Università Politecnica delle Marche
Dipartimento di Scienze Economiche e Sociali

Depopulation in the Apennines in the 20th century: an empirical investigation

Riccardo Lucchetti Gabriele Morettini

QUADERNI DI RICERCA n. 463*

February 2022

(*) La numerazione progressiva continua dalla serie denominata "Quaderni di ricerca — Dipartimento di economia"

Comitato scientifico:

Giulia Bettin
Marco Gallegati
Stefano Staffolani
Alessandro Sterlacchini

Collana curata da Massimo Tamberi

ISSN: 2279-9575

Abstract

We propose an empirical investigation of the population dynamics between 1931 and 2011 in a mountain area in central Italy. The main novelty of our work is the usage of sub-municipal data, which makes it possible to disentangle several drivers of the overall depopulation trend. All these factors had been considered previously by separate strands of literature, but never jointly, as we do.

One of our most interesting results is that different factors operate in different historical periods. Therefore, we use a flexible statistical strategy by which we divide the sample in four different 20-year spans and adopt a different statistical model for each. Another notable result is that an appropriate quantitative description of the phenomenon must take into account the disappearance of inhabited centres separately from their size in terms on inhabitants.

In order to implement "place-based" policies in remote mountain areas, the most meaningful unit to consider as the foundation of social interactions is sub-municipal. Moreover, the concept of community is crucial for a systematic understanding of population change and related policy actions.

JEL Class.: N34, N94, N54

Indirizzo: Università Politecnica delle Marche

Depopulation in the Apennines in the 20^{th} century: an empirical investigation

Riccardo Lucchetti *Gabriele Morettini*

1 Introduction

In recent years, the question of shrinking areas has received growing interest among scholars and policymakers since many developed countries have witnessed population decline (Matanle and Rausch, 2011; Coleman and Rowthorn, 2011; Bontje et al., 2012; Rodríguez-Soler et al., 2020). The decrease in the number and size of settlements was acutely experienced in rural areas of America (Johnson and Lichter, 2019), Australia (McManus et al., 2012), central and eastern Europe (Madjevikj et al., 2016; Mladenov and Ilieva, 2012; Kohler et al., 2017), and Mediterranean regions (Pinilla et al., 2008; García-Ruiz et al., 2020).

Permanent depopulation of large areas is usually considered the unavoidable and often neglected consequence of a global scenario marked by rushing agglomeration economies, massive migratory flows, sectoral economic shifts and sudden crises, which exacerbate the vulnerabilities of marginal contexts (Elshof et al., 2014; Haddaway et al., 2013). The structural decay of peripheral settings has been amplified by major shocks as the Great Recession, natural disasters and the recent Covid-19 pandemic. Adverse events mark significant turning points in development trajectories since they broaden territorial gaps (Fratesi and Perucca, 2018) and accelerate demographic ageing (Reynaud and Miccoli, 2019).

Population decrease is sometimes considered a self-reinforcing process (Myrdal and Sitohang, 1957; Elshof et al., 2014), that can trigger a downward spiral characterised by the loss of economic functions (Leetmaa et al., 2015), the cut of public and commercial services (Rizzo, 2016), and more housing vacancies (Franklin and van Leeuwen, 2018). Beyond a critical threshold these intertwined processes become irreversible and may lead to territorial abandonment, fraught with dramatic social and environmental implications, as already occurred in the US Great Plains, where "many small towns are emptying and ageing at an all-time high rate, and some are dying" (Popper and Popper, 1987, p. 14). This unprecedented large-scale desertion is a key social issue for the twenty-first century (Reher, 2007) when demographic projections boost concerns about the future of an increasingly polarised Europe, between crowded cities and wide inhabited lands.

Despite this, the shrinkage in rural areas is still unclear and under-investigated (Milbourne, 2007). Scholars call for a holistic, cross-disciplinary and innovative research path able to grasp dynamics, interdependencies and feedback of complex processes (Franklin and van Leeuwen, 2018).

First, it is necessary to clarify the meaning of depopulation (Sousa and Pinho, 2015); this term is generally associated with decrease in the number of inhabitants, but this indicator masks the nature and the drivers of a multifaceted process: population reduction may result either from prolonged out-migration or from chronic natural decrease induced by low fertility and population ageing (Bucher and Mai, 2005; Johnson and Lichter, 2019).

Depopulation also calls for place- and time-specific research (Sánchez-Zamora et al., 2014). Greater attention must be placed on the selection of an appropriate spatial unit able to measure the size, dynamics and the pace of the shrinkage (Franklin and van Leeuwen, 2018). The village is the framework in which policies are effectively implemented and where people forge shared memories and a collective identity (Banini et al., 2017), and therefore provides a valid point of view to observe a prolonged demographic decline still rarely explored at detailed scale for large regions (Reynaud and Miccoli, 2019). The village is the basis of upland settlement: it is an independent cell and a source of belonging (Di Méo, 1991). A further shortcoming in previous studies is the scant attention that has been given to the temporal profile of depopulation. The scarcity of longitudinal data and the change in local boundaries over time have steered research towards short-term analysis which, however, can not comprehensively reconstruct the dynamics underlying the shrinking and peripheralisation processes (Kühn, 2015).

Under these premises, this article provides a theoretical framework for unravelling the complexity of population trends. We systematically examine a large sub-municipal dataset in order to determine the extents, stages and drivers of a long-period shrinkage in the remote mountain contexts. The adoption of different metrics allows for a comprehensive quantification of depopulation patterns, both at municipal and sub-municipal level. This descriptive part is complemented by a micro-founded empirical inquiry aimed to explore the heterogeneous drivers (geophysical, socioeconomic, demographic) of population changes in the period going from 1931 to 2011. The study area is the Italian Apennines hit by the earthquakes of 2016-17, which is a paradigmatic case of slow-burn changes (Pike et al., 2010) due to a demographic and economic decay run since the 1950s (Compagnucci and Morettini, 2020). Identification of determinants of population change should stimulate the design of place-specific policies to face sharp shrinkage in mountainous settings.

The paper contributes in several ways to the literature on the rural decline in advanced countries (Li et al., 2019; Isserman et al., 2009; Chi and

Ventura, 2011; Sánchez-Zamora et al., 2014; Sørensen, 2018). Firstly, it incorporates different statistical sources in a large, consistent, original dataset aimed to disentangle the complexities (in the forms, causes, scales, time) of population change. Such a holistic approach is fundamental in order to identify the multiple determinants of spatially and temporally uneven shrinkage processes.

Second, the paper provides systematic quantitative insights of the demographic evolution in the period 1931–2011 for a set of 1016 villages.Very few studies have ventured into the sub-municipal scale (Sørensen, 2018), since available data are often heterogeneous, sparse and unreliable (Mladenov and Ilieva, 2012). It thereby fills the gap between the detailed but fragmentary knowledge of qualitative surveys and the blurred view of regional statistics, which may hide territorial dynamics and overlook local peculiarities (Milbourne, 2007). The method proposed can spur other empirical, longitudinal studies at local scale, hindered by challenging measurement obstacles, boundary changes and lack of available data (Di Figlia, 2016).

The paper contains six sections. The next one explores the main issues debated in the related literature. The empirical analysis is organised into stages. First, we present the data and assess depopulation through two different metrics (3); then we run a set of regression models to explore the drivers of population changes at different time stages (4). Section 5 discusses the main empirical results while last section (6) provides a conclusion.

2 Literature review

Industrialisation and urbanisation processes have brought about population shrinkage in peripheral spaces in the US, eastern Asia and Europe (see *eg* Johnson and Lichter, 2019). In France (Mathieu, 2000) and the United Kingdom (Saville, 1957) depopulation began at the end of the 19^{th} century whereas in southern Europe (Collantes, 2009) massive emigration from rural areas has risen since the second half of the 20^{th} century. This structural decline has now reached dramatic dimensions (Delgado Viñas, 2019; Haddaway et al., 2013) and several areas are in danger of demographic desertification.

Such concerns are particularly relevant in Italy, which is characterised by both scattered settlements and large, deep-rooted regional disparities. The issue of territorial imbalances was stifled for a long time by the "southern question" (Felice, 2015), although some have made important distinctions; for example, the INEA report of 1938, describing the harsh living standard in the mountains or Rossi Doria (1958), who focused on the differences between "pulp and bone". The demographic decline was a matter of "the mountain and the plain" rather than of the North-South divide, claimed as early as 1902 by Luchino Dal Verme, a member of the Italian Parliament. The shrinkage of the uplands goes back to the end of nineteenth century (Bonelli, 1967) but it increased its pace and magnitude with the industrialisation occurred during the so-called Italy's "economic miracle". Since the 1950s the Apennines were particularly exposed to a demographic decrease that was fast, virulent and widespread (Tino, 2002). In the early 21^{th} century, Italy became a laboratory to design original policies, as "National Strategy for Inner Areas" (NSIA) (Barca et al., 2014), aimed at tackling the widespread and apparently unavoidable depopulation of peripheral settings.

Several scholars call for innovative theoretical and methodological approaches to unravel the complexity of population change (Milbourne, 2007). The first misunderstanding arises from the use of the number of inhabitants as the main (often the only) indicator of shrinkage that, instead, also entails a structural crisis of settlement patterns (Sousa and Pinho, 2015). INEA already observed in the 1930s that population reduction deserves "the more comprehensive and appropriate name of demographic crisis" (INEA, 1938, p. 4) whereas the term "depopulation" refers to the spatial events, such as land or hamlet abandonment, thus revealing the pathological characters of the exodus from the uplands (INEA, 1938, p. 4). Those issues are not always correlated, so there might be demographic reduction without depopulation or vice versa (INEA, 1938, p. 144). However, few studies jointly consider the twofold nature of shrinkage.

Previous literature also failed to grasp the interplay of various drivers of shrinkage (Wang et al., 2020). The adoption of a specific disciplinary perspective may steer the analysis of rural settlements in a specific direction, while in fact they evolve under the influence of inter-related economic, social, demographic, historical, political, and ethnographic elements. A holistic view of population change thus requires a multidimensional approach (Chi and Ventura, 2011).

Moreover, a diachronic overview is necessary to describe different population dynamics and the underlying drivers, that may be changing over time (McManus et al., 2012). The longitudinal perspective blends the local level with broader socio-economic changes: except for sudden and catastrophic events, village abandonment has been a gradual process, either in ancient times (Beresford et al., 1979) and in the present age (Di Figlia, 2016). For the study of the Apennines the understanding of its specific settlement model, dating back to the 13th century (Wickham et al., 1988), is crucial. In spite of this, most of the research has not adopted a long-term view, mainly because of data scarcity (Milbourne, 2007) and the ingrained (as much as unwarranted) assumption that uplands "have no history" (Braudel, 1966, p. 186).

An additional key methodological step is the choice of the appropriate spatial unit, so as to disentangle population dynamics generated by factors operating at different scales (Franklin and van Leeuwen, 2018). Data at the national or regional level may hide the true extent of depopulation in peripheral areas, characterised by extremely unequal local patterns (Delgado Viñas, 2019). The literature has seldom focused on the local level, which more properly approximates the scattered settlements of mountain settings (Collantes and Pinilla, 2004), marked by small villages endowed with their own patrimonial, religious and political identity (Gobbi, 2004). These hamlets and the municipal seat are separated by a few kilometres but also by a centuries-long delay in lifestyle: in some cases the time seems to "stand still in the Middle Ages or in the eve of Hesiod or Virgil" (Desplanques, 1969).

Nevertheless, very few studies have ventured beyond the municipal level. Scholars have been complaining for a long time about "the absence of systematic investigation on villages, despite it would be very interesting" (INEA, 1938). According to municipal figures, during the first half of the 20th century Italian mountains accommodated the population growth that had started in the previous century (Sori, 2004), but the way population has changed over the dense network of village, hamlets and communities remains unclear: these secondary centres are often located in remote places, whose decay is offset by the demographic increase of the municipal seat or other villages at the valley floor (INEA, 1938). Municipal indicators tend to overlook short-distance re-locations (Stockdale, 2016), despite these account for most of the mobility in rural settings (Walford, 2007). A similar trend has also been observed for South Australia in Smailes et al. (2002).

The major obstacle is the lack of sub-municipal statistics. Although the population census collects official, detailed, reliable and standardised information for small units, it has substantial shortcomings when investigating population change. A plausible local unit might be the fraction[1], with data available since 1871, but a consistent time series cannot be constructed because of the frequent and considerable re-drawing of boundaries (Walford, 2001; Han et al., 2016). Often, a fraction comprises other inhabited localities, plagued by the same inter-census discontinuity.

Among these, the "inhabited centre" provides an adequate meaningful spatial unit for long-term analysis in many aspects. The concept of an inhabited centre was defined in 1931 by ISTAT as "an aggregate of contiguous or close dwellings... characterised by the availability of facilities or public places (i.e. church, school, railway station, public office, drug-store, shop, public market....) that identify a gathering place, also for residents in nearby places, and where a shape of social life emerges, coordinated by the same centre" (ISTAT, 1958, p. 26). Such definition leaves out groups of houses without public services (therefore without interactions among peo-

[1]Fractions are partitions of municipal territory which are identified according to the gravitation of inhabitants of some places on the neighbouring villages (ISTAT 1958, 22).

ple) but also railway stations, churches, shops spread in the countryside or on the road, because of the absence of an aggregated social life. Population size is a relevant but not exclusive determinant for the identification of the inhabited centre; the distinctive feature is the existence of a gathering place where a local community of people meets.

In our view, the inhabited centre properly captures a relational space that embraces productive relations and social interactions, of both material and symbolic dimensions (Di Méo, 1991). The usage of social interactions to define the boundaries of the geographical unit (McManus et al., 2012) combines topographical with topological metrics (Sánchez-Zamora et al., 2014). Space is characterised by morphological, historical and social parameters not always perfectly overlapping; such dyscrasia is solved by the concept of community, that may depict past and present identities, significant relations erased or still existing. Settlements have a spatial location but they are also a social construction (Pecqueur, 2001), fostered by interactions between people (Liepins, 2000; Teti, 2004) who share resources and ideas through trade, rituals and political practices (Gustafson, 2001).

The inhabited centre also perfectly suits the case of the Apennines, which exhibit a crystallisation of settlements (Quaini, 1973) due to the persistence of collective properties, remoteness from urban areas, and agriculture-based production systems. Municipalities are organised in dense networks of small villages that manage local resources in order to fulfil environmental constraints and to preserve social, economic and demographic balance. "In the traditional society, membership is often organised around an economic, social, religious place in contrast with another place, sometimes distant several hundred metres" (Teti, 2004, p. 41). Here the meeting point always coincides with the parish church, the centrepiece of the local community: this is where parish records are kept and where a sparse population gathers every Sunday. The bell tower is the centre of the village and fosters a sense of belonging (Le Bras and Le Bras-Folain, 1976, p. 37). The inhabited centre is therefore a dynamic concept that allows to observe the "continuous reset of the territory" (Teti, 2017, p. 193) and that can change over time by incorporating new areas, downgrading or vanishing due to the desertion or absorption of other settlements. Such variations shall not prejudice the study of local settlements, that involve melting and abandonment processes. The loss of status of inhabited centre does not imply the complete abandonment of the village, in any case very rare (McLeman, 2011), but it is a sign of outbreak of a social environment; conversely, an extension of the centre implies a widening of the community space.

That said, the village remains a suitable unit of investigation when making broad comparisons (Braudel, 1985), but research has so far focused only on a small number of cases, limited in scale and devoid of an organic view of the territory. The complexity of the depopulation process can be understood by incorporating the local dimension within large, quantitative datasets. The method proposed here pursues a detailed and systematic insight of the settlement patterns in the selected area. As we will explain in detail in section 4, we adopt a twofold metric for a more comprehensive assessment of population decline which occurs at multiple spatial-scale levels (Bontje et al., 2012) but has not been investigated empirically yet.

3 Case Study

Figure 1: The study area

The study area is located in central Italy (Figure 1), in the mountain municipalities[2] included in the so-called "seismic crater" of the 2016-17 earthquakes (the portion most affected by seismic events). The sample includes inner areas which are far from urban centres and geographically dominated by sparsely populated uplands, with just over 27 inhabitants per square kilometre (in 2011). Morphological constraints, harsh climate, scarcity of fertile soil and poor communication infrastructure are among the ingredients that have generated structural decay, chronic shrinkage and ageing in these territories. The continual exposure to seismic hazard has exacerbated the vulnerability of this "slow burn" setting (Pike et al., 2010), where no less than four ruinous earthquakes occurred in the 1997–2016 period only (Zullo et al., 2020).

[2]According to article 1 of the Italian law 991/1952, the identification of mountain municipality is based on both geo-morphologic (at least 80% of the areas higher than 600 meters or a vertical drop more than 600 meters) and economic (average taxable income for hectare lower than 2.400 lyres) criteria.

Here we have an original local society that transcends administrative borders and is characterised by geographical consistency, settlement model and cultural homogeneity (Phythian-Adams, 1993). Space is organised around a network of small and scattered villages, where local resources are carefully managed so as to preserve a fragile environment. Upland villages have a long tradition of self-government, dating back to the XII-XIII centuries (Di Méo, 1991), when a dense set of localities (towns, castles, villages, hamlets, abbeys) was created in the central Apennines. This settlement pattern is not subject to the boundary changes common to the more dynamical hills and plain systems.

Although our sample appears to be the quintessence of Italian rural inner areas, the literature on shrinkage has not been abundant. The Apennines are a peripheral context, that spreads across different regions and it has been examined through urban-centric interpretative models, unable to grasp their functional and cultural features. The present paper aims to help the understanding of shrinking processes in other southern European inner peripheries (De Toni et al., 2021b) characterised by scarcity of agricultural land, remoteness, economic backwardness and dispersed settlements (for the Pyrenees, see Collantes and Pinilla, 2004).

With regard to the territorial unit, we operate on two scales, that are both the municipal (n=105) and the local levels (n=1016), namely inhabited centres (see section 2 for a definition). Since these socio-geographical units have remained stably defined over time, we were able to put together a consistent longitudinal series of demographic data for the period between 1931 and 2011 (the last census year). 1931 is the first year in which Italian National Institute of Statistics (ISTAT), alongside with the best Italian geographers of the time, provided an official, reliable and comprehensive list of inhabited centres in conformity with uniform standards (ISTAT, 1935). The year also marks the peak of centuries-old population in the central Apennines. Earlier historical chronicles report several settlement crises due to earthquakes, starvation, epidemics or wars but strong depopulation was confined to few remote, rugged territories, affected by natural catastrophes (Bevilacqua, 1952). Large scale settlement decline occurred in the second half of the 20th century; the 1931–2011 bout therefore embeds the whole period in which the shrinking process of the area starts, spreads and exacerbates.

To reconstruct the inhabited centres' time series data for the interval 1931–2011 extreme methodological care in the selection and reading of the sources is needed. Two of the consistency criteria that we used are to check that the altitude of the centre remains unchanged across censuses[3] Thus, our dataset is perfectly suited for studying the population change of lo-

[3] Altitude of an inhabited centre is determined by the meeting point of the village (ISTAT, 1958) and the occurrence of anomalous inter-census population swings.

cal communities, without being hindered by rigid topographical limits or unstable administrative units.

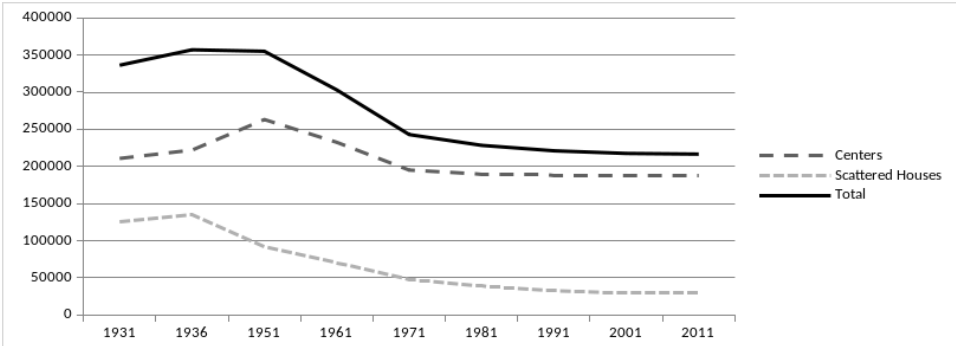


Figure 2: Population by type of location, 1931–2011

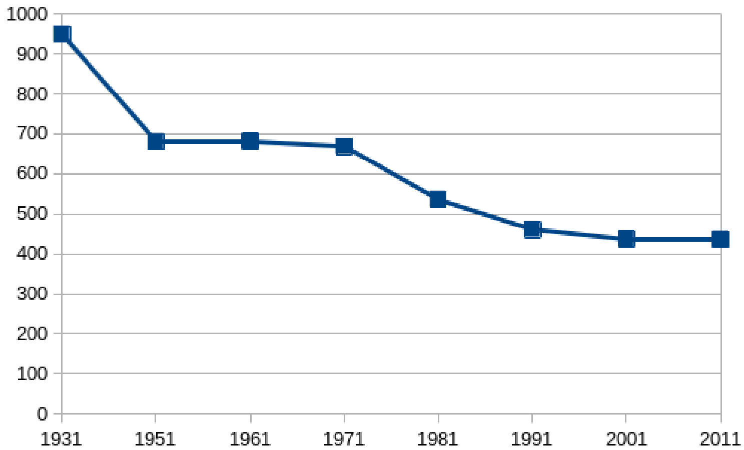


Figure 3: Number of inhabited centres, 1931–2011

From simple descriptive statistics, two main results emerge. The municipal time-series shows a significant population decrease, mostly in the 1951–1971 period (Fig. 2). Most of the shrinkage affected scattered houses whereas for the inhabited centres, in the long term, "we cannot strictly speak of depopulation, because mountain setting seems initially to have absorbed and then disposed the overpopulation left by demographic transition" (Sori, 2004, p. 31). The number of centres, conversely, dropped substantially – from 949 (1931) to 436 (2011), with a decrease of 513 units (54%), as can be seen in Fig. 3. In the period under review, 67 new centres were created but 580 ceased to exist. The disappearance of inhabited centres peaked between 1951 and 1981, with the negative trend continuing in the following decades, which we take as sign of a structural process.

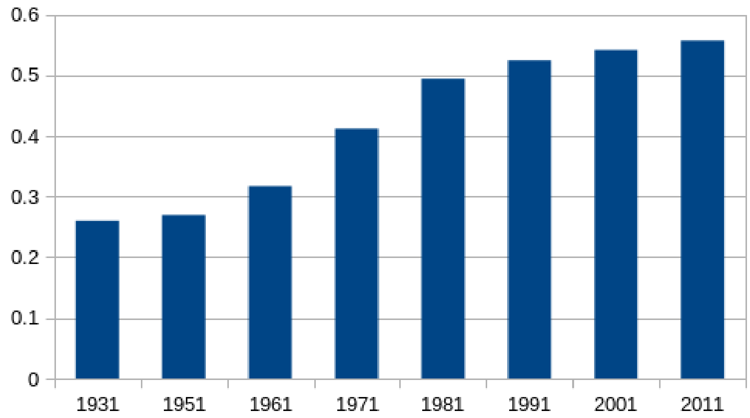


Figure 4: Population in municipal capital (as a share of the total population), 1931–2011

The uplands experienced a dramatic shift in the settlement pattern rather than just a population loss; this transformation can be properly described only by adopting a twofold metric, both at the municipal and the village levels. The longitudinal investigation clearly highlights a sharp dichotomy between the growth in size of some centres and the substantial shrinkage of many others. Local population moves into major centres or somewhere close to the main roads at the expense of remote villages, often located on steep slopes or isolated highlands. Between 1931 and 2011, the share of population living in municipal seats grew from 28% to to 56% (Fig. 4). Concentration and abandonment are the most visible outcomes of a settlement polarisation that endangers the social biodiversity of a sparsely populated area.

As an example of the dissolution of a dense network of meeting points, which used to be a traditional, essential feature of uplands, take the iconic town of Norcia, where the growth of the municipal capital (from 2,682 to 2,964 inhabitants) appears to be in stark contrast with the collapse of the other 23 inhabited centres (from 4,547 to 1,069 inhabitants). The town of Amatrice provides another example[4] of how demographic dynamics have undermined its "peculiar polycentric settlement" (Bevilacqua, 1952) where many small villages gravitate around the main centre. In the 1931–2011 period, the municipal seat recorded only a small population decline (from 1,411 to 1,046 people), compared to the other 49 inhabited centres existing

[4] It is the hardest hit municipality by the 2016–17 earthquakes, in terms of human lives (239 deaths on a total of 299) and buildings destroyed.

in 1931 (with 4,890 inhabitants), that dropped to 5 (with just 304 residents) in 2011.

In short, the community perspective reveals a widespread settlement vulnerability, undetected either by municipal data nor by a single case study. Population change is the result of many different dynamics, both infra- and intra-municipal. The large decrease in inhabited centres is a less well known, and yet worrying, sign of local shrinkage. The loss of many meeting spaces deprives territories of their vital nodes, that provide a resilience (or development) factor for places where community has traditionally played a key role (Ciuffetti, 2019).

4 Empirical methods

Given the nature of the issue at hand, we analyse the dynamics of population in the area of interest across 20-year spans, starting from 1931–1951 to 1991–2011, by using ISTAT census data.

Period	start	in	out	survivors	rel. Δ
1931–1951	949	41	309	640	5.65
1951–1971	681	21	33	648	-17.93
1971–1991	669	13	221	448	7.23
1991–2011	461	1	26	436	1.77

Table 1: Number of centres, 1931–2011

As can be seen from Table 1, the figures for the four sub-periods we analyse are quite different from one another. The column labelled "start" indicates how many centres existed at the beginning of the period; "in" and "out" hold the number of centres that appeared and disappeared, respectively, so that the column "survivors", with the difference between "start" and "out", contains the number of centres existing from the beginning to the end of the 20-year span. The rightmost column, "rel. Δ", indicates the percentage change in population in the surviving centres.

In the 1931–1951 and 1971–1991 periods, the number of centres shrank dramatically, but population grew. On the contrary, centres were stable in the 1971–1991 period, but population declined. Finally, there was very little change in the final period. This evidence is hardly surprising, considering that those four periods are very different from each other from a historical perspective: at first (31–51), the Fascist regime fostered a policy of self-sufficiency, with massive state intervention in agriculture and constraints on population mobility which increased demographic pressure on the mountain areas; after World War II, Italy experienced the so called "economic miracle" (1951–71) and a large rise of industrialisation, which was fuelled by labour force emigrating from the uplands. This Golden

Age ended with the productivity slowdown, that started a complex path of restoration and relaunch (1971–1991). The substantial fall of both domestic and foreign mobility slowed down the out-migration by inner areas but they did not halt it. The last period (1991-2011) is marked by European integration and declining competitiveness. Large waves of foreign immigrants counterbalanced the population decline of the natives. Depopulation continued in the uplands, which are penalised by ageing and low fertility.

Therefore, we will analyse the change in population using different models for each period. The framework we use can generally be described as

$$\Delta n_{i,t} = \boldsymbol{\beta}' \mathbf{x}_{i,t-1} + \varepsilon_i \qquad (1)$$

where n_t is the natural logarithm of the population of centre i at time t (where $t = 1931, 1951, \ldots, 2011$) and $\mathbf{x}_{i,t-1}$ is a suitable set of explanatory variables, as observed at the beginning of each period. Of course, in this context the most obvious characteristics to include among the explanatory variables $\mathbf{x}_i$ are altitude and population size, and in fact we will show in the next section that these two variable play a key role, especially in the earlier subperiods. Table 2 provides some descriptive statistics for those variables, relative to the centres existing at each point in time that we consider.

	Mean	Median	S.D.	Min	Max
1931 (949 centres)					
altitude	711	710	228.3	194	1452
population	221.9	121	484.3	16	10965
1951 (681 centres)					
altitude	691.6	676	239.6	194	1452
population	289.9	155	629.8	15	12400
1971 (669 centres)					
altitude	682.8	667	241.8	46	1452
population	241	92	859	2	18355
1991 (461 centres)					
altitude	663.5	647	243.1	194	1452
population	344.6	98	1237	8	21172
2011 (436 centres)					
altitude	659.7	637.5	243.8	194	1452
population	366.3	90	1367	7	23230

Table 2: Descriptive statistics

The first issue to consider is the fact that centres appear and disappear at different rates, in the different subperiods we consider (see Table 1). Therefore, apart from estimating an equation like (1), we also set up a binary model aimed at describing the factors that make a centre more or less likely to survive at the end of each 20-year period:

$$s_i^* = \gamma' \mathbf{z}_i + u_i \tag{2}$$

$$s_i = 1 \iff s_i^* > 0 \tag{3}$$

In other words, equation (2) is used to determine the probability that centre i survives as such at the end of the 20-year span. Put another way, while equation equation (1) describes the drivers of population dynamics, (2) describes the drivers that explain why a centre may remain active, or disappear. Of course, some of the factors may be the same and affect the two phenomena in different ways; or some factor may enter one equation but not the other.

Naturally, these auxiliary models for centre survival may be considered superfluous for periods such as 1951–1971 or 1991–2011, when very little change was observed. However, the issue of sample selection has to be considered: if the two error terms ε_i and u_i are correlated, OLS estimation of equation (1) on the sole sample of surviving centres will yield biased estimates. Put differently: if the unobservable factors that account for population movement also influence the probability of a centre to remain active (as is possible), then a model that describes population change using the data on surviving centres is going to give misleading indications. Therefore, equation (1) should, in principle, be estimated by taking properly into account that we only observe centres that have survived.

Therefore, we decided to estimate jointly the two equations (1) and (2) for each period by using Heckman's sample selection model. However, we found that the correlation between ε_i and u_i was never significant in any of the four periods: we take this to mean that the information set we have for each period is large enough to rule out the possibility that we are omitting some systematic unobserved factor that plays a significant role in both the population dynamics of a centre and its chances to remain such at the end of the period. Therefore, we only report the result of the separate models. Of course, we do not claim our models offer a comprehensive description of the population dynamics. In fact, in several cases idiosyncratic factors seem to dominate: in most of the models we estimate, the R^2 is rather low; what we claim is that the observable explanatory variables we employ contain an information set that is rich enough to shield us from "survivor bias".

Another potential problem with equation (1) is heteroskedasticity: since the dependent variable is a relative rate of change, it may be surmised that larger centres should exhibit figures that are less prone to be contaminated by idiosyncratic factors than smaller ones (for example: if a whole family decides to migrate for some random reason, this would affect a centre with

50 inhabitants to a much larger extent than one with 1000). This was confirmed, in most cases, by running standard heteroskedasticity tests on the OLS estimates. As a consequence, to mitigate this effect, we decided to employ weighted least squares for the estimation of (1), using the square root of n_i as weighting variable. Statistically, this can be considered optimal if the variance of ε_i was proportional to the population size of centre i.[5]

Finally: the very reason for setting up separate models for each of our 20-year spans is that we believe that there are dramatic differences that set each period apart from one another. Therefore, we used separate specifications for each subperiod, without resorting to formal methods of variable selection such as information criteria, stepwise addition/elimination or regularised least squares techniques, but opted for a qualitative approach in which we also took into account the possible nonlinear effect of some of the explanatory variables. Moreover, data for some of these variables are available for some subperiods only, so we were forced to omit those in some of the models.

5 Results

In this section, we provide a comment on the results for the different models that we estimated for each 20-year span. It is worth recalling that in no case a selection effect was found to be significant, and therefore we estimated two separate models for centre persistence and population variation.

In some of the models, nonlinear effects of centre size and altitude are particularly important: in Tables 3 and 4, the variables `a` and `lpop` refer to altitude and log population, respectively. The additional variables `a2`, `lpop2` and `la` are used to indicate their cross-products, so that for example `lpop2` is the square of `lpop`.

5.1 The 1931–1951 span

The model for survival of inhabited centres between 1931 and 1951 features predominantly population size and altitude, the latter with a quadratic effect such that mid-altitude, small centres are the most likely to cease to exist. By using information on the concavity, we estimate the elevation at which a centre is least likely to persist as such at around 730 metres. This finding is consistent with studies arguing that the Apennines' depopulation started in the medium-altitude villages, clinging to steep slopes, without the fertile soils of the valley floor or the lush pastures at greater altitudes (Vitte, 1995).

[5]For the sake of robustness, we experimented with different solutions and obtained qualitatively similar results as those reported.

Table 3: Estimates for the 1931–1951 span

WLS model (population change)

	Coefficient	Std. Error	t-ratio	p-value
const	2.20747	0.479351	4.605	0.0000
a	−1.03689	0.376624	−2.753	0.0061
a2	0.316768	0.155915	2.032	0.0427
lpop	−0.404795	0.130719	−3.097	0.0021
lpop2	0.0275000	0.00905322	3.038	0.0025
la	0.0656971	0.0455453	1.442	0.1497
pres	−0.590046	0.101289	−5.825	0.0000
cap	0.190981	0.0371180	5.145	0.0000
walls	−0.0964575	0.0354905	−2.718	0.0068

Statistics based on the weighted data:

Sum squared resid	685.5440	S.E. of regression	1.104459
R^2	0.134152	Adjusted R^2	0.121826
$F(8, 562)$	11.35017	P-value(F)	5.73e–15
Log-likelihood	−862.4100	Akaike criterion	1742.820
Schwarz criterion	1781.947	Hannan–Quinn	1758.085

Statistics based on the original data:

Mean dependent var	0.014630	S.D. dependent var	0.346799
Sum squared resid	59.29841	S.E. of regression	0.324828

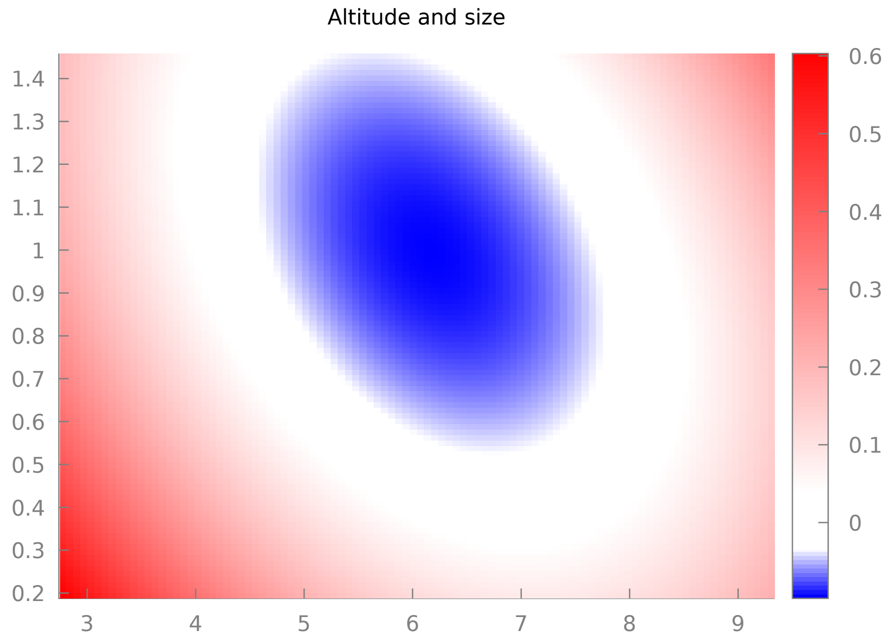
Probit model (centre survival)

	Coefficient	Std. Error	z	p-value
const	−2.6750	0.5987	−4.4681	0.0000
a	−5.3778	1.4184	−3.7914	0.0001
a2	3.6804	0.9666	3.8074	0.0001
lpop	1.0387	0.0798	13.0227	0.0000

Mean dependent var	0.674394	S.D. dependent var	0.468848
McFadden R^2	0.210110	Adjusted R^2	0.203431
Log-likelihood	−473.0182	Akaike criterion	954.0365
Schwarz criterion	973.4581	Hannan–Quinn	961.4368

Number of cases 'correctly predicted' = 708 (74.6 percent)
Likelihood ratio test: $\chi^2(3)$ = 251.645 [0.0000]

Figure 5: Combined population/altitude effect: the 1931–1951 span



Population changes are also driven by altitude and scale (see Table 3). These variables capture, to some extent, the standard of living for a village and its link to the demographic pressure on the available resources. Altitude, in fact, provides a proxy for several factors, such as remoteness, economic backwardness, poor endowment of resources, harsh climate and the persistence of traditional agricultural practices. Nonlinear effects for size and altitude are substantial. Negative changes mostly occur in mid-sized, high elevation centres (see Figure 5).

The period is marked by the Great Depression, starvation and World War II. The deterioration of living conditions, however, did not bring about massive depopulation of the uplands also on account of the Fascist regime hindering long-range mobility, so that population remained in the mountains, where they developed several survival strategies. In fact, in the 1930s, the central Apennines recorded their all-time high in population density (Bonelli, 1967), but people reallocated within the area, so as to ease demographic pressure on the overcrowded, fragile settings, where all suitable lands were cultivated, even on very steep slopes. The low productivity of mountain farming encouraged many to seek some kind of additional income via seasonal mobility, transhumance and collective ownership (INEA, 1937).

As a proxy for temporary migration we use the present/resident population ratio, which takes a negative sign: in a context of out-migration, a lower ratio means higher temporary mobility. Our interpretation is that between 1931 and 1951 temporary emigration did not undermine the community: on the contrary, migrants acted as a welfare hedge for the village, by providing remittance inflow and reducing the demographic pressure on the scant local resources (McLeman, 2011). A contemporary official survey emphasises that villages with large migratory flows enjoyed better life conditions than neighbouring areas (INEA, 1937).

The two dummy variables "municipal capital" and "walled settlement" relate to the importance of short-distance movements. The period marks the beginning of an agglomeration process within the municipal border that was bound to continue in the following years. Until the 1930s, the municipal capital was quite indistinguishable from the other settlements (INEA, 1937). Agglomeration forces led to settlement restructuring, with new municipal hierarchies taking shape in a context that was still polycentric. This process can be observed in the lower demographic trend of walled settlements (*terra*, *civitas* and *castrum*) compared to open villages (where buildings are interspersed with cultivated fields). Such a discrepancy is firstly related to the severe economic crisis of the 1930s, which mostly affected centres that were dependent on other villages for their agricultural supply. In addition, several craft activities, hitherto concentrated in castles, opened up to bigger centres or the municipal capital in search of broader markets. This displacement reflects the decline of the pluri-activity model, supplanted by a pattern of growing job specialisation. The separation between farm and craft activities in the Apennines was thoroughly displayed for the municipalities of Sellano (Ciuffetti, 2019) or Rasiglia (Marinelli, 2009).

5.2 The 1951–1971 span

Between the 1950s and the 1960s, a new lifestyle broke into the Apennines. In this period, southern Europe recorded the collapse of mountain economies based on traditional, no longer profitable activities, such as agriculture and sheep farming (Collantes and Pinilla, 2004).

The number of inhabited centres remained remarkably stable (see Table 1), so we do not report the corresponding probit model. Conversely, depopulation occurred almost everywhere, but mainly from high-altitude centres (Table 4). Interestingly, settlement size plays a marginal role in the great exodus from the Apennines, and does so only jointly with altitude (Figure 6). Migration effects (`pres`) are significant but with an opposite sign compared to the previous time span: centres with a higher share of residents working somewhere else experience a greater population loss. In our interpretation, demographic decline is linked to the shift from temporary to permanent emigration, that brings about a sizeable loss of labour and local social capital (McLeman, 2011). This tendency had a devastating effect on the fragile economy of the mountain settings, which largely relied

Table 4: Estimates for the 1951–1971 span

WLS model (population change)

	Coefficient	Std. Error	t-ratio	p-value
const	−0.435362	0.558322	−0.7798	0.4358
a	−0.267653	0.472684	−0.5662	0.5714
a2	0.628501	0.204846	3.068	0.0023
lpop	−0.00596013	0.150651	−0.03956	0.9685
lpop2	0.00450055	0.0107869	0.4172	0.6767
la	−0.160056	0.0623180	−2.568	0.0105
pres	0.284862	0.119744	2.379	0.0177
cap	0.170218	0.0607406	2.802	0.0052
pcoll	−0.0989148	0.0325952	−3.035	0.0025
services	0.0157950	0.00355808	4.439	0.0000

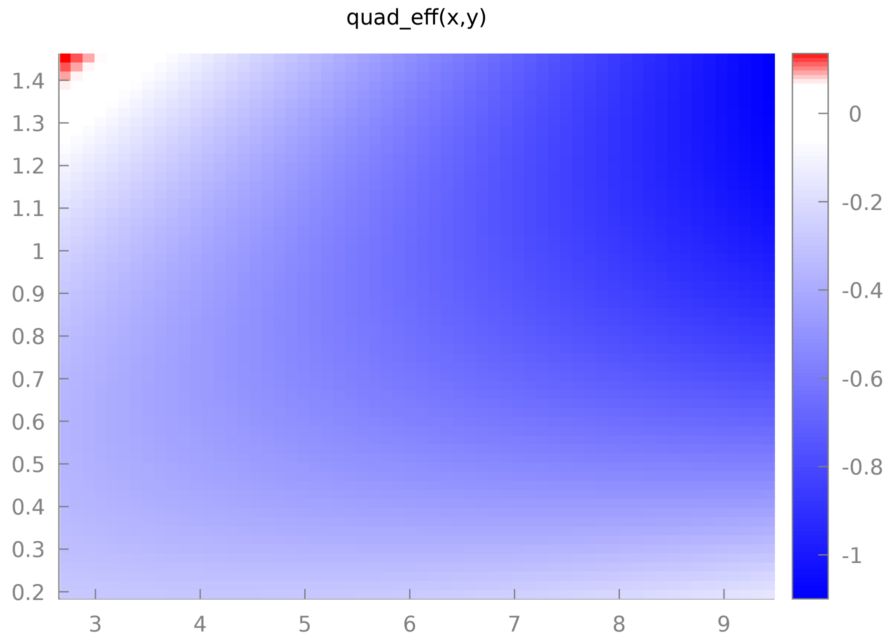
Statistics based on the weighted data:

Sum squared resid	1131.697	S.E. of regression	1.395652
R^2	0.386438	Adjusted R^2	0.376933
$F(9, 581)$	40.65878	P-value(F)	3.19e–56
Log-likelihood	−1030.567	Akaike criterion	2081.133
Schwarz criterion	2124.951	Hannan–Quinn	2098.202

Statistics based on the original data:

Mean dependent var	−0.513092	S.D. dependent var	0.438546
Sum squared resid	85.31187	S.E. of regression	0.383192

Figure 6: Combined population/altitude effect: the 1951–1971 span



on pluri-activity and external resources.

Depopulation is stronger for centres where collective ownership (`pcoll`) is more common (Ciuffetti, 2019). This form of property is a traditional response to lack of arable areas (see Vitte, 1995, p. 201) and is usually associated with woods and grazing. Therefore, we use collective ownership as a proxy for the presence of marginal lands, unsuitable for farming.

A very interesting feature of the data for this time span is that rich information is available on the set of available services in 1951 (ISTAT, 1957). In order to incorporate it into our model for population change, we summarised several variables via a Principal Component Analysis and we used the first principal component[6] as a synthetic indicator of availability of services; descriptive statistics for the original variables are provided in Table 5. Figure 7 shows a scatterplot of our composite indicator versus population in 1951. As can be seen, correlation is unsurprisingly positive, but far from perfect. We find that our proxy (despite being only an imperfect measure of service availability) exerts a very strong counter-effect to depopulation, as expected (Wang et al., 2020).

The process of industrialisation and urbanisation in Italy between 1951 and 1971 led to rising living standards, both in the economic and the social dimensions (Li et al., 2019). Rural population strove for the mod-

[6]The percentage of retained variance is 29.1%.

	Mean	Median	S.D.	Min	Max
Road	0.8342	1.000	0.3721	0.000	1.000
local road	0.4948	0.000	0.5003	0.000	1.000
B-road	0.2513	0.000	0.4340	0.000	1.000
A-road	0.08808	0.000	0.2836	0.000	1.000
Train station	0.03109	0.000	0.1737	0.000	1.000
Post Office	0.3381	0.000	0.4734	0.000	1.000
(Distance from nearest)	3.041	2.500	3.183	0.000	18.00
Telegraph	0.2759	0.000	0.4473	0.000	1.000
(Distance from nearest)	4.183	3.500	3.985	0.000	20.00
Telephone	0.4339	0.000	0.4959	0.000	1.000
(Distance from nearest)	2.778	1.350	3.651	0.000	25.00
Permanent hotels	0.04016	0.000	0.2436	0.000	3.000
Seasonal hotels	0.01943	0.000	0.2712	0.000	4.000
Inns	0.07513	0.000	0.2638	0.000	1.000
Restaurants	0.1723	0.000	0.3779	0.000	1.000
Bank branches	0.1308	0.000	0.4882	0.000	6.000
Aqueduct	0.7189	1.000	0.4498	0.000	1.000
Sewers (partial)	0.2915	0.000	0.4547	0.000	1.000
Sewers	0.06477	0.000	0.2463	0.000	1.000
Doctor	0.2176	0.000	0.4129	0.000	1.000
Midwife	0.1930	0.000	0.3949	0.000	1.000
Chemist	0.1606	0.000	0.3674	0.000	1.000
Hospital	0.03886	0.000	0.1934	0.000	1.000
Municipal hospital	0.2733	0.000	0.4460	0.000	1.000
Primary school	0.9106	1.000	0.2855	0.000	1.000
Middle school	0.04793	0.000	0.2138	0.000	1.000
Church	0.09585	0.000	0.2946	0.000	1.000
Parish	0.7966	1.000	0.4028	0.000	1.000
Cathedral	0.01554	0.000	0.1238	0.000	1.000

Table 5: Variables used in the PCA analysis, descriptive statistics

ern, comfortable, vibrant lifestyle of the city promoted by mass media or newly-built motorway construction (Di Figlia, 2016; Rizzo, 2016). The lack of facilities such as healthcare, education and shops has not only practical implications, but also a symbolic meaning for the communities which were progressively pervaded by a sense of remoteness and backwardness (Christiaanse and Haartsen, 2017). Lowe and Ward (2009) report a similar phenomenon for Wales in the same period: "*physical remoteness and poor infrastructure explain some of the situation*" as well as population mobility to the municipal capital, where services were increasingly available.

5.3 The 1971–1991 span

In this period, many centres ceased to exist as such. The main determinants of this phenomenon are altitude, population in 1971 (with the expected signs) and the `quake` dummy, which identifies the centres affected

Table 6: Estimates for the 1971–1991 span

WLS model (population change)

	Coefficient	Std. Error	t-ratio	p-value
const	0.147434	0.0521029	2.830	0.0049
a	−0.601881	0.0717106	−8.393	0.0000
cap	0.258612	0.0356530	7.254	0.0000
quake	−0.0617634	0.0428049	−1.443	0.1498

Statistics based on the weighted data:

Sum squared resid	818.9660	S.E. of regression	1.358130
R^2	0.290857	Adjusted R^2	0.286066
$F(3, 444)$	60.70273	P-value(F)	6.66e–33
Log-likelihood	−770.8123	Akaike criterion	1549.625
Schwarz criterion	1566.044	Hannan–Quinn	1556.097

Statistics based on the original data:

Mean dependent var	−0.226844	S.D. dependent var	0.464186
Sum squared resid	76.89193	S.E. of regression	0.416149

Probit model (centre survival)

	Coefficient	Std. Error	z	p-value
const	−3.84629	0.409979	−9.382	0.0000
a	−0.547954	0.259920	−2.108	0.0350
lpop	1.02310	0.0846567	12.09	0.0000
quake	0.659355	0.148588	4.437	0.0000

Mean dependent var	0.669656	S.D. dependent var	0.470689
McFadden R^2	0.278422	Adjusted R^2	0.268998
Log-likelihood	−306.2580	Akaike criterion	620.5159
Schwarz criterion	638.5391	Hannan–Quinn	627.4975

Number of cases 'correctly predicted' = 536 (80.1 percent)
Likelihood ratio test: $\chi^2(3)$ = 236.340 [0.0000]

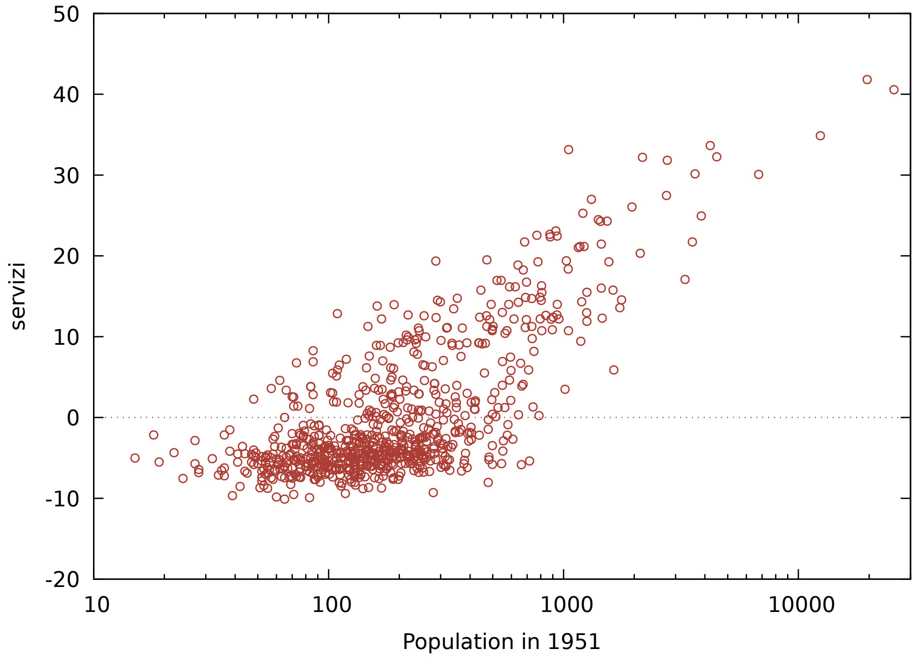


Figure 7: Services composite indicator vs centre size

by a strong earthquake in 1979. For the Probit model, this variable has a positive effect. Although this finding could be considered surprising at first sight, it should be considered that natural disasters call for the maintenance of gathering places for people and public operators working on the recovery; these efforts, however, failed to reverse the prolonged, preexisting demographic decline, as confirmed by the regression on population change. The area keeps losing inhabitants, albeit at a slower pace than the 1951–71 period.

Nonlinear effects are insignificant, and therefore the traditional interpretation, whereby depopulation is a simple outcome of altitude and size, is warranted here. Shrinkage is particularly strong in the high-altitude settlements, where inhabitants suffer most from the increasing remoteness and the lack of services. Mountain areas are divided between shrinking villages depleted by long and short mobility, and the capital town or nearby villages, which are the destination of local migrations.

5.4 The 1991–2011 span

This period is remarkably static, both in the number of the inhabited centres and in the demographic size. Population mostly drops at higher altitudes, whereas centre size is not significant. Municipal capitals are less affected by depopulation, although the coefficient for the `cap` variable is only weakly

Table 7: Demographic indicators

		Mean	S.D.	Min	Max
inactive	Share of inactive population over 15	0.6459	0.08127	0.4	0.92
elderdep	Elderly dependency rate: $\frac{n_{64+}}{n_{15-54}}$	0.1251	0.05907	0	0.67
age6575	$\frac{n_{65-75}}{n_{tot}}$	0.0572	0.02881	0	0.22
ageover75	$\frac{n_{75+}}{n_{tot}}$	0.03907	0.02753	0	0.22

significant. Despite the cuts to local services, the spread of ICT and the arrival of lifestyle migrants, the growth of settlement polarisation confirms the relevance of low scale mobility towards the municipal capitals.

In addition to these usual drivers, population dynamics is influenced by demography, for which we use the variables described in Table 7. In this period, the age structure of the population matters more than the size of the settlement. The nature of depopulation has changed substantially, going from out-migration to natural decline, induced by unbalanced age structure. Shrinkage is fuelled by endogenous cumulative effects started in the previous decades that are difficult to reverse (Bucher and Mai, 2005; Rizzo, 2016).

6 Conclusions, policy indications and ideas for further research

The main findings of our study are summarised as follows. First, the most appropriate way to approach a quantitative analysis of depopulation in the Apennines is to split the phenomenon using two dimensions: the number of villages and their size, separately. These twofold metric allows for a more comprehensive assessment of multifaceted depopulation process, that involve both population change and settlement framework. “In an increasingly performance-oriented society, metrics matter. What we measure affects what we do. If we have the wrong metrics, we will strive for the wrong things” (Stiglitz et al., 2010). This perspective reconciles the discrepancy between scholars who think, based on municipal data, that the Apennines’ depopulation has come to a halt (Sori, 2004) and those who worry about the abandonment of many villages. The settlement hollowing shows a neglected but dramatic facet of depopulation (Song and Li, 2020) which is also boosted by the agglomeration effect within the municipal borders. The concentration of residents in the municipal capital or the valley floor (Sørensen, 2018) deconstructs the centuries-old polycentric settlement of mountain areas.

Second, a comparative analysis of long-term population change poses the issue of the intra-rural divide (Rizzo, 2016; Johnson and Lichter, 2019).

Table 8: Estimates for the 1991–2011 span

WLS model (population change)

	Coefficient	Std. Error	t-ratio	p-value
const	0.922603	0.207891	4.438	0.0000
a	−0.323391	0.0665919	−4.856	0.0000
lpop	−0.000966317	0.0139584	−0.06923	0.9448
cap	0.0708661	0.0397476	1.783	0.0753
inactive	−1.04680	0.252541	−4.145	0.0000
elderdep	3.89495	1.63369	2.384	0.0176
age6575	−7.69811	2.27251	−3.387	0.0008
ageover75	−6.15265	2.43178	−2.530	0.0118

Statistics based on the weighted data:

Sum squared resid	530.3944	S.E. of regression	1.114514
R^2	0.206877	Adjusted R^2	0.193875
$F(7, 427)$	15.91116	P-value(F)	1.35e–18
Log-likelihood	−660.3630	Akaike criterion	1336.726
Schwarz criterion	1369.329	Hannan–Quinn	1349.594

Statistics based on the original data:

Mean dependent var	−0.142178	S.D. dependent var	0.397990
Sum squared resid	57.35161	S.E. of regression	0.366487

We found ample evidence of local redistribution of inhabitants within municipal settlements; this highlights the role of the rural mobility (Elshof et al., 2017; Milbourne, 2007; Han et al., 2016). Despite a relative lack of attention, short distance relocations are a consolidated practice in rural settings, that are "at least as mobile as the urban, if not more so" (Bell and Osti, 2010, p. 199).

Third, the complexity of population change can only be addressed by considering the joint interdependence of a variety of social, economic, cultural, institutional and environmental factors operating at multiple scales (Beresford et al., 1979). "None of the factors can individually determine the direction and magnitude of population change" (Chi and Ventura, 2011, 12). In our empirical model, we strive to combine these elements by using the widest possible data array in order to achieve a comprehensive understanding of the mechanisms driving rural shrinkage.

Fourth, depopulation is a multistage, cumulative process of increasing vulnerability, decline, and self-reinforcing decay (Wang et al., 2020; McLeman, 2011; Di Figlia, 2016). Population fall has manifold manifestations and causes, engaged according to the place and the period under consideration: "one important factor in a certain time period may become unimportant in another, and vice versa" (Chi and Ventura, 2011, 2). Some drivers, such as temporary migration or elevation, affect in a different manner each specific phase of the village depopulation.

Our empirical findings show that the demographic decline of the central Apennines could be divided in several phases, in which different mechanisms operate. The period between 1931 and 1951 is characterised by population redistribution within the mountain areas: local mobility became a strategy to face excessive demographic pressure on scarce resources. The massive shrinkage of the Apennines in the '50s and '60s, instead, is mainly linked to out-migration, due to the socio-economic changes driven by the modernisation process and the appeal of the urban context (Di Figlia, 2016). This phenomenon has also been observed for other countries (Wang et al., 2020; Collantes, 2009); in Italy, remote rugged areas remained at the fringes of mass motorisation, widespread industrialisation, and access to basic services and comforts that underpin life plans during the so-called "economic miracle".

In later years, the great exodus affected the demographic decline of the '70s and '80s, since the departure of younger population provoked ageing and further loss of inhabited centres. The modernisation process fostered the agglomeration of the residents within few settlements, thereby giving rise to a localisation pattern split amongst "oases" and "deserts" (Otterstrom and Shumway, 2003), namely, few growing municipal seats and many shrinking peripheral centres. Since the '90s, depopulation becomes a self-reinforcing process, that erodes local social capital and produces an unbalanced age structure and gender ratio. The simultaneous deficit of both net migratory and natural balance has exacerbated the shrinkage (Matanle and Rausch, 2011). In turn, this brings about a severe shortages of taxes, basic public services and shops, which undermine the vitality of villages and reduce their resilience to exogenous shocks (Wang et al., 2021; McLeman, 2011).

Mountain settlements have been described as "a thin and rudimentary canvas, which could tear at each unusual natural event" (Gambi, 1972, p. 19). However, catastrophic events play only a minor role in village shrinkage. They mostly speed up a settlement decline that has already started (McLeman, 2011; Wang et al., 2020) because they overlap with structural socioeconomic and demographic processes that are difficult to reverse (ageing, low population density, de-natality etc.). The 2016-17 earthquakes in the Apennines, however, could have had particularly harmful consequences because of the extension of the affected area, the adverse economic conjuncture, the constraints of public spending, and the discourage brought by repeated, violent tremors. Many settlements, exhausted by prolonged shrinkage, economic downturns and social exclusion are close to a point of no return.

In the literature, there is no scientific consensus yet on the optimal strategy to confront this unprecedented village abandonment. The debate swings between a rewilding approach, aimed at enhancing nature conservation, and an ecological restoration strategy through few inhabitants engaged in traditional, sustainable activities (i.e. extensive grazing). Some scholars strive for organised depopulation (Orcao and Cornago, 2007), but the selection criteria for choosing which villages to leave are unclear.

In this paper, we aim to contribute to the theoretical debate by introducing a conceptual model that is tested using long-term longitudinal data from a sample of small settlements in central Italy. Further research should be extended to long-term analysis of inhabited centres in other mountain areas either in Italy or elsewhere. In addition, the set of variables used in the paper may be further identified and improved. For instance, we do not consider the spillover effects on neighbour settlements (Chi and Ventura, 2011; Han et al., 2016).

We suggest that the adoption of a quantitative analysis based on detailed and reliable data promotes a critical understanding of an issue often tackled from an emotional perspective (Zullo et al., 2020). Tracing the network and evolution of inhabited villages in the Apennines at the the submunicipal scale allows for effective local planning, by taking appropriately into account the identity and the historical legacy of the specific places.

The concept of community is crucial for a systematic understanding of population change, which may have major implications for regional planning. We empirically found that demographic trends depend on many drivers, which are space and time contingent; this opens rooms for effective policies aimed at reversing (Kühn, 2015) or mitigating (Peters et al.,

2018) the seemingly inexorable rural depopulation, whereas "rural is not necessarily always synonymous with decline" (Ward and Brown, 2009, p. 1238).

The abandonment of traditional former villages undermines the historical memory of the places; it causes waste of cultural heritage and land resources (Wang et al., 2020), a loss of aesthetic and tourist values (van der Zanden et al., 2017), biodiversity, environmental protection, ecosystem services (García-Ruiz et al., 2020). The vanishing of traditional landscape in semi natural contexts shaped from a century-old relationship between man and nature (Agnoletti, 2014) is a threat to the identity of inner areas, which assume an unusual structure, with few "oases" surrounded by many desert villages (Otterstrom and Shumway, 2003).

On the other hand, "not all shrinkage is decline" (Peters et al., 2018, p. 41), as illustrated by the twofold metric used in the present paper. Some scholars suggest that population drop could be properly managed in order to guarantee social equity and a better life quality, linked to a more sustainable lifestyle. A successful smart shrinkage strategy needs stronger social ties, significant civic engagement and a shared cultural background (Peters et al., 2018). Local community may therefore be an engine of resilience (McManus et al., 2012) which must be recognised and strengthened (Imperiale and Vanclay, 2016).

If one sees the survival of local communities as a crucial factor for managing shrinkage, then appropriate policies should mainly promote the residency of people. This difficult task calls for the provision of targeted actions, adequately tailored to specific settlements (Sánchez-Zamora et al., 2014). Mountain areas, for example, must be provided with a bundle of public services (healthcare, education, etc.) so as to meet the basic needs of the population and guarantee them an adequate lifestyle (Wang et al., 2020; Malý, 2018); at the same time their inhabitants "could be financially compensated for ecosystem services provision" (De Toni et al., 2021a).

"It is time to refocus our attention on the rural people and places left behind" (Johnson and Lichter, 2019, p. 25) by a globalisation process that has widened territorial polarisation and accelerated the shrinkage of mountain settlements, less equipped to face broader competition (Collantes and Pinilla, 2004).

The safeguard of mountain settlements not only is a cultural need and a moral duty towards our ancestors but also a pressing political issue. The growing gap between urban and rural areas has amplified economic, social and political instability in the EU (De Toni et al., 2021a) and forged the rise of populist waves in recent political elections (Rodríguez-Pose, 2018; Wuthnow, 2019). The ruins of the Basilica of St. Benedict, the patron of Europe, in Norcia (a village still devastated by the 2016 earthquake) remind us that the original spirit of the European Union, constantly on the edge between competitiveness and cohesiveness goals (Fratesi and Perucca, 2018), lies in the protection and the effective, sustainable recovery of mountain settlements.

References

AGNOLETTI, M. (2014): "Rural landscape, nature conservation and culture: Some notes on research trends and management approaches from a (southern) European perspective," *Landscape and Urban Planning*, 126, 66–73.

BANINI, T. ET AL. (2017): "Proposing a theoretical framework for local territorial identities: Concepts, questions and pitfalls," *Territorial identity and development*, 2, 16–23.

BARCA, F., P. CASAVOLA, AND S. LUCATELLI (2014): "A strategy for inner areas in Italy: definition, objectives, tools and governance," *Materiali Uval Series*, 31.

BELL, M. M. AND G. OSTI (2010): "Mobilities and ruralities: An introduction," *Sociologia Ruralis*, 50, 199–204.

BERESFORD, M. W., J. K. S. S. JOSEPH, AND J. JOSEPH (1979): *Medieval England: an aerial survey*, vol. 2, Cambridge University Press.

BEVILACQUA, E. (1952): *I centri abitati più elevati dell'Appennino con particolare riguardo a quelli dell'Abruzzo*, Consiglio nazionale delle ricerche.

BONELLI, F. (1967): *Evoluzione demografica ed ambiente economico nelle Marche e nell'Umbria dell'Ottocento, in «Archivio economico dell'unificazione italiana», s. II, vol*, Turin: ILTE.

BONTJE, M., S. MUSTERD, ET AL. (2012): *Understanding shrinkage in European regions*, Alexandrine Press.

BRAUDEL, F. (1966): *La Méditerranée et le monde méditerranéen à l'époque de Philippe II*, vol. 3, Paris: Armand Colin.

——— (1985): *La Méditerranée: l'espace et l'histoire*, vol. 1, Flammarion.

BUCHER, H. AND R. MAI (2005): "Depopulation and its consequences for the regions of Europe," *DG III–Social cohesion. Brussels*.

CHI, G. AND S. J. VENTURA (2011): "Population change and its driving factors in rural, suburban, and urban areas of Wisconsin, USA, 1970–2000," *International Journal of Population Research*, 12.

Christiaanse, S. and T. Haartsen (2017): "The influence of symbolic and emotional meanings of rural facilities on reactions to closure: The case of the village supermarket," *Journal of Rural Studies*, 54, 326–336.

Ciuffetti, A. (2019): *Appennino: economie, culture e spazi sociali dal medioevo all'età contemporanea*, Carocci.

Coleman, D. and R. Rowthorn (2011): "Who's afraid of population decline? A critical examination of its consequences," *Population and development review*, 37, 217–248.

Collantes, F. (2009): "Rural Europe reshaped: the economic transformation of upland regions, 1850–2000," *The Economic History Review*, 62, 306–323.

Collantes, F. and V. Pinilla (2004): "Extreme depopulation in the Spanish rural mountain areas: a case study of Aragon in the nineteenth and twentieth centuries," *Rural History*, 15, 149–166.

Compagnucci, F. and G. Morettini (2020): "Improving resilience at the local level: The location of essential services within inner areas. Three case studies in the Italian Marche region," *Regional Science Policy & Practice*, 12, 767–792.

De Toni, A., P. Di Martino, and T. Dax (2021a): "Location matters. Are science and policy arenas facing the Inner Peripheries challenges in EU?" *Land Use Policy*, 100, 105111.

De Toni, A., M. Vizzarri, M. Di Febbraro, B. Lasserre, J. Noguera, and P. Di Martino (2021b): "Aligning Inner Peripheries with rural development in Italy: Territorial evidence to support policy contextualization," *Land Use Policy*, 100, 104899.

Delgado Viñas, C. (2019): *Depopulation Processes in European Rural Areas. A case Study of Cantabria (Spain)*, De Gruyter Open Ltd.

Desplanques, H. (1969): *Campagnes ombrienne. Contribution à l'étude des paysages ruraux en Italie*, Paris: A. Colin.

Di Figlia, L. (2016): "Turnaround: abandoned villages, from discarded elements of modern Italian society to possible resources," *International Planning Studies*, 21, 278–297.

Di Méo, G. (1991): "La genèse du territoire local: complexité dialectique et espace-temps," *Annales de géographie*, 559, 273–294.

Elshof, H., T. Haartsen, L. van Wissen, and C. H. Mulder (2017): "The influence of village attractiveness on flows of movers in a declining rural region," *Journal of Rural Studies*, 56, 39–52.

ELSHOF, H., L. VAN WISSEN, AND C. H. MULDER (2014): "The self-reinforcing effects of population decline: An analysis of differences in moving behaviour between rural neighbourhoods with declining and stable populations," *Journal of Rural Studies*, 36, 285–299.

FELICE, E. (2015): "Italy's North-South divide (1861-2011): the state of the art," Tech. Rep. 62209, MPRA.

FRANKLIN, R. S. AND E. S. VAN LEEUWEN (2018): "For whom the bells toll: Alonso and a regional science of decline," *International regional science review*, 41, 134–151.

FRATESI, U. AND G. PERUCCA (2018): "Territorial capital and the resilience of European regions," *The Annals of Regional Science*, 60, 241–264.

GAMBI, L. (1972): "I valori storici dei quadri ambientali," in *Storia d'Italia. I Caratteri Originali*, ed. by R. Romano and C. Vivanti, Turin: Giulio Einaudi, 5–132.

GARCÍA-RUIZ, J. M., T. LASANTA, E. NADAL-ROMERO, N. LANA-RENAULT, AND B. ÁLVAREZ-FARIZO (2020): "Rewilding and restoring cultural landscapes in Mediterranean mountains: opportunities and challenges," *Land use policy*, 99, 104850.

GOBBI, O. (2004): "Gerarchie e organizzazione del territorio dei Sibillini in età moderna," in *Economie nel tempo. Persistenze e cambiamenti negli Appennini in età moderna*, ed. by A. G. Calafati and E. Sori, Milan: Franco Angeli, 39–75.

GUSTAFSON, P. (2001): "Meanings of place: Everyday experience and theoretical conceptualizations," *Journal of environmental psychology*, 21, 5–16.

HADDAWAY, N. R., D. STYLES, AND A. S. PULLIN (2013): "Environmental impacts of farm land abandonment in high altitude/mountain regions: a systematic map of the evidence," *Environmental Evidence*, 2, 1–7.

HAN, M., J. HÅKANSSON, AND L. RÖNNEGÅRD (2016): "To What Extent do Neighbouring Populations Affect Local Population Growth Over Time?" *Population, Space and Place*, 22, 68–83.

IMPERIALE, A. J. AND F. VANCLAY (2016): "Experiencing local community resilience in action: Learning from post-disaster communities," *Journal of Rural Studies*, 47, 204–219.

INEA (1937): "L' Appennino abruzzese-laziale," in *Lo spopolamento montano in Italia*, ed. by INEA, Rome: Failli, vol. VII.

——— (1938): "Relazione generale," in *Lo spopolamento montano in Italia: indagine geografico-economico-agraria*, ed. by INEA, Rome: Failli, vol. VIII.

ISSERMAN, A. M., E. FESER, AND D. E. WARREN (2009): "Why some rural places prosper and others do not," *International regional science review*, 32, 300–342.

ISTAT (1935): *Censimento generale della popolazione: 21 aprile 1931*, vol. VII, Rome: Istituto poligrafico dello stato.

——— (1957): *Dizionario ufficiale dei comuni e dei centri abitati*, vol. I, ISTAT, Rome.

——— (1958): *Censimento generale della popolazione: 4 novembre 1951*, vol. VIII, Rome: Soc. Abete.

JOHNSON, K. M. AND D. T. LICHTER (2019): "Rural depopulation: growth and decline processes over the past century," *Rural Sociology*, 84, 3–27.

KOHLER, T., N. ELIZBARASHVILI, G. MELADZE, D. SVANADZE, AND H. MEESSEN (2017): "The demogeographic crisis in Racha, Georgia: Depopulation in the central Caucasus mountains," *Mountain Research and Development*, 37, 415–424.

KÜHN, M. (2015): "Peripheralization: Theoretical concepts explaining socio-spatial inequalities," *European Planning Studies*, 23, 367–378.

LE BRAS, G. AND M. LE BRAS-FOLAIN (1976): *L'église et le village*, Paris: FeniXX.

LEETMAA, K., A. KRISZAN, M. NUGA, AND J. BURDACK (2015): "Strategies to cope with shrinkage in the lower end of the urban hierarchy in Estonia and Central Germany," *European Planning Studies*, 23, 147–165.

LI, Y., H. WESTLUND, AND Y. LIU (2019): "Why some rural areas decline while some others not: An overview of rural evolution in the world," *Journal of Rural Studies*, 68, 135–143.

LIEPINS, R. (2000): "Exploring rurality through community: discourses, practices and spaces shaping Australian and New Zealand rural communities," *Journal of Rural Studies*, 16, 325–341.

LOWE, P. AND N. WARD (2009): "England's rural futures: A sociogeographical approach to scenarios analysis," *Regional Studies*, 43, 1319–1332.

MADJEVIKJ, M., B. A. TOSHEVSKA, S. GORIN, M. LJAKOSKA, ET AL. (2016): "The regional differentiation of the demographic movements in the Republic of Macedonia," *Environmental & Socio-economic Studies*, 4, 10–20.

MALÝ, J. (2018): "Questioning territorial cohesion: (Un)equal access to services of general interest," *Papers in Regional Science*, 97, 323–343.

MARINELLI, B. (2009): "Tintori e lanaioli nella Valle del Menotre," *Prosposte e Ricerche*, 63, 8–17.

MATANLE, P. AND A. S. RAUSCH (2011): *Japan's shrinking regions in the 21st century: Contemporary responses to depopulation and socioeconomic decline*, Cambria press.

MATHIEU, J. (2000): "From ecotypes to sociotypes: Peasant household and state-building in the Alps, sixteenth–nineteenth centuries," *The History of the Family*, 5, 55–74.

MCLEMAN, R. A. (2011): "Settlement abandonment in the context of global environmental change," *Global Environmental Change*, 21, S108–S120.

MCMANUS, P., J. WALMSLEY, N. ARGENT, S. BAUM, L. BOURKE, J. MARTIN, B. PRITCHARD, AND T. SORENSEN (2012): "Rural Community and Rural Resilience: What is important to farmers in keeping their country towns alive?" *Journal of Rural Studies*, 28, 20–29.

MILBOURNE, P. (2007): "Re-populating rural studies: Migrations, movements and mobilities," *Journal of Rural Studies*, 23, 381–386.

MLADENOV, C. AND M. ILIEVA (2012): "The depopulation of the Bulgarian villages," *Bulletin of Geography. Socio-economic series*, 99–107.

MYRDAL, G. AND P. SITOHANG (1957): *Economic theory and under-developed regions*, Duckworth London.

ORCAO, A. I. E. AND C. D. CORNAGO (2007): "Accessibility to basic services in one of the most sparsely populated areas in Europe: the province of Teruel (Spain)," *Area*, 39, 295–309.

OTTERSTROM, S. M. AND J. M. SHUMWAY (2003): "Deserts and oases: The continuing concentration of population in the American Mountain West," *Journal of Rural Studies*, 19, 445–462.

PECQUEUR, B. (2001): "Qualité et développement territorial: l'hypothèse du panier de biens et de services territorialisés," *Économie rurale*, 261, 37–49.

PETERS, D. J., S. HAMIDEH, K. E. ZARECOR, AND M. GHANDOUR (2018): "Using entrepreneurial social infrastructure to understand smart shrinkage in small towns," *Journal of Rural Studies*, 64, 39–49.

PHYTHIAN-ADAMS, C. (1993): "Local history and societal history," *Local Population Studies*, 51, 30–45.

PIKE, A., S. DAWLEY, AND J. TOMANEY (2010): "Resilience, adaptation and adaptability," *Cambridge journal of regions, economy and society*, 3, 59–70.

PINILLA, V., M.-I. AYUDA, AND L.-A. SÁEZ (2008): "Rural depopulation and the migration turnaround in Mediterranean Western Europe: a case study of Aragon," *Journal of Rural and Community Development*, 3, 1–22.

POPPER, D. E. AND F. J. POPPER (1987): "The Great Plains: from dust to dust," *Planning*, 53, 12–18.

QUAINI, M. (1973): "Geografia storica o storia sociale del popolamento rurale?" *Quaderni storici*, 8, 691–744.

REHER, D. S. (2007): "Towards long-term population decline: a discussion of relevant issues," *European Journal of Population/Revue europeenne de demographie*, 23, 189–207.

REYNAUD, C. AND S. MICCOLI (2019): "Population ageing in Italy after the 2008 economic crisis: A demographic approach," *Futures*, 105, 17–26.

RIZZO, A. (2016): "Declining, transition and slow rural territories in southern Italy Characterizing the intra-rural divides," *European Planning Studies*, 24, 231–253.

RODRÍGUEZ-POSE, A. (2018): "The revenge of the places that don't matter (and what to do about it)," *Cambridge journal of regions, economy and society*, 11, 189–209.

RODRÍGUEZ-SOLER, R., J. URIBE-TORIL, AND J. D. P. VALENCIANO (2020): "Worldwide trends in the scientific production on rural depopulation, a bibliometric analysis using bibliometrix R-tool," *Land Use Policy*, 97, 104787.

ROSSI DORIA, M. (1958): *Dieci anni di politica agraria nel Mezzogiorno*, Bari: Laterza.

SÁNCHEZ-ZAMORA, P., R. GALLARDO-COBOS, AND F. CEÑA-DELGADO (2014): "Rural areas face the economic crisis: Analyzing the determinants of successful territorial dynamics," *Journal of Rural Studies*, 35, 11–25.

SAVILLE, J. (1957): "Rural Depopulation in the United Kingdom," .

SMAILES, P. J., N. ARGENT, AND T. L. GRIFFIN (2002): "Rural population density: its impact on social and demographic aspects of rural communities," *Journal of Rural Studies*, 18, 385–404.

SONG, W. AND H. LI (2020): "Spatial pattern evolution of rural settlements from 1961 to 2030 in Tongzhou District, China," *Land Use Policy*, 99, 105044.

Sørensen, J. F. (2018): "The importance of place-based, internal resources for the population development in small rural communities," *Journal of Rural Studies*, 59, 78–87.

Sori, E. (2004): "Storiografia e storia della montagna appenninica: l'evoluzione demografica," in *Economie nel tempo. Persistenze e cambiamenti negli Appennini in età moderna*, ed. by A. G. Calafati and E. Sori, Milan: Franco Angeli, 39–75.

Sousa, S. and P. Pinho (2015): "Planning for shrinkage: Paradox or paradigm," *European planning studies*, 23, 12–32.

Stiglitz, J. E., A. Sen, and J.-P. Fitoussi (2010): *Mismeasuring our lives: Why GDP doesn't add up*, The New Press.

Stockdale, A. (2016): "Contemporary and 'messy'rural in-migration processes: Comparing counterurban and lateral rural migration," *Population, Space and Place*, 22, 599–616.

Teti, V. (2004): *Il senso dei luoghi: paesi abbandonati di Calabria*, Rome: Donzelli.

——— (2017): *Quel che resta: l'Italia dei paesi, tra abbandoni e ritorni*, Rome: Donzelli.

Tino, P. (2002): "Da centro a periferia. Popolazione e risorse nell'Appennino meridionale nei secoli XIX e XX," *Meridiana*, 15–63.

van der Zanden, E. H., P. H. Verburg, C. J. Schulp, and P. J. Verkerk (2017): "Trade-offs of European agricultural abandonment," *Land use policy*, 62, 290–301.

Vitte, P. (1995): *Le campagne dell'alto Appennino: evoluzione di una società montana*, Unicopli.

Walford, N. (2001): "Reconstructing the small area geography of Mid-Wales for an analysis of population change 1961–95," *International Journal of Population Geography*, 7, 311–338.

——— (2007): "Geographical and geodemographic connections between different types of small area as the origins and destinations of migrants to Mid-Wales," *Journal of Rural Studies*, 23, 318–331.

Wang, C., B. Gao, Z. Weng, and Y. Tian (2020): "Primary causes of total hamlet abandonment for different types of hamlets in remote mountain areas of China: A case study of Shouning County, Fujian Province," *Land Use Policy*, 95, 104627.

Wang, C., Y. Wang, B. Gao, Z. Weng, and Y. Tian (2021): "Manifestations and patterns of village abandonment in mountains of China from a dynamic perspective," *GeoJournal*, 86, 93–108.

Ward, N. and D. L. Brown (2009): "Placing the rural in regional development," *Regional studies*, 43, 1237–1244.

Wickham, C. et al. (1988): *The mountains and the city: the Tuscan Appennines in the early Middle Ages*, Oxford: Oxford University Press.

Wuthnow, R. (2019): *The left behind*, Princeton University Press.

Zullo, F., A. Marucci, L. Fiorini, and B. Romano (2020): "The Italian Apennines between earthquakes, high naturalness and urban growth," *Environment and Planning B: Urban Analytics and City Science*, 47, 716–731.