) My current supervisor, he knew I was looking for a job. We discussed, and he thought about it. He didn't have much time to recruit, and he knew me already. So he trusted me, and I think I was the only candidate. So I asked what I wanted [telework with an office in a coworking space subsidised by the employer] and he accepted everything.*

4 Daily practices of coworking: Living a rural life while being connected

4.1 Motivations for choosing remote working in the countryside

As several works on amenity migration have described, newly arrived populations in the countryside ("neorurals") are frequently attracted by environmental amenities and recreational activities many of them have discovered during holidays (Pistre 2012, Talandier 2007, Tommasi 2014). Indeed, it is not by chance that those territories are affected by both touristic and lifestyle migration flows, since both are frequently interconnected in individuals' biographies. When asked about their motivations to move, many interviewees refer to environmental amenities as the following excerpts from respectively Maëlle, a photographer and Matthieu, a forest manager, show:

> *I came for the holidays. I knew a little already. But it was mostly my intuition, from when I came. The landscapes, really, it was mostly about the landscapes. And I also had the intuition that there was a social life that would fit me.*

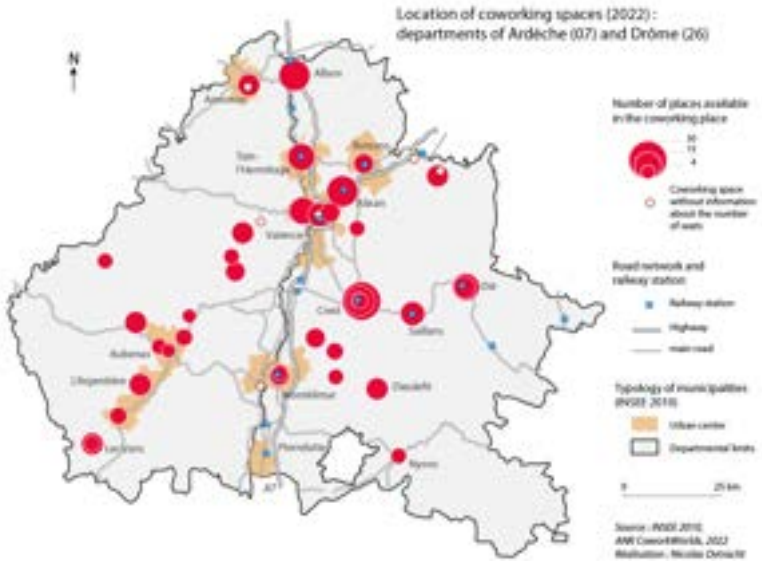

Figure 2: Map of CSs in Drôme and Ardèche

> *It was a bit by chance, a bit from the feeling, a bit ... because it's well placed, between the Chartreuse, the Vercors, Ardèche*[8]*. ... With my wife, we have the same attraction for mountains. (...) We could have lived elsewhere. That's really by taste that we chose here.*

The cultural dynamism of those rural areas, inherited from a long history of waves of demographic renewal (Cognard 2006, Sencébé, Lepicier 2007), also plays a major role in the positive image they reflect, as we can see in the first interview excerpt. For many of our interviewees, those countrysides are remote enough to "look like a real countryside" (versus more artificialised peri-urban landscapes) but still attractive enough to remain "alive" (with activities and an important service-oriented local economy that, as we saw, is partly driven by the touristic flows).

On a living area scale, we notice that connectivity remains an important feature of coworking spaces. Most of them are located along the main local roads and in the local centralities. Few of them depart from those structuring axes, as we see in Figure 2 focused on the counties of Drôme and Ardèche.

Though those territories lack mobility infrastructures and transport services for daily commutes, the temporalities of teleworking, with rares episodes of long-distance mobility intersected with longer periods of sedentarity, projects accessibility on a different scale, as those two coworkers, Mikaël, a web developer, and Alice, a photographer, explain:

> *With this job, it's about once a month in Paris, so generally I drive to the fast train station*[9] *and after, I take the train. I was doing more or less the same thing when I was working for M. [in California]: taking the fast train to Paris and then a flight. And I think it will be the same with this project in Germany I'm going to start soon: a fast train and then...*
>
> *[I go to Paris at least twice a year]. When I was still a member of an agency, I used to go more often. I was on the board so I had to go every two months in Paris, and I was going through my meetings with clients at the same time.*

Again, the transportation needs of the coworkers are more similar to those of the tourists than to those of the average population who commutes mainly within the county, from residential to industrial areas. In the case of coworkers, the proximity of the Rhône valley, that is particularly well connected to big cities and especially Paris with the presence of

[8] Those are different chains of mountains and/or regional natural parks.
[9] In his case, a one-hour drive.

the high-speed train from Paris to Marseille, is frequently referred to as an important factor for having chosen Drôme and Ardèche as a place of work.

Another striking fact when looking at the localisation of CSs at the county-level is the fact that they are situated in local centralities and small cities that correspond with the most urbanized areas of the countryside. Not being "out of nowhere", they are frequently situated in the inner areas of those small towns, close to shops and services (schools, retail trade, services and equipments). As Agata, the co-founder of a coworking space in Isère explains what motivated the choice of the centre of a 1,450 inhabitants village:

> *This is why we chose here, it's ideal because it's really a central location, the farmers' market is just here. (...) We chose here because it's the central town in the area, it's the village where you have some shops, maybe a dozen. And there's also school, kindergarden and middle school. There is everything, in fact.*

In this respect, the case of coworkers highlight the importance of those local equipments in the creation of a dynamic of attractivity (Talandier, Jousseaume 2013). Characterized both by centrality and the presence of equipments, they reflect a desire to conjugate both the benefits of the city and the countryside in "human-sized" microcities (Charmes 2019). This dimension of access to services and equipments has also been found by Hölzel, de Vries (2021) in the context of German rural CSs.

4.2 From the shared office to the collective utopia: Varieties of third-places in the countryside

The spread of CSs and third-places outside the city results from a progressive differentiation from the original californian concept. They thus share a certain number of characteristics that one can find in any of such places around the world and reflect their common culture: paperboards, sticky notes and colourful decoration, mix of home and office furniture (couches, balls, cushions, but also printers, screens, and a lot of wires), DIY experiments are amongst the most common features of such places wherever they be, giving a sense of common identity all around the world (Fabbri 2016, Flipo, Lejoux 2020, Gourlay et al. 2021).

However, despite a common "look", those places differ in their organisation and purposes, including within small cities and rural areas. The data we have gathered allow us to distinguish between 3 main categories of places.

The first and most common is the small shared self-administered office (5 to 10 persons). It is created at the initiative of a group of independents and remote workers who used to work from home and that gather around the will of having a common place of work in order to help them differentiate their private and professional lives (Flipo, Ortar 2020), ensure a daily sociality and share the costs. As Stéphane, co-funder of a CS in Drôme, tells:

> *We were a group of 5 persons ... our motives were to break down social isolation and having a friendly place to discuss, share and pool resources.*

Added to those motives is the need for gaining visibility, thus ensuring potential outputs to their members. Indeed, it is not rare that coworking space initiatives derive from business and employment co-operatives as Paul, co-funder of a coworking space in Ardèche, explains:

> *We have created sort of a brand, I mean a network of skills that are highlighted and allows us to showcase different provisions of services (...) and despite all the benefits of teleworking and modern telecommunications, it is way more natural and motivating to share a common space.*

Those places are organised through independent and self-managed non-profit associations, are self-administered in most of the cases, and are frequently supported by local authorities through the provision of premises belonging to the municipality at low rent. In exchange, municipalities find a way to renew and value vacant premises with the help of public

subsidies, and to promote their digital dynamism. In our study, the wide majority of places belong to this category, many of them being very small.

The second model is the hybrid non-profit third-place, created at the initiative of a person or a group of persons that do not necessarily have a use of such a place for themselves, but wish to bring a new type of service on the territory. Those places are generally bigger (10 to 50 persons), offers a range of activities (café, workshops, cultural events, community gardens, etc). In some cases, it even comprises a project of shared housing. Those projects are developed in buildings bearing a particular identity or image, often a wide and more or less abandoned premise that is part of the local architectural heritage such as an ancient factory, mill or convent. Part of the project is directed towards restoration, similarly to what has been described in city centres (see, for example Mariotti et al. 2017). As Cécile, the founder of a third-place in Drôme explains:

> *When we saw the [abandoned] factory, we sort of fell in love with the place. We thought: Wow, there is so much to do here. We instantly thought about workshops, about a wide diversity of activities, a café, a place that would be ... alive, opened, melting a maximum of public and of different people.*

Those ambitious projects are thus very different in terms of budget from the small shared offices, and are very more likely to be managed by skilled cultural entrepreneurs, for which they represent a both professional and personal project. In those cases, the coworking activity is designed to complement other activities, provide funding and use the space. Those places mix more diverse actors and lie on a larger base of volunteers and supporters. They are based on the will of providing a "hub" for social, cultural and territorial innovation, which allow them to have access to bigger and more diverse sources of funding (such as the "Fabriques de territoire" funding scheme, which implied explicitely the necessity of having a strategy towards local development). In our study, 3 places belong to this category.

The third model is the heir of telecottages: places that have been entirely created by local development actors, or telecottages that have been transformed in coworking spaces by a change of scenography or visual identity. Those places usually lack a solid base of coworkers and are rather used for punctual needs, by mobile professionals or tourists in need of an internet connection. Indeed, when they are not led and actively animated by users themselves, those places lack a real community and fail to attract users. In our sample this category is fairly rare (1 case only) but could be expanding with the increase appeal for municipalities and intermunicipalities to "have their own third place".

4.3 The creative class in the countryside: portraits of users

The data from our quantitative study based on a sample of 377 users in the Auvergne-Rhône-Alpes region shows that while places vary, their users remain very homogeneous and more importantly, their profiles are not very different from the ones attending the coworking spaces located in the big metropolitan areas. As a matter of fact, our study shows that family status aside, city centres' coworkers and rural coworkers are very similar. Within founders' narratives, we also find a lot of previous experiences of coworking in urban areas, like Benoît, a 43 years-old entrepreneur, explains:

> *I knew about coworking already, because I used to live in Paris where I tried a few ones, and also because I'm interested in the managerial literature, innovation etc.*

On average, rural users are indeed slightly older and more frequently live in couple with children, while urban coworkers are younger and more often single. They are, however, both characterized by a very high skill level. In our quantitative sample, 91 % of them have a university degree, 66 % a graduate degree (74 % in the city centres). The type of occupations is also similar in the wide majority of cases: our study confirms the importance of what has been labelled by Florida (Florida 2004) the "creative classes" (photographers, graphic designers, architects, writers and translators) and of occupations connected with the digital economy (web developers, web designers, community managers, computer programmers...), that has been underlined in the literature on coworking spaces (Gandini

Table 5: Sociodemographics of coworkers

	Rural environment (N=79)	Total sample (N=377)
Gender		
Men	51%	54%
Women	49%	46%
Age		
18-25 years-old	3%	7%
26-35 years-old	49%	44%
36-55 years-old	47%	47%
56 and over	1%	2%
Professional status		
Wage-earner	53%	48%
Independent	47%	52%
Level of qualification		
Primary and secondary school	8%	5%
Undergraduates	25%	29%
Graduates and postgraduates	66%	65%

Source: based on authors' own study (N=377)

2015, Gill, Pratt 2008, among others). It also confirms the importance among those highly qualified office-users of a wide "consulting" sector, from life coaches to engineering consultants, including newest occupations such as "facilitator in collective intelligence". Some occupations, however, are specific to the rural areas: forest managers, botanists and nature guides can have a use of a coworking space for the administrative part of their jobs, as well as diverse small companies connected with nature and tourism. Finally, rural coworking spaces and third places are also frequently hosts for local associations' employees, who use those places as their registered office.

Status-wise, our data (Table 5) shows that rural coworking spaces distinguish themselves from urban ones by a slight majority of wage-earners (53%) versus independent workers, while the ratio is reverse in the city (52% of independent workers). Among those, more than half (29%) is made of local small businesses and associations employees, while the rest (20%) is made of long-distance teleworkers whose employers are in the main cities of France, Europe and even the world as we discussed earlier.

We can notice that the rural coworkers profile is fairly different from the "traditional" rural home teleworker, who has been described as mostly in the second half of their career and in a "nest-emptying phase" (Sajous 2015). Coworkers are younger and frequently have young children at home, which is one of the reasons why they need a separate space to work (Flipo, Ortar 2020).

5 Expected benefits and limits of third-places for rural renewals

5.1 Managing residential mobility and professional transitions

Our study reveals that the public of rural coworking space and third-places is overwhelmingly made of new residents that arrived recently from the big cities of the region (Lyon, Marseille, Grenoble), but also from Paris and even from expatriation abroad. Although in some cases it is motivated by a desire to return to the region where they grew up, more frequently it is a result of a multidimensional life project including professional, residential and even educational strategies. Indeed, the presence of numerous alternative schools around the coworking spaces is no coincidence. Those families are frequently looking for a place to "land" and to reinvent their lives, and coworking spaces give them the opportunity to secure their access to a professional network. In this respect, the presence of a coworking space can be decisive in the choice of a place to live, as Maëlle, 35 years old, a photographer who was back from 10 years in the Middle-East, explains:

> *I had sort of a life-changing event in my life last year, and I decided to stop living out a suitcase, to stop this nomadism that was burdensome. (...) I decided I had to look where to settle down and [this area] was already in my top 3. I came for whoofing, for holidays, with the perspective of snooping around already. So I just looked up the internet for shared places of work, coworking spaces. I had already visited one before coming here. I had the plan to visit another one too, but when I visited here I though "OK, this is what I need". I felt like it was very much like me, in the spirit, the values... I didn't know [City] and I had never stepped a foot in there before. (...) So I took an appointment in the coworking space (...) and I travelled here especially for the visit. (...) There was one free spot and I said right away "OK, I want it. It's here". Then I visited [City] and two hours later it was decided: "This is it. This is where I am going to settle".*

Indeed, coworking space managers we have met have reported being called regularly by prospecting new residents looking for a place to land in a more or less wide area. Jeanne has arrived from the North of France and left a "very urban life" to reconnect with nature. She and her husband were prospecting in a wide southern France to enjoy the dry and sunny weather. Although their choice of localisation has been primarily determined by the presence of a renowned alternative school, the presence of a coworking space in a neighbouring village has also been determinant. As Jeanne explains,

> *When I first came here I thought: "Oh my god, what am I going to do here?" So this coworking space, it gave me a project.*

While the coworking space can be a place of familiarity and an easy way to make new friends in a new environment like Maëlle underlined, it can also support professional transitions, in particular the change from wage-earner to independent worker that many new residents make. For those "lifestyle entrepreneurs" (Gomez-Breysse 2016, Saleilles 2010), coworking spaces bring crucial resources: a network that is professional, but even more importantly spatial and local. Indeed, the projects of "lifestyle entrepreneurs" are frequently based on some valorisation of the concept of "being local". Having access to local social resources is thus particularly important, and coworking space make those resources available way more easily and quickly than it used to be. For teleworkers, the main benefits of CSs are the possibility to maintain a daily sociality and avoid isolation, while promoting a better balance between personal and professional lives by creating a spatial differentiation between home and work (Flipo, Ortar 2020).

5.2 Cosmopolitan and anchored: the tertiarization of neorural migrations

Being crossing points, sometimes included in international networks, coworking spaces and third places also provide an answer to the desire of many new residents to "reconcile a local identity with a global citizenship" (Tommasi 2014, p. 62). This desire is visible in the persisting interest that is put into travelling, testified by the affluence of travel guides in the common bookshelves. Being urban and highly educated, coworkers often share a cosmopolitan socialisation. They have travelled a lot, sometimes since childhood, and frequently have maintained cross-national ties. As Jeanne puts it, "what we offer is a more gentle life, while remaining connected to the world".

This remaining connexion with big cities and foreign countries participates in the redefinition of the frontiers between urbanity and rurality. On one hand, they embody the "landscape idyll and desire to live in "human-size" units with associated social practices, meaning the friendliness attributed to small communities because of generalised mutual acquaintance" that Poulot (2015) labelled "urban ruralisation". But on the other hand, they also participate to a soft rural urbanisation by importing urban lifestyles, practices and references in the countryside. Their interest and participation in city centres' renewals is typical of this will of finding (or bringing back) some urbanity in their daily lives.

Although pertaining to very different sectors than the traditional "neopeasantry" that is traditionally associated with neorurality (Sallustio 2018), rural coworking space and third-places adopt a number of concepts in common. Being grass-roots, sometimes associated with a local symbolic architectural premise, they correspond with the idea of a

"concrete local utopia" that is typical of the "fifth wave of neorurality" (Rouvière 2016). They also embody the ideal of "relocation" of activity (Sencébé, Lepicier 2007) – though it is by means of telework. Indeed, coworking space managers and users often use the concept of "short circuit" as both a model and a metaphor, with the idea that coworking spaces contribute to the fact that "things are being made locally".

5.3 Are third-places levers for rural renewals or gentrification forefronts?

While it seems clear that coworking space participates in creating a rural renewal dynamic, several limits have to be pointed out.

First, it appears that coworking space and third-places have met an existing demand that is the first reason of their success. Unlike telecottages that have been implemented top-down, the public support to those places has been mainly indirect and based on grass-roots initiatives. From our study in the Auvergne-Rhône-Alpes region, we have found that when local authorities have decided to "set up their own coworking space" without leaving the initiative to local entrepreneurs and remote workers, those places did not succeed, either because they have been ignored by the local demand that has preferred other places, or because there was no demand to meet. This tends to prove that although coworking spaces reinforce local dynamism, it cannot create one from scratch. Therefore, our study has shown that coworking spaces have spread in areas that were already benefiting from a favourable demography, not the other way round. Their development, however, also confirms that the existence of varied equipment and services foster the attractivity of rural areas (Talandier, Jousseaume 2013) and create positive dynamics of attractivity. Founders of CSs chose a village over another because of the presence of such equipment and services such as: general stores, bakeries, cafés, schools, post offices etc. Third-places often come with new services (such as cafés and restaurants, exhibition spaces and concert halls…) to add to those already existing, while coworkers are keen on consuming the local services and goods. As a result, coworking spaces and third-places participate in the presential economy and the revitalisation of small cities centres, that have been almost totally deprived of economic activity since the expansion of hyperstores and peripheral commercial areas in the 1970s. This positive effect is likely to benefit the whole local population.

The second main limit is the lack of social diversity that can be found in those places (Krauss, Tremblay 2019). Indeed, the identity of those places is to be found in their values, scenography, cultural references and lifestyles that are both urban, educated and millenial. Because they are predominantly places of work, designed by and for certain occupations and for certain generations, they share cultural and social references that are far from being widespread. The lack of diversity is also explained by their functioning, based on acquaintances and co-optation, leading to social homogamy (Berrebi-Hoffmann et al. 2018). In this respect, CSs do not provide social diversity but rather strengthens the networks of like-minded individuals, bearing the risk of estranging themselves from the rest of the population. In this context, spatial marginality may be doubled with social marginality, with those newly arrived social groups not sharing the same places of work, of shopping or even of education than the rest of the population (the bloom of alternative private schooling also being a distinctive feature in those areas). Indeed, as described elsewhere, spatial marginality is often seen as a resource for new communities (Léger, Hervieu 1983). However, this aspect should not be overstated nor the opposition between "neos" and "locals" caricatured. Indeed, among the places we have researched during fieldwork, we have also noticed that some of those that we have labelled "multifunctional third-places" have developed active strategies to encourage their appropriation by a wider range of inhabitants, like the provision of services (printing and photocopy, distribution site for local newspapers and informations…) or the provision of workshops, that attract a wider diversity of users. However, this often relies on the energy and willingness of voluntaries and many places reckon they lack such energy and time for unpaid work. The main limit here is thus the lack of social and cultural mediation that is needed to ensure the appropriation by a wider range of inhabitants.

Finally, attractiveness also creates tensions on the housing market, that appear affordable for those coming from the city and teleworkers who keep their urban salary

while moving to the countryside. Until the pandemic, those migrations have remained too anecdotical to have an impact on local housing markets. Indeed, coworkers remain very few compared to the wide range of other places of work that make most of the rural economies. But the expansion of telework during the Covid-19 has increased the tensions not so much because of actual massive flows (Milet et al. 2022), than because of the creation of a housing bubble caused by the novel interest of investors for those places (Delage, Rousseau 2021). In places where the housing market was already tense because of the abundance of secondary homes, telework has worsen the situation. Would it be generalized, telework would probably create new forms of spatial segregation, less determined by the distance to city centres than by quality of life and amenities.

6 Conclusion and discussion

Our study has shown that while CSs seem to have undoubtable positive impacts for their users, their impact on the territory is not so clear and easy to evaluate. Their location patterns tend to show that CSs and third-places reveal the wider evolutions of contemporary rural areas, both socially, demographically, and also culturally in the way rurality is defined, inhabited and imagined. While a massive "urban exodus" has not happened, the pandemic has revealed – and maybe accelerated – a quiet and mild alteration that was already ongoing, with the spread of remote labour allowing an increased number of workers to access lifestyle migration – whether it be in the countryside, or elsewhere. The power of those narratives of "life change" has been unveiled at the occasion of the COVID-19 lockdown, during which those romanticized and idealized visions of the countryside have been described as "the new Eldorado".

The fact that places that are remote and were previously described as mostly marginal are now pictured as the new "places to be" interrogates. Indeed, there is an obvious contradiction between the numerous empirical evidence of a growing marginalisation of rural areas in France (see for example the report by Dufrégne, Mattei 2019), and their increased desirability (including in public policy narratives). In this article, we have argued that not only the diversity of rural areas and their uneven dynamism is frequently underestimated, but also that the same territories can be dwelled on differently by various social groups, with very different experiences of marginality. The example of coworking shows that marginality can be accommodated, and even yearned for, when high connectivity, multilocality and reversibility of anchorages provides resources for individuals to cope with or even circumvent the constraints of marginality, and keep only the positive aspects of it. We thus argue that there is a need to better take into consideration the social dimensions of marginality in public policy making. Favouring local development through business and social innovation-oriented strategies may not benefit the most precarious local populations nor the most marginalised territories. Instead of reducing inequalities between rural and urban areas, it may increase the inequalities between desirable and less desirable areas – whether they be urban and rural. Indeed, we have seen from our study that those places were unevenly distributed – even at the scale of the region – and way more developed in the most attractive areas of the region. Reversely, the attempts at implementing such places in locations where there was no local demand have been failing. In addition, within the considered areas those places are likely to benefit first and foremost to populations that are not generally lacking social networks nor professional opportunities. As a result, there is a need of thinking about such places as not only responding to the needs of the most qualified and mobile workforce territories often wish to attract, but also responding to the needs of the local population (for example, with coupling it with employment and training services, or providing more general public services that are lacking in many rural areas).

The geography of coworking spaces also confirms the factors of attractivity for residential migration, in particular local services and landscape amenities, but also cultural dynamism. This attractivity for lifestyle migrations has fostered the development of CSs and allowed for their success. The touristic dimension appears particularly important, both as a factor of discovery for potential new residents, but also as a way of offering a high number of local businesses despite the relatively low size of the local

markets. They also echo the processes of gentrification described in the literature about city centres, with the presence of CSs following the quest for a certain local "identity" (Mariotti et al. 2017), that we have here referred to as a mix of rural and urban features. And similarly to the urban context, the rise of housing prices are not so much driven by the behaviour of individual households relocating, than by investors looking for a good opportunity (Delage, Rousseau 2021). Finally, we have shown that the habits and uses of mobility made by coworkers, being closer to those of tourists than of the more "classical" rural workforce, is likely to distort the definition of accessibility and marginality in their narratives. Because they don't commute every day and because when they use remote activities to avoid unwanted mobilities, many coworkers are likely to consider a 2-hour drive to the train station as "close enough" and not interpret marginality as a problem, but rather as an "appropriate distance" to the city.

However, those places also participate in the rural renewals by facilitating the spatial and professional transitions of newcomers. CSs provide crucial resources to lifestyle entrepreneurs, by offering networks that are both professional-like and peer group-like. They also undoubtedly enhance the quality of work life of teleworkers and help prevent some of the main psychosocial risks associated with telework. Nevertheless, despite their project of social mixing, the anchorage of those places in creative labour creates mechanically a lack of social diversity and a difficulty to reach a wider audience in the absence of dedicated human resources to manage them. Then, the question of their social impact remains an open question: should places of work be subsidised by public funding? This question is even more important after the pandemic, when many firms have decided to reduce their office surface and save on their buildings' expenses.

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The THEMA tool to support heritage-based development strategies for marginal areas: Evidence from an Italian inner area in Campania Region

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Abstract. The ongoing forced reflection on the leading urbanization models' crisis has led to greater attention to marginal areas. In Italy, the scientific and media debate has focused on inner areas that, since 2014, have represented the target of an innovative national cohesion policy aimed at tackling their shrinking dynamics: the National Strategy for Inner Areas (SNAI). Indeed, Italian inner areas are endowed with extraordinary natural capital and settlement models far from urban density. Thus, they seem to respond perfectly to the new raised living needs.

However, leaving aside the optimistic rhetoric, strong political and administrative choices are necessary to trigger a 'return process' based on this broader attention toward inner areas, thus countering humankind's natural tendency to concentrate on urban realities.

In this light, the paper proposes a tool to support SNAI in designing and implementing heritage-based local development strategies to address inner areas' real needs. After a critical reading of the new challenges for planning posed by the pandemic and SNAI's role within them, the contribution moves to frame the THEMA (Tool for Heritage-based Enhancement of Marginal Areas) tool, focusing on specificities of the inner areas as cultural heritage. Finally, the tool's application to a case study, an inner area in Campania Region, allows to outline and discuss its possible benefits for SNAI implementation and its limits.

Key words: Marginal areas, inner areas, public policies, decision support, local development

1 Introduction

The ongoing forced reflection about the leading urbanization model's crisis (Sharifi, Khavarian-Garmsir 2020) has led to a focus on marginal areas and their possible role in addressing this crisis (Pinto et al. 2020). This reflection has resulted in growing attention toward territorial cohesion policies that, starting from the Lisbon Treaty in 2007, are at the core of European programs to reduce disparities between and within EU member states (Atkinson, Pacchi 2020). In the Italian context, the emerging debate has focused on inner areas, which, since 2014, are the core of the National Strategy for Inner Areas (SNAI), an innovative national policy representing one of the most interesting laboratories toward EU territorial cohesion (Cotella, Vitale Brovarone 2020). The SNAI aims to tackle

the negative demographic trends affecting some Italian marginal areas by promoting actions for local development and rebalancing welfare services (Lucatelli 2015). This national policy focuses on Italian inner areas defined and identified as (Barca et al. 2014):

- Significantly distant from the main centers offering essential welfare services (education, healthcare, and mobility);
- Endowed with significant environmental resources (water resources, agricultural systems,
  villages, craft centers);
- A diversified territory as a result of the different natural systems' dynamics and human activity.

In operational terms, inner areas are identified by dividing the national territory into five zones (centers, peri-urban areas, intermediate areas, peripheral areas, and ultra-peripheral areas) according to an accessibility indicator (Calvaresi 2015).

This accessibility indicator is measured in minutes needed to reach the closest center, defined as a municipality or a cluster of neighboring municipalities, offering simultaneously: all the secondary education provisions, hospitals with I level DEA, and at least a Silver railway station, according to RFI classification (DPS 2014). According to this classification, inner areas include all the municipalities resulting in intermediate (20-40 minutes needed to reach the closest center), peripheral (40-75 minutes required), and ultraperipheral (more than 75 minutes required). Among them, seventy-two project areas, including several municipalities classified as inner areas, have been chosen for the SNAI implementation.

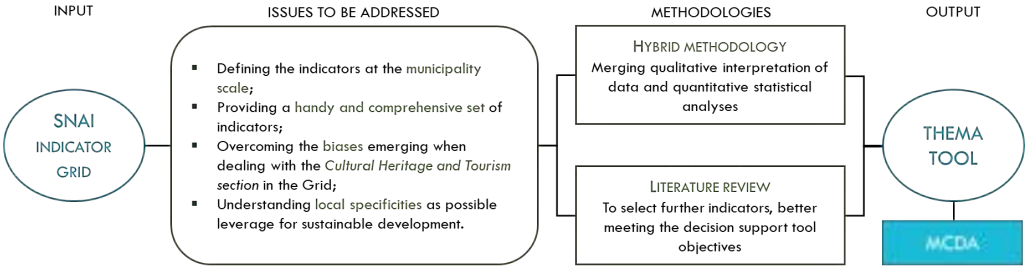
Thanks to their endowment of natural and cultural resources and their settlement model, far from urban density, inner areas seem to be a good response to the new living needs raised by the Covid-19 pandemic (Bruni 2021). However, leaving aside the optimistic rhetoric, looking at inner areas as the new centers of territorial development, strong political and administrative choices are necessary to trigger a 'return process', thus countering humankind's natural tendency to concentrate on urban realities (Lucatelli 2020). In this light, there is an urgent need to provide decision-makers in the SNAI perspective with effective decision-support tools. On the one hand, it is essential to leverage inner areas' specificities and potentialities, thus shunning prepacked and ineffective development models. On the other hand, it is important to overcome the limited vision, identifying a territory's marginalization degree merely with its peripherality level and ground development strategies for inner areas on a more in-depth and aware analysis of their dynamics. Indeed, defining marginality as "an involuntary position and condition of an individual or group at the margin of social, political, economic, ecological, and biophysical systems, that prevent them from access to resources, assets, services, restraining freedom of choice, preventing the development of capabilities, and eventually causing extreme poverty" (Gatzweiler et al. 2011, Gatzweiler, Baumuller 2014), it seems evident that it cannot be reduced to an accessibility issue, but must be addressed through a broader perspective. Furthermore, some virtuous experiences in inner areas show that the peripherality level does not necessarily index the area's weakness (Barca et al. 2014, Martinelli 2020).

Based on these premises, the research proposes a decision-support tool, named THEMA (Tool for Heritage-based Enhancement of Marginal Areas), to help decision-makers in the SNAI context defining local development strategies for Italian inner areas based on one of their primary, even if undervalued, sources: the cultural heritage (Rossitti, Torrieri 2021). Indeed, even if cultural heritage is widely recognized as territorial capital for sustainable development (Camagni et al. 2009, Foster 2020) and included within local development priorities, heritage-based actions in the SNAI implementation Strategy are often missing or reduced to tourism-oriented interventions. This is evident by looking at the planned interventions within the Area Strategies and the Framework Program Agreements (Agenzia per la Coesione Territoriale 2017, 2019, 2021a,b) of the four selected inner areas in the Campania Region. Indeed, by analyzing the data about the incidence of funding for cultural heritage interventions on the total of local development funding, it emerges how the built cultural capital is not adequately considered. This incidence is around 5% for three inner areas. The only exception is represented by the Alta Irpinia

Table 1: Planned cultural heritage fundings by the four inner areas in the Campania Region

Inner Area	Total Local Development Funding	Cultural Heritage Funding	% of Cultural Heritage Funding on Local Development Funding	% of Tourism oriented funding on Cultural Heritage Funding
Alta Irpinia	€20,579,482	€7,000,000	34.01%	100.00%
Cilento Interno	€10,779,280	€520,000	4.82%	100.00%
Tammaro – Titerno	€17,443,370	€860,100	4.93%	12.77%
Vallo di Diano	€13,756,900	€646,600	4.70%	100.00%

Source: Authors' elaboration on data provided by the Framework Program Agreements of Campania Region's inner areas



Source: Authors' elaboration

Figure 1: The methodological path towards the THEMA definition

inner area, but in its Strategy, all the interventions are limited to tourism promotion (Table 1).

After describing the complex methodological path leading to its definition, the THEMA tool is implemented through a case study: Tammaro-Titerno inner area in the Campania Region. Finally, the tool's value as a cognitive and operative device for SNAI implementation is discussed.

2 The methodological path towards the THEMA tool for heritage-based local development strategies in inner areas

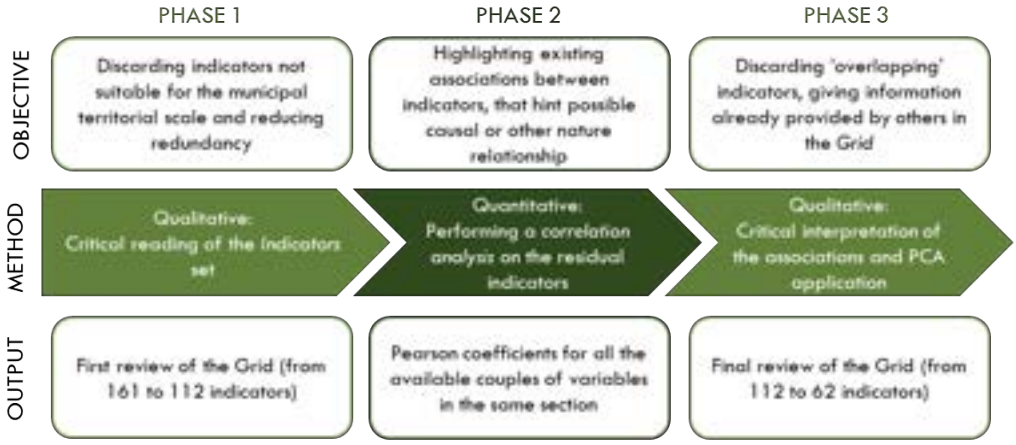
The complex challenges in territorial planning and the need to reduce disparities among and within territories call for proper tools to support policies and strategies toward territorial cohesion and local development, as the SNAI is. Such tools must consider the multiple dimensions of local development, recognize the differences among territories and provide objective data as a reference for decisions.

In this light, the SNAI Indicator Grid, used by the Technical Committee for Inner Areas in selecting project areas, represents a valuable starting point for the THEMA tool definition. However, its application as a decision-support tool for heritage-based local development strategies brings along some issues that need to be detected and solved. With this aim, the research integrates a hybrid methodology, merging qualitative data interpretation and statistical analyses with a literature review process to meet the THEMA tool objectives (Figure 1).

The two methodologies' integration returns a comprehensive tool for heritage-based local development strategies in inner areas that can be used as a cognitive tool or integrated with Multi-Criteria Decision Analysis (MCDA) techniques to support decisions in the SNAI perspective effectively.

2.1 2.1 The SNAI Indicator Grid

The SNAI Indicator Grid, used by the Technical Committee to evaluate the candidacies to inner areas submitted by the different Regions, represents the starting point for the THEMA tool definition.



Source: Authors' elaboration

Figure 2: Hybrid methodological approach toward SNAI Indicator Grid's review

It is a matrix to understand inner areas' characteristics through quantitative indicators. It includes both context variables (i.e., productive specialization indexes, demographic indicators) and result variables, measuring essential services' quality (i.e., share of population reached by broadband) or specific activities' economic success (number of visitors per 1000 inhabitants) (Carlucci, Lucatelli 2016). The Grid is divided into nine sections:

- Main characteristics;
- Demography;
- Agriculture and sectoral specialization;
- Digital divide;
- Cultural heritage and tourism;
- Health;
- Accessibility;
- School;
- Cooperation among municipalities.

Each section includes several indicators, which return an exhaustive and objective overview of the project areas' conditions to be integrated with qualitative considerations and the evidence from on-field activities.

2.2 The SNAI Indicator Grid: which issues to address?

The awareness of the Grid's potential in yielding a picture of inner areas' conditions hints at its use as a reference for a decision-support tool to guide heritage-based local development strategies. However, this new application field brings out some issues to be addressed towards improving its effectiveness. They can be listed as follow:

- The high number of indicators (161 indicators) makes it cumbersome to collect the necessary information to update the Grid or to apply it at the municipality scale to understand the power balances among municipalities within an inner area;
- The Grid contains much information, which is not always easily accessible, while it requires cooperation among different public institutions. The related effort to access data, if appropriate for the Grid's original use, which is the project areas selection, can discourage its extensive use as practical support for decisions;
- Both the large amount of information to manage and the difficulties in accessing data sources hinder the process of comprehensive qualitative analysis aimed at investigating the relations among different variables;

Table 2: Selected indicators for the Cultural Heritage and Tourism section after the critical analysis of the indicators set

E. CULTURAL HERITAGE AND TOURISM			
e.6	Number of state and non-state cultural sites in 2015	e.7	Number of visitors in 2015
e.8	Number of visitors per 1000 inhabitants in 2015	e.10	Accommodation rate – bed places for 1000 inhabitants in 2016
e.11	Tourism rate – number of presences per 1000 inhabitants in 2016	e.13	Arrivals in 2016
e.14	Percentage variation in arrivals 2014-2016	e.16	Presences in 2016
e.17	Percentage variation in presences 2014-2016	e.18	Percentage of presences in hotel facilities in 2016
e.19	Percentage of presences in extra-hotel facilities in 2016	e.20	Percentage of arrivals in hotel facilities in 2016
e.21	Percentage of arrivals in extra-hotel facilities in 2016		

- The Cultural Heritage and Tourism section in the Grid reflects a partial and limited vision of cultural heritage as a tourism attraction. Indeed, all the indicators belonging to this section are measures of tourist flows, and there is no variable providing information about built heritage conditions. In addition, indicators in the Cooperation among municipalities section are limited to describing the relations among municipalities without considering the existence of associative forms within local communities;
- Applying some indicators to the municipality scale is impossible since they are only conceived for the inner area's territorial dimension.

To overcome these issues, raised from the willingness to adapt the Grid to different needs, the research resorts to the integration of two different methodologies:

- a hybrid methodology, merging statistical analysis and qualitative data interpretation to reduce redundancy in the indicators set and keep only the relevant variables for the SNAI purposes;
- a literature review aimed at identifying other indicators to fill the existing knowledge gaps in the reviewed Indicator Grid.

2.3 The hybrid methodology for the SNAI Grid review

The hybrid methodology addresses the Grid's most relevant limit, which is the high number of indicators. This methodology finds its logical basis in the law of briefness that, when applied to data science, results in parsimonious models, allowing a significant explanatory power of a dataset by using the minimum number of variables (Daganzo et al. 2012). Indeed, it is geared toward reducing redundancy and keeping only the relevant variables in the Indicator set through a methodological path structured into three phases (Figure 2) (Rossitti et al. 2021):

1. The first qualitative phase is based on a critical analysis of the indicator set. This preliminary step has a dual purpose. On the one hand, it aims at discarding indicators referring to the inner area territorial scale, thus allowing to turn the Grid into a tool applicable at the municipality scale. Indeed, the Grid application to the municipality scale can help understand power balances among municipalities, thus providing an in-depth knowledge of its dynamics. On the other hand, it is oriented to reduce the Grid's redundancy, intended as the presence of more than one indicator providing the same piece of information (Huang et al. 2015). More in detail, this task mainly addresses temporal redundancy and, thus, rejects indicators occurring twice with different time horizons when their simultaneous presence doesn't pitch in understanding the ongoing territorial dynamics (Table 2). Thanks to this first phase, the number of indicators in the Grid drops from 161 to 112.

Table 3: Correlation matrix for the selected indicators in the Cultural Heritage and Tourism section

	e.6	e.7	e.8	e.10	e.11	e.13	e.14	e.16	e.17	e.18	e.19	e.20	e.21
e.6	1.00												
e.7	0.40	1.00											
e.8	0.48	0.85	1.00										
e.10	0.16	-0.04	0.21	1.00									
e.11	0.06	-0.02	0.19	0.93	1.00								
e.13	-0.01	0.10	0.27	0.59	0.77	1.00							
e.14	-0.17	0.06	0.12	0.01	0.01	-0.02	1.00						
e.16	-0.09	0.05	0.16	0.51	0.71	0.94	-0.02	1.00					
e.17	-0.20	0.00	0.06	0.01	0.02	-0.01	0.83	-0.01	1.00				
e.18	-0.21	0.24	0.18	0.08	0.17	0.18	-0.19	0.10	-0.07	1.00			
e.19	0.21	-0.24	-0.18	-0.08	-0.17	-0.18	0.19	-0.10	0.07	-1.000	1.00		
e.20	-0.30	0.19	0.12	0.08	0.17	0.23	-0.15	0.15	-0.06	0.97	-0.95	1.00	
e.21	0.30	-0.19	-0.12	-0.08	-0.17	-0.23	0.15	-0.15	0.06	-0.97	0.95	-1.00	1.00

Table 4: Selected indicators after the review of the Cultural Heritage and Tourism section of the SNAI Indicator Grid

E. CULTURAL HERITAGE AND TOURISM			
e.6	Number of state and non-state cultural sites in 2015	e.8	Number of visitors per 1000 inhabitants in 2015
e.10	Accommodation rate – bed places for 1000 inhabitants in 2016	e.11	Tourism rate – number of presences per 1000 inhabitants in 2016

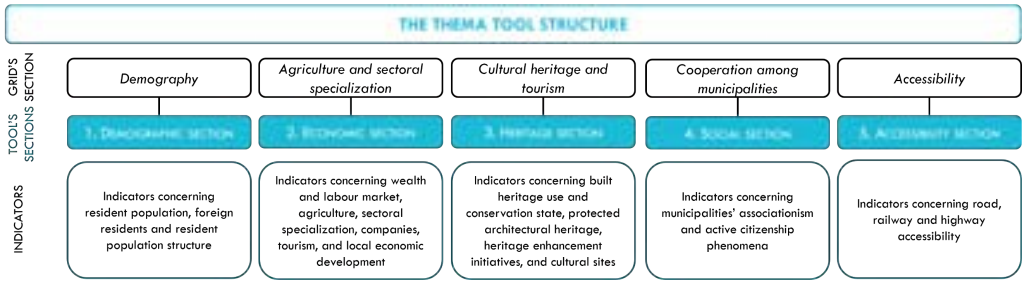
2. A second qualitative phase, grounding on the statistical analysis of the selected indicators. This step allows highlighting relationships among variables that hint at possible causal or other nature associations. More in detail, a Pearson correlation analysis is performed among each couple of variables within each Grid category (Table 3) (Archdeacon 1994). The correlation analysis rests on the numerical data, referred to the 72 project inner areas, provided for each indicator by the Technical Committee for Inner Areas and updated in 2017 (Agenzia per la Coesione Territoriale 2017).
3. The third and last phase moves from the results of the correlation analysis to a refined list of indicators. Since high correlation values among variables hint at causal or other nature associations, a critical interpretation of these associations is necessary (Table 4). After evaluating each relationship, it is possible to discard 'overlapping' indicators ultimately providing the same information eventually, or to combine them into fewer composite indicators by resorting to a Principal Component Analysis (PCA) (Hair et al. 2006).
   Through this last phase, the number of selected indicators in the Grid decreases from 161 to 62.

2.4 The literature review process

Applying the hybrid methodology to the SNAI Indicators Grid allows its significant review with a reduction of the number of indicators from 161 to 62 without losing its information and complexity level. Furthermore, it enables to deal with some of the Grid's detected issues for its application as a decision-support tool at the municipality level:

- the large number of indicators is dramatically reduced (from 161 to 62), thus turning the Grid into a handier indicator set;
- all the indicators can be defined at the municipality scale, thus allowing the Grid's application at the municipality level and a better understanding of the ongoing dynamics among municipalities within an inner area.

However, some issues still exist, whose solution is crucial for the Grid application as an effective decision-support tool. Indeed, the Grid still requires collecting much information



Source: Authors' elaboration

Figure 3: THEMA tool's structure

that, together with the difficulties in accessing some required data, discourages its extensive use as practical support for knowledge and decisions and its application to different territorial realities. Furthermore, some sections in the Grid, such as the Cultural Heritage and Tourism and the Cooperation among municipalities, include indicators unable to describe territorial dynamics' complexity.

In this light, the research addresses these remaining shortcomings towards framing a handy and effective tool. First, to overcome the high amount of information needed, it proposes an 'optimized' version of the Grid, including only the relevant sections for the addressed decisional issue. Thus, considering the research's objective to support local development strategies in inner areas, focusing on their cultural heritage, universally acknowledged as a key source for sustainable development (Fusco Girard, Gravagnuolo 2017), the tool structure is limited to five sections:

- The Demographic section, since the main SNAI objective is to tackle abandonment processes and hinder depopulation (Tantillo 2015);
- The Economic section, since economic dynamics cannot be dismissed in any local development issue (Jay et al. 2020);
- The Heritage section, finding its reason for considering cultural heritage as leverage for local development processes (Capello et al. 2020);
- The Social section, advocated by the acknowledged importance of social involvement for strategies aiming at tackling depopulation and for heritage issues (Bartocci, Picciaia 2020);
- The Accessibility section, since accessibility stands as a fundamental requirement for each territorial transformation process (Chacon-Hurtado et al. 2020)

Furthermore, to address the need to fill gaps in the indicator set, thus providing a complete picture of the municipalities' conditions and power balances, the research delves into a literature review process to identify accurate indicators for the THEMA tool's purposes. This literature review process examines European and national Indicators databases, official websites, and documents, providing indicators or relevant information to define indicators for the public policies' domain. Table 5 displays the different reference sources for each section of the THEMA tool.

Thanks to this process, it is possible to obtain a comprehensive decision-support tool (Figure 3) whose indicators, defined for the different sections, provide a multi-dimensional picture of the conditions and ongoing dynamics of different municipalities within an inner area (Table 6). Indeed, besides updating some existing indicators in the Grid with the most recent available values, the data sources consultation process enriches the THEMA tool with valuable references for gaining comprehensive knowledge and grounding decision. More in detail:

- The Demographic section in the tool keeps the selected indicators in the Demography section from the SNAI Grid and completes them with the Ageing index as a dynamic and synthetic indicator of the population's structure;
- The Economic section also keeps the well-structured indicators set in the reviewed Agriculture and sectoral specialization section of the SNAI Grid. However, the

Table 5: List of consulted sources for the definition of additional relevant indicators in each section

Tool's Section	Sources
Demographic	ISTAT – Population and Household Census
Economic	MEF (Finance Department) – Open data ISTAT – Agricultural Census ISTAT – Atlante Statistico dei Comuni (ASC) ASIA Register of Companies CERVED Register of Companies Region official documents SNAI official documents
Heritage	ISTAT – Population and Households Census ISTAT – 8milaCensus MIBACT Registers https://borghipiubelliditalia.it/ https://www.borghiautenticiditalia.it/ http://www.borghinrete.it/ http://www.borghidellamemoria.it/ https://www.eventiesagre.it ISTAT – Atlante Statistico dei Comuni (ASC)
Social	SNAI official documents Regional Register of Third Sector entities
Accessibility	Google maps Transport companies' websites

existing set is integrated with other variables, capturing relevant phenomena. Firstly, it includes tourism indicators belonging to the Cultural heritage and Tourism section in the SNAI Grid. Secondly, it is enriched with several indicators capturing municipalities' involvement in local economic development processes;

- The Heritage section markedly distances itself from the structure of the Grid's Cultural Heritage and Tourism section, which meets a vision of cultural heritage as a mere touristic attraction. Indeed, the Heritage section includes indicators concerning built heritage use and conservation state, protected architectural heritage, cultural sites, and the presence of heritage enhancement initiatives. Thus, through the THEMA tool's lens, it is possible to obtain a broader picture of the heritage dimension.
- The Social Section resumes some indicators concerning municipalities' associationism, already present in the Cooperation among municipalities section of the SNAI Grid and adapts them to the municipality scale definition. Furthermore, it includes other indicators capturing active citizenship realities, which are essential for place-based local development strategies.
- The Accessibility Section takes the existing indicators in the homonymous section from the SNAI Grid and adapts them to the need to be defined at the municipality scale and easily updated.

Table 6: Complete list of indicators for each section in the THEMA tool

1. DEMOGRAPHIC SECTION			
1.1 Resident population			
POP_VAR_71-01	Percentage variation in the resident population 1971-2001	POP_VAR_01-11	Percentage variation in the resident population 2001-2011
POP_VAR_11-20	Percentage variation in the resident population 2011-2020		

continued below

Table 6: Complete list of indicators for each section in the THEMA tool (continued)

1.2 Resident foreigners			
FOR_VAR_01-11	Percentage variation in the resident foreigners 2001-2011	FOR_VAR_11-20	Percentage variation in the resident foreigners 2011-2020
FOR_PER_20	Percentage of resident foreigners in 2020		
1.3 Resident population structure			
AGE_20	Aging index in 2020		
2. ECONOMIC SECTION			
2.1 Wealth and labor market			
PCI_18	Per capita income in 2018	EMP_18	Employment rate in 2018
2.2 Agriculture			
UUA_VAR_82-10	Percentage variation in the Utilized Agricultural Area 1982-2010	FARX1000_10	Number of farms per 1000 inhabitants in 2010
FAR_VAR_82-10	Percentage variation in the number of farms per 1000 inhabit. 1982-2010	AGR_IMP_10	Importance of the agricultural sector in 2010
2.3 Sectoral specialization			
SP_IND_E&W_1	Specialization index for the 'Energy, Water and Gas' sector in 2017	SP_IND_MAN_17	Specialization index for the 'Manufacturing' sector in 2017
SP_IND_CON_17	Specialization index for the 'Construction' sector in 2017	SP_IND_T&T_17	Specialization index for the 'Trade and Transport' sector in 2017
SP_IND_SER_17	Specialization index for the 'Other services' sector in 2017		
2.4 Companies			
COMX1000_20	Number of active companies per 1000 inhabitants in 2020	COM_GRO_20	Companies stock growth rate in 2020
COM_VAR_15-20	Percentage variation in the active companies 2015-2020		
2.5 Tourism			
ACC_RA_19	Accommodation rate in 2019		
2.6 Local economic development			
QU_PRO_16	Producers and processors of DOP/IGP/STG quality products in 2016	FOOD_DEV	Local development based on food and high-quality agriculture
INDU_DEV	Local development based on productive specialization	TOUR_DEV	Local development based on tourism
RES_DEV	Local development based on the attraction of new residents		
3. HERITAGE SECTION			
3.1 Built heritage			
DIS_RATE_11	Building disuse rate in 2011	HIS_RATE_11	Rate of residential building up to 1945
BAD_INC_11	Incidence of residential building in bad conservation state in 2011		
3.2 Protected architectural heritage			
PRO_ARC_HER	Protected architectural heritage		
3.3 Heritage enhancement			
VIL_ENH	Historical villages enhancement initiatives	EX_REG_EVE	Events of extra-regional importance in 2019
LOC_EVE	Events of local importance in 2019		
3.4 Cultural sites			

continued below

Table 6: Complete list of indicators for each section in the THEMA tool (continued)

VISX1000_18	Number of visitors per 1000 inhabitants in 2018		
4. SOCIAL SECTION			
4.1 Municipalities' associationism			
UNI_MUN	Municipality's membership in a Union of Municipalities	MCOM_MUN	Municipality's membership in a Mountain Community
LAG_MUN	Municipality's membership in a LAG (Local Action Group)		
4.2 Active citizenship			
APS_20	Social promotion associations	ODV_20	Voluntary organizations
OTH_20	Other local associations	SCOP_20	Social cooperatives
5. ACCESSIBILITY SECTION			
5.1 Road accessibility			
CEN_DIS	Average distance from the nearest centers in minutes	CEN_LPT	Road LPT (Local Public Transports) offer to connect with the local centers
5.2 Railway accessibility			
RAIL_DIS	Average distance from the nearest railway station in minutes		
5.3 Highway accessibility			
HIGH_DIS	Average distance from the nearest highway tool booth in minutes		

Colourcodes:

Indicators already present in the SNAI Grid	Indicators already present in the SNAI Grid with a different year/time span of reference	Indicators selected after the literature review process

3 The THEMA tool implementation in Tammaro-Titerno inner area in Campania Region

Once the THEMA tool's structure is defined, implementing it in a case study is crucial to understand its potentialities, limits, and room for improvement. For this reason, the tool is tested on one of the 72 SNAI inner areas: Tammaro–Titerno inner area in the Campania Region (Figure 4).

This area, located in the north-eastern part of Benevento Province, includes 24 municipalities. It is affected by demographic shrinking and marginalization dynamics common to all Italian inner areas. One of the main criticalities is accessibility: a mountain ridge stands as a natural barrier, dividing the area into poorly connected parts, the Tammaro and the Titerno (Figure 5).

Furthermore, the analysis of Tammaro-Titerno's inner area Framework Program Agreement returns a low incidence of funding devoted to cultural heritage interventions on the total funding for local development initiatives (4,93%) (Agenzia per la Coesione Territoriale 2021b).

However, it shows a solid agricultural vocation, a good associationism tradition, and an array of distinctive heritage elements, from the tangible to the intangible dimension, making it prone to undergo heritage-led local development processes (Associazione Sannio Smart Land 2020).

The tool's implementation to Tammaro-Titerno inner area requires calculating the different indicators' values assigned to each municipality within the area. These values represent useful references to understand the municipalities' conditions concerning specific phenomena and the existing power balances within them. In this sense, a significant advantage can stem from integrating the indicators set in a GIS environment (Figure 6),

Source: Cnai's elaboration on ISTAT administrative boundaries data, 2015

Figure 4: Tammaro-Titerno inner area in Campania Region

thus allowing an easier comprehension of data based on a graphical representation of the indicators' values (Duhr, Muller 2012, Oppio et al. 2021).

The indicators' values, calculated for each municipality, also allow investigation of some ongoing dynamics in the area through the graphical representation and qualitative interpretation of the relationships among variables (Figure 7).

Furthermore, the multi-dimensional nature of the decision-support tool fits the integration with an MCDA methodology aimed at drawing out a ranking of municipalities according to their need or potentialities in the different considered dimensions (Kiker et al. 2005, Falcao et al. 2021). In this light, among the different MCDA methodologies, the research applies the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) directly in a GIS environment thanks to the QGIS plugin VectorMCDA (Massei 2018). The TOPSIS is a MCDA ranking method that has received much interest and application in decision-making related to different fields (Behzadian et al. 2012). It allows ranking alternatives by privileging the ones having the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution (Yoon, Hwang 1995).

Concerning the practical application of the TOPSIS methodology to the case study, it requires the definition of the ideal point and the worst point for each indicator in the decision-support tool. More in detail, the two points are defined by referring to the values provided by scientific literature or to the average Italian performance for the considered indicators. When, for an indicator, the reference to these values is not meaningful, the ideal and the worst points are placed equal respectively to the best and the worst score within the ones given to Tammaro-Titerno municipalities for that indicator. Table 7 shows an example of the definition of the ideal and worst points, propaedeutic to the TOPSIS application, regarding the indicators belonging to the Heritage section: the consequent value functions are shown in Figure 8.

After this step and essential for score standardization, the municipalities' scores within each tool's section are aggregated through an indifferent system of weights, thus providing the municipalities' overall performance for any of the five dimensions (Figure 9).

Source: Authors' elaboration on ISTAT administrative boundaries data, 2021

Figure 5: The distinction between Tammaro and Titerno municipalities

Finally, the five overall scores related to the five sections in the tool are aggregated in a unique score, expressing the municipalities' inclination to undergo heritage-led local development processes (Figure 10).

4 Results

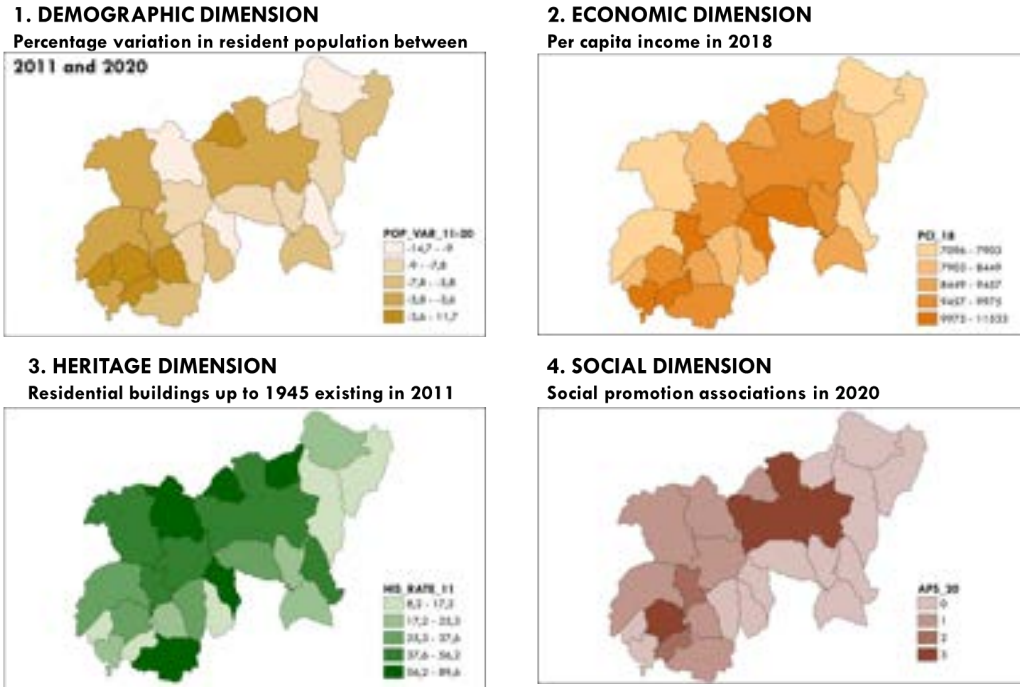
The tool's application to the Tammaro-Titerno inner area highlights its potentialities, limits, and room for improvement in supporting heritage-based development strategies for marginal areas. The value maps produced for each indicator allow understanding of the municipalities' minor or major inclination to transformation, according to the dimensions considered. Concerning Tammaro-Titerno inner area, the value maps with municipalities' overall score for each dimension (Figure 9) hint that Titerno municipalities show a higher disposition to transformation, according to most of the considered development dimensions. Furthermore, Telese Terme stands as an outlier since it seems not to be affected by the ongoing marginalization dynamics in the area.

The qualitative and graphical interpretation of the relationships among the selected variables reveals some interesting phenomena in the area (Figure 7). For instance, it is possible to state that:

- the increase in the foreign population doesn't seem to hinder the buildings' disuse rate;
- there seems to be a positive relationship between the number of third sector entities and the increase in foreign population;
- the resident population decline appears to affect the buildings' conservation state;
- the existing relationship between agricultural quality products and the number of local events per municipality makes the areas' strong agricultural vocation evident.

The tool's integration with a MCDA methodology allows to draw out a ranking of municipalities (Figure 10), according to their need or potentialities in the considered dimensions, that can be used as good support for grounding decisions. For instance, it can serve the choice of a pilot cluster of Tammaro-Titerno municipalities to implement heritage-based development strategies by leveraging their inclination to transformation and considering their proximity in light of a systemic and integrated approach to local development (Figure 11) (Salvia, Quaranta 2017).

Finally, the decision-support tool proposes complimentary reading keys to the one proposed by SNAI, based on the accessibility indicator, in understanding the municipalities'



Source: Authors' elaboration on ISTAT administrative boundaries data, 2021

Figure 6: Value maps for different indicators belonging to four sections (demographic, economic, heritage, and social) of the decision-support tool

marginalization conditions. Indeed, such multi-dimensional reading provides a more detailed and comprehensive definition of the marginalization phenomena than the one based only on the accessibility indicator. This reading's importance is evident by comparing the classification of Tammaro-Titerno municipalities provided by SNAI with the ones grounded on the overall performances obtained for each dimension of the tool through the MCDA methodology (Figure 9). Classifications are defined on a five-point scale (from 1 for the worst performances to 5 for the best ones) by grouping municipalities in five quantiles according to the overall score obtained for each dimension.

Table 8, displaying the comparison among these different classifications, clearly shows the limits of a definition of marginalization merely based on accessibility. Indeed, there are some municipalities (i.e. Cerreto Sannita, Morcone, San Lorenzello), classified as peripheral by SNAI, performing better than others classified as intermediate (i.e. Amorosi, Pontelandolfo, Puglianello). The broader perspective towards marginality shows that these intermediate municipalities in accessibility terms are affected by more severe marginality phenomena in economic, social, and heritage terms. Furthermore, even focusing on the accessibility definition, its extension to other factors than only the distance from the closest center, as the offer of local public transport, determines some differences with the classification provided by SNAI. Furthermore, declining the marginalization notion to the different relevant dimensions for local development allows for defining systemic policies by addressing each municipality's specific need.

5 Discussion and conclusions

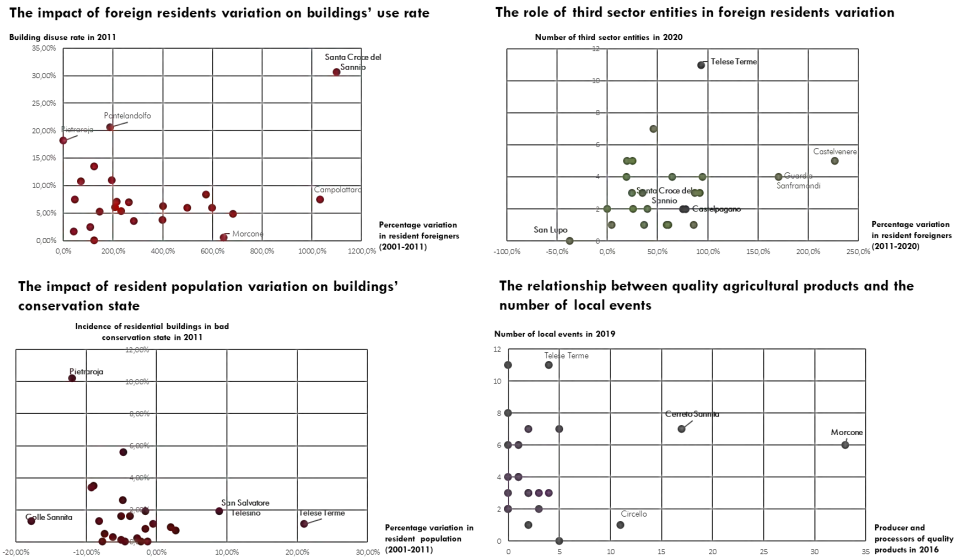
The paper proposes a tool to support SNAI in designing and implementing heritage-based local development strategies to address marginal areas' real needs. The analysis of the tool's application to a case study, represented by the Tammaro-Titerno inner area, clearly reveals its potential for SNAI implementation. Indeed, the THEMA tool, also through the integration with proper methodologies such as MCDA, can help SNAI decision-makers in public and private spheres in:

Table 7: Ideal and worst point definition method for the indicators belonging to the Heritage section

Id	Indicator	Ideal and worst point definition method	Ideal	Worst
DIS_RATE_11	Building disuse rate in 2011	Reference to the best and worst scores gained by Tammaro-Titerno municipalities	0%	30,6%
HIS_RATE_11	Rate of residential building up to 1945	Reference to the average Italian performance for the ideal point. The worst point is placed equal to zero.	25,9%	0%
BAD_INC_11	Incidence of residential building in bad conservation state in 2011	Reference to the best and worst scores gained by Tammaro-Titerno municipalities	0%	10,2%
PRO_ARC_HER	Protected architectural heritage	Reference to the best and worst scores gained by Tammaro-Titerno municipalities	18	0
VIL_ENH	Historical villages enhancement initiatives	The nature of the indicator (binary) automatically determines the ideal and worst points	1	0
EX_REG_EVE	Events of extra-regional importance in 2019	Reference to the best and worst scores gained by Tammaro-Titerno municipalities	2	0
LOC_EVE	Events of local importance in 2019	Reference to the best and worst scores gained by Tammaro-Titerno municipalities	11	0
VISX1000_18	Number of visitors per 1000 inhabitants in 2018	Reference to the cumulative Italian performance for the ideal point. The worst point is placed equal to zero.	2150	0

Table 8: Comparison between the SNAI classification of Tammaro-Titerno municipalities and the classifications based on the overall performances obtained from the THEMA tool

Municipality	SNAI classif.	Demographic	Economic	Heritage	Social	Accessibility
Amorosi	Intermediate	4	1	2	1	4
Campolattaro	Intermediate	4	1	2	2	5
Castelpagano	Peripheral	2	2	1	2	1
Castelvenere	Intermediate	5	5	3	4	2
Cerreto Sannita	Peripheral	4	4	5	4	2
Circello	Peripheral	2	3	1	3	2
Colle Sannita	Peripheral	2	2	2	3	1
Cusano Mutri	Peripheral	4	1	4	4	1
Faicchio	Intermediate	3	3	4	4	2
Fragneto l'Abate	Intermediate	1	2	4	1	5
Fragneto Monforte	Intermediate	4	5	3	1	5
Guardia Sanframondi	Intermediate	3	4	5	4	3
Morcone	Peripheral	2	4	5	5	3
Pietraroja	Peripheral	1	5	1	5	1
Pontelandolfo	Intermediate	1	4	1	2	4
Puglianello	Intermediate	5	1	2	1	3
San Lorenzello	Peripheral	3	5	5	5	1
San Lorenzo Maggiore	Intermediate	5	2	1	2	5
San Lupo	Intermediate	1	5	3	3	5
San Salvatore Telesino	Intermediate	5	4	3	5	4
Santa Croce del Sannio	Peripheral	3	3	2	2	2
Sassinoro	Peripheral	1	1	4	3	4
Solopaca	Intermediate	2	3	5	1	3
Telese Terme	Intermediate	5	2	4	5	4



Source: Authors' elaboration

Figure 7: Graphical representation of some relationships among the selected variables in the decision sup-port tool

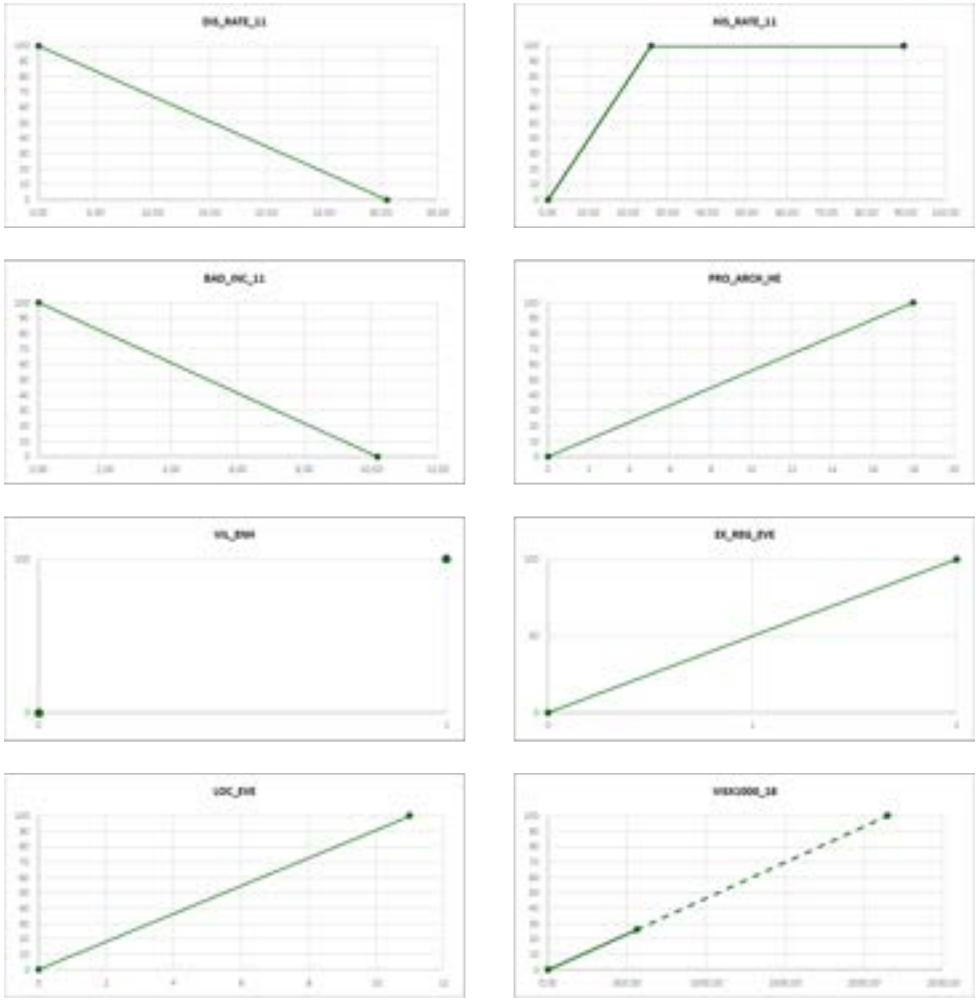
- Gaining a comprehensive and multi-dimensional knowledge of territorial dynamics and power balances thanks to the values defined for each indicator in the tool and available for each municipality. Value maps, in this sense, can offer valid support for the detected phenomena comprehension and communication;
- Defining interventions and allocating resources according to the municipalities' actual needs in the considered dimensions;
- Setting goals to be reached related to local development, in terms of performance, to monitor the effectiveness of the implemented policies;
- Prioritizing actions within a project inner area or selecting additional territories for SNAI relaunch.

More in detail, in the public sphere, the tool can address local and regional administrators' needs to properly manage limited financial resources by grounding investment decisions on a solid knowledge of territorial dynamics. For national administrators, if applied to the whole national context, it can stand as a powerful instrument for the planning agenda. Instead, the tool can support private actors in assessing different territorial investment opportunities.

Furthermore, regarding the possible role for SNAI project areas selection, the THEMA tool offers complementary reading to the one proposed by SNAI, based on the accessibility indicator, to understand the municipalities' marginalization conditions. Indeed, the proposed multi-dimensional reading provides a more detailed and comprehensive definition of the marginalization phenomena than the one based only on the accessibility indicator. This declination of the marginalization notion to the different relevant dimensions for local development allows for defining systemic policies by addressing each municipality's specific need.

Thanks to its objective and transparent framework, the decision-support tool can play a significant role in SNAI implementation through its application to the different inner areas. However, in exporting the tool to other territorial contexts, the need for a place-based perspective on local development (Barca et al. 2012) requires adapting its structure to the inner area under study by eventually discarding not representative indicators or including new ones, able to capture its specificities.

The importance of adopting a place-based approach to marginal areas' local development (Cotella et al. 2021) opens some considerations on the limits of the THEMA tool application and how to overcome them.

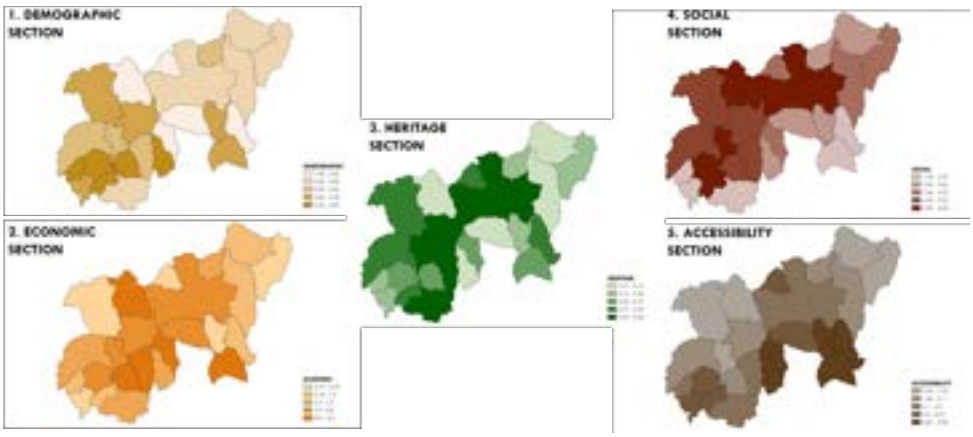


Source: Authors' elaboration

Figure 8: Value functions for the standardization of the scores, related to the Heritage indicators, stemming from the ideal and worst point definition

Indeed, territorial dynamics can fully be captured only through direct contact with the territorial context under study and its community. In this sense, the decision-support tool cannot stand as the exclusive basis for decisions. Its data must be integrated with the values stemming from the interaction with local communities, their system of preferences, and expectations (Oppio et al. 2021). In practical terms, this integration can be pursued by involving key local stakeholders in applying participatory weighting methodologies for the MCDA implementation, such as the Swing, the SMARTER, or the SRF (Edwards, Hutton Barron 1994, Figueira, Roy 2002, Dell'Ovo et al. 2021), or placing the results of the tool's application at the core of an informed dialogue with them based on participatory tools like focus groups, semi-structured interviews, questionnaires, and workshops.

Another challenge towards the tool implementation as adequate support in the decision arena is related to its practical use by local technicians or private. However, this limit can be overcome by developing a user-friendly online platform to be consulted and by setting specific training programs for local technicians to access data for updating it and interpreting its results.



Source: Authors' elaboration on ISTAT administrative boundaries data, 2021

Figure 9: Value maps with municipalities' overall score for any of the five dimensions considered in the decision-support tool

Source: Authors' elaboration on ISTAT administrative boundaries data, 2021

Figure 10: Tammaro-Titerno municipalities' overall ranking according to their inclination to undergo heritage-led local development processes

Source: Authors' elaboration on ISTAT administrative boundaries data, 2021

Figure 11: A pilot cluster of municipalities for the implementation of heritage-based development strategies

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Redefining marginality on Italian Apennines: An approach to reconsider the notion of basic needs in low density territories

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Abstract. The concept of basic needs and essential services evolves according to sociocultural parameters. Therefore, defining marginality based on the distance from a predefined set of services, institutionally considered essential for life, may lead to an unfocused representation of marginal and more fragile areas.

This work focuses on a territory located on the Apennine of the Province of Piacenza, northern Italy. These mountainous areas are characterized by significant shrinking processes, ageing population, low income and educational rate, unemployment, and by work/study-related mobility practices over long distances and at high speed, revealing low levels of attractivity and significant dependence on more dynamic areas of the region. Moreover, according to the National Italian Strategy for Inner Areas, they have been identified as inner areas because of the high distance from main services.

Starting from a previous research work aimed at mapping and assessing the availability, location, and accessibility to a set of services considered essential, the present work aims to reconsider and integrate this quantitative approach with an on-site qualitative survey, thanks to interviews with inhabitants and persons with special knowledge of the territory as well as participant observation.

The hypothesis is that, particularly in low density and peripheral areas, a mixed-methods research methodology that includes the accounts of populations and local stakeholders may help to extend the knowledge of their actual needs and their willingness to travel, thus reconsidering their accessibility to what they perceive as essential services and, consequently, redefining the notion of marginal and fragile territories.

Key words: marginality, accessibility, basic needs, qualitative data, mixed methods

1 Introduction

The concepts of basic need and essential service have been already addressed in mobility and accessibility studies and informed operational approaches and policy frameworks (Carrosio, Faccini 2018, Lucas 2012, Martens 2017), such as the Italian National Strategy for Inner Areas (SNAI). SNAI classifies the Italian territory according to the distances from three main services: education, health, and mobility[1]. According to this classification,

[1]SNAI classifies the Italian municipalities based on the level of accessibility to three citizenship rights: mobility, education, and health. According to the Strategy, the level of accessibility to these rights

the level of marginality of the Italian territory is inversely related to its physical level of accessibility.

Based on the definition of accessibility as "the capacity to reach a place, event, opportunity or social contact in a way that fulfils what people need" (Ferreira, Papa 2020), the paper discusses the limits of marginality assessments based on aggregate measures of accessibility to a predefined set of services and activities often arbitrarily considered essential. Notions of basic needs and essential services have been widely discussed in the literature (Froud et al. 2018). Concerning the selection of target services, some authors argue that the identification of basic needs is still "an unresolved challenge in the academic literature" (Pereira et al. 2017, p. 20) and that it is not possible to define a univocal and comprehensive list of essential needs (Nussbaum 2011).

In this work, we discuss the hypothesis that a mixed-methods research based on the listening of target populations and local stakeholders may help to both reconsider essential services, redefine the notions of marginal and fragile territories, and produce a basic knowledge for the design of more context-sensitive land use and mobility policies. As matter of fact, while quantitative data highlight general trends at larger scale, qualitative survey data help to show diversities in behaviors and to describe specific processes affecting the individual sphere. A combination of both quantitative and qualitative data may thus lead to unexplored directions of research.

However, existing literature suggests that qualitative methodologies may have some limits as it "still involve a form of aggregation and tend to lose the richness of individuals' lived experiences" (Preston, Rajé 2007), focusing on specific population groups (Titheridge et al. 2009, Shergold, Parkhurst 2012, Ryan et al. 2015) or target activities (Fransen et al. 2015, Mao, Nekirchuk 2013, Higgs et al. 2015, Materiali Uval 2014). For this reason, more sophisticated approaches based on individual accessibility are needed. Methodologies based on tools such as personal travel diaries (Kenyon 2006, Neutens et al. 2007, Chudyk et al. 2015), the collection of microstories (Vecchio 2020), or the use of disaggregated GPS, social networks, and telephone traffic digital data (Järv et al. 2014) respond to this challenge. Those methods may provide additional elements for the design of more effective policy actions as they detect features of the mobility experience that, despite their relevance for personal preferences and behaviors, are still difficult to be included in policy design using quantitative aggregated data.

The present work aims to reconsider and integrate a quantitative approach that analyzes the availability, location, and accessibility to a set of essential services with an on-site qualitative survey. Through interviews with groups of inhabitants and persons with special knowledge of the territory and participant observation, the work discusses how listening to the voices and stories of a territory can, despite some limitations, contribute to critically reconsidering the set of essential activities and services that should be available and accessible for improving the quality of life in these areas, reducing marginality. It also analyses how place-based policies and strategies may contribute to a fairer distribution and access to services and opportunities.

The approach is tested through empirical observation in a territory located on the Apennine of the Province of Piacenza in the Emilia Romagna region, northern Italy. These mountainous areas are characterized by significant shrinking processes, ageing population, low income and educational rate, unemployment, and work/study-related mobility practices over long distances and at high speed, revealing low levels of attractivity and significant dependence on more dynamic areas of the region (Vendemmia et al. 2021). Moreover, they have been defined as peripheral according to the Italian National Strategy for Inner Areas, thus representing an interesting case study to analyze the link between accessibility to basic needs and marginality.

After this introduction, in Section 2 we introduce an overview of basic needs and essential activities as well as of services for accessibility assessment. In Section 3, we outline the research design introducing the case study and the method. We then discuss the more

is proxied by the driving distance from three main services: "silver" railway station (small/medium size mainly served by local trains), secondary schools, and hospitals with an emergency room. The resulting classification further identifies three types of peripheral territories: intermediate, peripheral, and ultra-peripheral areas (Materiali Uval 2014).

relevant results (Section 4), arguing about the advantages of the applied methodology and its main limits (Section 5). Section 6 will outline the main conclusions.

2 Basic needs and essential services in accessibility: an assessment

The operational approaches informed by the concepts of basic need and essential services aims at measuring whereby people are able or not to access and participate in the fundamental activities of the economic, political, and social life of the community of belonging. Several conditions are relevant to this process: the spatial and temporal availability, the quantity/ quality of services and the activities required, and the capabilities related to the organization of one's movements on which individuals can rely on to reach spatial opportunities (Geurs, van Wee 2004, Moseley 1979) as for the concept of "motility" (Kaufmann et al. 2004). Reduced accessibility to opportunities, services, and social networks, due wholly or in part to insufficient mobility (Kenyon et al. 2002, Preston, Rajé 2007, Pucci, Vecchio 2019) may limit individual participation to essential activities and cause inequalities and potential social exclusion (Preston, Rajé 2007, Ryan et al. 2015).

Referring to the concept of basic needs means orienting mobility research towards the definition of a sufficient level of basic accessibility in order to allow participation to those essential activities also defined as activity participation (Martens 2017, Allen, Farber 2020). Accessibility thus takes on a normative value: a lower level of accessibility experienced by people will demonstrate society's duty to increase it (Farrington 2007) and to enable individuals' activities participation as a condition of basic agency, inclusion, and justice (Farrington, Farrington 2005, Lucas et al. 2016). Therefore, accessibility evaluation requires a detailed understanding of the basic needs of different social groups within a population, in the awareness that different people (if not individuals) express different needs that may vary in terms of space-time geographies and are influenced by their life chances (Martens et al. 2019, Cotella, Vitale Bovarone 2020).

Consequently, the assessment of needs is a complex task that involves a judgment about people's "wants and taste" (Handy, Niemeier 1997, p. 1175) and must be relative to the society in question (Farrington, Farrington 2005). Furthermore, it must be recognized as an embedded conflict due to the fact that essential needs are generally imposed by prevailing cultures. This is why many accessibility analyses consider a relatively limited array of activities of universal value such as healthcare, education, and transport as basic needs, refraining from an intrusive value-judgment and considering them instead as basic and instrumental conditions for the agency (Alkire 2005, Farrington, Farrington 2005).

As previously seen, a similar choice was made also in the case of SNAI, where accessibility has been measured at the national level to detect inequalities between different areas of the country to three basic rights: healthcare, education, and mobility. However, SNAI does not consider the population groups that may or may not need to reach those facilities and where they live, nor do they evaluate accessibility level according to different means of transport.

Clearly, there are more varied and representative sets of "opportunity types" (Van der Veen et al. 2020, p. 1362). In 2018, the Foundational Economy Collective, for example, defined goods and services necessary for everyday life, which are the ones whose limited access prevents living and limits its possibilities (Froud et al. 2018). Foundational economies are "material", that is consisting of "pipes and cables, networks and branches" (Froud et al. 2018, p. 20); "providential", that is inclusive of public-sector welfare activities providing universal services, such as health, instruction, public order, and public administration; and, finally, the "overlooked economy" that is inclusive of goods and services culturally defined as essential.

According to Preston, Rajé (2007), aggregate access mapping may be weak in describing accessibility levels considering varied needs and opportunity types as people living in the same spatial context with different demographic and social characteristics may have different levels and forms of motility (Kaufmann et al. 2004). Consequently, since they are specifically aimed at showing general trends and tendencies at an aggregate or national scale, those approaches risk overlooking the complexity and granularity of individual needs (Handy, Niemeier 1997) expressed by different populations in different socio-cultural

contexts, providing only a partial view of what can make a place marginal.

To assess the level of activity participation in a given place, many scholars started focusing on specific population groups, activities, territorial scales and transport means. One example is the interest in accessibility for elder people induced by ageing demographic trends. Kim et al. (2018), analyzing accessibility to private and public healthcare facilities in Seoul, recognize a negative relation between accessibility and income level and, consequently, identify low income among the main factor that influence accessibility level. Nevertheless, this work "arbitrarily defines the bottom 25% of accessibility to be the threshold for problematic" (Kim et al. 2018, p. 13), thus proposing policies guidelines that may be misleading in reducing inequalities. Fransen et al. (2015) analyze accessibility to daycare centers, also considering trip-chain, and reveal important spatial differences in accessibility compared to commuter-based versions. Mao, Nekirchuk (2013) also reached similar results by incorporating transportation modes into the accessibility estimation, even if their research still presents some limits, such as overestimating the demand for daycare. Stjenborg et al. (2014) analyze how becoming alone in the household may reduce the level of accessibility for older people, particularly focusing on the factors that influence active mobility. Shergold, Parkhurst (2012) focus on older people's accessibility in rural contexts concluding that the car-dependent nature of travel in these contexts increase the risk of mobility related social exclusion particularly amongst the old.

One of the most important limits of these works is the use of aggregated data collected for other purposes, exploring known hypotheses such as considering health care facilities as the most important destination for the elderly. Another critical point is the age of the elder. As a matter of fact, in some countries, elders are defined as people aged more than 65 y.o. while in other cases they are aged more than 60 y.o. (Titheridge et al. 2009). The age threshold mainly corresponds to the retirement age, which is different between different countries, and still defines a wide category that includes people with very different needs and abilities.

Accessibility of youth has not been deeply analyzed in the literature, except for some works considering the access to recreational spaces and sport facilities (Ogilvie et al. 2011, Higgs et al. 2015, Karusisi et al. 2013), as it has been taken for granted that high accessibility level of the caregiver is reflected on young people they take care of (Mattioli, Vendemmia 2021, Waygood et al. 2017). The main limits of these works are the neglect of age, ethnic grouping, socioeconomic circumstances, sporting preferences or gender of the local population and their interaction with the type of sporting facility being used.

Confirming that assuming some activities as essential can be misleading, research based on the use of travel diaries (Hägerstrand 1967) to analyze individual space-time behaviors (Neutens et al. 2007, Kenyon 2006) revealed unexpected results. Chudyk et al. (2015), demonstrated through an analysis based on travel diaries that the most relevant destination for older adults with low income were grocery stores, malls and restaurants or café. Other research based on National Travel Survey and focus group (Titheridge et al. 2009), aiming at establishing micro-level criteria to evaluate accessibility to various destinations, confirm that elder do more food shopping trips than average and twice the number of medical trips, affirming that "elderly people value just being able to get out and about" (Titheridge et al. 2009, p. 45).

Although travel diaries may not be completely reliable due to the level of accuracy required from the participant in recording different activities (Kenyon 2006), they allow exploring more innovative concepts that try to investigate accessibility as the ability to conduct activities and to reach opportunities.

Already in 2003, Schönfelder, Axhausen worked on the concept of activity space to identify persons at risk of social exclusion. According to the authors, "activity space is that part of the environment, which a traveler is using for his/her daily activities" (Schönfelder, Axhausen 2003, p. 274) and can be considered as cognitive or mental maps of the traveler. On the same direction, Perceived Activity Set' (PAS) is a concept used to analyze the set of out-of-home activities a person considers relevant (Le Vine et al. 2013). The PAS is not based on an a priori judgment of which activity locations a person considers important, rather it makes use of empirical observations, such as travel diaries and statistical methods to draw such inferences. In the same direction, Allen, Farber

(2020) analyze participation deserts, which are areas "where residents have lower than expected rates of daily activity participation" (Allen, Farber 2020, p. 13), making use of travel diaries. Other authors focused on the opportunities offered by digital data for the spatiotemporal mapping of individual activity spaces. Techniques such as digital positioning data analysis or mobile phone data tracking can produce information that can be used as digital travel diaries through which the set of out-of-home activities participated by individuals can be inferred and lists of individual as well as context-sensitive needs can be defined in order to feed accessibility evaluation models (Järv et al. 2014).

Finally, micro stories (Vecchio 2020) and in-depth interviews (Vendemmia 2020, Bahrami, Rigal 2021) are also useful to integrate more established approaches to accessibility measures and understand factors of choice related to the mobility experience that may be difficult to read with aggregate evaluations.

Definitely, in order to analyze the availability, location, and accessibility to essential services in rural and marginal territories, the recourse to research methodologies aimed at proposing a context and population-sensitive basic needs assessment, such as the involvement of local people through interviews, micro stories, focus groups and other forms of participation, can be an interesting way to enrich or rethink the list of basic needs to be considered and according to what kind of social and territorial profiles (Levinson 1998). Participation of the local community has been already recognized in the health sector as a key strategy for effectively reducing health disparities in underserved communities (Ahari et al. 2012). Also, considering accessibility planning, Preston, Rajé (2007) suggest supplementing top-down solutions with bottom-up community participation, while Martens (2017) suggests a participatory process that involves citizens and specially informed people through focus groups and interviews to define minimum accessibility thresholds. Moreover, they can reflect the features that facilitate or impede individual mobility and show how each person shapes his own activity space, offering a more varied and granular picture of many different forms of territorial marginality.

3 Research design

The present work integrates the result of a previous quantitative research that analyzes the availability, location, and accessibility to a set of essential services conducted to develop the Piacenza Provincial Plan (PTAV) [2] with an on-site qualitative survey. The authors believe that this method may also give important results for urban planning and territorial policies, helping to better identify the different factors that have a negative impact on accessibility level, and reduce territorial inequalities in remote and marginal territories.

The selected method forecasts direct observation through site visits of specific areas and interviews with inhabitants and key informants.

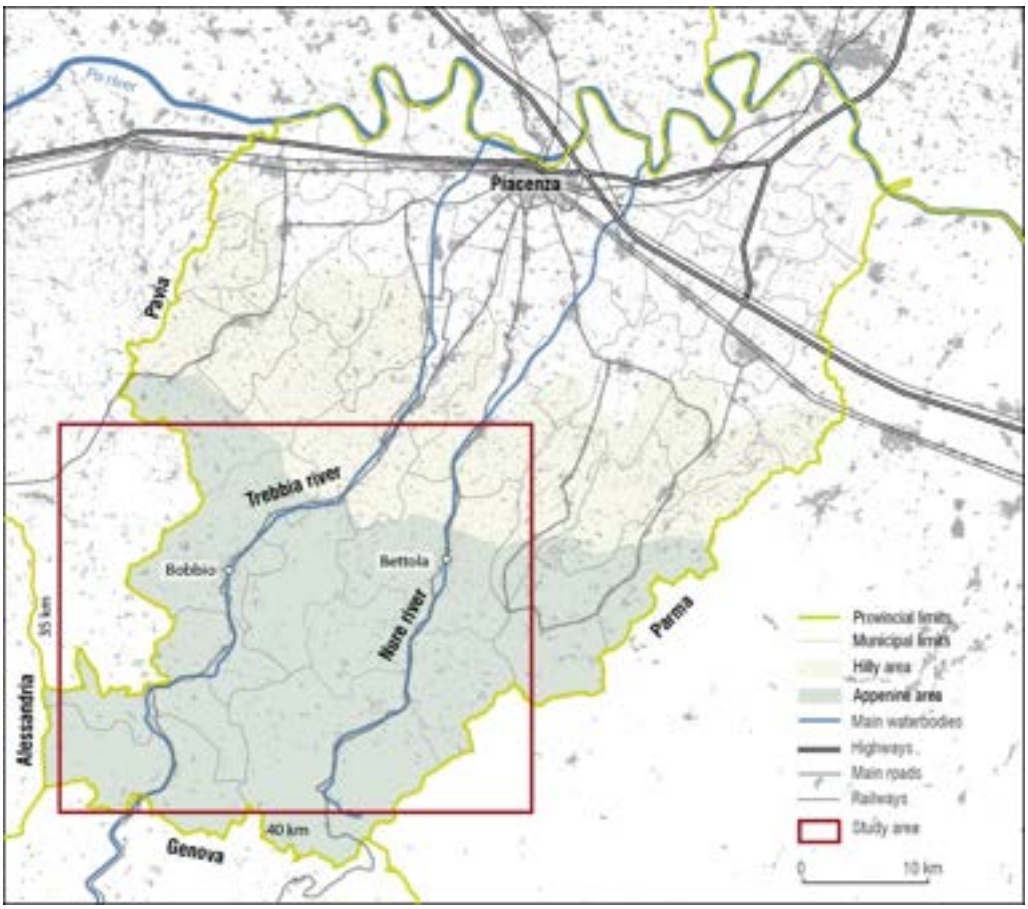
3.1 Introduction to the case study

The case study proposed in this work concerns the Apennine belt of the province of Piacenza, on the west border of Emilia-Romagna Region. The area of about 2,200 km^2 extends from the main city and the plains along the Po River towards the southwest, up to the borders with Liguria, Piemonte, and Lombardia. The area is also called the "Four Provinces" for its peculiar administrative position and historical and cultural heritage at the intersection among four different Regions and Provinces (Tarpino 2016) (see Figure 1).

Going away from Piacenza following the course of Trebbia and Nure rivers along the homonymous valleys, one crosses at first a gently hilly territory which, little by little, becomes more and more rough and wooded.

The roads at the valley floor run along the rivers while crossing little populated centers. Some of these centers, such as Bobbio and Bettola, were particularly important

[2]The accessibility analysis has been conducted by a research group lead by P. Pucci in 2020 for the General plan of the Province of Piacenza (PTAV) cfr. (PTAV 2020) Dotazione di Servizi, accessibilità e rango dei centri in Piano Territoriale di Area Vasta Piacenza – Quadro conoscitivo. pp. 157 -164. Source: https://ptavpiacenza.it/wp-content/uploads/2021/05/2021-05-PTAV-Quadro-ConoscitivoWEB.pdf



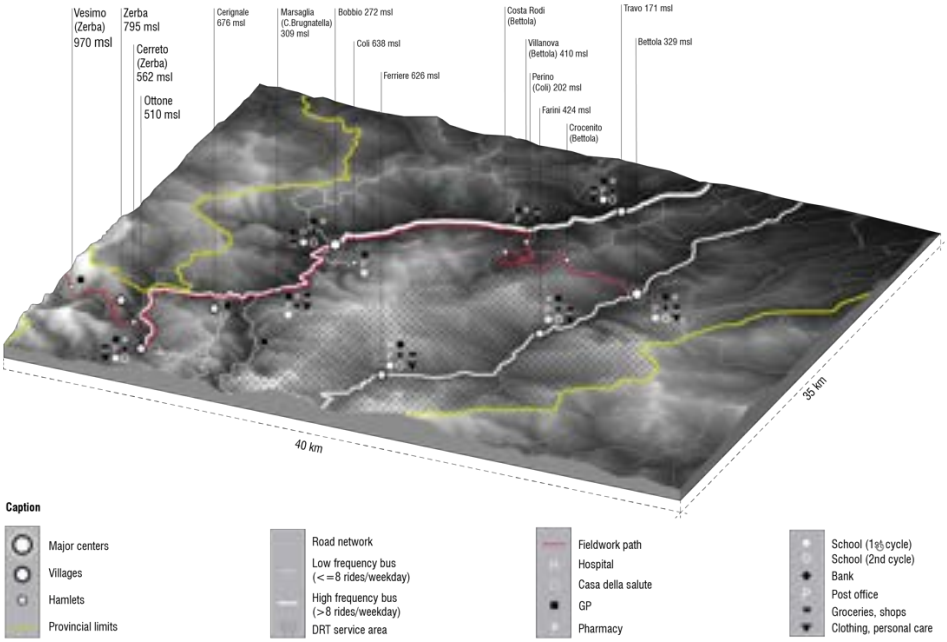
Source: our elaboration.

Figure 1: The province of Piacenza and the study area

from a historical point of view because they were the seat of small local power centers, monasteries, and abbeys. Today, they still fulfill their role as reference centers for the Trebbia and Nure valleys, respectively, and host numerous services at local and territorial scales such as the Hospital of Bobbio and the "casa della salute" (health house) in Bettola. They are almost the only villages that, since the post-war period, have developed a productive industry made of small manufacturing and related services alongside the more traditional agricultural activities.

For these reasons, Bobbio and Bettola still maintain a central role in the social and economic dynamics of the valley and represent nuclei that offer an almost complete range of commercial activities and proximity services, as shown in the analysis of accessibility of PTAV (PTAV 2020). Moreover, the analysis showed a significant inequality in terms of access to services by public transport (PT) between the mountain area and the hills and plains of the province, as the structure of the PT network, mainly facilitates the bus rides from the valley floor toward the city of Piacenza. On the contrary, bus rides are often low frequency or absent on the hilltop, and in some areas they are activated according to a Demand Responsive Transport (DRT) system[3]. Here, considerable travel times are required both to reach essential and rare services (e.g., hospitals) and to access proximity services, making the hamlets poorly accessible and isolated. Figure 2 illustrates the system of the two valleys with villages and hamlets and the public transport.

[3]In some municipalities of the Nure Valley (Farini, Ferriere and Bettola) since 2019 an experiment has been carried out trying to foresee the conversion of traditional bus lines in on-demand services. The user needs to book the trip by telephone, requesting the transit of the bus and the return to the closest stop according to a timetable defined by the operator. In this way, the routes can be modulated according to users' requests.



Source: our elaboration

Figure 2: The System of Val Trebbia and Val Nure with the main centers, the villages, the mountain hamlets, and the system of PT

The history of the Trebbia and Nure valleys is common to many Apennine areas in Italy that have undergone a progressive depopulation process starting from the post-war period up to the present day, as a consequence of the low presence of services and the migration flows toward territories with higher standards of welfare (Colucci 2018).

In the mountain villages, the process of internal migration has only been partially contrasted by the arrival of young inhabitants, the return of the elderly after retirement, and the strenuous resistance of those who have always remained here. Statistical data shows increasing depopulation that can reach a decline of 15% in the municipalities on the hilltop (see Figure 3), an employment rate under 20%, especially for youth with a percentage of NEET up to 20% in the municipalities of Cerignale and very low average income (under €17,500 per year). People aged more than 65 y.o. represent the 25% of the total population in the province of Piacenza, although this percentage is much higher in the mountainous municipalities.

This demographic homogeneity reflects a long-lasting trend, already pointed out by Moseley in 1979, highlighting the aging process as the main trend among rural populations. The sparse distribution and poor availability of proximity services and local welfare, which is also the reason why those areas have been defined as peripheral and ultra-peripheral by the SNAI (Materiali Uval 2014), is mainly due to the absence of sufficiently significant demand, and this is also one of the main reasons for internal migration. For those living in the most remote and isolated areas, this means having to travel significant distances to reach any services the person may need in their daily lives. In many cases, these complex journeys can only be made using a private vehicle.

3.2 Research method: site visit, selection of the sample, and interviews

The empirical analysis focuses on two areas in the province of Piacenza: the Val Nure and the Val Trebbia. For the Val Trebbia, the focus was on the municipalities on the high valley as those were identified as the most remote and poorly accessible according to the desk-based analysis. For the Val Nure, the municipality of Bettola and its many dispersed hamlets were investigated.

Figure 3: Abandoned rural constructions in the municipality of Zerba

Different tools have been used for the investigation: direct observation, face-to-face semi-structured interviews with key informants, surveys to various members of the community, and mapping.

The fieldwork was conducted in September 2020 by two investigators; the period has been chosen according to the interviewees' availability and to the occurrence of a local event that allows meeting as many people as possible. In addition, the visit coincided with a time when the low incidence of the Covid-19 pandemic allowed the possibility to move and interact with the respondents. The journeys were made by car due to the low presence of PT and the significant distances to be traveled.

Key informants have been contacted previously and interviewed with semi-structured interviews. In the beginning, two interviews were planned with the majors of Bettola and Cerignale. However, we had the chance to interview also other key informants while visiting the site. In Bettola, we interviewed a city councilor working as a nurse at the local health house, and we had a telephonic interview with the local health authority manager, sharing his knowledge and data about home assistance programs.

Concerning the survey, at the first stage, the focus was set on old adults by selecting a small purposive sample of six elders aged more than 65 y.o., which is the retirement age in Italy, although, as highlighted before, this threshold may change from country to country. This choice was initially made considering the results of the desk-based analysis from which it emerged that the elderly population was particularly significant in demographic terms. In addition, elderlies are a demographic group that can ideally dispose of a more limited mobility capital, as also highlighted in the bibliographic review, producing forms of potential disadvantage and marginality. The sample was selected thanks to direct knowledge. However, while travelling around the context, we enlarged our sample by including five other younger subjects that allowed us to better understand the territory and the needs of its inhabitants. Interviewing younger people made it possible to identify how conditions of marginality in an Apennine reality do not only concern older people. Depending on the individual possibility and ability to move, other age profiles can experience limitations in activity participation and basic needs fulfillment due to low availability and accessibility to valuable opportunities. As will be seen below, this limited motility particularly concerns people who do not own a private vehicle or a driving license in a context of low population density and high car dependency.

Table 1: The interviewees: age, place of residence and work, type of work and household composition

Name	Year of birth	Place of residence	Place of work	Job	Household composition
Tiziana	1928	Cerignale	Cerignale	Hotel Owner	Widow
Emanuela	1936	Cerignale	-	retired	Widow
Antonio	1936	Bettola	-	retired	Widow
Giovanni	1927	Cerignale	-	retired	Unmarried
Palmira	1951	Cerignale	-	retired	Married, 3 sons
Pamela	1931	Cerignale	-	retired	Married, 3 sons
Raffaele	1939	Piacenza	GroppaVisdomo	beekeeper	Married, 1 son
Cesare	1960	Zerba	Zerba	Hotel Owner	Married, 2 sons
Sara	1977	Zerba	Zerba	Public employee	Married, 2 son
Loredana	1965	Piacenza	Piacenza	nurse	Married, 2 sons
Claudio	1980	Bettola	Bettola	Farmer, restaurant owner	Single
Francesco	1978	Bettola	Bettola	Farmer, restaurant owner	In couple, 3 sons

The sample is listed in Table 1. Names are pseudonymized to protect the privacy of the interviewees.

After collecting data on their social and economic condition, the interview focused on understanding their basic needs, preferred means of transport, how often they need to travel to reach these opportunities and how far they need to go.

The interview was composed of different sections: 1) general information on the subject; 2) family conditions; 3) economic conditions and the context of living; 4) activities and mobility: work, grocery, health care, other activities such as visiting friends and relatives, sport, personal care, leisure; 5) use of the internet. The interviews were conducted face-to-face because on the one hand, most of the interviewees, in particular the elderly, were not even reachable over the phone or via e-mail as they had no accessibility to a landline, mobile phone, or ADSL connection; on the other hand, because of their general fragility and Covid-19 disease, we were introduced to them via younger family members or close friends.

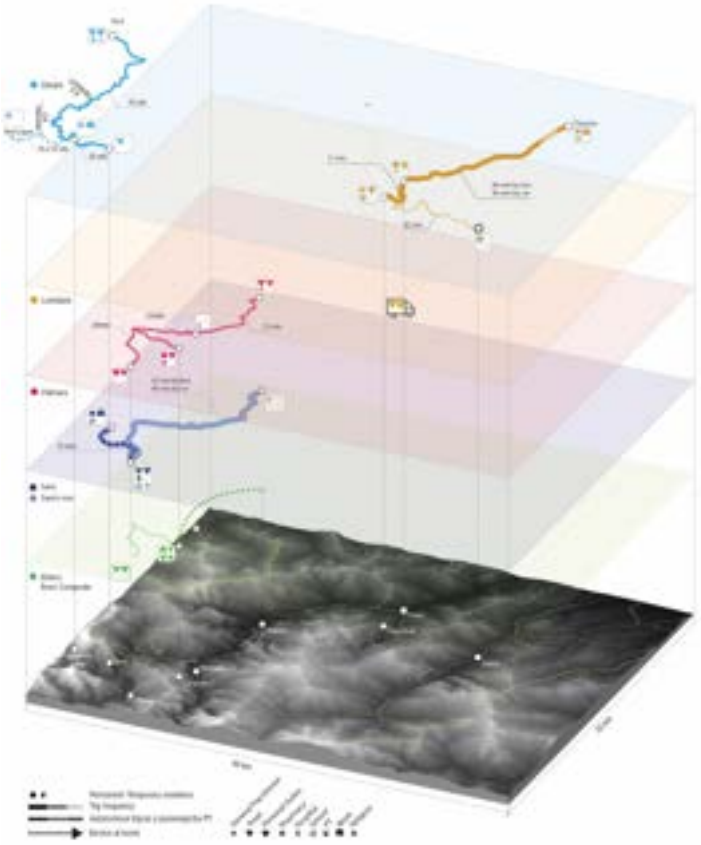
The results have been mapped using a Digital Elevation Model of the Area (DEM) to show the complexity of everyday path for those living in small hamlets located up to the mountain (Figure 4). In these cases, the distances as the crow flies between residences and activities are only a far-distant proxy of the effective distance because of the slope and the winding pathways.

4 Results

The site visit and interviews highlight some important territorial dynamics. Concerning the use of territory and services (Subsection 4.1), the interviews reveal a much-differentiated use of the territory that is also dependent on individual characteristics and capabilities (4.2). Moreover, important findings are also related to the implementation and relevance of local policies and bottom-up practices based on mutual help (4.3).

4.1 Use of territory and services. How far do I need to travel to reach my essential needs? Reinterpreting municipal borders according to basic needs

The interviews confirm low accessibility to shopping, education, and health services, often reachable only by car. Nonetheless, interviewees revealed that the most important services to be reached are not only education and health, but also food and personal services, above all considering that there are no food stores in many villages and hamlets. This condition characterizes the case of Zerba, where the grocery store is only open during summer. Sara, a resident working for the municipality as employee, reported that the closest shop is in Ottone, a village at 15 minutes driving distance and 330 meters of difference in altitude, or within 2 hours walking distance. Furthermore, when the streets are covered by snow during winter, even the car may not be an easy option, and driving



Notes: Each layer corresponds to an interviewee or to a small group of interviewees: the elder people living in Cerignale (over 80 y.o.); Sara and his sons; Palmira; Loredana; Cesare. In some cases, we group them on the same map to show the chain of linked displacements or because of the similarity of their paths. In other cases, the overlapping between the different paths allow to highlight the heterogeneity of needs, capacities, and thresholds.

Figure 4: Map of activity space

time may extend. To the inhabitants of Zerba, reaching Ottone means also finding the closest primary and middle schools, pharmacy, and public transport.

At the moment of the survey, Sara's son had just started high school in Bobbio, which is the closest to Zerba but still at about 40 minutes by car or 80 minutes by bus. Every morning, Sara brings her son to the bus stop in Ottone before returning to work in Zerba. Her son will then take the bus on the valley floor to reach Bobbio (see Figure 4). When asked about the difficulties of living in a remote village, Sara explained to us that the moment of life when children go to high school might correspond, for some families, to residential migration toward more served and accessible places, especially if parents have no strong local ties.

Similar conditions have also been found in Costa Rodi, a hamlet which is part of the municipal territory of Bettola, although located 40 minutes driving far from the center. Loredana was born in Costa Rodi, where she grew up, and from where she moved to Piacenza to attend the secondary school, confirming a migration path due to educational reasons from the mountain to the valley. She is a nurse and works for the hospital in Piacenza. Now that her husband retired, she spends six months/year in Piacenza and the other six in the family house in Costa Rodi, commuting 45 minutes by car daily to reach her job place. Costa Rodi is connected to Bettola and the Nure valley with Demand Responsive Transit (DRT), but it would take much longer for Liliana to reach Piacenza via Bettola through PT, so she travels by car via Perino and the Trebbia Valley. Furthermore, according to Loredana, DRT is not working properly, as the bus stops are

far from the hamlets, along the main roads. In the case of Costa Rodi, the closest stop is located at 4 km, 260m below. Loredana told us that Costa Rodi and Villanova inhabitants prefer to go to Perino, in the municipality of Coli, Trebbia Valley, for shopping, food, pharmacy, bank, hairdresser, and beautician, as it is just 10 minutes by car from the village. Furthermore, a shuttle bus managed by the municipality of Coli is available for bringing people from Costa Rodi to the market of Coli on Monday morning.

The interviews show that it is not unusual that inhabitants' activity spaces create geographies that often disregard administrative boundaries, suggesting the existence of an administrative mismatch. In Zerba, for example, the use of extended activity spaces is even more accentuated as some people find it more convenient to travel to other regions, such as Lombardy or Piedmont, for the doctor, the school, or the bank, also because the streets are more comfortable and the trip is shorter, as reported by Cesare (see Figure 4).

4.2 Accessible for whom? Reconsidering categories and basic needs

The interviews reveal a great complexity of the individual conditions, confirming that despite a statistical demographic homogeneity, the population of rural areas is pretty heterogeneous (Moseley 1979, p. 9).

First of all, each interviewee has different access conditions to services and amenities. Not only has the availability of a car but also the ability to drive it impacted on accessibility level. Palmira, for example, has a car but she is not driving because she doesn't have a driving license; this is also the case for Sara's son who is not in legal age and, more generally for younger residents.

Furthermore, the interviews clarify that people aged more than 65 y.o. are not a homogeneous category and basic needs may vary according to capacities and expectations. People aged more than 80 y.o., such as Tiziana, Emanuela, Giovanni, and Pamela, described a very restricted activity space often limited in everyday life to the home and the food store and extended to the church and the doctor's office, once or twice a week (see Figure 4); occasionally they need to reach the centers on the valley floor for specific needs such as medical exams or the hairdresser. According to the interviews, their PAS (Le Vine et al. 2013) coincides with the space of the village, mainly thanks to the provincial home care system (see Subsection 4.3), but also thanks to caregivers from other countries[4], as in the case of Giovanni, or family members that decided to move back at the family village also to assist their parents, as in the case of Emanuela and Pamela. Different is the case of Raffaele, a resident of Piacenza that, despite his age, took advantage of retirement to run a beekeeping activity reusing an old family house in the Apennines and who travels along all the province to sell his products. Nevertheless, Antonio and Raffaele who are over 80 y.o. still drive the car to move around, showing that each individual has his own ability to move – motility – independently from age category.

Additionally, over 65 y.o. is a very large category and may include very different conditions. Palmira was born in Cerignale, where she moved back after retiring. Due to her age, she may be among the elders even if it is possible to appreciate important differences between the activities needed by the over 80s and hers (see Figure 4). Indeed, the set of activities Palmira is looking for, although retired, is more extended than the eldest, as well as the places she reaches to fulfill these activities, which are not always chosen according to the distance and to personal preferences: for example, she prefers to go to Bobbio for buying medicines because she finds that the nearest pharmacy, located in Perino, doesn't meet her needs as well.

On the other side, younger residents, which are almost absent in statistic data, emerge as the category with lower accessibility to their basic needs, as the schools, sport, social, and leisure activities are located in the villages of the valley floor, and so they are inaccessible without a car, as shown in the case of Sara's son. Also, Francesco, owner of a farmhouse and a restaurant in Crocenito, a small hamlet in the municipality of Bettola, 10km from the center of the village with a 320 m drop, has three children and organizes his mobility according to a complex mobility chain that pivots around school schedule.

[4]In some cases, elder were assisted by caregivers coming from Eastern Europe countries or Latin America.

The brothers Claudio and Francesco decided to live in Crocenito because of available land and natural resources. Here they settled their business, opening a farmhouse and self-producing all their products. They are representative of a growing group of inhabitants in these territories that can be defined as amenity migrants (Moss 1994) or mountaineers by choice (Dematteis 2011). During the study trip, we met Federico and his girlfriend, who recently moved to live in Crocenito respectively from Piacenza and Genova and are involved in homeschooling projects. Also, the community Tempo di Vivere[5] attracts new residents in the area. In this case, all basic needs seem to be satisfied at the local scale, and geographical marginality is considered an important value, as affirmed by Claudio, who says that if he were living in a city, he would probably miss almost all his needs.

4.3 Bottom-up practices, local centralities, and strategies. From people to services to services to people

The interviews also allow to recognize bottom-up strategies developed to cope with low accessibility to services and activities, such as individual practices adopted by citizens or local entrepreneurs and informal caring practices as well as more institutional local policies currently implemented at different levels of territorial governance. With reference to individual practices implemented by local entrepreneurs, the site visit has highlighted that, in some cases, food shops or farmhouses work as local centralities. The farmhouse in Crocenito in the municipality of Bettola attracts tourists from all over Italy and works at the same time as a local centrality for residents. The farmhouse also sells homemade products, such as bread, pasta, cheese, and meat, and represented an important reference point during the Covid-19 lockdown between March and May 2020. In the case of Costa Rodi, the lack of local shops is balanced by the presence of travelling salespeople that bring different goods: foods fresh and frozen, houseware and, occasionally, clothing. These mobile bazars are difficult to map, as they are spontaneous and not institutionalized. Nevertheless, they are important elements to improve accessibility to basic needs in remote territories, reducing their marginality.

In Cerignale, *la Bottega della Bruna*, a food shop recently reopened thanks to the support of the municipality, provides a place for social aggregation. Bruna lives in the Trebbia valley floor with her husband and two children. She arrived in Cerignale as a waitress for the local restaurant (the *hotel del Pino*) and then started her own business. Due to the age and im-mobility of some clients, *La Bottega* also delivers goods directly at client's home. Those practices may also be connected to informal caring based on mutual assistance, that were particularly visible in Cerignale. For example, while travelling from home to work, Bruna brings other goods from the bottom of the valley up to Cerignale, such as medical supplies from the pharmacy in Marsaglia.

During the Covid-19 lockdown in March and April 2020, the younger inhabitants of Zerba were going for shopping food and essential goods in Ottone and they delivered them to the elders' homes, since they couldn't go out from their homes.

The site visit also highlighted the existence of many actions at different levels of governance, from more institutionalized initiatives at the provincial scale to more spontaneous bottom-up ones at the municipalities scale in an effort to close the gap between people and services by bringing the latter to the former. In Cerignale, at the municipal level the major Massimo Castelli implemented several bottom-up actions to protect the community and reinforce the sense of belonging, such as the delivery of the daily newspaper for elders and a self-organized delivery service for medical products organized by the pharmacists and the younger villagers in agreement with family doctors. The municipality also offers a service of "Social taxi". The social taxi is a public car driven by a voluntary from Auser[6] providing a demand-based transport service that helps the inhabitants of more remote territories to reach special and far services such as the hospital or the doctor, and the weekly market. Palmira says that she often goes to Bobbio or Marsaglia, on the valley floor, for the pharmacy, the weekly market, or the hairdresser. On these occasions, she takes advantage of the social taxi if someone is already going

[5] https://www.tempodivivere.it/

[6] Auser is a national volunteer association to promote active ageing and to enhance the role of elder in society. https://www.auser.it/

out. She would like to use regular public transport, but the schedule is based only on the school timetable, and it is not very comfortable for short commissions in the valley. In her case, the use of bottom-up services at the municipal scale somehow balances the lack of services and efficient public transport.

At the provincial level, the interviews revealed the existence of an institutional system of integrated home care. Home care is addressed mainly to elders who have low accessibility levels to health services due to the remoteness of their home and the difficulty of driving and moving autonomously. Home care includes both social and health support. Social workers, doctors, and nurses take care of patients in their own homes traveling among the different villages and valleys, establishing different programs and frequencies of visits according to the conditions of patients. Data collected during an interview with the local Health Authority shows that 8,6 % of the population over 65 y.o. officially subscribed to a home care contract, the percentage rises to 14,4% if we consider the population over 75 y.o. Yet, it is worth noting that in mountainous municipalities percentage of subscription double, rising to 17% for the population over 65 y.o. and 27% for the population over 75 y.o. highlighting that these policies are quite efficient, particularly in remote and low accessibility territories.

5 The contribution of qualitative research methods in the definition of marginal territories

From the methodological point of view, direct observation and interviews offer interesting perspectives to understand the reasons behind marginality, as they integrate and critically question existing approaches based on statistical data.

Firstly, concerning population categories based on age, gender, income, nationality, this approach allows a focus on the individual sphere (Preston, Rajé 2007), questioning the same criteria that brought to the configuration of those categories. In particular, it has been already highlighted that retirement age may differ from country to country according to national law, although the interviews outlined the non-effectiveness of a category that considers all the people aged more than 65 y.o in the same way. Indeed, this is a wide category including people with very different motilities, and this may lead to adaptive preference in the selection of basic needs and essential services for people aged more than 80 y.o., as demonstrated by the interviews and the maps which show a considerably reduced activity space compared to younger people in the same category. Consequently, also Perceived Activity Sets (Le Vine et al. 2013) may differ significantly. In this case, identifying a univocal set of activities and target spaces may be misleading and may drive to ineffective policies. While it is not possible to design policies based on individual experience, a deeper knowledge of these dynamics may help to better understand the reasons of marginality and design more inclusive territories, as also reported by Vecchio (2020).

Secondly, direct observation and interviews also enable the overcoming of traditional boundaries between disciplines, taking into account welfare and health policies that even though not directly related to transport and mobility may still significantly affect accessibility level. At the same time, this method highlights bottom-up practices and self-serving networks, the impacts of which are difficult to measure through more aggregated data and to simulate in accessibility measurement. Nonetheless, these policies and practices shorten the distances between people and services and generate new forms of accessibility contrasting marginality. By making these "hidden" dynamics visible, this method enriches the representation of low dense, scattered, marginal territories provided by more traditional accessibility analysis. Nevertheless, we recognize that though these approaches can be individually useful and relatively inexpensive for the planner, they can hardly be a turning point for an entire territory as they completely depend upon individual resources and motility. That is why more efforts need to be done to systematize these actions and create a framework that allows a general increase of accessibility level.

Thirdly, the use of qualitative data directly questions some characteristics of the operative tools implemented for accessibility assessment. In mountainous and low dense territories, the interviews and the maps allow a better understanding of the distances

and paths covered to reach destinations, which cannot be weighted only by the distances between municipality centroids or the distance between the center of the municipality and the main target destination. This is even more important in an area where around 55% of the total population (8.300 out of 15.000 inhabitants) is not living in the central villages, as registered by the Italian National Institute of Statistics (ISTAT), and the orographic conditions oblige to long travels. For example, in the case of Bettola, people living in the hamlets of Crocenito, Villanova and Costa Rodi are at a distance of 30 minutes driving from the center of the village.

Moreover, even if accessibility thresholds are generally established and measured with reference to municipal and provincial borders, the interviews reveal that those boundaries are not always observed when looking for essential services: for example, at municipality scale, Villanova and Costa Rodi, both under the municipality of Bettola, refer to Perino in the municipality of Coli for everyday duties; instead, Zerba and the municipalities on the regional border may refer even to centralities located in other regions such as Varzi in Lombardy region. These dynamics suggest the existence of an administrative mismatch in measuring accessibility, as already observed, for example, in the case of management of natural resources (Herrfahrdt-Pähle 2014). Considering this mismatch in the design of public transport and mobility would help to design a mobility system more respondent to people needs, thus improving accessibility levels.

At a more geographical level, qualitative data also pinpoint that some minor centralities should still be considered as relevant destinations in an accessibility measurement, even if they only provide some more mundane services than most important centers such as Bobbio and Bettola. This is the case for example of Ottone, Coli, or Corte Brugnatella that represent important reference points in everyday life for many of the interviewees living in small villages on the mountain, as they are intermediate centralities for shopping and everyday duties and are major points to shift from individual private transport to the public transport lines on the valley floor. The information collected thanks to site surveys and interview may definitely help to guide spatial planning and territorial design, suggesting reinforcing the role of those middle size centralities at provincial scale as service providers and mobility transfer points.

In conclusion, a mixed-methods approach that includes interviews and direct observation reveals important resources that may be used to ameliorate operative tools for accessibility assessment, such as the actual distance and travel time between people and services. In terms of governance, it could also inform and redirect multi-sectorial policy design toward a more context-sensitive approach reconsidering valued destinations, time thresholds, and modal choice going beyond a predefined set of services and places considered as main target, as claimed by the PAS approach (Le Vine et al. 2013).

It should also be noticed that this approach has some limits. First, it is time and money consuming for the researcher. Then, due to the specificity of each territory and the research technique, results may not be generalized. Furthermore, the low density of the area and the average population age also influenced the number of respondents, and the information collected is a very deep representation of the needs and capacities of the population and the places they refer to. Improvement may be done on the criteria of selection of the interviewees, that may conduct to some biases on the lecture of territorial dynamics as well as adaptive preference (Vecchio 2020), that may be the consequence of lack of services and infrastructure.

6 Conclusion

In this paper, we analyzed a marginal territory located in the province of Piacenza in the Emilia Romagna Region, northern Italy. The area has been classified as marginal according to SNAI. A quantitative analysis elaborated for the Territorial plan of the province of Piacenza reports this area among the less accessible and served of the provincial territory because of the lack of services and low density and frequency of public transport.

To better understand the factors that define the marginality of this area, we performed a qualitative analysis based on direct observation, interviews with key informants, a survey of inhabitants and mapping.

Despite some limits, the emerging qualitative data seems to be very helpful to better understand different factors of marginality, allowing to complement and reconsider aggregated accessibility evaluations, adding elements based on the individual perspective towards the design of more inclusive systems of accessibility. The use of interviews and qualitative data in low dense and mountainous areas, marginal by definition, appears particularly helpful in highlighting the diversity of basic needs and the presence of territorial centralities at different scales, while 3D mapping of activity space seems to unveil the complexity of the path due to orographic configuration. Moreover, interviews allow a reconsideration of the very definition of marginal territory through the direct accounts of local daily experiences from the local population that, in many cases, also cooperates in a more or less spontaneous way to overcome the difficulties they encounter daily.

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The Asymmetric Impacts of Fiscal Consolidation on Poverty and Social Exclusion: Regional Perspective

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Abstract. The presented paper contributes to the current state of discussion about the effects of fiscal policy on economic activity via three key points. It focuses on the effects of fiscal policy on poverty and social exclusion instead of on broad measures of economic performance. The analysis is performed on the regional level of some EU national economies, and it focuses on possible asymmetric impacts according to the level of the economic performance of the regions regarding the national levels. The results show that fiscal restrictions, both expenditure-oriented and income-oriented, have significant negative impacts on both poverty and social exclusion. Especially as far as social exclusion is concerned, the impacts on the already underperforming regions seem to be even more profound. When poverty is considered as a measure of inequality instead of social exclusion, revenue-oriented fiscal restrictions seem relatively more harmful than expenditure-oriented fiscal consolidations as far as the underperforming regions are concerned.

JEL classification: E62, I32, R00

Key words: EU, fiscal consolidation, GMM, NUTS2, poverty, social exclusion

Statements and Declarations

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1 Introduction

As a reaction to the COVID epidemic, European governments chose to close down significant parts of their economies in 2020 and 2021, and in an attempt to mitigate negative economic shocks they resorted to massive fiscal expansions, especially, via the expenditure side of the budgets. As a result, general government debt burdens have increased and are expected to increase over the foreseeable future. In the wake of the previous economic crisis, the Great Recession, European governments agreed to set up various forms of so-called debt brakes, incorporated in laws, which oblige governments to proceed with austerity measures once they start approaching predefined limits of general government debt. Given the current economic development, fiscal restrictions are expected in the coming years.

Regarding austerity policies applied in the wake of the Great Recession, fiscal restrictions may have had rather disastrous impacts on both economic activity and wealth (Jordà, Taylor 2016, Fragetta, Tamborini 2019). Moreover, they may well have missed the main target, which was a decrease in public indebtedness (Fatás, Summers 2018). These issues are presented in more detail in the following section. While there is a large body of both theoretical and empirical sources related to these questions on the level of national economies, there is a lack of empirical evidence as far as regional economies are concerned.

Usually, the focus is placed on economic activity. To broaden the current state of knowledge, the presented paper not only focuses on the effects of fiscal policy on regional economies, which is rare, but especially puts the spotlight on the effects of fiscal policy on poverty and social exclusion. These measures of economic outcomes are often kept out of economic analysis altogether. It is shown in the discussion of the results that the long-term economic development of the regions is to be expected to be at risk when poverty or social exclusion increases. In the following section, it is also briefly discussed that increasing poverty and social exclusion may also lead to political instability (Dijkstra et al. 2020).

The discussion below shows clearly that negative economic effects of fiscal consolidations on the regional level are indeed to be expected so that in qualitative terms the results presented in the empirical part are not surprising (Auerbach, Gorodnichenko 2017). However, what is novel is the distinction between the impacts of the business cycle and discretionary fiscal policy and the role of persistent poverty or social exclusion. It is shown that the negative impacts of fiscal consolidations are found to be more profound in the case of already underperforming regions. This, in turn, means that austerity measures add to the observed discrepancies between regional economies.

More specifically, this study is conducted on a sample of NUTS2 regions of the following countries: Czechia, Estonia, Spain, Italy, Cyprus, Latvia, Luxembourg, Hungary, Malta, and Slovakia. The fact that the sample of countries does not include all or most EU economies is due to insufficient availability of data on poverty and social exclusions at the regional level. The generalized method of moments is employed to investigate the relationship between fiscal policy and the selected poverty indicators.

The paper is structured as follows: Section 2 sheds light on the impacts of fiscal restrictive policy from the point of view of national economies and it also presents some important findings regarding regional economies that are partially reflected in the construction of the empirical model; Section 3 provides information on the data and empirical approach; Section 4 presents the estimates and then places the results in the context of existing studies, especially focused on economic growth; Section 5 summarizes the main findings.

2 Regional Development and Effects of Fiscal Policy

On the level of national economies, there is substantial evidence published in the aftermath of the Great Recession which shows that fiscal restrictions during economic downturns have strong negative impacts on economic activity.

Canzoneri et al. (2016) show that financial frictions, price rigidity, and the severity of recession increase fiscal multipliers. On the sample of OECD countries, Riera-Crichton et al. (2015) estimate that spending multipliers may reach well over one in periods of extreme recessions. In this context, Bilbao-Ubillos, Fernandez-Sainz (2014) show, as many others did, that the original reasoning behind the push of fiscal consolidations in the EU had counted on much lower fiscal multipliers. Deleidi et al. (2020) and Gabriel et al. (2020) confirm in the sample of selected EU countries, that public investment multipliers may have long-term effects on economic activity and that the Great Recession gave rise to an increase in them. The long-term negative effects of austerity measures in the aftermath of the Great Recession on GDP growth in the EU and OECD are also presented by Jordà, Taylor (2016) and Fragetta, Tamborini (2019). Fiscal consolidations in the EU were, in general, revenue-oriented: Van der Wielen (2020) estimates that they had a medium-term negative impact on output and that the associated multiplier was greater than one.

The fact that economic development may be severely hampered by fiscal consolidation can result in so-called self-defeating consolidations (DeLong, Summers 2012). Fatás, Summers (2018)Fatás and Summers (2018) show that self-defeating consolidations may well have been the reality in the case of EU countries. On the sample of OECD and EU countries, the same result is implied by Auerbach, Gorodnichenko (2017). The context of fiscal consolidations in the EU is quite peculiar, as argued by Tamborini, Tomaselli (2020). They show that the policy was driven predominantly by compliance with established fiscal rules with little concern about actual market conditions.

A fundamental contribution to the analysis presented in this paper comes from Coady, Gupta (2012) who, on a large sample of world economies, show that fiscal consolidations bring about rising income inequality. The reason is that fiscal consolidations are accompanied by decreasing wage share, which, given the relatively higher share of low-income households in the overall wage share, leads to higher income inequality. The other important driver is that increasing unemployment typically first hits those with low skills and lower incomes.

Fiscal consolidations are therefore expected to have negative impacts on regional poverty and social exclusion. The empirical analysis below shows how big the impact is, and it also sets it apart from the impact of the business cycle and hysteresis in the sense of the persistence of poverty and social exclusion.

Most empirical analyses concerned with the economic development of regional economies are focused on long-term issues, especially the question of convergence/divergence of economic development. Castells-Quintana et al. (2015) link the observed increasing inequality at the level of EU regions to economic growth promoted by openness, technological change, and tertiary specialization. Gómez Tello et al. (2020) note that regional disparities in the EU are on the rise in the sense that quite a significant portion of regions are closer to the average but the smaller group of the richest regions move further and fast above the average. Concerning the previously cited paper, the main reason might be summarized as technological change.

Crescenzi, Rodríguez-Pose (2012) identify innovation capacity, the capacity to attract migrants, and some population characteristics as the key factors behind regional economic growth. Innovation capacity and technology are found to be important determinants of resilience on the regional level in the aftermath of the Great Recession in the papers by Bristow, Healy (2018) and Cappelli et al. (2021).

An important contribution regarding the purpose of this paper comes from Hauptmeier et al. (2020), who show that the effects of monetary policy are highly asymmetric. Poorer EU regions register stronger negative and more persistent impacts of restrictive monetary policy. The question of asymmetric regional impacts in the context of fiscal policy is posed by Piacentini et al. (2016) and Lucidi (2021), who focus on Italy. Piacentini et al. (2016) show that fiscal consolidation adopted in the wake of the financial crisis had more significant negative impacts on the poorer southern regions of the Italian economy than on the northern regions. The analysis of Lucidi (2021) supports their results.

The existing literature on the economic development of regions pays very little attention to the effects of economic policy in terms of monetary and fiscal policy. Therefore, the first goal of the paper is to show quantitatively what the impacts of fiscal policy on regional development in terms of social exclusion and poverty are. The second goal of this paper is to show that the impacts of fiscal policy on poverty and social exclusion depend on their initial levels. The substantiation comes from the analysis of regional impacts of monetary policy and indirectly from the many analyses concerned with long-term growth patterns at the regional level.

Seeing these asymmetries is also crucial from the point of view of a broader socioeconomic analysis. Dijkstra et al. (2020) and Winkler (2019) show that the observed persistent underperformance of some regions promotes social discontent with the expected inclination towards political instability. Using the household survey conducted by the Austrian Central Bank, Belabed, Hake (2018) show that higher income inequality is associated with higher distrust in national government institutions on a sample of countries from Central, Eastern, and Southeastern Europe.

3 Data and Econometrical Analysis

The econometrical model is set up to explain the behavior of the at-risk-of-poverty rate and the percentage of people at risk of poverty or social exclusion in the EU NUTS2 regions. The yearly data comes from the Eurostat and Ameco databases (Eurostat 2022a, Ameco 2022). The sample runs from 2005 to 2019. The adjusted sample, shown in Tables 2 and 3, goes from 2007 to 2019. The adjustment comes from first-differenced data and lags included in the empirical model. The at-risk-of-poverty rate and the percentage of people at risk of poverty or social exclusion come from the Eurostat database and are defined as follows (Eurostat 2022b):

- The at risk-of-poverty rate (below designated as poverty) is defined as a share of people with an equivalised disposable income below the at risk-of-poverty threshold, which is set at 60 % of the national median equivalised disposable income. The equivalised disposable income is the total disposable income of a household divided by the number of household members converted into equivalised units, which means weighting each member by their age.
- The percentage of people at risk of poverty or social exclusion (below designated as exclusion) is a broader measure. It includes all people at risk of poverty and also those who are socially materially deprived or who live in a household with very low work intensity. A person designated as socially deprived means that they cannot afford at least three of the following items: to pay rent/mortgage/utilities, to keep the home adequately warm, to face unexpected expenditures, to eat meat or proteins regularly, to go on holiday, a television set, a washing machine, a car, a telephone. A household with very low work intensity is such whose members of working age worked less than 20 % of their total potential during the previous 12 months.

Since both measures are expected to show a great deal of persistence over time because they are influenced by wealth, which, as a typical stock variable, is persistent, the model should take account of this feature.

The key question is to what extent these two measures are influenced by the business cycle, on the one hand, and discretionary fiscal policy, on the other. The business cycle is captured by year-on-year relative changes in gross domestic product in purchasing power standard per inhabitant (below designated as output). Therefore, it is not expressed by output gap since output gap is by definition stationary and, as explained further below, the model is estimated in first differences. The measure of the business cycle includes, among others, the effects of monetary policy and automatic stabilizers. Discretionary fiscal policy is captured by cyclically adjusted net lending without interest payments, cyclically adjusted total revenue, and cyclically adjusted total expenditure without interest payments. These variables are referred to as net lending, revenues, and expenditures, respectively. All three variables are related to the sector of the general government and are expressed as a percentage of gross domestic product. These data are from the Ameco database. The differences in these variables enable us to capture the effects of discretionary fiscal policy. Positive values of differenced series of net lending and total revenue and negative values of differenced series of total expenditure represent fiscal restriction.

Lessmann, Seidel (2017) and Crescenzi, Rodríguez-Pose (2012) present some large analyses of regional growth and inequality, which for the purpose of this paper, was a useful source of information as to what variables might be taken into account as control variables. However, the focus in this paper is different. It is not concerned with long-term economic development, and many control variables used in the cited papers would be of little or no relevance also because they changed quite negligibly given the sample in question.

Two control variables used as instruments are employed: the dependency ratio and the share of higher levels of education attained in the population. The dependency ratio is defined as a ratio of those of aged up to 14 and over 65 to those of age between 15 and 64. The share of higher levels of attained education is a ratio of those who attained levels

Table 1: Summary of NUTS2 Regions Included in Stage 1 (Table 3) and Stage 2 (Table 4) of the Analysis

Country	NUTS 2	Included	Country	NUTS 2	Included
Czechia	CZ01	1	Italy	ITH1	1
Czechia	CZ02	1, 2	Italy	ITH2	1
Czechia	CZ03	1, 2	Italy	ITH3	1
Czechia	CZ04	1, 2	Italy	ITH4	1
Czechia	CZ05	1, 2	Italy	ITH5	1
Czechia	CZ06	1, 2	Italy	ITI1	1, 2
Czechia	CZ07	1, 2	Italy	ITI2	1, 2
Czechia	CZ08	1, 2	Italy	ITI3	1
Estonia	EE00	1	Italy	ITI4	1
Spain	ES11	1, 2	Italy	ITF1	1, 2
Spain	ES12	1, 2	Italy	ITF2	1, 2
Spain	ES13	1, 2	Italy	ITF3	1, 2
Spain	ES21	1	Italy	ITF4	1, 2
Spain	ES22	1	Italy	ITF5	1, 2
Spain	ES23	1	Italy	ITF6	1, 2
Spain	ES24	1	Italy	ITG1	1, 2
Spain	ES30	1	Italy	ITG2	1, 2
Spain	ES41	1, 2	Cyprus	CY00	1
Spain	ES42	1, 2	Latvia	LV00	1
Spain	ES43	1, 2	Luxembourg	LU00	1
Spain	ES51	1	Hungary	HU21	1, 2
Spain	ES52	1, 2	Hungary	HU22	1, 2
Spain	ES53	1	Hungary	HU23	1, 2
Spain	ES61	1, 2	Hungary	HU31	1, 2
Spain	ES62	1, 2	Hungary	HU32	1, 2
Spain	ES63	1, 2	Hungary	HU33	1, 2
Spain	ES64	1, 2	Malta	MT00	1
Spain	ES70	1, 2	Slovakia	SK01	1
Italy	ITC1	1	Slovakia	SK02	1, 2
Italy	ITC2	1	Slovakia	SK03	1, 2
Italy	ITC3	1	Slovakia	SK04	1, 2
Italy	ITC4	1			

Notes: Region coding corresponds to the practice of Eurostat, included in 1 and/or 2 means included in the first and/or the second stage of the analysis.

of education higher than lower secondary aged between 25 and 64 to the total population of the same age.

The dependency ratio is extremely important from the point of view of discretionary fiscal policy. Fiscal restriction oftentimes relies on increasing indirect taxes and cutting social welfare. Regions with a higher share of the retired population and a higher share of children are thus expected to be hit relatively more than those with a higher share of the economically active population where the percentage of households with relatively higher income must be greater.

The higher share of higher levels of attained education means that the risk of losing a job during a period of fiscal restriction is expected to be lower than in regions with lower levels of attained education. The variable is called the education ratio.

All of the EU NUTS2 regions were considered; however, many countries do not supply the data on at-risk-of-poverty rates or social exclusion on the regional level at all or have started only recently. The panel includes 63 regions in total. The regions included are presented in Table 1.

Table 2 presents the statistical characteristics of the data series. The series may be considered as non-stationary in levels and stationary in first differences. The Breitung unit

Table 2: Statistical Properties of the Data

Series/Statistics	Mean	Standard deviation	Normality	Unit root – series in levels	Unit root – series in 1st differences
Poverty	17.38	8.82	136.33***	0.38	-10.94***
Exclusion	24.52	10.45	88.46***	2.31	-9.85***
Output	10.03	0.37	37.09***	0.32	-3.81***
Net lending	0.06	2.60	107.21***	1.17	-3.87***
Expenditures	41.85	2.82	28.47***	-1.58*	-8.04***
Revenues	41.91	3.95	65.53***	-1.12	-3.87***
Education ratio	66.22	17.04	58.13***	-0.36	-10.08**
Dependency ratio	49.56	5.72	3.54	13.29	-2.15**

Notes: Poverty (At risk of poverty rate, in %), Exclusion (Percentage of those at risk of poverty and social exclusion, in %), Output (GDP in PPS per inhabitant, logarithm), Net lending (cyclically adjusted net lending of the general government as a percentage of GDP, in %), Expenditures (cyclically adjusted total expenditure of the general government as a percentage of GDP, in %), Revenues (cyclically adjusted total revenue of the general government as a percentage of GDP, in %), Education ratio (share of education levels of 3 and higher of those aged between 25 and 64 in the population aged between 25 and 64, in %), the Dependency ratio (ratio of those aged up to 14 and over 65 to those aged between 15 and 64, in %). Source of the data: Eurostat and Ameco. Normality is tested by the Jarque-Bera test under the null of normal distribution, the unit root is tested by the Breitung test under the null of a unit root.

root test was employed. It assumes a common unit root process across the cross-sections. The Breitung test is less computationally complex than, for example, the Levin-Lin-Chu test, which, given the data limitations with respect to time, makes it more convenient for the purpose of the analysis. The null hypothesis of the Breitung test is that the data contains a unit root process.

The general structure of the empirical model is as follows:

$$y_{i,t} = c_i + \alpha y_{i,t-1} + \delta x_{i,} + \epsilon_{i,t} \tag{1}$$

where c represents constants, y contains the at-risk-of-poverty rate or the percentage of people at risk of poverty or social exclusion, x contains the measure of the business cycle and one of the three measures of discretionary fiscal policy.

Practically in all economic relationships the problem of endogeneity should be suspected. Endogeneity arises due to measurement errors, omitted variables, and interdependencies between the dependent and explanatory variables. Since the true economic model is never known in economics, the problem of omission is always present. As far as simultaneity is concerned, it cannot be ruled out that changes in poverty have effects on the conduct of fiscal policy and, thus, the business cycle. Under such conditions, it would be incorrect to base the estimation on the OLS estimator. Any transformation based on fixed or random effects approaches does not solve the problem as it would entail a positive correlation between the transformed error term and transformed lagged dependent variable. The problem of endogeneity is oftentimes solved by applying instrumental variables. Therefore, this type of model is typically dealt with in the first differences:

$$\Delta y_{i,t} = \alpha \Delta y_{i,t-1} + \delta \Delta x_{i,t} + \Delta \epsilon_{i,t} \tag{2}$$

which have already been shown to be stationary, see Table 2. The estimation of transformation (2) typically rests on a generalized method of moments, GMM, which employs instrumental variables. The Arellano-Bond estimator is used. Dynamic one lag of the measure of the business cycle, the dependency ratio, and the education ratio are used as instruments. Since the number of instrumental variables exceeds the number of estimated parameters, the model is overidentified. This enables testing of the validity of instruments by applying the Sargan-Hansen J-test with the null hypothesis that the instruments are valid.

Table 3: All regions

	Poverty	Poverty	Poverty	Exclusion	Exclusion	Exclusion
Dependent (-1)	0.29***	0.32***	0.28***	0.58***	0.63***	0.63***
Output	0.00	0.01*	-0.01***	-0.08***	-0.07***	-0.09***
Net lending	0.12***	XXX	XXX	0.25***	XXX	XXX
Expenditures	XXX	-0.16***	XXX	XXX	-0.29***	XXX
Revenues	XXX	XXX	0.17***	XXX	XXX	0.30***
J-stat (p-value)	64.02 (0.37)	59.13 (0.51)	61.99 (0.44)	61.92 (0.44)	63.26 (0.40)	62.21 (0.47)
AR(1)	-2.55**	-2.45**	-2.48**	-3.45***	-3.58***	-3.44***
AR(2)	0.71	0.70	0.70	0.69	0.73	0.68
no. of cross-section: 63, adjusted time sample: 2007:2019						

Notes: Variables: Poverty (At risk-of-poverty rate), Exclusion (Percentage of those at risk of poverty and social exclusion), Output (GDP in PPS per capita), Net lending (cyclically adjusted net lending of the general government as a percentage of GDP), Expenditures (cyclically adjusted total expenditure of the general government as a percentage of GDP), Revenues (cyclically adjusted total revenue of the general government as a percentage of GDP). Instruments: dynamic one lag of output, education ratio, and dependency ratio. The J statistic refers to the test of the validity of over-identifying restrictions with the null of the restrictions being valid; p-values show that the null is not rejected in any case. AR(1) and AR(2) refer to the m-statistic of the autocorrelation test in residuals with the null of no autocorrelation. *, **, *** means rejection of the null at a level of significance of 10%, 5%, and 1%, respectively.

A two-step White weighting matrix that is robust to panel-specific autocorrelation and heteroscedasticity is employed. Autocorrelation in the residuals is tested using the Arellano-Bond test for the presence of autoregression in the residuals. Given the fact that the model is estimated in first differences, the Arellano-Bond test for AR(1) shows possible autoregression in the first differences of the residuals. This is generally confirmed and is also expected. The more important is the test for AR(2) autoregression, which indicates whether or not there is autoregression in the levels of the residuals.

The empirical investigation is carried out in two stages. The first stage consists of running the estimation over the whole sample to detect the effects of fiscal policy and also to compare them with those of the business cycle and persistency. The second stage consists of running the estimation only for those regions whose starting position with respect to the economic output was below the country value. More specifically, the second stage considers those regions whose ratio of GDP in PPS per capita to GDP in PPS per capita of the country to which they belong is below 1. A lower cut-off value of the ratio would result in a sample that is too small.

4 Results and Discussion

Table 3 shows the estimates for the whole sample of 63 EU NUTS2 regions. The first lag of the dependent variable, poverty or exclusion, is found to be highly significant and the magnitude of the estimated coefficients points towards the high persistency of the two characteristics. This is much more pronounced in the case of exclusion where the estimated coefficients of lagged dependent variable reach 0.58 or 0.63 compared to 0.29, 0.28 and 0.32 when the measure of poverty is concerned. To put it in a broader context, Chen et al. (2018) show that income inequality in the EU increased especially between 2013 and 2014 and expose that there was a great deal of persistence as far as the overall figure is concerned. This also holds for the at-risk-of-poverty ratio. However, when looking at its structure from the perspective of age groups, there was a dramatic increase in the at risk of poverty ratio between 2008 and 2015 for the age group 18-24. It also increased in the groups of people aged between 25 and 64 years, however, it slightly decreased for those 65 years and older. The estimates given in this paper show that persistence is much higher in the case of the percentage of people at risk of poverty or social exclusion.

The role of the business cycle should be considered insignificant in the case of the at-risk-of-poverty ratio, as the estimates are both/either insignificant and/or very close to zero (0.00, 0.01, -0.01). On the other hand, increases in GDP in PPS per capita tend to decrease the percentage of people at risk of poverty or social exclusion. In quantitative terms, the effect is rather small (-0.08, -0.07, -0.09).

The role of discretionary fiscal policy is statistically significant. Positive changes in cyclically adjusted net lending and revenues increase both the at-risk-of-poverty ratio (0.12 and 0.17) and the percentage of people at risk of poverty or social exclusion (0.25 and 0.30), while positive changes in cyclically adjusted expenditures reduce it (-0.16 and -0.29). The magnitudes of the estimated coefficients show that the impact of fiscal policy is much higher in the case of the percentage of people at risk of poverty or social exclusion.

The results confirm the large body of evidence that shows that the fiscal consolidations that took place in the EU after the Great Recession had a negative effect on the economic development of national economies. Some studies show that the negative effects were long-lasting in nature. This is confirmed by this analysis carried out at the regional level and also shows that the negative effects translated into increased poverty and social exclusion.

Although this paper focuses on poverty and exclusion, which is a different concept from that of income inequality, Staicu (2017), among others, reports a positive relationship between inequality and poverty in a large sample of world economies. These findings are important for the following contextualization of the results of this study.

Anderson et al. (2017) present a large meta-regression analysis concerning the relationship between government spending, or fiscal policy in more general terms, and inequality. The sign of the relationship between government spending and inequality depends on the exact adopted fiscal measures, so that there is no definitive answer from their perspective. However, an important piece of information resulting from their analysis is that they find evidence of publication bias in the sense that the negative relationship between government spending and inequality seems to have been under-reported.

A very important question related to inequality is its connection to economic growth. Balcilar et al. (2021) reach a rather frequently occuring result concerning this issue in the sense that they estimate that up to a certain level income inequality may have a positive impact on economic growth, while beyond this level it has a negative impact on future development. Woo (2020) shows that a positive effect of lower income inequality on long-term economic growth may be more than offset by a negative effect caused by redistributive fiscal policy employed to reach lower levels of income inequality. He shows that the final results depend on the initial levels of income inequality and the magnitude of fiscal intervention. However, neither of these papers properly takes into account the theoretical and empirical results of Halter et al. (2014), who explain these often contradictory effects of income inequality on economic growth found in the empirical literature. Halter et al. (2014) summarize the reasons why a higher level of inequality may have both positive and negative impacts on economic growth. The positive and rather short-run impacts stem from the fact that higher inequality may promote a higher rate of savings and thus investments. On the other hand, negative and long-run effects of higher inequality reflect the fact that it hampers the evolution of human capital, it may lead to the adoption of expensive fiscal policies, and it may also contribute to political instability; see the second section of the paper for references regarding the last point.

It may therefore be deduced that protracted restrictive fiscal policy that leads to higher levels of poverty and exclusion, which usually goes hand in hand with higher income inequality, has some long-term detrimental effects on economic growth. This leads us back to Deleidi et al. (2020), Jordà, Taylor (2016), and Fragetta, Tamborini (2019), who without the links to poverty and income inequality showed that the fiscal consolidation adopted in the EU had had long-term negative effects on economic development.

The second stage of the analysis is presented in Table 4. Only those regions whose starting position in terms of GDP in PPS per capita at a national level was less than one are included. The output confirms the results of the first stage with respect to the persistence of both the at-risk-of-poverty ratio (0.29, 0.34, 0.25) and the percentage of people at risk of poverty or social exclusion (0.47, 0.56, 0.53) and the relatively small role of the business cycle. The persistency is again much more pronounced when exclusion is considered instead of poverty. The difference with respect to the role of the business cycle is that now the impact of the business cycle is found to be statistically significant in all cases, but it still its effect is negligible when the measure of poverty is used (-0.01, -0.02, -0.01) compared to the estimates with exclusion (-0.12, -0.09, -0.12).

Table 4: Underperforming Regions

	Poverty	Poverty	Poverty	Exclusion	Exclusion	Exclusion
Dependent (-1)	0.29***	0.34***	0.25***	0.47***	0.56***	0.53***
Output	-0.01**	-0.02*	-0.01***	-0.12***	-0.09***	-0.12***
Net lending	0.12***	XXX	XXX	0.33***	XXX	XXX
Expenditures	XXX	-0.13***	XXX	XXX	-0.39***	XXX
Revenues	XXX	XXX	0.22***	XXX	XXX	0.39***
J-stat (p-value)	38.37 (0.36)	33.54 (0.59)	39.29 (0.37)	36.52 (0.40)	37.44 (0.45)	38.64 (0.35)
AR(1)	-2.22**	-2.22**	-2.17**	-2.93***	-2.63**	-2.91***
AR(2)	0.56	0.60	0.52	0.70	0.65	0.68
no. of cross-section: 38, adjusted time sample: 2007:2019						

Notes: Variables: Poverty (At risk-of-poverty rate), Exclusion (Percentage of those at risk of poverty and social exclusion), Output (GDP in PPS per capita), Net lending (cyclically adjusted net lending of the general government as a percentage of GDP), Expenditures (cyclically adjusted total expenditure of the general government as a percentage of GDP), Revenues (cyclically adjusted total revenue of the general government as a percentage of GDP). Instruments: dynamic one lag of output, education ratio, and dependency ratio. The J statistic refers to the test of the validity of over-identifying restrictions with the null of the restrictions being valid; p-values show that the null is not rejected in any case. AR(1) and AR(2) refer to the m-statistic of the autocorrelation test in residuals with the null of no autocorrelation. *, **, *** means rejection of the null at a level of significance of 10%, 5%, and 1%, respectively.

The effects of fiscal policy captured by the changes in cyclically adjusted net lending and expenditures are higher in the case of the percentage of people at risk of poverty or social exclusion (0.33 and -0.39) than the estimates on the whole sample (0.25 and -0.29) shown in Table 3. When cyclically adjusted revenues are used as a measure of discretionary fiscal policy, the effects seem higher in both cases: the at-risk-of-poverty ratio (0.22, Table 4, as compared to 0.17, Table 3) and the percentage of people at risk of poverty or social exclusion (0.39, Table 4, as compared to 0.30, Table 3).

The results are qualitatively in line with the findings presented in the case of the Italian regions mentioned in the second section of the paper (Piacentini et al. 2016, Lucidi 2021). However, at the same time, they should be viewed with a degree of caution given the fact that the sample is rather small and for the very same reasons, it is not possible to further verify the results by changing the cut-off value, which would define the subsamples of regions with worse starting conditions.

5 Conclusions

The estimates point to a significant persistence of both the at-risk-of-poverty ratio and the percentage of people at risk of poverty or social exclusion, and to the insignificant or very weak role that the business cycle plays in their dynamics. On the other hand, the analysis confirms some highly significant impacts discretionary fiscal policy has on the dynamics of both the at-risk-of-poverty ratio and the percentage of people at risk of poverty or social exclusion. It is shown that the impact of fiscal discretionary policy is higher in the case of the percentage of people at risk of poverty or social exclusion. In addition, the impact is higher in the already underperforming regions when this indicator is considered.

The effects of revenue-oriented and expenditure-oriented fiscal policies seem quite comparable when the whole sample of regions is taken into account, meaning those regions with GDP in PPS per capita above the national level, as well those below it. Also, the result does not change whether the at-risk-of-poverty ratio or the percentage of people at risk of poverty or social exclusion is taken as a measure of inequality.

This result changes slightly when only regions whose GDP in PPS per capita is below the national level are taken into account. In this case, the effects of revenue-oriented fiscal policy seem stronger compared to expenditure-oriented fiscal policy when the at-risk-of-poverty ratio is used as the measure of inequality.

Taking account of the confirmed high persistence in the dynamics of both the at-risk-of-poverty ratio and the percentage of people at risk of poverty or social exclusion and the significant impacts of both revenue and the expenditure-oriented fiscal policy, it is

clear that restrictive fiscal policy has the potential to set already underperforming regions in particular on a path of long-term divergent dynamics.

When these results are placed in the context of growth theory, specifically the relationship between income inequality and economic growth, it can be deduced that restrictive fiscal policy that gives rise to higher levels of poverty undermines future economic development. Various papers have reached similar results, focusing on national economies and the impacts of consolidation policies adopted in the EU after the direct impacts of the financial crisis. In this sense, this paper contributes to these findings as it shows possible reasons for why it happened.

The underperforming regions are on average found away from metropolitan areas. Plans of fiscal restrictions, if deemed necessary, need to be constructed with regard to the disruptive impacts they have, especially on the underperforming regions, so that the long-term economic and social harms are kept to a minimum.

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Smart Specialization in less developed regions of the European Union: A Systematic Literature Review

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Abstract. This paper reviews the literature on Smart Specialization implementation in less developed regions of the European Union (EU). Using a systematic literature review research protocol, I critically explore the content of selected relevant papers, examine the challenges in the Smart Specialization implementation in less developed regions of the EU, and raise critical factors that could potentially enhance the success of its implementation. The first finding of this study shows that research on related topics published in leading journals has increased significantly in recent years. Furthermore, as an essential contribution, I categorize the selected papers according to diversity in research design and methodology. Finally, I summarise three key issues of Smart Specialization implementation in less developed regions of the EU: RIS capacity and governance, local and extra-regional collaboration, and regional administrative and financial governance.

Key words: Smart Specialization; regional innovation; innovation policy; less developed regions, European Union

1 Introduction

The Smart Specialization innovation policy concept emphasizes specialization based on a region's resources or assets, using those resources to enable the discovery of new and innovative competitive advantages to drive regional economic growth and transformation (Foray et al. 2011). However, the theory and concept underpinning Smart Specialization (Foray et al. 2009) have undergone a certain degree of criticism concerning its application in both developed and less developed regions (LDRs) (Hassink, Gong 2019, Krammer 2017). According to empirical evidence so far, the implementation of Smart Specialization in less-developed countries has been characterized by several barriers, including, for example, the lack of entrepreneurial dynamism to strengthen the existence of new domains of excellence (Morgan 2013) and the indistinct roles between the central government and foreign companies (Radosevic, Stancova 2015). All the while, the focus on wider territorial context has become an essential concern in Smart Specialization innovation policies (Barca 2009).

Criticism has also been raised about the relevance of Smart Specialization in addressing problems in developed regions (e.g., Kroll 2017a,b), and its implementation in LDRs has been recognised as an area of particular academic focus (Capello, Kroll 2016). Various issues and phenomena related to the implementation of Smart Specialization in LDRs have emerged in the course of the process of designing or developing Regional Innovation

Systems (RIS) at the regional level, especially issues related to structural problems in organisations and institutions, and funding or budgeting issues (Trippl et al. 2019). As more and more regions implement Smart Specialization innovation policies, the knowledge base on Smart Specialization implementation is also growing (Sörvik et al. 2019).

Numerous studies on Smart Specialization in the European Union (EU) have been conducted in the context of both developing countries and underdeveloped regions. However, there is arguably still scope for further systematic and in-depth research addressing Smart Specialization implementation, specifically in less developed regions of the EU. While previous research has yielded several systematic studies dealing with innovation and implementing Smart Specialization, those focusing on less developed regions are still very limited. Pires et al. (2020) is one such study, which reviews many papers and analyzes the Territorial Innovation Model (TIM) in LDRs. Eder (2019) previously conducted a similar systematic literature study to look at the state and evolution of innovation in peripheral regions in Europe. Lopes et al. (2019) is perhaps the closest systematic literature study to this topic – Research and Innovation Strategies for Smart Specialization (RIS3) – which summarises and categorizes several specific sub-themes of Smart Specialization studies. These studies, however, do not systematically examine research design, methodological diversity, and critical issues in Smart Specialization studies.

This study aims to achieve two main research objectives. Firstly, to systematically analyze current studies focusing on the implementation of Smart Specialization in less developed regions (LDRs) in the European Union (EU). Second, it aims to comprehensively examine the experience and implementation of Smart Specialization in LDRs of the EU while raising several critical issues, challenges, and recommendations that can contribute to understanding how the concept can be successfully implemented in the future. Applying protocols appropriate to a systematic literature review, the study selects key papers as a focus for a three-stage analysis. Firstly, the study systematically assesses the source and nature of the selected papers. Secondly, an analysis is applied to the diversity in research design and methodology. Thirdly, the study considers an evidence-based analysis of the challenges in implementing Smart Specialization in less developed regions of the EU. With a systematic and consistent protocol, this paper theoretically enriches the study of Smart Specialization in LDRs of the EU. It provides greater insight and experience perspectives to increase the chances of successfully adopting and implementing Smart Specialization.

The remainder of this paper is presented as follows. The theoretical background on innovation and Smart Specialization is outlined in the second section, both in the context of the region in general and the specific region. The third section outlines the systematic sequence and protocol of the systematic literature review of this paper. The fourth section discusses the key findings. This section is further divided into three subsections. The fifth section summarizes and concludes with some limitations explicitly stated.

2 Literature background

2.1 Regional innovation and Smart Specialization policy concept

A country's international competitiveness can be achieved by producing goods or services most efficiently and can also be achieved through a dynamic process of learning and innovation (Freeman 2004, Porter 1990). In international trade theory, increasing competitiveness is considered a more promising approach when compared to the more static cost approach. Current theoretical and practical implications of innovation emphasize the involvement of many actors and organizations in innovation activities, while innovation itself is also understood to be a product of learning processes aimed at creating centres of long-term growth. The innovation system concept – which arose in the context of the 'second normative turn' in innovation studies in the latter decades of the twentieth century – is a competitiveness-focused approach (Asheim 2019). The innovation system concept marked a step-change in the way the drivers of innovation were understood – moving away from the 'static', linear process of applied research activity to develop a new process or product which dominated previous science and technology policies (Lundvall, Borrás 2005). Innovation policies that support innovation systems accordingly emphasize

stakeholder' or innovation actor dynamics, and the systemic relationships that characterize these actors' roles in promoting innovation and competitiveness.

Actors in the innovation system form a relationship or 'node' which promotes innovation in their environment. That is, they are the main components of the innovation system. The innovation system, therefore, constitutes a collection of all innovation actors and can be grouped into two subsystems: exploration and exploitation (Asheim 2019). Exploration subsystems, such as research institutes and universities, are generally those which generate or introduce new knowledge, while exploitation subsystems, such as firms or industries, are those which utilize this new knowledge for innovation purposes. These two subsystems then interact systematically over the long term to form an innovation system. In innovation systems, the government or public institutions play a crucial role in the planning process – as in some Western European and Nordic countries – which have a more coordinated market economy system, as opposed to, for example, traditional Anglo-Saxon model, where the role of the private sector as the capital provider is much more important than the role of government or public institutions. The latter tends to be less systematic and arguably applies over shorter time periods.

The regional innovation system (RIS) therefore represents an important approach to regional economic development. RIS is hence aimed at the dynamic goal of regional economic growth in the long term through innovation-based economic development. This innovation-based regional policy can also be used as an instrument to analyze regional economic development, and to measure the effectiveness of planned and implemented regional development. Therefore, the concept of RIS can be seen in terms of its function as an instrument for policy analysis, as opposed to its primary purpose of fostering innovation (Asheim et al. 2017, Asheim 2019).

In LDRs with some structural institutional and organizational weaknesses, the innovation learning and competitiveness approach can be used to achieve regional economic transformation through the Entrepreneurial Discovery Process (EDP). EDP constitutes the core process of the RIS3 policy approach, adopted by the European Commission as part of the reformed Cohesion Policy in 2014 (McCann, Ortega-Argilés 2014, 2016). This policy approach has been used to help regions construct their RIS in the early stages (Asheim 2019, Ranga 2018). Gustavsen, Ennals (1999) put forward the concept of "learning regions" for regional development, where a region draws necessary knowledge from outside their region then processes and disseminates it to the external environment around them (e.g., firms or industries) or uses that knowledge for their internal benefit (e.g., private R&D institutions). This process circulates within the RIS through horizontal collaboration (or a bottom-up approach). Such an innovation policy approach requires strong ties between organizations and critical actors in the innovation network. It also requires that local innovation actors should have the necessary capacities and capabilities (Lundvall 2007).

There is a dichotomy which dominates the concept of innovation within the framework of economic geography. First, economically more developed regions are considered more innovative than LDRs. Second, innovation is heterogeneous, following the region where it occurs (Edquist, Chaminade 2006, Rodríguez-Pose, Wilkie 2019) – i.e., institutional and socio-economic factors drive innovation success in more developed regions. It is because more developed regions generally have more skilled human resources, established physical capital, and supportive technological infrastructure (Bettencourt et al. 2007, Feldman, Florida 1994, Florida 2005). Developed regions also leverage agglomeration and externalities to bring private firms or institutions closer to regional public organizations or institutions. They also benefit economically from diversification and knowledge flows (Andersson et al. 2005, Anselin et al. 1997). The concentration of economic activity or agglomeration is suitable for innovation, especially from the institutional side. Even though institutions active in innovation are complex systems in themselves, they are essential factors in the process of knowledge diffusion and transfer, as well as in shaping collaboration for innovation (Fitjar, Rodríguez-Pose 2011, Rodríguez-Pose 1999). Unfortunately, a lack of these aforementioned conditioning factors often represents a significant challenge for LDRs. Structural problems are very likely faced by LDRs, such as socioeconomic conditions, local institutions, geographical location, the quality of human resources, and

skilled workforce composition (Bathelt et al. 2004, Lee et al. 2010, Ozgen et al. 2012, Pater, Lewandowska 2015, Rodríguez-Pose, di Cataldo 2015). Some of these limitations have a direct impact on the process of absorbing external knowledge or exploiting external knowledge from other regions, which is crucial for developing the innovation capacity of the region (Moreno et al. 2005, Rodríguez-Pose, Crescenzi 2008, Sonn, Storper 2008). In essence, the factors supporting innovation or innovation capacity in LDRs lead to stark contrasts with developed regions. Rodríguez-Pose, Wilkie (2019) state that conducive institutional conditions significantly distinguish these two types of regions besides their socioeconomic structure.

In this regard, some important questions arise about how these factors relate to Smart Specialization-centred place-based innovation policies. Trippl et al. (2019) explain that the existing approaches in RIS, such as institutions and organizations in a system, have a special place in the Smart Specialization policy framework, especially from the point of view of supporting innovation and entrepreneurship (Trippl et al. 2018) and from a governance perspective of innovation policy (Asheim, Isaksen 2002, Tödtling, Trippl 2005). In other words, the implementation of Smart Specialization in a region is influenced by the RIS.

Furthermore, the success of innovation policy governance in regions can be said to be determined by the competence of a region in designing its regional innovation policy, which will duly affect a region's ability to adopt Smart Specialization (in this case, called a Smart Specialization Strategy (S3)). Therefore, decentralization of power (regional autonomy), including decentralization of regional finance, is an issue that often arises in implementing Smart Specialization at the regional level (Trippl et al. 2019). On the other hand, decentralization affords a particular wiggle room to regions, allowing a degree regional manoeuvrability in formulating regional innovation policies. However, this discretion is highly dependent on the structure and quality of local government institutions, the capacity and capability of innovation actors, and the administrative and governance capabilities (Kroll 2015, 2017b, Rodríguez-Pose, di Cataldo 2015).

Other factors – often related to past policies – can hinder the adoption and implementation of this new type of innovation policy at the regional level (Aranguren et al. 2019, Morgan 2017). More developed regions are generally more prepared to adopt S3 because they have already overcome this problem in their area. More developed regions are generally more prepared to adopt the Smart Specialization approach because they have already overcome the more structural problems in their area. However, LDRs are still struggling with some of these problems. Smart Specialization requires multilevel arrangements and governance where coordination is crucial (Aranguren et al. 2019, Kroll 2017b). LDRs may face complex coordination challenges to create good governance of S3. However, because of these experiences, it can be argued that LDRs will benefit more from S3 than more developed regions (Kroll 2017a).

The adoption process of RIS3 at the regional level is strongly influenced by the organizational factors of RIS, especially in terms of the organizational structure of regional innovation, level of regional specialization, density, and diversity of firms and industries, as well as support from local knowledge institutions (Trippl et al. 2019). Regions can differ significantly due to economic structure, industry heterogeneity, and firm/industry innovation and diversification capabilities (Balland et al. 2019, Isaksen, Trippl 2017). However, this opens up opportunities for implementing Smart Specialization regarding regional priority selection – a process that can become a developmental project given solid stakeholder buy-in and engagement. Accordingly, the skills of the innovation actors are necessary for the success of the prioritization process. On the other hand, certain regions may face difficulties mobilizing these actors to engage in the RIS3 process, particularly when balancing their roles in the priority selection and decision-making process. Trippl et al. (2019) explicitly explore the adoption practices of RIS3 as influenced by the characteristics of RIS in the region.

3 Methodology

The first protocol of this study is underpinned by a preliminary scoping search process based on a number of pre-established research questions. Based on the preliminary study conducted prior to the research's commencing – as well as the background and motivation outlined in the introduction –two research questions are formulated, namely, "how does regional innovation take place in less developed regions (LDRs) of the EU?" and "how is Smart Specialization implemented in less developed regions (LDRs) of the EU?".

The initial scoping strategy was conducted using the PICOC concept (de Barcelos Silva et al. 2020, Mengist et al. 2020, Roehrs et al. 2017). This study's population (P) was specifically chosen to be only those regions in European Union (EU). The chosen intervention (I) was implementation and experience. The Smart Specialization and regional innovation strategy explain the comparison (C) element. Outcomes (O) expected at the end of the study are findings or analysis results related to problems, challenges, obstacles, opportunities, and recommendations. The context (C) of the study is expressly limited to specific regions, namely less developed regions, lagging regions, peripheral regions, and less-innovative regions.

Based on this PICOC concept, selected keywords are applied to the subsequent search phase, namely "less-developed, lagging, less-innovative, regions" (explaining the "who" element), "innovation, Smart Specialization" (to cover the "what" element) and "implementation, experience, problem, challenge, recommendation" (for the "how" element). All these keywords are henceforth combined in the literature search process through four primary databases (Web of Science, Science Direct, Wiley, and EBSCO), based on inclusion criteria which must be included in the literature search process.

Exclusion criteria control for papers deemed not to contain the above elements. Firstly, "China, US, UK" represent the "who" exclusion element. This literature was not considered because this study focuses on EU regions where Smart Specialization policies are implemented. Second, "tourism, environment, sustainable cities, universities". This literature was also excluded due to the study's specific focus on regional innovation policies rather than subtopics or specific sectors. Thirdly, "semi-autonomous" is applied as an exclusion criterion as it is judged that the term might not represent the specificity of "less-developed, lagging, less-innovative, regions".

The second protocol constitutes a search for papers in the four databases by applying the terms and criteria defined in the first protocol. Table 1 shows the details of the paper search applied to the four primary databases. The papers are sorted with certain restrictions such as language, year of publication, subject areas, article type, number of citations, and geographic region.

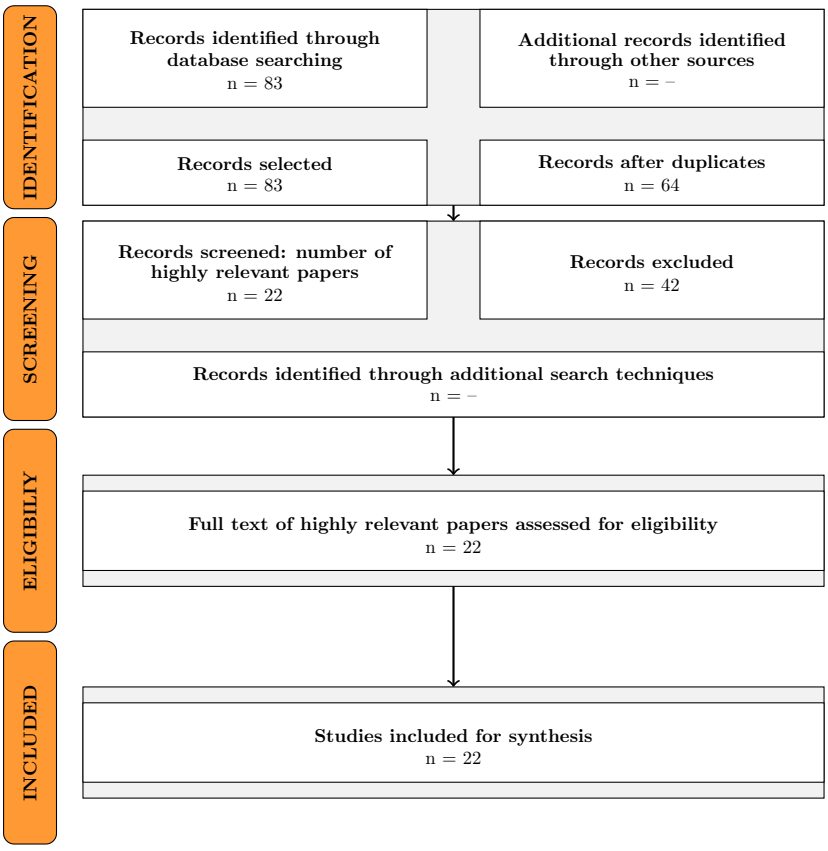
A total of 83 potentially relevant papers were collected and tabulated. This process found that some papers were duplicated on different database sources and are thus removed. At this stage, the number of potentially relevant papers is reduced to 64. Following further refinement based on exportable parts of the database (title, keywords, abstract, and conclusion 22 papers were finally selected as most relevant to the research objectives. These papers are screened based on details such as research question or objective, location and subject of the study, paradigm and discipline, theory, methods, data, and important research findings. This selection process affirmed these 22 papers as the main papers to be systematically analyzed in this study. The selection process flow is summarized in the PRISMA diagram in Figure 1.

The third protocol analyzes and reviews 22 papers systematically. Three steps are applied. First, articles are grouped based on their nature and origin, i.e., analyzing the number and trend of articles published in a certain period and grouping them based on their publication source (publication journal). This section aims to look at the research patterns related to Smart Specialization in LDRs of the EU, the widely discussed sub-topics, to identify which type of journals discuss or publish articles on this particular topic. Second, the selected papers are analyzed based on the research design and methodology. It identifies the kind of research approaches widely applied in the study of innovation and Smart Specialization policies and which make a significant impact and contribution to the development of the concept, theory, and practice of innovation and

Table 1: Search queries process

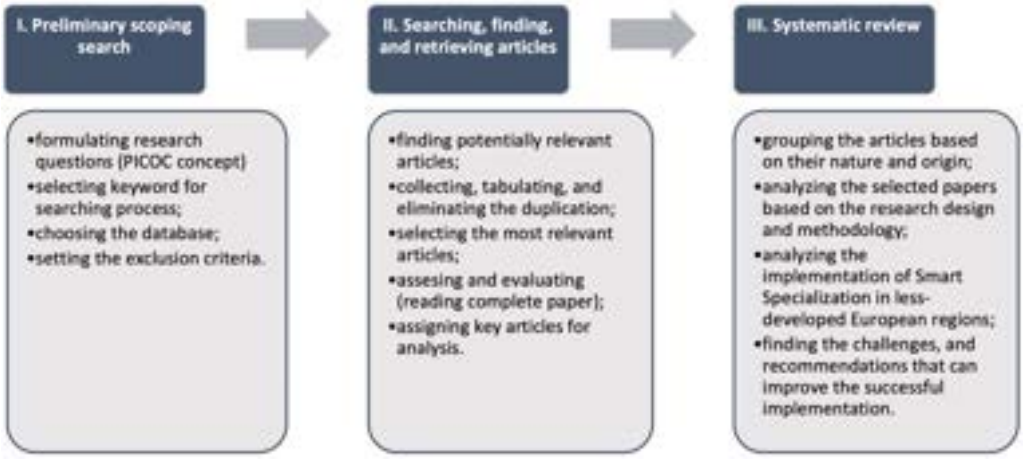
Database	Search queries detail	Potentially relevant papers
Web of Science	*Topic*: (SMART SPECIALIZATION INNOVATION LAGGING LESS) *Timespan*: All years. *Indexes*: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC. (24 results)	24
Science Direct	*Key terms*: "Smart Specialization" AND "innovation" (311 results) *Years range*: 2010 - 2021 (311 results) *Subject areas*: Economics, Econometrics and Finance (75 results) *Titles*: smart speciali(s)(z)ation; innovation; implement*; monitor*; less' (19 results)	19
Wiley	*Key search*: "Smart Specialization; innovation; less; lagging" (1253 results) *Applied Filters*: 2010 - 2020; Journals; subject: Business & Management *Titles*: smart speciali(s)(z)ation; innovation; implement*; less; lagging (5 results)	5
EBSCO	*TS*=("Smart Specialization" AND "innovation" AND "less" OR "lagging") *Geography*: Europe; Poland; Spain; Italy (70 results) *Choose by Title* (35 result)	35
	TOTAL	83

Source: processed data, own work



Source: processed data, own work – PRISMA diagram refers to Moher et al. (2009) and Page et al. (2021)

Figure 1: PRISMA diagram of the paper search process



Source: processed data, own work

Figure 2: The research protocols

Smart Specialization in LDRs of the EU. Third, it analyzes the implementation of Smart Specialization in LDRs of the EU. This critical section aims to find constraints, barriers, challenges, and recommendations which can improve the successful implementation of Smart Specialization in LDRs of the EU. A systematic and evidence-based analysis is applied to the most relevant papers and contributes to the research objectives. This section's critical information is summarized through graphs, figures, and tables. This research process is outlined in Figure 2:

4 Study findings

4.1 Systematic assessment of selected articles

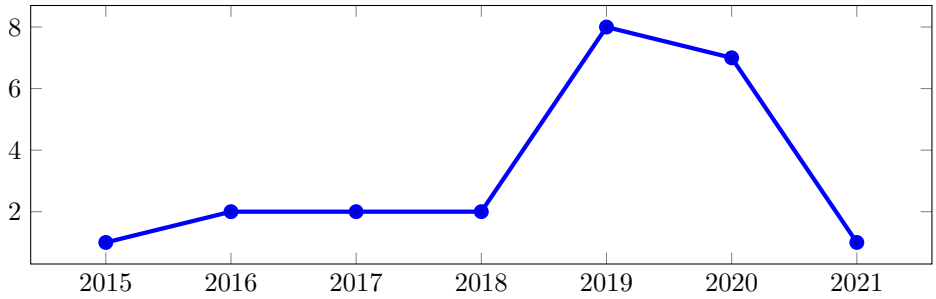
This subsection assesses the 22 selected papers based on two groupings. First, the source and nature of the articles, and second, the diversity in research design and methodology. Of the selected articles, the study finds that studies on Smart Specialization policies published in top leading journals started in 2015 – the first period of Smart Specialization implementation – which took place from 2014-2020 in the context of the EU's corresponding Multi-annual Financial Framework (Becic, Svarc 2010). The last article found was in 2021 (Serbanica 2021), during which time this study was ongoing. The distribution of articles from 2015-2021 shows that the trend of research on the chosen topic has increased significantly, although when working on this study in 2021, only one paper was captured on this topic from a leading journal.

In 2016-2018, five articles related to innovation and Smart Specialization were published: papers examining the linkages, design, and development of regional innovation systems (RIS) related to the new policy concept of RIS3 (e.g., Healy 2016, Krammer 2017, Ranga 2018) and papers examining the subfields of innovation research related to Smart Specialization and the transition and transformation processes of less developed regions in preparing their regions to adopt the Smart Specialization policies (Doloreux, Porto Gomez 2017, Wojnicka-Sycz 2018). The 2019-2020 period saw the most studies on Smart Specialization policies in less developed regions. There were 15 articles found in this period. The territorial context is an essential issue in the studies of these years, for instance, studies on implementing innovative programs, strategies, or policies in less-developed, rural, peripheral, and sparsely populated areas. Furthermore, there are also studies on the economic impact of Smart Specialization at the firm, regional and national levels, the potential of less developed regions in developing the innovation strategy RIS3, the implementation and factors affecting the success of S3, and future research opportunities which focus on S3 in less developed regions. This kind of research trend has dramatically expanded in the last five years. The number of articles and publication trends over time

Table 2: Number of articles published over time

No.	Year of publication	No. of articles
1	2015	1
2	2016	2
3	2017	2
4	2018	2
5	2019	8
6	2020	7
7	2021	1

Source: processed data, own work



Source: processed data, own work

Figure 3: Publication trends over time

are summarized in Table 2 and Figure 3.

Regarding the publication sources (Table 3), nine articles were published in two top leading journals, namely European Planning Studies and Regional Studies. Another five articles were published in Growth and Change and the Journal of Knowledge Economy. The remaining eight articles were published in top leading, reputable, and high-impact journals. The paradigms and scientific approaches in the selected articles also show a close relationship. The subject areas and subject categories of these publications are Geography, Planning and Development (eight articles), Social Sciences (five articles), Economics and Econometrics (three articles), Environmental Science (three articles), Public Administration (one article), and Management of Technology and Innovation (one article).

4.2 Diversity in research design and methodology

In this subsection, the selected articles are further analyzed following the research design and methodology diversity. First, the papers are categorized into two research methodology traits: non-empirical and empirical research. Non-empirical research has the common trait of using theoretical data and making logical assumptions about the research subject, whereas empirical research leads to hypothesis testing to conclude valid and verified findings (Dan 2017).

From the selected papers, research of a non-empirical nature is research that conducts a study in the form of a systematic literature review. In general, one of the critical objectives is to find the theoretical and practical gaps in the analyzed research topic and to identify research opportunities or crucial issues to be tackled in future studies.

Pires et al. (2020) systematically review 99 papers and conduct in-depth inductive analysis of the contents of their selected papers. This paper explores the theoretical and practical gaps in the TIM research agenda in LDRs. The study constructs some theoretical bases and opens up new horizons regarding TIM research and how policy practice relates to it in the less-developed European region. The findings of this study demonstrate the evolution of innovation policy over time with clear literary evidence and

Table 3: List of publication sources/journals

No	Journal name	Quartile (2021)	No. of articles
1	European Planning Studies	Q1 - Geography, Planning and Development	5
2	Regional Studies	Q1 - Social Sciences	4
3	Growth and Change	Q3 - Environmental Science	3
4	Journal of the Knowledge Economy	Q3 - Economics and Econometrics	2
5	International Regional Science Review	Q1 - Social Sciences	1
6	Transylvanian Review of Administrative Sciences	Q3 - Public Administration	1
7	Innovation: The European Journal of Social Science Research	Q2 - Geography, Planning and Development	1
8	Cambridge Journal of Regions, Economy and Society	Q1 - Geography, Planning and Development	1
9	Papers in Regional Science	Q1 - Geography, Planning and Development	1
10	Agricultural Economics (Czech Republic)	Q1 - Economics, Econometrics and Finance	1
11	Technological Forecasting and Social Change	Q1 - Management of Technology and Innovation	1
12	Journal of Common Market Studies	Q1 - Economics and Econometrics	1

Source: processed data, own work

based on science and technology-based concepts and theories of innovation for economic development. The second thrust of this study is on the factors which influence the pattern of innovation in less developed regions and the impact of innovation on the region. The third substantial tenor, related to innovation policy, relates to the critical role of various actors as subjects or actors of innovation in formulating innovation objectives based on proven innovation theories and practices, such as through the entrepreneurial discovery process.

Eder (2019) and Lopes et al. (2019) also conduct systematic literature reviews but use different analytical approaches. Eder (2019) conducts a study which draws on an earlier study by Webster, Watson (2002) to review in-depth studies on innovation in peripheral European regions. The findings of this study first suggest that the designation of peripheral regions as the subject of study should be more explicitly emphasized, for example, from the perspective of geography or functional areas. It is found that research results can be compared between specific regions and countries. The innovation studies that have developed so far generally focus on successful experiences in developed and innovative regions, while such innovation success factors are considered biased for peripheral regions. Studies on the evolution of innovation in peripheral regions are still insufficient, even though an evolutionary perspective is vital to trace how these peripheral regions innovate over time. The study finally shows that regional ties to the urban core are fundamental for firms in peripheral locations to innovate amidst the many other challenges and constraints they face. Lopes et al. (2019) systematically analyze the literature to find challenges and opportunities in RIS3, which could be helpful for future studies. The method used is a bibliometric analysis which leads to the conclusion of six topic clusters related to RIS3 research to help future researchers build theoretical bases and design research related to innovation policy in the context of Smart Specialization.

The second category of the research approach is empirical research. The empirical research found in the selected group of papers is generally qualitative, applying much analysis to strategy or policy documents and analyzing the behaviour of stakeholders or policymakers as innovation actors. In addition, the primary papers of this study also specialize in their studies on quantitative research approaches and a mixture of qualitative and quantitative research approaches.

Healy (2016) explores the constraints and challenges of implementing Smart Specialization in one of Europe's least developed regions, Northeast Romania. The qualitative data was obtained from observations and interviews of local stakeholders, including local governments, council members, universities, companies, and selected correspondents who work within the Smart Specialization innovation policy scope, and then analyzed by means

of a qualitative approach. The development of regional RIS3 was promoted after Romania launched the national RIS3. The Smart Specialization policy approach has provided opportunities for regions to explore their spatial potential further while at the same time providing learning benefits for regions, in that it has encouraged researchers to build and develop RIS3 in their regions actively. The study concluded the importance of solid institutional structures in supporting the effective implementation of Smart Specialization in regions such as Northeast Romania.

A subsequent study by Kolehmainen et al. (2016) also employs a qualitative research approach to analyzing the actor's role in the business sector, higher education institutions, government organizations, and community groups (quadrupole helix) in economic and social development in less developed or marginalized regions. The study finds that innovation in urban areas is often considered a benchmark in designing and developing RIS3 in less developed regions and assumes that the same policies can be applied in their areas. The study finds that underdeveloped, peripheral, or rural areas with a triple helix base will benefit more from the involvement of the fourth actor, namely social groups, and communities (quadruple helix concept), in the knowledge-based development process in less developed regions.

A study by Ranga (2018) sheds light on evidence from the implementation of RIS3 in eight regions in Romania. Again, through a qualitative research approach, the study reviews how the innovation policy of Smart Specialization triggered the accelerated development of RIS which were previously relatively low. Accordingly, this is found to have been no easy feat, given Romania's centralized innovation system. This paper is the result of two years of research conducted in 2017-2018, consolidating many stakeholders from national authorities involved in formulating RIS3. The research started with forming working groups, conducting workshops, and analyzing the research project's progress. The research finds that strong and coordinated multilevel governance at the regional level is needed by regions in countries with a centralized national innovation system like Romania. Industry dynamics and a conducive regional research and innovation climate are created through appropriate national and regional innovation policy interventions at the institutional level. Thus, there is no "golden rule" for implementing innovation policy in the region, but rather the region must learn to understand its actual conditions and characteristics in formulating and implementing RIS3.

From several examples of these studies, data collection in the qualitative research approach is generally obtained from interviews and observations. Qualitative studies can be preceded by an initial review of strategy documents or policy documents and then further observations by gathering information from local stakeholders (e.g., Healy 2016, Ranga 2018, Sörvik et al. 2019). Some scholars also apply longitudinal studies to complement these two methods by distributing questionnaires to those considered capable of providing more information or explanations if they are reluctant to convey some information during the interview or observation process (e.g., Kolehmainen et al. 2016).

In addition to primary data directly obtained from respondents, secondary data readily available from various reliable sources is also widely used in innovation policy studies, such as socio-economic and financial/budgetary data. The data can be obtained online from the offices or official websites of state or regional statistical agencies or other institutions that publish specific data in the public interest. Secondary data can also be obtained with special procedures or permissions at the company level. This kind of data is the main empirical research data with a quantitative approach.

Rodríguez-Pose, Wilkie (2019) apply the econometric analysis method using the Organization for Economic Co-operation and Development (OECD) regional statistical data to analyze the factors affecting patenting in less developed regions in America and Europe. The study finds that innovation in lagging regions in North America is directly related to regional Research and Development (R&D) investment in higher education institutions, regional human capital quality, location concentration of economic activities, and local population size. However, in less developed regions in Europe, regional innovation capacity depends on the R&D investment of firms present in the area, the availability of skilled human resources, and the economic structure of the regions, all

of which are closely linked to economic agglomeration. As a result, variations in the knowledge transfer processes contribute to building innovation capacity in lagging regions in North America and Europe.

Varga et al. (2020) use complex quantitative data to build an economic impact model with Geographic, Macro, and Regional (GMR) Hungary economic impact modelling. This study is closely related to Smart Specialization policies in Hungarian regions. Economic impact modelling is expected to provide a reliable picture of the economic impact of Smart Specialization policies from various dimensions, namely industry, regional, and national levels, so that this study can help policymakers implement Smart Specialization in the region. The study utilizes statistical data from three types of selected regions, namely developed regions (Budapest), industrial regions (Győr-Moson-Sopron), and less developed regions (Baranya). Economic impact modelling leads to conclusions about the potential for regional economic development with policy interventions related to smart specialization tailored to local resource factors. Developed regions are synonymous with the service sector with high added value and knowledge intensification embedded in the regional economic system. Industrial estates spread across several sub-regions contribute to high regional economic growth. Meanwhile, less developed regions are still dominated by the agricultural sector with limited regional capital, and much effort is still needed to develop the regional economy.

Crescenzi et al. (2020) use quantitative data at the firm level to analyze the impact of the implementation of the Collaborative Industrial Research (CIR) programme on several Italian firms during 2007-2013. Collaborative Industrial Research (CIR) is a research and competitiveness program scheme within the framework of the EU Cohesion Policy 2007-2013 that is jointly funded by the Italian national budget and the European Regional Development Fund (ERDF). The CIR program aims to support R&D activities carried out by industrial firms in less developed Italian regions such as Sicily, Campania, Apulia, and Calabria. The program is also seen to have essential features that are compatible with the Smart Specialization Strategy (S3). The study's objective was to evaluate the impact of the CIR program in driving value-added, investment, and employment across all beneficiary firms. The evaluation results showed a minimal impact on the CIR beneficiary firms. Even greater funding support has as yet not managed to increase the effectiveness of the firm's R&D projects. Interestingly, firms from low-tech industry sectors have seen greater benefits from this program. According to the study, significant reforms are needed to create effective regional innovation strategies and policies. In addition, it is also necessary to develop specific policy tools that can encourage collaboration in innovation programs to optimize the impact of implemented policies.

Mixed methods which combine qualitative and quantitative research approaches seem to be more successful in contributing to innovation studies related to Smart Specialization. For example, Krammer (2017) employs mixed methods to analyze and propose RIS3 policy tools in less developed regions in Bulgaria. The study is complemented by an innovation system framework which can improve common economic indicators such as economic growth and regional competitiveness. The study utilizes industry-level export data from The United Nations Comtrade national statistical data, and international patent data from the European Patent Office (EPO) and the United States Patent and Trademark Office (USPTO). The study results identify economic sectors that have the potential to be adapted into Smart Specialization policies at an early stage. Some obstacles in implementing S3 in less developed regions are also discussed in this paper. The paper recommends a multi-level policy instrument in the management of S3 in less developed regions such as Bulgaria, which is a multi-level policy instrument that links economic sectors, regional governance elements, and systemic national policies.

Trippl et al. (2019) apply a mixed methods approach by analyzing secondary data, conducting a desk-based analysis of regional innovation policy practices, and analyzing and evaluating regional innovation policy documents. The study addressed several key research questions. First, how can European regions with diverse geographical conditions adopt and implement Smart Specialization while identifying the main opportunities and challenges of Smart Specialization implementation in European regions? Second, how RIS's organizational and institutional factors influence the implementation of Smart

Table 4: The diversity in research design and methodology

Nature of Research Methodology	Research Method Approach	Selected Papers
Non-empirical Research	Systematic Literature Review	Pires et al. (2020), Eder (2019), Lopes et al. (2019)
Empirical Research	Qualitative methods	Healy (2016), Kolehmainen et al. (2016), Ranga (2018)
	Quantitative methods	Rodríguez-Pose, Wilkie (2019), Varga et al. (2020), Crescenzi et al. (2020)
	Mixed methods	Krammer (2017), Trippl et al. (2019), Ghinoi et al. (2021)

Source: processed data, own work

Specialization in three different types of regions: developed regions, intermediate regions, and less developed regions. Third, how Smart Specialization provides crucial lessons for regions in realizing better regional innovation systems and policies (RIS and RIS3). Furthermore, Ghinoi et al. (2021) recently applied a mixed method in analyzing the implementation of S3 in peripheral regions with a data triangulation approach, namely by reviewing the RIS3 document belonging to the Lapland region (Finland), followed by in-depth interviews with stakeholders active in the formulation of RIS3, and finally circulating an online survey to obtain more complete data from stakeholders in the region. Both studies are complex and very interesting, so I consider them for a further and more in-depth discussion in the following subsections. The diversity in research design and methodology outlined in the sample papers is summarized in Table 4:

4.3 Challenges in implementing Smart Specialization in less developed regions (LDRs) of the EU

This section summarizes the findings of studies related to the implementation of S3 in LDRs of the EU. Selected case examples are taken from the selected papers which thoroughly analyze the challenges or obstacles in implementing S3 in LDRs of the EU. Meanwhile, the literature review section has previously discussed the literature on regional innovation systems (RIS) and their relationship with the adoption of Smart Specialization (Section 2).

Trippl et al. (2019) specifically discuss the influence of RIS development in 15 regions on implementing the S3 and the opportunities and challenges it faces. The 15 regions are categorized into advanced, intermediate, and less developed regions based on diverse spatial characteristics. The positive role of S3 in LDRs raises new challenges for regions to improve their RIS to be better prepared to participate in Smart Specialization policies. The development of S3 enhances mutual trust, which has the potential to increase mutually beneficial relationships and collaboration between research institutions and industry. The bottom-up approach that characterizes S3 has also led to changes in the governance of policymaking at the local level and created better coordination with higher levels of government.

The two main points of emphasis in this paper in terms of S3 implementation include the determination of priority domains and the involvement of stakeholders in the innovation policy formulation process for Smart Specialization. LDRs have a tough challenge in the prioritization process. This process does not seem to work well due to intrigues within the policy-making environment and past inherent problems in governance. The LDRs have significant tasks in forming a broad consensus of stakeholders and determining their S3 prioritization mechanism. Stakeholder engagement is essential in S3 policy while it is new to LDRs. It is not easy for LDRs to mobilize all interests under conditions of institutional thinness, cooperation culture, and weak policy capacity.

In the prioritization process, the identification process in some regions focuses on strengthening established priority areas. In contrast, in other regions, the identification process is geared towards increasing the contribution and role of existing resources or

the growth of entirely new pathways. Unfortunately, the creation of new pathways is arguably the least preferred prioritization mechanism in the LDRs, because exploiting these new growth pathways requires a good institutional infrastructure and research organization, which has been partly responsible for the failure of new growth pathways in the past. In addition, there are many limitations in diversification and innovation potential in existing domains, some of which are due to limited linkages between industry and universities and a less dynamic entrepreneurial ecosystem. Another critical issue in successfully implementing LDRs is the limitation of regional financial autonomy, which ultimately limits budget allocations for regions. The problems mentioned earlier also contribute to the ability of regions to use their budgets optimally. Similarly, to participate in S3, multilevel coordination and governance between regional and national governments in managing regional budgets for innovation seems to be very much needed.

Some of the problems discussed have led to three challenges in implementing S3 in LDRs. Overcoming these challenges and problems has the potential to support the successful implementation of S3. These challenges include increasing RIS capacity, transparency and accountability of funding and budgets, and resource allocation in the innovation policy governance system. It is also essential to understand that S3 is not a parallel policy process. S3 is a process embedded in RIS, so addressing these three critical solutions will not only improve the regional innovation system but also guide the region in successfully implementing S3.

Sörvik et al. (2019) explore the implementation of S3 in five sparsely populated regions (SPAs) in Europe, representing many of the challenges of implementing S3, such as in LDRs. The implementation of S3 in their regions positively impacted their regional innovation policies. I draw three points that should concern S3 policy practitioners related to improving the quality of human capital, access to external knowledge, and developing or renewing growth paths. In this case, access to external knowledge and the quality of human capital are interrelated. One of the successes of S3 can be realized by imitating the success or excellence of other regions and making it a benchmark. Therefore, competent, talented, and committed personnel are indispensable for absorbing external knowledge and enhancing regional innovation capacity. In addition, a conducive innovation environment is necessary to motivate the region's critical mass to shape a better future innovation environment. In mobilizing such competent resources, intermediaries are also needed whose role can be to mediate various dialogues or socialization among stakeholders as well as to mediate between regions or countries, between public sectors or private sectors, and between public research institutions or universities and industries in creating local and extra-regional collaboration opportunities or engaging extensively in global innovation networks.

Improving the quality of human resources is not only focused on those in formal organizations, but workers with weak skills are equally essential to improve the competence of a critical mass of innovation actors. Research incentives can be provided to researchers in universities and industries to improve motivation and performance. However, for low-skilled workers, it is essential to improve their skills to enhance their role in innovation. For example, vocational training and education for young workers can be proposed as an innovation strategy in regional innovation policies whose budgetary support can also be proposed in the S3 funding framework.

Furthermore, the link between pathway development and new pathway creation. In formulating regional innovation policies, results-oriented innovation development programs focus on the effectiveness of program implementation and the efficient use of resources. Because S3 is a place-based policy concept, it is imperative to consider the region's socio-economic conditions and institutional character. Although each region has advantages in certain areas or domains, its relationship with other areas or domains must also be considered.

SPAs are subject to global competition which can change the direction of demand in the region. In the S3 policy, many stakeholders are involved in the EDP process. In this case, private actors, industries, and companies understand these conditions best, as they are the main actors in the market. The proper EDP practices and periodic evaluations of prioritized domains should be carried out consistently. Stagnant or not

growing domains should be discontinued and replaced by exploring opportunities for new, more transformative activities. In the course of implementing S3, the region will look at its economic development from a broader perspective and realize new opportunities that have the potential to improve its competitiveness globally.

The problem of collaboration in LDRs is the focus of Barzotto et al. (2019). One case study is the Italian region of Puglia, one of the poorest regions in Italy, with high unemployment and many socio-economic problems. Initially, the region implemented strategic sectoral policies encouraging substantial public investment in state-owned companies in the steel and aerospace sectors. However, this policy failed to address the region's numerous problems. The region has finally focused on developing local industries and EU-funded projects in the last two decades, although their effectiveness has also been limited. Puglia has typical LDR characteristics: poor quality of governance, high levels of corruption, low levels of public trust, and limited social capital. Public trust is challenging to gain under the existing conditions, making the implementation of S3, particularly for EDP processes, in the region very challenging.

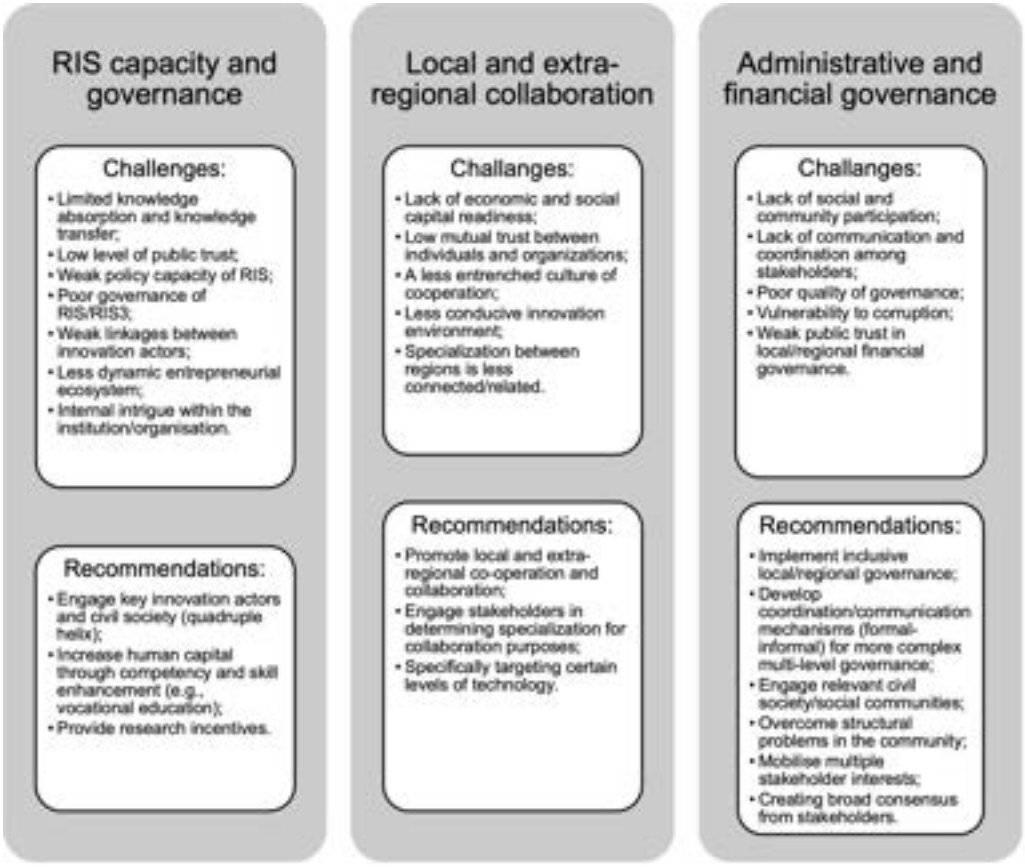
The problems in Puglia began to be overcome when the government began to develop traditional sectors and try to find new, more dynamic opportunities through increasing research and education capacity in manufacturing, digitalization, ICT, and aerospace. RIS3 in the region is evolving with a focus on the technology domains they have identified. Various stakeholders are involved in these activities, the network of innovation actors in the region is growing, and they are also engaged in extra-regional collaborations that strongly support innovation development.

The most fundamental challenge in the study region before they go far into successful extra-regional collaboration is to find new specializations that fit the character of their region and overcome deep-rooted innovation capacity weaknesses that are difficult to change. Barzotto et al. (2019) recommend three critical policies. First, extra-regional collaboration should focus on adopting new technologies and opportunities to discover innovation domains. Second, regional participation in RIS3 should lead to policy learning in governance administration, which is crucial in the design and implementation of S3. Third, lagging regions should have an industrial strategy that can address the region's structural problems, such as HR quality issues, network access, and social capital, which opens up new investment opportunities and broader involvement in extra-regional collaboration.

Ghinoi et al. (2021) applied the triangulation research approach in Lapland (Finland), which was also used as a study region by Sörvik et al. (2019). The research took a data triangulation methodology approach by examining RIS3 early in the process, followed by in-depth interviews with stakeholders directly involved in RIS3, and finally, collecting data through an online survey of various regional stakeholders. This study aims to improve the understanding of good governance practices related to regional participation in S3 innovation policy.

Ghinoi et al. (2021) focus further on several dimensions, such as EDP, decision-making, and discovering new domains. The study only focuses on governance, the most glaring regional network studies issue. Firstly, like the case of LDRs by Trippl et al. (2019), the most significant S3 governance issues in the studied region started from the entrepreneurial discovery process (EDP), which he then linked to the diversity and intensity of organizational networks. Two factors can explain this phenomenon: the ability of innovation networks to absorb external knowledge (absorptive capacity) and the limitations of local resources in the knowledge transfer process (transfer capacity). Both factors were incapable of creating the entrepreneurial activity required for S3 implementation. Secondly, the interaction of stakeholders involved in the decision-making process is strongly supported by inclusive governance. This inclusive governance environment, formally and informally, is indispensable in encouraging good communication and cooperation between actors. Third, in the domain development process, the role of human resources is crucial (competency). The participatory methods applied in the region are a testament to the success of inclusive governance in creating a better innovation environment, even if it has not fully encouraged the emergence of new technology domains.

This study is interesting because Ghinoi et al. (2021) emphasise that regions can rely



Source: processed data, own work

Figure 4: Key issues of S3 implementation in less-developed European regions

on informal coordination to strengthen formal linkages if they engage in multiregional relationships. Nevertheless, this should be tailored to the policy objectives and the stakeholders involved in the S3 formulation process. If in this process, the region also involves relations with the central government, such informal coordination can be applied. For example, if the region needs special access to specific centralized business associations, the central government can facilitate this. Informal approaches from the regions can be made to obtain such support. Next, in place-based innovation policies such as S3, civil society involvement in efforts to create inclusive governance can be sought to address governance weaknesses in the regions. This kind of bottom-up approach is one of the characteristics of S3.

Based on the findings of the studies that raised issues in the implementation of S3 in less-developed European regions, especially concerning the specific challenges and barriers faced in these regions, this subsection is summarized in (Figure 4).

5 Summary and Conclusion

In this paper, a systematic review of the literature on innovation and new place-based innovation policies of "Smart Specialization" in less developed regions (LDRs) of the EU is applied due to a preponderance of theoretical background and practical evidence in this space. This paper emphasizes and analyzes the selected papers on at least two main points. Firstly, on the systematic analysis of innovation studies and Smart Specialization in less-developed European regions. Secondly, the paper highlights the critical issues in implementing RIS3 in LDRs (such as problems, challenges, and recommendations).

The first finding of this study relates to the number and trend of studies in the Smart Specialization implementation period 2014-2020. At the beginning of the implementation

period, it is natural that empirical and theoretical studies related to this policy, especially in less developed regions, were insufficient. However, referring to previous regional innovation studies provides a great deal of insight in addressing innovation issues based on regional differences. Studies on Smart Specialization in LDRs of the EU emerged about two years after implementation began and have increased significantly in the last four years. This phenomenon shows that the implementation issues of Smart Specialization in less developed regions are receiving greater attention. Many researchers, scholars, and policymakers expect significant contributions from these studies.

The paper further analyzes the systematics of the research papers in terms of research design and methodology. First, research approaches are categorised based on non-empirical and empirical research. The research methods applied in these papers are then discussed in detail. Non-empirical research of the systematic literature review type helped design the study. Empirical research groups dominate the selected papers. Primarily, this empirical research thus uses a qualitative approach. It is prevalent considering that innovation studies concerning Smart Specialization require strategy and policy documents which can be reviewed or evaluated in depth by means of desk-based analytical approaches, interviews, observations, and questionnaires. As Smart Specialization emphasizes the importance of the role of innovation actors, many qualitative studies have been conducted involving multiple stakeholders. The use of secondary data in quantitative studies, or qualitative data which can be quantified, is equally essential in innovation studies. Applying appropriate analytical techniques to quantitative data can provide valid and verifiable evidence for the designed hypotheses. Processing and analyzing quantitative data and showing robust evidence can convince other researchers or policymakers to use the study results as a reference for future studies or to take specific policy steps.

Mixed methods combining qualitative and quantitative approaches have significantly contributed to regional innovation studies related to Smart Specialization. Mixed methods can propose specific frameworks for regional innovation in less developed regions of the EU. The combination of several analytical methods aims to obtain complementary information, establish coherence between cases, and present a significant result. Given the complexity of the methods, the process is also balanced by the number of resources required. It is characterized by such studies being carried out over a long period (more than one year), being a collaborative research project involving several parties, and requiring adequate financial resources.

The final subsection of this study analyzes the implementation of Smart Specialization in less developed regions (LDRs) of the EU. The critical point of this subsection is finding the key issues of Smart Specialization implementation, such as the challenges and barriers that many regions face and the study's recommendations. The three main issues from the selected papers constitute issues on RIS capacity and governance, local and extra-regional collaboration, and issues related to local/regional administrative and financial governance.

This study has also found that studies on Smart Specialization in LDRs of the EU are insufficient, implying that the literature sources to be selected were also limited. In the initial scoping search process to find the most relevant literature, exclusion factors entailed that over half the potentially relevant papers were omitted. Despite using desired keywords, many papers identified were too narrow and focused on specific fields, economic sectors, and regions without comparing them to other regions. Certain limitations in discussing this kind of literature and generalizing it as a subset of LDRs of the EU are therefore acknowledged. The present study does not intend to draw the conclusion that the three types of regions discussed in the fourth section (LDRs, SPAs, and peripheral regions) are homogeneous. The present study, therefore, argues that these three regions tend to differ in their characteristics, strengths, and weaknesses. It could be that certain regions are currently very intensively developing one or more of the three key issues of implementing S3, while other regions may still experience systemic difficulties. Therefore, discussing the challenges in implementing S3 according to different types of regions will open further insights in the course of future research. This paper has not covered such literature, so examining this issue in future studies is highly recommended and advisable.

This study has followed the research protocol as consistently as possible through a systematic literature review. However, previous studies have presented much more

complete systematic reviews, such as author performance, number of citations, networks between them, and clustering of specific topics or sub-topics. For the same reason, I acknowledge the limitations in pursuing or fulfilling such important analysis due to limited literature resources. Finally, the synthesis of the key issues in implementing Smart Specialization in LDRs of the EU at the end of this study is, of course, still very much open to investigation. The summary of these issues is based on the relatively few papers that are considered to have made the most significant contribution to this topic. Nevertheless, these findings are a significant contribution to this paper. It is hoped that the key points in each challenge or recommendation in the key issues will interest policy observers, policymakers, or other scholars to study them in future research.

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Development of a Quantitative Model in Land Use Planning Using GIS – A Case Study of Zarrin Dasht County, Iran

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Abstract. Land evaluation methods are crucial for evaluating the potentials and constraints of land for intended land use. In the procedure, environmental criteria such as topography, soil, climate, hydrology, and socioeconomic parameters are evaluated. Different technical procedures are also used for land evaluation ranging from simple methods based on expert knowledge to more complex methods based on simulation models. The main goal of this research is to evaluate land use and natural resources for future sustainable land planning using Geographic Information System (GIS). So, in this study, the Iranian ecological evaluation model was used for the analysis of the ecological and resources maps of the study area. First, ecological capability maps of different land uses such as forestry, agriculture, range management, environmental conservation, ecotourism, and development of villages, urban and industrial areas were developed by overlaying geographical maps based on Boolean overlay method (as a Multi-Criteria Evaluation Method) in GIS for the Township. The final step of this research was the prioritization of land uses considering the ecological and socio-economic characteristics (by distributing questionnaires to 63 experts) of the study area using a quantitative model. The results showed that the maximum area of proposed uses is 78.31%, which is related to rainfed agriculture, showing this land use has high potential and socio-economic demands in the study area. Meanwhile, minimum area of proposed uses is related to forest and ecotourism. One of the most important practical results of this study is that different or even modified methods should always be used in the same region to check the capability of land and the common method will not always be as best method.

Key words: Boolean Theory, Land-use planning, Modified Model, GIS, Zarrin Dasht County

1 Introduction

From the earliest times, people have performed land suitability assessments. They learnt by experience how to estimate what land will produce and how it must be managed. Land evaluation is the process of assessing the suitability of land for a specified kind of land use (van Lier 1998, Jozi 2010, Sarvazad et al. 2015, Masoudi, Zare 2019). Possibilities for land use types such as high-input arable farming, extensive grazing by dairy cattle combined with nature conservation or timber production in short-rotation forestry can

be explored. The principal purpose of land evaluation is to predict the potentials and constraints of land for changing use. This may involve the introduction of a fully new land use type or the introduction of a new management practice, such as minimum soil tillage instead of conventional tillage (Dent, Young 1981, Mokarram, Zarei 2021).

Land evaluation deals with two major aspects of land, physical resources, and socio-economic resources. The physical resources include soil, topography, hydrology, and climate, whereas the socio-economic resources comprise, for instance, availability of labour, capital, size and configuration of land holdings, land ownership, and infrastructure (Alavi Panah et al. 2001, Jokar, Masoudi 2016, Yohannes, Soromessa 2018, Masoudi et al. 2020). The physical resources are relatively stable. On the other hand, the socio-economic resources are more time-dependent because they are affected by the social, economic, and political settings. The distinctly different nature of both resources has resulted in a procedure with separate evaluations, i.e., physical evaluation and economic evaluation, which may be processed subsequently or in parallel in an integral land evaluation approach (Dent, Young 1981, Masoudi, Jokar 2015, Asadifard et al. 2019, Jahantigh et al. 2019). Physical land evaluation aims to assess land qualities or the suitability of a specific land use type, as conditioned by biophysical parameters. Different technical procedures can be used for physical land evaluation (Lahmian 2016). These procedures range from expert knowledge based on farmers' experience to process-oriented simulation models based on generally applicable physical and biological laws, which are derived from extensive laboratory and field experiments (Pan et al. 2021).

In ecological evaluation, GIS is quickly becoming data management standard in planning the use of land and natural resources (Makhdoom 2001, Prato 2007, Makhdoom et al. 2009, Abu Hammad, Tumeizi 2010, Marani Barzani, Khairulmaini 2013, Jafari, Bakhshandehmehr 2013). Virtually all environmental issues involve map–based data, and real-world problems typically extend over relatively large areas (Nouri, Sharifipour 2004, Zakerinejad, Masoudi 2019). GIS is used for geography patterns (Pauleit, Duhme 2000, Bojórquez-Tapia et al. 2001, Biswas, Baran 2005, Peel, Lloyd 2007). Also, GIS is an indispensable tool for land and resource managers (Swanson 2003, Gandasasmita, Sakamoto 2007, Oyinloye, Kufoniyi 2013, Ayalew 2015). In GIS-based methods like Multi Criteria Evaluation (MCE), quantitative criteria are evaluated as fully continuous variables rather than collapsing them to Boolean constraints (e.g., Weighted Linear Combination [WLC], Ordered Weighted Averaging [OWA]) (Malczewski 2004, Fallahshamsi 2004, Sanaee et al. 2010, Kumar, Biswas 2013, Oyinloye, Kufoniyi 2013, Pourkhabbaz et al. 2014). In the WLC method, maps are combined based on linear weighting. In this method, areas can be classified according to varying degrees of suitability. The OWA is extension and generalization of the WLC. This method is a weighted sum with ordered evaluation criteria (Sanaee et al. 2010, Kumar, Biswas 2013, Pourkhabbaz et al. 2014, Jokar et al. 2021).

Current land use planning in Iran by Iranian evaluation quantitative model has some problems like difficulties in assessment of ecological and socio-economic information used in related scenarios. Also, it is possible because of the sum of scores derived from different scenarios; a model may prioritize land use without ecological capability or recommended changing urban land cover to a pasture. Therefore, the main goal of this study is to solve these problems and develop and modify the current quantitative method of the Iranian ecological model (Makhdoom 2001) to evaluate better land use planning in Iran. Our research will help to achieve the Sustainable Development Goals of the United Nations and the Land Degradation Neutrality challenges due to the proper soil and water management we propose (Keesstra et al. 2018, 2021).

2 Material and Methods

Zarrin Dasht County with an area of 4,626 km^2 is located in the Fars province and Southern parts of Iran (Figure 1). Zarrin Dasht city is located at geographical longitude 54°25′E and geographical latitudes 28°12′N. This area is located in the mountainous area of Zagros and has an arid and semi-arid climate.

The data in this paper are included in two types 1) numerical and descriptive data

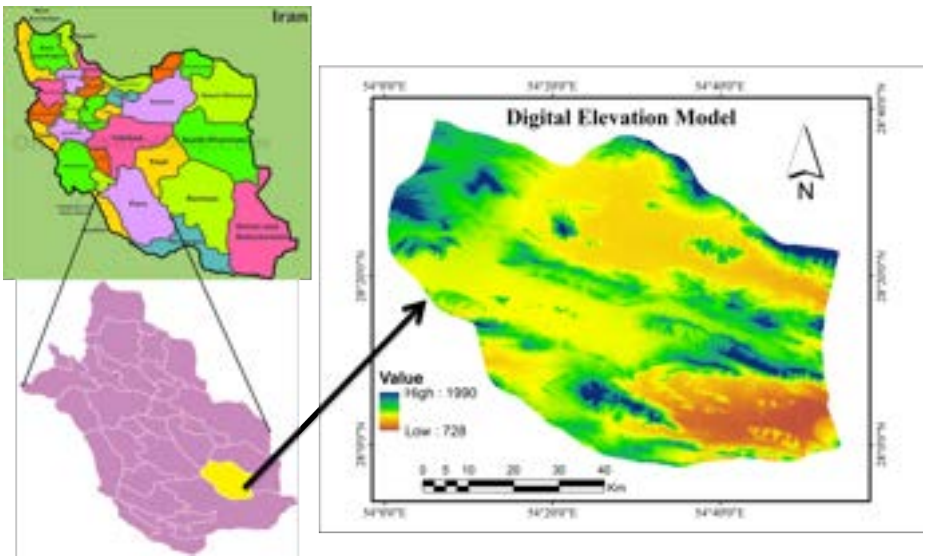

Figure 1: Position of Zarrin Dasht in Fars Province and Iran

and 2) thematic maps, but mainly in the map format (vector) with mostly semi-detailed scale (1:50000 scale) for the GIS analysis. All such relevant data (Table 1) were obtained from the local and main offices and institutes of the Ministries of Agriculture and Energy and the Meteorological Organization of Iran. Also, some soil samples and field data were gathered during field work to check and improve the maps and reports used, wherever needed. The different kinds of maps used in this research to determine the ecological resources of the area under study were Digital Elevation Model (DEM), slope and aspect, soil data, erosion, geology, iso-precipitation (iso-hyetal), iso-thermal, iso-evaporation, climate, canopy percentage and type, in addition to water resources data.

This research was done based on two main parts:

1. Ecological capability evaluation for different uses, and
2. Prioritizing the different land uses.

For ecological capability evaluation for different uses (step I), a systematic method known as the Iranian ecological evaluation model based on Boolean model (FAO 1976, Burrough et al. 1992, Davidson et al. 1994, Makhdoom 2001, Baja et al. 2002, Amiri et al. 2010) was used for the analysis of maps in relation to the ecological and socio-economic resources of the study area. The Boolean model (as an MCE Method) is an overlay method which combines parameters based on AND (intersection) and OR (union) operators in GIS.

Different ecological capability models of the Iranian ecological evaluation model based on ecological data were used to evaluate ecological capability of different land uses including forestry, agriculture, range management, environmental conservation, ecotourism, and the development of village, urban, and industry (Makhdoom 2001). We can classify an area based on these models to different capability classes. Ecological capability classes for forestry, agriculture, range management, environmental conservation, ecotourism, and the development of village, urban, and industry are 7, 7, 4, 3, 3 and 3, respectively. The best capability class in each model is class 1 and the worst capability class is the biggest number in the classification of models. The good and moderate classes of the different models were shown in Table 1.

In order to identify the effective criteria for every use in the study area, they were based on a literature review and previous studies (Makhdoom 2001, Fallahshamsi 2004, Makhdoom et al. 2009).

It should be noted that in Table 1, good and moderate classes are listed based on influence on every use. Also, poor and not suitable classes have been excluded due to their unimportant role in classification.

Table 1: Moderate and good classes of different indicators for every use (Masoudi 2018)

A) Indicators related to topography and soil criteria

Indicators	Class	Forestry (classes 1-4)	Agriculture & range management (classes 1-4)	Ecotourism (intensive) (classes 1-2)	Development (classes 1-2)
Elevation(m)	Good	0-1000	-	-	400-1200
	Good to moderate	0-1000	-	-	0-400, 1200-1800
	Moderate	0-1400	-	-	-
	Mostly moderate	400-1800	-	-	-
Slope (%)	Good	0-25	0-5	0-5	0-12
	Good to moderate	0-35	5-8	5-15	12-20
	Moderate	0-45	-	-	-
	Mostly moderate	0-55	8-15	-	-
Soil Texture & Type	Good	brown soil and forest semi humid to loam clay texture	Clay, loam clay, humus	usually moderate	moderate(often)
	Good to moderate	brown soil and forest semi humid to loam clay texture	Clay, loam clay, humus clay, sandy loam clay, sandy clay loam, clay loam, loam	Coarse, light, heavy	light(often)
	Moderate	brown soil to clay loam texture	clay loam, loam sand, loam clay sand, clay loam sandy, sand	-	-

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Indicators	Class	Forestry (classes 1-4)	Agriculture & range management (classes 1-4)	Ecotourism (intensive) (classes 1-2)	Development (classes 1-2)
	Mostly moderate	brown rendezina to clay loam texture, regosols brown soil, litosols to sand loam texture	Clay, loam clay, clay loam, loam	-	-
Drainage	Good	Moderate to perfect	perfect	Good	Good
	Good to moderate	Moderate to good	good	moderate to poor	moderate
	Moderate	Rather incomplete to good	Moderate to incomplete	-	-
	Mostly moderate	Rather incomplete to Moderate	-	-	-
Depth	Good	Deep	Deep	Deep	Deep
	Good to moderate	Deep	Moderate to good	Semi deep	Semi deep
	Moderate	Moderate to good	Low to Moderate	-	-
	Mostly moderate	Moderate to good	-	-	-
Structure	Good	Granulating fine to moderate, a bit Gravel, Evoluted	Granulating fine to moderate, none Gravel, Evoluted, low erosion	Perfect evolution	Slight erosion to Granulating Moderate and Perfect evolution
	Good to moderate	Granulating fine to moderate, by Gravel, Evoluted	Granulating fine to moderate, none Gravel, Evoluted, low to moderate erosion	moderate evolution	moderate erosion to Granulating Fine, Coarse and moderate evolution

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Indicators	Class	Forestry (classes 1-4)	Agriculture & range management (classes 1-4)	Ecotourism (intensive) (classes 1-2)	Development (classes 1-2)
	Moderate	Granulating fine to moderate, by Gravel, Evoluted	Granulating moderate to coarse, by Gravel, moderate Evolution, moderate erosion		
	Mostly moderate	Granulating fine to moderate, by Rubble, low to moderate Evolution	-	-	-
Fertility	Good	perfect	perfect	Good, Moderate	Good,
	Good to Moderate	Good	Good	Low	Moderate
	Moderate	Moderate to good	Moderate	-	-
	Mostly moderate	Low to Moderate	-	-	-

B) Indicators related to climate, vegetation, and water criteria

Indicators	Class	Forestry (classes 1-4)	Agriculture & range management (classes 1-4)	Ecotourism (intensive) (classes 1-2)	Development (classes 1-2)
Climate and Precipitation (mm)	Good	>800	Warm & moderate (Mediterranean to humid)	-	501-800
	Good to Moderate	>800	Warm & moderate & cold (Semi-arid to humid)		51-500, >800

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Indicators	Class	Forestry (classes 1-4)	Agriculture & range management (classes 1-4)	Ecotourism (intensive) (classes 1-2)	Development (classes 1-2)
	Moderate	>500	Warm & moderate & cold & very cold) Arid to humid		-
	Mostly moderate	>500	-		-
Temperature (∘C)	Good	18-21	-	21-24[1]	18.1-24
	Good to Moderate	18-21		18-21, 24-30	24.1-30, <18
	Moderate	<18, 18-30		-	-
	Mostly moderate	<18, 18-30		-	-
Sunny days[2]	Good to Moderate	-	-	>15	-
	Moderate			7-15	
Relative humid (%)	Good to moderate	-	-	-	40.1-70
	Moderate				<40, 70-80
Canopy Cover (%)	Good	>80	-	Forest lands (with canopy cover of >50%)	0-25
	Good to moderate	60-80		Forest lands (with canopy cover of 5-50%)	26-50
	Moderate	50-70		-	-
	Mostly moderate	40-60		-	-

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[1] in spring & summer seasons
[2] in spring & summer seasons

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Indicators	Class	Forestry (classes 1-4)	Agriculture & range management (classes 1-4)	Ecotourism (intensive) (classes 1-2)	Development (classes 1-2)
Annual Growth (m^3)	Good	>6	-	-	-
	Good to Moderate	>6			
	Moderate	>5			
	Mostly moderate	>4			
Quantity of water for everyone (Lit/day)	Good	-	6000-10000[3]	>40	<225
	Good to Moderate		4000-6000	12-39.9	150-225
	Moderate		3000-5000	-	-
	Mostly moderate		To 3000	-	-

[3] in m^3/ha

Table 2: The questionnaire sample distributed among experts

		LAND USE						
		Development	Ecotourism	Conservation	Rainfed farming	Rangeland	Forest	Irrigated farming
SCENARIO	Scenario b							
	Scenario c							
	Scenario d							

In the next step, after producing ecological capability maps, the land use map was prepared. To prioritize the different land uses (step II), the model consists of four scenarios in each land unit including: a) present land utilization of the study area, b) economic needs of the study area, c) social needs of the study area and d) ecological needs of the study area. The first scenario to make its ranking was evaluated using current land use. But for the other scenarios (b, c, and d) a questionnaire was prepared to ask experts of the study area to rank different land uses for each scenario based on their knowledge and experience from the study area. Questionnaire filling is a good method especially for finding socio-economic needs of an area that depend on many things like: socio-political characteristics, population composition, relative earning conditions, immigration condition, present land utilization, agriculture and animal husbandry conditions, hygiene, health, education, and other public services. The above socio-economic information helped the experts to rank the utilizations in economic and social scenarios (Fallahshamsi 2004, Hamzeh et al. 2014). The questionnaire sample distributed among experts is shown in Table 2.

It should be noted that 70 experts were identified from related organizations for different land uses (e.g., urban, agricultural offices, etc.) and based accessibility to them. The questionnaire was sent to 70 experts and 63 responses were received and used in the analysis. The average of the results helped us to rank different land uses for each scenario.

So, all land uses are ranked for each scenario and then scored from 10 to lower based on their ranks and ecological capability (the lowest score is 4). For example, if in one scenario, rank of forestry is third place and its ecological capability is class two in a land unit; its score in first step is given 8 and then one score is lowered for its capability reduction (class two) that makes its score number 7 for forestry in the land unit. It should say that this one-point reduction for forestry in three other scenarios is repeated because of one place of reduction compared to first class of ecological capability. If ecological capability class is class three, the reduction in each scenario would be two.

To achieve a systematic analytical model, all maps' layers are in vector format in the ArcGIS software environment. These maps were operated using ArcGIS 9.3 and the appropriate utilization of each land unit was determined and prioritized. The appropriate utilizations are those that have higher sum of scores among used scenarios. Many of the units were seen fit fortwo appropriate uses. Hence, selection for the best utilization of the area is based on socio-economic status of the area and consistency of land uses and current land use, too.

The important modifications in this paper are explained below:

Land capability evaluation: In the process of work, environmental units were not prepared (such as the Iranian ecological evaluation model). In this research, current method of systemic analysis for preparation of environmental units was not utilized for assessing the ecological capability maps and land use planning of quantitative model. It may be used only for assessing the small areas with low diversity (e.g., small watershed). Hence, for assessing the larger areas (e.g., large watersheds, counties, and provinces), preparation of environmental units eliminates a lot of information used in the ecological capability models. So, in the present study all indicator maps related to different ecological capability models were overlaid in GIS.

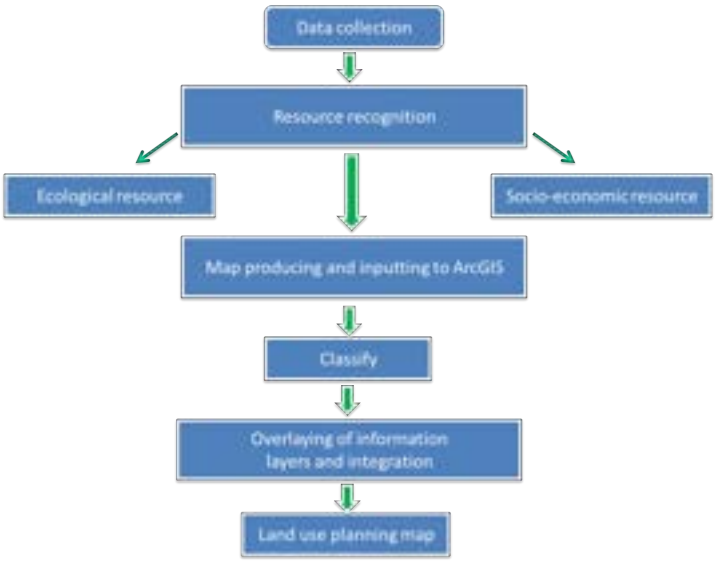


Figure 2: Process of evaluation

Land use prioritizing: Other modifications in the process of work done for assessing the land use planning model included:

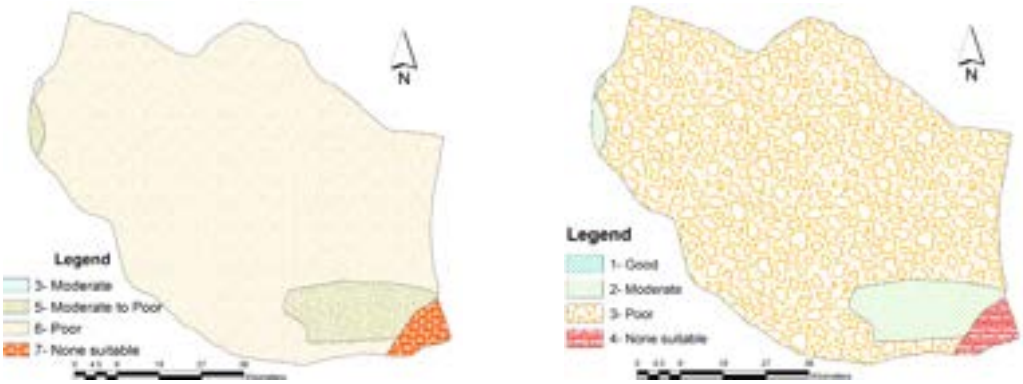
1. Prioritization of each use was based on the highest score derived after summing the scenarios' scores (ecological, economic, social, and area) (Makhdoom 2001). Also, it was considered suitable capability for the use with highest score, for example if in a land unit development has highest score among other land uses but its capability class is unsuitable we don't select it as priority in the land use planning process (this point does not appear in Iranian ecological evaluation method).
2. Using current land-use map in assessment mainly due to the socio-economic compulsions of the population especially in rural area. Also, we hold the following land utilizations in the end of land-use planning process:
   (a) Irrigated lands with suitable capability.
   (b) Settlement lands (urban, rural, and industrial area).
   (c) The Forest lands with canopy cover of more than 25% and those with conservational role.
   (d) Lake and river bed.

Finally, land use planning maps of the Zarrin Dasht County were developed considering the ecological and socio-economic characteristics of the area. Process for evaluation included the following steps presented in Figure 2.

3 Results and Discussion

In this study for each model the related indicators were overlaid. Then land capability maps were accessed. The capability maps are shown in Figures 3 to 5 and percent of area for different ecological capabilities of land uses is observed in Table 3.

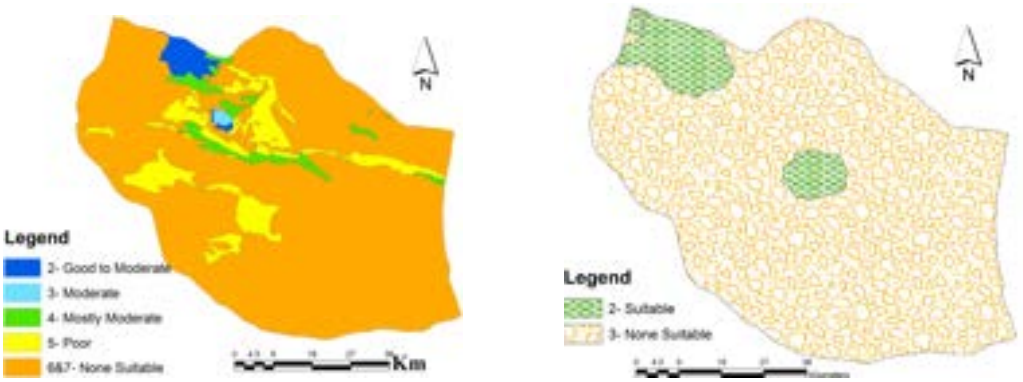
Table 3 shows percent of area for different ecological capability classes of land uses. For agriculture use, minimum and maximum areas are related to class 3 (0.16%) and class 6 (91%) respectively. For Range management & dry farming uses, minimum and maximum areas are related to class 1 (0.09%) and class 3 (90.61%) respectively. For forest use, minimum and maximum areas are related to class 3 (0.45%) and class 7 (58%) respectively. For Conservation use, minimum and maximum areas are related to class 2 (8%) and class 3 (92%) respectively. For ecotourism use, the whole area is in class 3. For



(a) Land capability classification map for irrigation agriculture

(b) Land capability classification map for range management and dry farming

Figure 3: Land capability classification maps



(a) Land capability classification map for forest

(b) Land capability classification map for environmental conservation

Figure 4: Land capability classification maps

development use, minimum and maximum areas are related to class 2 (10.53%) and class 3 (89.47%) respectively.

Also, results of uses ranking are seen below:

Area scenario: Irrigated farming > Range > Rainfed farming > Development > Forest > Ecotourism > Conservation.

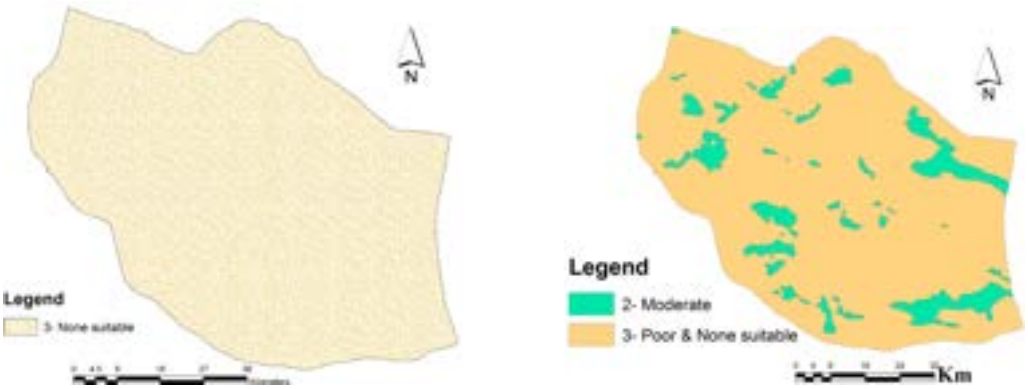
Ecological scenario: Conservation > Irrigated farming > Rainfed farming > Development > Range > Ecotourism > Forest.

Economic scenario: Development > Irrigated farming > Rainfed farming > Conservation > Range > Ecotourism > Forest.

Social scenario: Development > Irrigated farming > Conservation > Rainfed farming > Range > Ecotourism > Forest.

Table 4 also shows sum of scores for different land uses based on capability classes and quantitative method with 4 scenarios in the study area. As can be seen, agriculture and development are more important (higher scores) than other uses in study area based on sum of scores in 4 scenarios method.

The land capability maps were then overlaid and land use planning map was assessed (Figure 6) by a quantitative approach. Table 5 also shows percentage of area in current land use and proposed land use maps. The main results of this comparison indicate that



(a) Land capability classification map for ecotourism (intensive)

(b) Land capability classification map for urban, rural and industrial development

Figure 5: Land capability classification maps

current area is more than proposed area for irrigated and range management and it is showing these land uses are located more than their capabilities in the study area. While current area is less than proposed area for urban, rural, and industrial development, rainfed and environmental conservation showing these land uses are located less than their capabilities in the study area. Also Figure 6 and Table 5 show the maximum area of proposed uses is 78.31% related to rainfed agriculture showing this land use has high potential and socio-economic demands in the study area. While minimum area of proposed uses is related to forest and ecotourism.

Figure 6: Land use planning map

Therefore, proposed model has higher functionality for land use planning. The Iranian ecological evaluation model and the current modified Iranian ecological evaluation model also were evaluated in Firuzabad, Shiraz and Darab Townships in southern Iran (Asadifard 2015, Masoudi, Jokar 2015, Masoudi et al. 2017); after validation of two models, results showed that the modified model has higher accuracy for land use planning in these regions. Lack of elementary classes in each model (e.g., class 1 in the model of urban development) is caused by the strict method of Boolean logic. The use of the Boolean logic theory to land evaluation methods has been criticized by many authors (Burrough et al. 1992, Davidson et al. 1994, Baja et al. 2002, Masoudi 2018). In the classic methods like the FAO model for land evaluation (FAO 1976) using maximum limitation, makes the classification quite strict. Because, in Boolean logic, only one index with lower effect is enough to reduce the suitability of lands from highly suitable classes to not suitable classes.

Babaie Kafaky et al. (2009) showed that if the importance of the multiple-use of Zagros forests is not recognized in forest management, the forests will lose many of the recreational, natural ecosystem characteristics and countless values.

Table 3: Percent of area for different ecological capabilities of land uses

Land Type	class	Percent
Agriculture	3	0.16
	5	7
	6	91
	7	1.84
Range management and dry farming	1	0.09
	2	7.43
	3	90.61
	4	1.87
Forestry	2	1.75
	3	0.45
	4	3.8
	5	12
	6	24
	7	58
Conservation	2	8
	3	92
Ecotourism	3	100
Development of urban, rural and industry	2	10.53
	3	89.47

Table 4: Sum of scores for different land uses based on capability classes and 4 scenarios method

Capability Land use	1	2	3	4	5	6	7
Forest	-	14	10	6	2	-2	-6
Ecotourism	-	-	12	-	-	-	-
Development	-	30	26	-	-	-	-
Irrigated farming	-	-	29	-	21	19	13
Range	27	23	19	15	-	-	-
Rainfed farming	31	27	23	19	-	-	-
Conservation	-	25	21	-	-	-	-

Amiri et al. (2010) utilized two methods for assessing the ecological capability of forestry in Mazandaran Province. Their findings after using the conventional Boolean Model revealed that there are categories 3, 5, 6, and 7 of forest capability in the area. Our research is in good agreement with them, from a Boolean perspective.

4 Conclusion

Land evaluation based on physical resources and socio-economic resources is an essential prerequisite for rational land- use planning, which must be based on a knowledge of what land resources are available and what they are suitable for. Generally, it should be noted that current research implemented reforms in Iranian ecological evaluation model. In ecological capability evaluation part, classification of parameters was somewhat changed compared to the initial model in order to have a higher compatibility with the study area. Some modifications in the process of work were also done , such as no preparation of environmental units (as in the Iranian ecological evaluation model) and all indicator maps related to different ecological capability models were overlaid in GIS. Other modifications in the process of work done for assessing the land use planning model were prioritization

Table 5: Comparison of land percent in Current land use and proposed land use maps

Land Type	Percent of Current land use	Percent of Proposed land use
Forestry	0.03	-
Ecotourism	-	-
Urban, rural and industrial development	0.25	10.55
Irrigation agriculture	10.6	0.24
Range management	77.14	1.64
Rainfed agriculture	1.35	78.31
Environmental conservation	-	9.24
Saline land	5.75	0.02
Bare land	4.88	-

of each use was based on the highest score derived after summing the scenarios' scores (ecological, economic, social, area) with regard to suitable capability for the use with highest score (this point does not appear in Iranian ecological evaluation method). To use the current land-use map in assessment mainly due to the socio-economic compulsions of the population especially in rural area was another revision. Generally, the results of this study are suggested to managers and other stakeholders according to this land management study.

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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An introduction to pspatreg. A new R package for semiparametric spatial autoregressive analysis

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Abstract. This article introduces a new R package (*pspatreg*) for the estimation of semiparametric spatial autoregressive models. *pspatreg* fits penalized spline semiparametric spatial autoregressive models via Restricted Maximum Likelihood or Maximum Likelihood. These models are very flexible as they make it possible to simultaneously control for spatial dependence, nonlinearities in the functional form, and spatio-temporal heterogeneity. The package also allows to estimate parametric spatial autoregressive models for both cross-sectional and panel data (with fixed effects), thus avoiding the use of different libraries. The official demos, vignettes, and tutorials of the package are distributed either in CRAN or GitHub. This article illustrates the potentials of the package by applying it to cross-sectional data.

Key words: R package, Spatial dependence, Semiparametric models, Splines

1 Introduction

Modeling spatial and spatio-temporal data requires flexible econometric tools that allow us to control spatial and temporal dependence, spatial heterogeneity, non-linearities, and other possible model specification biases. When combined with standard parametric spatial econometric approaches, semiparametric regression models can provide an answer to this demand for flexibility. New computational methods developed within most modern statistical software (such as R) allow us to overcome all technical problems that arise in this process.

Several packages have recently been proposed to perform spatial econometrics in R (see Bivand et al. 2021, for a recent survey). Focusing on packages and methods dealing with polygonal (or areal) spatial data, the first package was *spdep* (Bivand et al. 2013, Bivand 2022). It was primarily designed for cross-sectional spatial data and to model spatial dependence through the Maximum Likelihood (ML) or the Generalized Method of Moments (GMM) estimation of the spatial lag model (SAR), the spatial error model (SEM), the spatial Durbin model (SDM), and the SARAR model. The estimation functions from *spdep* have recently been moved to the package *spatialreg* (Bivand et al. 2021). Other spatial econometric models for cross-sectional data have been implemented in other packages: *sphet* (Piras 2010) for estimating and testing spatial models with heteroskedastic innovations, *spfilteR* (Juhl 2021) for filtering out spatial dependence in linear models, *spgwr* (Bivand, Yu 2022) for estimating geographycally weighted regression

models, and *spsur* (Lopez et al. 2020) for estimating seemingly unrelated regression equations. Moreover, following several theoretical contributions to the literature on the estimation of static and dynamic spatial panel data models (see Elhorst 2014), other R packages for spatial econometric analysis have recently been developed. In particular, *splm* (Millo, Piras 2012) and *SDPDm* implement estimation methods for static and dynamic spatial panel data. All of these R packages focus on parametric methods (except *spgwr*, of course), leaving aside issues related to non-linearities in functional form and the estimation of spatio-temporal trends.

The main focus of this article is *pspatreg*, a new R package for spatial econometric analysis. *pspatreg* fits penalized spline (PS) semiparametric spatial autoregressive models via Restricted Maximum Likelihood (REML) and ML. This approach combines penalized regression spline methods[1] (Eilers et al. 2015) with standard spatial autoregressive models (such as SAR, SEM and SDM). These types of models (PS-SAR, PS-SEM and PS-SDM) are thoroughly discussed in Mínguez et al. (2020) (see also Montero et al. 2012, Basile et al. 2014, Hoshino 2018).

These models are very flexible as they make it possible to include within the same specification: *i*) spatial autoregressive terms (i.e. spatial lags of dependent and independent variables as well as spatial error terms) to capture spatial interaction or network effects; *ii*) time lags of the dependent variable to capture persistence effects; *iii*) parametric and nonparametric (smooth) terms to identify nonlinear relationships between the response variable and the covariates; *iv*) spatial and spatio-temporal trends, i.e. a smooth interaction between the spatial coordinates and the time trend, to capture site-specific nonlinear time trends.

The proposed method also allows the user to apply an ANOVA decomposition of the spatial or spatio-temporal trend into several components (spatial and temporal main effects, and second- and third-order interactions between them). This gives further insights into the dynamics of the data. Thus, we use the acronym PS-ANOVA-SAR (SEM, SDM, SLX) for the newly proposed data generating process (DGP). The use of nested B-spline bases for the interaction components of the spatio-temporal trend (Lee et al. 2013) contributes to the efficiency of the fitting procedure without compromising the goodness of fit of the model. Finally, we also consider an extension of the PS-ANOVA-SAR (SEM, SDM, SLX), including a first-order time series autoregressive term process (AR1) in the noise to accommodate residual serial correlation. Further extensions to include the time lag of the dependent variable (dynamic spatial model) will be considered in the future.

The next section (Section 2) describes the availability of *pspatreg* with documentation and examples. Section 3 presents a general specification of the semiparametric spatial autoregressive model. Section 4 shows an example of using *pspatreg* with cross-sectional spatial data. The last section presents a conclusion.

2 Documentation of *pspatreg*

The *pspatreg* package is available on both CRAN (https://cran.r-project.org/web/packages/pspatreg/index.html) and GitHub (https://github.com/rominsal/pspatreg) and can be installed in the usual way[2].

Once the package has been installed and loaded, an overview of the functionality of the package, including main functions, methods and databases, can be obtained executing the command `?pspatreg`.

The package includes three vignettes. The first one provides a brief description of the methodology used in the package. The second vignette gives a detailed example of modeling pure spatial data with semiparametric models and spatial lags using the well-

[1] P-splines are a flexible tool for smoothing. They are based on regressions with a large number of local basis functions (called B-splines). A penalty function based on differences between adjacent coefficients is also included in the maximum likelihood function to tune the smoothness of the estimated curve.

[2] You could install *pspatreg* from CRAN executing `install.packages("pspatreg")`. Usually the default options allow to install the package without any problems. Alternatively, to install from GitHub you could use *devtools* package. Once installed, execute the command `devtools::install_github("rominsal/pspatreg")` to install *pspatreg* package.

known *Ames* database included in package *AmesHousing* (Kuhn 2020). It also compares the results of *pspatreg* with the *spatialreg* package for parametric spatial regression models. Lastly, the third vignette provides some insights into spatio-temporal modeling using a panel database of unemployment in Italian provinces. First, this vignette compares the results of spatio-temporal parametric panels with the *splm* package, and then it shows the results of semiparametric spatio-temporal models. Plots of spatio-temporal trends are also included in these examples.

Of course, every function in the package includes reproducible examples. Those included in `pspatfit()`, `impactspar()`, `impactsnopar()`, `plot_sp2d()`, `plot_sp3d()`, and `plot_sptime()` functions are especially interesting. Furthermore, these examples can be also checked using the demos of the package, see `?demo(package = "pspatreg")` for details of the included demos.

3 The Semiparamentric Spatial Autoregressive Model

Let y_{it} be a sample of spatial panel data, where i is an index for the cross-sectional dimension (spatial units), with $i = 1, \ldots, N$, and t is an index for the time dimension (time periods), with $t = 1, \ldots, T$. The general model proposed is written as:

$$y_{it} = \rho \sum_{j=1}^{N} w_{ij,N} y_{jt} + \tilde{f}(s_{1i}, s_{2i}, \tau_t) + \sum_{\delta=1}^{k} g_\delta(x_{\delta_{it}}) + \epsilon_{it},$$

where (s_{1i}, s_{2i}) are the spatial coordinates (latitude and longitude) of individual i (when i refers to areal units: municipality, provinces, etc., the standard convention here is to identify representative points for areal units, the most typical being areal centroids), τ_t is the time period, and $x_{\delta_{it}}$ are independent variables; w_{ij} are the spatial weights, and ρ the spatial autoregressive parameter. The functions $g_\delta(.)$ are parametric or non-parametric smooth functions of the covariates $x_{\delta_{it}}$ (they can be linear, or can accommodate varying coefficient terms, smooth interaction between covariates, smooth by-factor curves, and so on), and $\tilde{f}(s_{1i}, s_{2i}, \tau_t)$ is an unknown non-parametric spatio-temporal trend. The idiosyncratic error term is assumed to follow an AR(1) process, i.e., $\epsilon_{it} = \phi \epsilon_{it-1} + u_{it}$ with $u_{it} \sim N(0, \sigma^2)$.

This semiparametric SAR model turns out to be extremely useful to capture interactive spatial and temporal unobserved heterogeneity when this heterogeneity is smoothly distributed over space and time (Mínguez et al. 2020). The dynamic extension (including y_{it-1} and $\sum_{j=1}^{N} w_{ij,N} y_{it-1}$) is also very promising and merits further theoretical investigation. Finally, the following semiparametric SAR model is very useful for modeling cross-setional spatial data taking into account non-linearities, spatial dependence, and spatial heterogeneity:

$$y_i = \rho \sum_{j=1}^{N} w_{ij,N} y_j + \sum_{\delta=1}^{\Delta} g_\delta(x_{\delta,i}) + \tilde{f}(s_{1i}, s_{2i}) + \epsilon_i$$

$$\epsilon_i \sim i.i.d.(0, \sigma_\epsilon^2).$$

3.1 The Anova Decomposition of the Spatio-temporal Trend

In many situations, the spatial or the spatio-temporal trend to be estimated can be complex, and the use of a single multidimensional smooth function may not be flexible enough to capture the structure in the data. To solve this problem, an ANOVA-type decomposition of $\tilde{f}(s_{1i}, s_{2i}, \tau_t)$ can be used, where spatial and temporal main effects, and second- and third-order interactions between them can be identified:

$$\begin{aligned} \tilde{f}(s_{1i}, s_{2i}, \tau_t) \quad = \quad & f_1(s_{1i}) + f_2(s_{2i}) + f_\tau(\tau_t) + f_{1,2}(s_{1i}, s_{2i}) + \\ & f_{1,\tau}(s_{1i}, \tau_t) + f_{2,\tau}(s_{2i}, \tau_t) + f_{1,2,\tau}(s_{1i}, s_{2i}, \tau_t) \end{aligned}$$

First, the geoadditive terms given by $f_1(s_{1i}), f_2(s_{2i}), f_{1,2}(s_{1i}, s_{2i})$ work as control functions to filter the spatial trend out of the residuals, and transfer it to the mean response in a model specification. Thus, they make it possible to capture the shape of the spatial distribution of y_{it}, conditional on the determinants included in the model. These control functions also isolate stochastic spatial dependence in the residuals, that is, spatially autocorrelated unobserved heterogeneity. Thus, the geoadditive terms can be regarded as an alternative to the use of individual regional dummies to capture unobserved heterogeneity, as long as such heterogeneity is smoothly distributed over space. Regional dummies peak at significantly higher and lower levels of the mean response variable. If these peaks are smoothly distributed over a two-dimensional surface (i.e., if unobserved heterogeneity is spatially autocorrelated), the smooth spatial trend is able to capture them. It is also worth noticing that, in a cross-sectional setting, the inclusion of a smooth spatial trend in the model specification is often the best way to control for unobserved spatial heterogeneity in the absence of degrees of freedom for the introduction of spatial fixed effects.

Second, the smooth time trend, $f_\tau(\tau_t)$, and the smooth interactions between space and time – $f_{1,\tau}(s_{1i}, \tau_t)$, $f_{2,\tau}, (s_{2i}, \tau_t)$, $f_{1,2,\tau}(s_{1i}, s_{2i}, \tau_t)$ – work as control functions to capture the heterogeneous effect of common shocks. Thus, conditional on a smooth distribution of the spatio-temporal heterogeneity, the PS-ANOVA-SAR (SDM, SEM, SLX) model works as an alternative to the models proposed by Bai, Li (2013), Shi, Lee (2018), Pesaran, Tosetti (2011), Bailey et al. (2016) and Vega, Elhorst (2016) which are extensions of common factor models to accommodate both strong cross-sectional dependence (through the estimation of the spatio-temporal trend) and weak cross-sectional dependence (through the estimation of spatial autoregressive parameters).

Furthermore, this framework is also flexible enough to control for the linear and non-linear functional relationships between the dependent variable and the covariates, as well as the heterogeneous effects of these regressors across space. The model inherits all the positive properties of penalized regression splines, such as coping with missing observations by appropriately weighting them and straightforward interpolation of the smooth functions.

3.2 Direct and Indirect (Spillover) Effects of Smooth Terms in the PS-SAR Model

In the case of a semiparametric model without the spatial lag of the dependent variable (PS model), if all regressors are independent of the errors, $\hat{g}_\delta(x_{\delta,it})$ can be interpreted as the conditional expectation of y given x_δ (net of the effect of the other regressors). Blundell, Powell (2003) use the term Average Structural Function (ASF) with reference to these functions. In contrast, in PS-SAR, PS-SDM or in PS-SARAR model, when ρ is different from zero, the estimated smooth functions cannot be interpreted as ASF. Taking advantage of the results obtained for parametric SAR, we can compute the total smooth effect (total–ASF) of x_δ as:

$$\hat{g}_\delta^T(x_\delta) = \Sigma_q \left[\mathbf{I}_n - \hat{\rho}\mathbf{W}_n\right]_{ij}^{-1} b_{\delta q}(x_\delta)\hat{\beta}_{\delta q},$$

where $b_{\delta q}(x_\delta)$ are the B-spline basis functions used to represent the smooth function, and $\hat{\beta}_{\delta q}$ the corresponding estimated parameters.

We can also compute direct and indirect (or spillover) effects of smooth terms in the PS-SAR case as:

$$\hat{g}_\delta^D(x_\delta) = \Sigma_q \left[\mathbf{I}_n - \hat{\rho}\mathbf{W}_n\right]_{ii}^{-1} b_{\delta q}(x_k)\hat{\beta}_{\delta q}$$

$$\hat{g}_\delta^I(x_\delta) = \hat{g}_\delta^T(x_\delta) - \hat{g}_\delta^D(x_\delta).$$

Similar expressions can be provided for the direct, indirect, and total effects of the PS-SDM.

4 Basic Information on *pspatreg*

We are now going to introduce some basic general information about the package. The main function in the *pspatreg* package is `pspatfit()`, which estimates spatio-temporal pernalized spline spatial regression models using either the REML method or the ML method. In its generic form, `pspatfit()` appears as:

```
pspatfit(formula, data, na.action, listw = NULL, type = "sim", method = "eigen",
    Durbin = NULL, zero.policy = NULL, interval = NULL,trs = NULL, cor = "none",
    dynamic = FALSE, control = list())
```

The function `pspatfit()` returns a list of objects of class `pspatreg`, including coefficients of the parametric terms and their standard errors, estimated coefficients corresponding to random effects in mixed model and their standard errors, equivalent degrees of freedom, residuals, fitted values, etc. A wide range of standard methods is also available for the `pspatreg` objects, including `print()`, `summary()`, `coef()`, `vcov()`, `anova()`, `fitted()`, `residuals()`, and `plot()`.

The argument `formula` within the function `pspatfit()` is formula similar to the GAM specification including parametric and non-parametric terms. Parametric covariates are included in the usual way. Non-parametric p-spline smooth terms are specified using `pspl(.)` and `pspt(.)` for the non-parametric covariates and spatial or spatio-temporal trends, respectively. For example:

[1]:
```
formula <- y ~ x1 + x2 + pspl(x3, nknots = 15) + pspl(x4, nknots = 20) +
  pspt(long, lat, year, nknots = c(18,18,8), psanova = TRUE,
       nest_sp1 = c(1, 2, 3),
       nest_sp2 = c(1, 2, 3),
       nest_time = c(1, 2, 2))
```

In the example above, the model includes two parametric terms, two non-parametric terms, and a spatio-temporal trend (with long and lat as spatial coordinates and year as temporal coordinate). The dimension of the basis function, both in `pspl(.)` and `pspt(.)`, is defined by `nknots`. This term should not be less than the dimension of the null space of the penalty for the term (see `null.space.dimension` and `choose.k` from package *mgcv* (Wood 2017) to know how to choose `nknots`). The default number of `nknots` in `pspl(.)` is 10 but, in this example, we have chosen 15 `nknots` for `g_1(x_3)` and 20 `nknots` for `g_2(x_4)`. The default number of `nknots` in `pspt(.)` is `c(10,10,5)`, but we have chosen `c(18,18,8)`.

In this example we also adopt an ANOVA decomposition of the spatio-temporal trend (choosing `psanova = TRUE`). Each effect has its own degree of smoothing which allows a greater flexibility for the spatio-temporal trend. Calculating up to third-order interactions can be computationally expensive. We can select subgroups of interaction effects for the second- and third-order effects to address this problem. We use three parameters available in `pspt()`: `nest_sp1`, `nest_sp2`, and `nest_time` to define these subgroups. These parameters indicate the divisors of the `nknots` parameters. For example, if we set `nest_sp1 = c(1,2,3)`, we will have all knots for the `s_1` effect, 18/2 for each second-order effects with `s_1`, and 18/3 nots for the third order effect with `s_1`[3].

We must set the parameters `f1_main`, `f2_main` or `ft_main` to `FALSE` (the default is `TRUE`) if we want to exclude any main effect. We can also exclude second- or third-order effects setting `f12_int`, `f1t_int`, `f2t_int`, `f12t_int` to `FALSE`.

Using the argument `Type`, we can choose different spatial model specifications: `"sar"`, `"sem"`, `"sdm"`, `"sdem"`, `"sarar"`, or `"slx"`. When creating a `"slx"`, `"sdem"`, or `"sdm"` model, we need to include the formula of the durbin part in the Durbin parameter.

The argument `data` must contain all the variables included in parametric and non-parametric terms of the model. If a `pspt(.)` term is included in `formula`, the data must contain the spatial and temporal coordinates specified in `pspt(.)`. In this case, the

[3] In most empirical cases, the main effects are more flexible than interaction effects and therefore the number of knots in B-Spline bases for interaction effects do not need to be as large as the number of knots for the main effects (Lee et al. 2013).

coordinates must be ordered choosing time as fast index and spatial coordinates as slow indexes.

Both `data.frame` and `sf` class objects can be used as `data` inputs[4]. `sf` objects are recommended since they allow the user to map spatial trends. We use two datasets in `sf` version for our demos.

Plotting the estimated non-parametric smooth terms represents an important step in semiparametric regression analyses. First, the function `fit_terms()` computes estimated non-parametric smooth terms. Then, the functions `plot_sp2d()` and `plot_sp3d()` are used to plot and map spatial and spatio-temporal trends, respectively, while `plot_sptime()` is used to plot the time trend for PS-ANOVA models in 3d. Finally, `plot_terms()` is used to plot smooth non-parametric terms.

The function `impactspar()` computes direct, indirect, and total impacts for continuous parametric covariates using the standard procedure for their computation (LeSage, Pace 2009).

The function `impactsnopar()` computes direct, indirect, and total impacts functions for continuous non-parametric covariates, while the function `plot_impactsnopar()` is used to plot these impacts' functions. It is worth noticing that total, direct, and indirect effects are never smooth over the domain of the variable x_δ due to the presence of the spatial multiplier matrix used in the algorithm for their computation. Indeed, a wiggly profile of direct, indirect, and total effects would appear even if the model was linear. Therefore, in the spirit of the semiparametric approach, we included the possibility of applying a spline smoother to obtain smooth curves (using the argument `smooth=TRUE` in the function `plot_impactsnopar()`).

5 Using *pspatreg* with Cross-sectional Spatial Data

Here, we present the use of *pspatreg* for spatial cross-sectional data (no time dimension involved). In particular, we use Italian province-level data for the estimation of the relationship between labor productivity growth and net internal migration. The standard neoclassical growth model can be specified, in its linear form, as follows:

$$\gamma_i = \alpha + \beta \ln y_{i,0} + \delta m_i + \tau \ln(n_i) + X_i^{'}\psi + \epsilon_i,$$

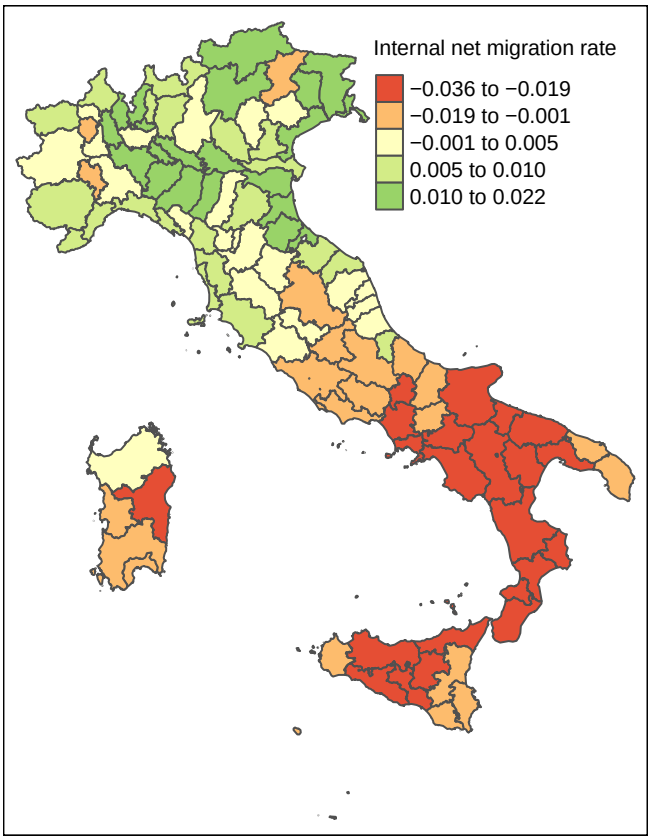
where $\gamma_i = (\ln y_{i,T} - \ln y_{i,0})/T$ is the average annual growth rate of labor productivity (measured as gross value added per worker) computed over T periods (our sample period goes from 2002 to 2018) for each province i (107 Italian provinces), $\ln y_{i,0}$ captures the initial conditions of each province (a negative value of β indicates conditional convergence), m_i is the average annual provincial internal net migration rate (computed as the difference between internal immigration and emigration flows of the working-age population, i.e. people aged 15-65, divided by the total working-age population), $\ln(n_i)$ is the average employment growth rate (the neoclassical growth model suggests a negative value of τ), X_i is a vector of variables controlling for other growth determinants such as physical and human investment rates, and ϵ_i is an identically and independently distributed error term.

Net population movements generally tend to be oriented towards prosperous areas which offer higher real income prospects. This is also true for the Italian case (see Figure 1), where all Southern provinces have negative net migration rates and all Northern provinces have positive rates.

According to the standard neoclassical framework, this pattern of migration should represent a mechanism for reducing spatial economic differentials. Labor migration from poor to rich areas lowers capital intensity (increases the return to capital) in the

[4] `sf` means simple features of spatial vector objects. The geographic vector data model is based on points located within a coordinate reference system (CRS). Points can represent self-standing features (e.g., the location of a house) or they can be linked together to form more complex geometries such as lines and polygons. Most point geometries contain only two dimensions `x` and `y` (3-dimensional CRSs contain an additional `z` value, typically representing height above sea level). `sf` objects provide both a *geometry* information, describing where on Earth the feature is located, and *attributes* information, describing other properties (like the population of the region, the unemployment rate, etc.). `data.frame` objects store only attributes information.

Figure 1: Internal net migration rate from 2002 to 2018 in Italian provinces



destination region and increases capital intensity (lowers the return to capital) in the region of origin. When the same technologies are used everywhere, migration speeds up per worker inter-regional convergence in capital intensity and labor productivity. Therefore, the neoclassical framework predicts a negative value of δ (i.e. net inward migration reduces labor productivity growth). However, alternative theories point to the importance of migrants' characteristics such as youthfulness, entrepreneurship, and skills that, together with their impact on aggregate demand, may have growth-enhancing effects. In terms of aggregate demand, regions losing population through migration may face economic contraction, whereas regions gaining population through migration may benefit from an expansionary effect on output, employment, and income. The transfer of human capital from one place to another is another critical aspect. In particular, skill-selective mobility may have deep effects on origin and destination places. All these alternative contributions predict a positive effect of net migration on growth (i.e. a positive value of δ). Moreover, the presence of a significantly positive effect of net migration is expected to decrease the estimate of β, the parameter associated to the initial conditions (i.e. it is expected to remove the positive omitted variable bias in estimates of β in regressions without the migration variable). Our empirical analysis confirms this intuition. Using our dataset and estimating the model with simple OLS, we actually find a positive effect of net migration on labor productivity growth, in line with several empirical studies:

[2]:
```
formlin_0 <- growth_PROD ~ lnPROD_0+lnoccgr
linear_0 <- lm(formlin_0, data = prod_it)
summary(linear_0, vcov = function(x) vcovHC(x, type = "HC1"))
```

[2]:
```
##
## Call:
## lm(formula = formlin_0, data = prod_it)
##
## Residuals:
```

```
##        Min         1Q     Median         3Q        Max
## -0.0085578 -0.0022181  0.0001756  0.0020764  0.0082702
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.036413   0.033147   1.099   0.2745
## lnPROD_0    -0.001892   0.003171  -0.596   0.5522
## lnoccgr     -0.153926   0.077535  -1.985   0.0498 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.003261 on 104 degrees of freedom
## Multiple R-squared:  0.0847, Adjusted R-squared:  0.0671
## F-statistic: 4.812 on 2 and 104 DF,  p-value: 0.01003
```

[3]:
```
beta_conv_0 <- as.numeric(-log(linear_0$coefficients[2]*16+1)/16)
beta_conv_0
```

[3]:
```
## [1] 0.00192075
```

[4]:
```
formlin <- growth_PROD ~ lnPROD_0+lnoccgr+net
linear <- lm(formlin, data = prod_it)
summary(linear, vcov = function(x) vcovHC(x, type = "HC1"))
```

[4]:
```
##
## Call:
## lm(formula = formlin, data = prod_it)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -0.0085734 -0.0019501 -0.0000671  0.0021081  0.0089063
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.131008   0.039651   3.304 0.001312 **
## lnPROD_0    -0.010650   0.003747  -2.842 0.005402 **
## lnoccgr     -0.153775   0.072837  -2.111 0.037173 *
## net          0.107752   0.027962   3.854 0.000203 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.003064 on 103 degrees of freedom
## Multiple R-squared:    0.2,  Adjusted R-squared:  0.1767
## F-statistic: 8.585 on 3 and 103 DF,  p-value: 3.854e-05
```

[5]:
```
beta_conv <- as.numeric(-log(linear$coefficients[2]*16 + 1)/16)
beta_conv
```

[5]:
```
## [1] 0.01167548
```

The results indicate a positive correlation between the growth rate of labor productivity and the net migration rate of working-age population. Nevertheless, this linear specification of the model is characterized by a number of potential mis-specification biases. First, there can be a reverse causality problem between migration and productivity growth, so that the net migration variable should be instrumented. A second source of endogeneity could be the presence of omitted variables (or unobserved heterogeneity) correlated with the observed covariates. Indeed, we do not control for human and physical capital accumulation rates in the estimation above, due to the lack of information on these variables at the province level in Italy. Additionally, we cannot exclude a correlation between these omitted terms and the coviarates introduced in the model. Third, substantive spatial dependence effects can emerge due to the network structure of Italian provinces, which are strongly connected via trade or other kinds of links. A wrong functional form (due to non-linearities) can represent a further source of model mis-specification. For the sake of simplicity, we disregard the reverse causality issue and focus on the other sources of bias (unobserved heterogeneity, spatial dependence, and nonlinearities) in what follows. In particular, we show that controlling for unobserved heterogeneity is a fundamental challenge in cross-sectional analysis (where we cannot include spatial fixed effects). Moreover, we

should also consider that spatial dependence may simply be the consequence of (spatially correlated) omitted variables rather than being the result of spillovers. If this is the case, there are no compelling reasons for using traditional parametric models, like the SAR or SEM. As McMillen (2012) shows, a simple semiparametric model, with a smooth interaction between latitude and longitude (the so-called Geoadditive Model), can remove unobserved heterogeneity.

5.1 The Parametric SAR Model

Following a step-by-step procedure, we first extend the linear classical model by including a spatial autoregressive term, i.e. by estimating a SAR model[5]:

$$\gamma_i = \alpha + \rho \sum_{j=1}^{N} w_{ij,N}\gamma_j + \beta \ln y_{i,0} + \delta m_i + \tau \ln(n_i) + \epsilon_i.$$

We estimate this model using the function `pspatfit()` of the package *pspatreg* and the function `impactspar()` to compute direct, indirect, and total marginal effects. The results show a significant spatial autoregressive parameter ρ of 0.365. The average direct effect of net migration (0.11) is similar to the coefficient estimated with OLS, but we also observe an indirect (spillover) impact of 0.06 and thus a total average effect of 0.17. The same results are obviously obtained using the package *spatialreg*.

[6]:
```
linsar <- pspatfit(formlin, data = prod_it,
                   listw = lwsp_it,
                   method = "eigen",
                   type = "sar")
```

[6]:
```
##
## Fitting Model...
##
##  Time to fit the model:  0.88 seconds
```

[7]:
```
summary(linsar)
```

[7]:
```
##
##  Call
## pspatfit(formula = formlin, data = prod_it, listw = lwsp_it,
##     type = "sar", method = "eigen")
##
##  Parametric Terms
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)  0.1310379  0.0368036  3.5605 0.0005640 ***
## lnPROD_0    -0.0111188  0.0034779 -3.1970 0.0018495 **
## lnoccgr     -0.1367972  0.0676062 -2.0234 0.0456430 *
## net          0.1087253  0.0259539  4.1892 5.961e-05 ***
## rho          0.3654309  0.0977673  3.7378 0.0003065 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Goodness-of-Fit
##
##  EDF Total:      5
##  Sigma: 0.00310498
##  AIC:  -1138.08
##  BIC:  -1124.72
```

[8]:
```
imp_parvar_sar <- impactspar(linsar, list_varpar)
summary(imp_parvar_sar)
```

[8]:
```
##
##  Total Parametric Impacts (sar)
##            Estimate Std. Error    t value Pr(>|t|)
## lnPROD_0 -0.0179094  0.0066196 -2.7055239   0.0068
```

[5] Preliminary diagnostic tests (using likelihood ratio statistics) work in favor of the SAR model, rather that the SDM and the SEM. Spatial autoregressive models are estimated using a standardized inverse distance W matrix combined with a binary minimum threshold distance matrix.

```
## lnoccgr  -0.2227227  0.1107963 -2.0101994   0.0444
## net       0.1767814  0.0510990  3.4595896   0.0005
##
##  Direct Parametric Impacts (sar)
##            Estimate Std. Error    t value Pr(>|t|)
## lnPROD_0 -0.0116030  0.0037606 -3.0854441   0.0020
## lnoccgr  -0.1450955  0.0691365 -2.0986808   0.0358
## net       0.1147453  0.0275071  4.1714852   0.0000
##
##  Indirect Parametric Impacts (sar)
##            Estimate Std. Error    t value Pr(>|t|)
## lnPROD_0 -0.0063064  0.0034608 -1.8222652   0.0684
## lnoccgr  -0.0776272  0.0493192 -1.5739763   0.1155
## net       0.0620361  0.0299719  2.0698063   0.0385
```

5.2 *Including the Spatial Trend*

As already mentioned, McMillen (2012) and McMillen (2003) stress the importance of considering whether apparent spatial dependence is in fact engendered by model mis-specifications, such as the erroneous inclusion or omission of covariates and the inappropriate functional form of included covariates. Therefore, we extend the SAR model by first including a smooth spatial trend (thus estimating a semiparametric geoadditive SAR model):

$$\gamma_i = \alpha + \rho \sum_{j=1}^{N} w_{ij,N}\gamma_j + \beta \ln y_{i,0} + \delta m_i + \tau \ln(n_i) + \tilde{f}(s_{1i}, s_{2i}) + \epsilon_i.$$

We use the function `pspt()` with 10 knots for each each variable (latitude and longitude of the centroid) to estimate the spatial trend. A model with a smooth spatial trend can also be estimated in `R` using alternative packages, such as *mgcv*. The novelty of *pspatreg* is to combine this model with the SAR or any other spatial model. The introduction of the spatial trend in the model has some relevant consequences on the parameters of the linear terms. First, the spatial lag parameter ρ decreases from 0.365 (estimated with the linear SAR) to 0.202. Therefore, there is a clear trade-off between controlling for unobserved heterogeneity and the extent of spatial spillover. Also, the parameter associated to the net migration variable diminishes from 0.109 to 0.072 and becomes less significant. This evidence suggests that omitted variables could have generated a bias in the estimates of both OLS linear and pure SAR linear models, which do not include any control for unobserved heterogeneity. Moreover, the marginal impacts do not reveal any more evidence of indirect (spatial spillover) effects of the covariates.

[9]:
```
formgeo <- growth_PROD ~ lnPROD_0+lnoccgr+ net +
  pspt(longitude,latitude, nknots = c(10, 10), psanova = FALSE)
geosar <- pspatfit(formgeo, data = prod_it,
                   listw = lwsp_it,
                   method = "eigen",
                   type = "sar")
```

[9]:
```
##
## Fitting Model...
##
##  Time to fit the model:  8.81 seconds
```

[10]:
```
summary(geosar)
```

[10]:
```
##
##  Call
## pspatfit(formula = formgeo, data = prod_it, listw = lwsp_it,
##     type = "sar", method = "eigen")
##
##  Parametric Terms
##               Estimate Std. Error t value  Pr(>|t|)
## (Intercept)  0.2169096  0.0473358  4.5824 1.430e-05 ***
## lnPROD_0    -0.0191931  0.0045088 -4.2568 4.958e-05 ***
## lnoccgr     -0.0451729  0.0761514 -0.5932   0.55449
## net          0.0727907  0.0415870  1.7503   0.08337 .
```

```
## Xspt.2      -0.0116569  0.0155548 -0.7494   0.45551
## Xspt.3       0.0119923  0.0174543  0.6871   0.49375
## Xspt.4      -0.0149656  0.0204262 -0.7327   0.46561
## rho          0.2017864  0.1127590  1.7895   0.07679 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Non-Parametric Spatio-Temporal Trend
##               EDF
## f(sp1, sp2) 6.228
##
##  Goodness-of-Fit
##
##  EDF Total: 14.2276
##  Sigma: 0.00271168
##  AIC:  -1122.71
##  BIC:  -1084.69
```

[11]:
```
list_varpar <- as.character(names(summary(geosar)$bfixed)[2:4])
eff_parvar <- impactspar(geosar, list_varpar)
summary(eff_parvar)
```

[11]:
```
##
##  Total Parametric Impacts (sar)
##            Estimate Std. Error    t value Pr(>|t|)
## lnPROD_0 -0.0246683  0.0069725 -3.5379541   0.0004
## lnoccgr  -0.0591070  0.0969102 -0.6099146   0.5419
## net       0.0938277  0.0555063  1.6903981   0.0910
##
##  Direct Parametric Impacts (sar)
##            Estimate Std. Error    t value Pr(>|t|)
## lnPROD_0 -0.0196565  0.0045438 -4.3259872   0.0000
## lnoccgr  -0.0478782  0.0766887 -0.6243182   0.5324
## net       0.0748585  0.0424452  1.7636519   0.0778
##
##  Indirect Parametric Impacts (sar)
##            Estimate Std. Error    t value Pr(>|t|)
## lnPROD_0 -0.0050118  0.0038085 -1.3159346   0.1882
## lnoccgr  -0.0112288  0.0240919 -0.4660817   0.6412
## net       0.0189692  0.0184880  1.0260276   0.3049
```

We can plot the estimated spatial trend using the function `plot_sp2d`.

[12]:
```
plot_sp2d(geosar, data = prod_it)
```

[12]:
```
For the output see Figure 2
```

5.3 *Including Other Univariate Smooth Terms*

As a last step in our empirical application, we extend the model by allowing the variables $lnPROD_0$ and *net* to enter smoothly as non-parametric terms. Specifically, we use the function `pspl` with 9 knots for each univariate term:

$$\gamma_i = \alpha + \rho \sum_{j=1}^{N} w_{ij,N}\gamma_j + g_1(\ln y_{i,0}) + g_2(m_i) + \tau \ln(n_i) + \tilde{f}(s_{1i}, s_{2i}) + \epsilon_i.$$

[13]:
```
formgam <- growth_PROD ~ pspl(lnPROD_0, nknots = 9)+
  lnoccgr+ pspl(net, nknots = 9)+
    pspt(longitude,latitude, nknots = c(10, 10), psanova = FALSE)

gamsar <- pspatfit(formgam, data = prod_it,
                   listw = lwsp_it,
                   method = "eigen",
                   type = "sar")
```

[13]:
```
##
## Fitting Model...
##
##  Time to fit the model:  8.76 seconds
```

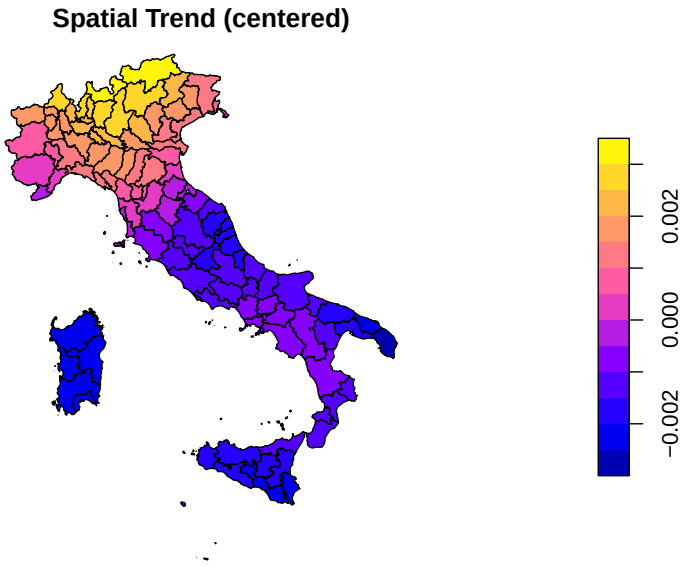


Figure 2: Output from codebox 12

[14]:
```
summary(gamsar)
```

[14]:
```
##
##  Call
## pspatfit(formula = formgam, data = prod_it, listw = lwsp_it,
##     type = "sar", method = "eigen")
##
##  Parametric Terms
##                                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)                   0.0108138  0.0021183  5.1050 1.754e-06 ***
## lnoccgr                      -0.0349342  0.0752188 -0.4644 0.6434249
## Xspt.2                       -0.0137355  0.0118824 -1.1560 0.2506681
## Xspt.3                        0.0172283  0.0137329  1.2545 0.2127989
## Xspt.4                       -0.0136286  0.0158405 -0.8604 0.3918063
## pspl(lnPROD_0, nknots = 9).1  0.0200607  0.0054356  3.6906 0.0003772 ***
## pspl(net, nknots = 9).1      -0.0052598  0.0031396 -1.6753 0.0972432 .
## rho                           0.1922019  0.1113342  1.7264 0.0876119 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Non-Parametric Terms
##                                EDF
## pspl(lnPROD_0, nknots = 9) 1.0295
## pspl(net, nknots = 9)      1.4016
##
##  Non-Parametric Spatio-Temporal Trend
##               EDF
## f(sp1, sp2) 3.769
##
##  Goodness-of-Fit
##
##  EDF Total: 14.2005
##  Sigma: 0.00268938
##  AIC:  -1126.26
##  BIC:  -1088.31
```

[15]:
```
list_varnopar <- c("lnPROD_0","net")
terms_nopar <- fit_terms(gamsar, list_varnopar)
plot_terms(terms_nopar, prod_it, alpha = 0.10)
```

[15]:
```
For the output see Figure 3
```

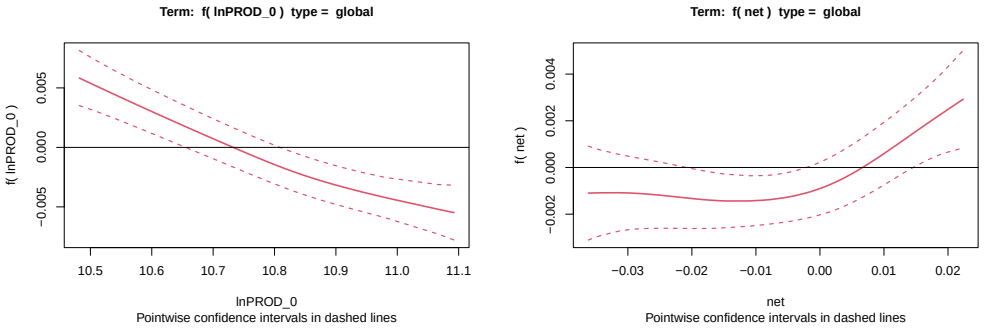


Figure 3: Ouput from codebox 15

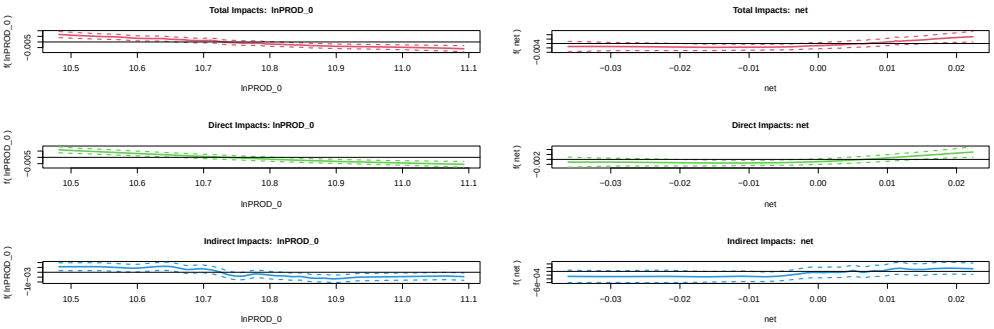


Figure 4: Output from codebox 16

Then, we compute the direct and indirect (or spillover) effects of the two smooth terms in the PS-SAR using the function `impactsnopar`:

[16]:
```
gamsar_impnopar <- impactsnopar(gamsar, listw = lwsp_it,
                                viewplot = FALSE,
                                smooth = FALSE, alpha = 0.1)
plot_impactsnopar(gamsar_impnopar, data = prod_it, smooth = TRUE)
```

[16]:
```
For the output see Figure 4
```

6 Conclusions

This article has highlighted several advantages of using a semiparametric approach over a purely parametric approach to space-time data modeling. Additionally, it has provided a brief introduction to a new `R` package (`psatreg`) that allows estimating this class of models.

The article has also demonstrated the use of this package by using spatial cross-sectional data. This simple application has illustrated the existence of a strong interference between the various problems of mis-specification that characterize the models for spatial data. Specifically, it highlighted the existence of a strong trade-off between spatial dependence and spatial heterogeneity. The inclusion of a spatial trend within a simple SAR model for cross-sectional data (where the lack of degrees of freedom prevents the inclusion of spatial fixed effects) has a strong impact on the magnitude of the spatial spillover parameter (ρ), as well on the magnitude of the other model parameters (β). Other important examples, also for spatio-temporal (i.e. panel) data, are provided by the vignettes included in the package.

We also recognize the existence of limitations of the semiparametric approach for dealing with spatio-temporal data proposed here. An obvious limitation is the difficulty of

these kinds of models to fit data that are characterized by a weak spatial pattern. In this case, while a fixed-effect approach (applied to spatial panel data) is capable of capturing spatial heterogeneity, the inclusion of a spatial trend surface on the r.h.s. of the model hardly captures the effects of omitted variables. However, we also observe that most of the standard economic and social variables show a relevant spatial trend.

We would also like to point out some practical problems associated with the implementation of Spatial Autoregressive Semiparametric Models. In particular, it is well known that nonparametric estimates may be spurious due to outliers, although in the case of penalized splines the effect of the extreme values is often mitigated. In practice, it might be necessary to trim extreme values at the edge of the data domain.

Regarding the problem of model selection, it seems preferable to simply compare the performance of the different models in terms of some Information Criterion. We do not yet provide a battery of diagnostic tests for Spatial Autoregressive Semiparametric Models like the Lagrange Multiplier tests widely used in the traditional parametric spatial econometric literature (LM-SEM,LM-SAR,LM-SARSAR). Indeed, the use and abuse of LM tests for the spatial autocorrelation of the residuals has been largely criticized, as it may lead to a mechanical selection process.

Finally, for future considerations, it is planned to include some functionalities in the package to allow the estimation and inference of spatio-temporal regression models with varying coefficients using P-spline metodology. These models can be seen as an alternative to the usual Geographically Weighted Regression (GWR) models.

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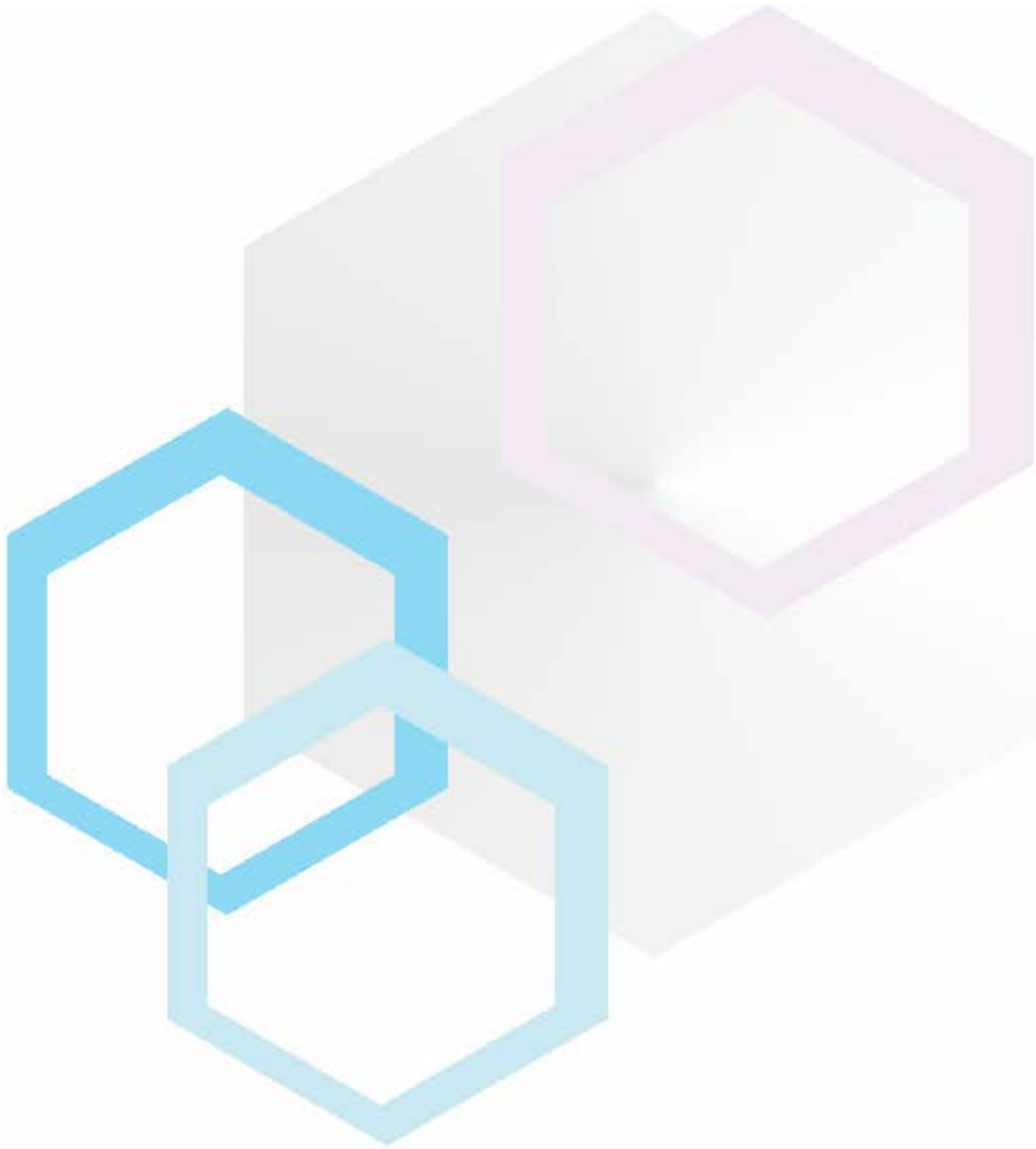

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