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DIFFERENCES AND SIMILARITIES BETWEEN DEPOPULATING AND REPOPULATING MUNICIPALITIES

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Abstract

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In a world with rapid growing cities and in the aftermath of a global pandemic that restricted mobility, marginalized areas that had been previously abandoned are coming back to the forefront of debate, with the topic of depopulation being at the centre of it.

This project explores the differences between depopulating and repopulating municipalities in the context of the region of Catalonia in the last decades. A panel of indicators measuring different aspects concerning demographics, economy and availability of services are compared between repopulating and depopulating municipalities within a push and pull framework of analysis.

The results show that there are few significant differences between depopulating and repopulating municipalities in the studied topics. Coinciding with previous research, it is found that depopulating municipalities have a higher prevalence of older people. Moreover, it is shown that women play a crucial role in the depopulating processes. The analysis of the availability of services provides surprising findings, as some are more easily available for depopulating municipalities instead of repopulating ones, thus challenging the assumption of them being a protective factor.

Keywords: Repopulation, Depopulation, Population, Demographics, Rural, Migration

Content

1. Introduction

People's preferences are in constant evolution as the world changes, resulting in new inventions, new values and new ways of doing things that drive progress and changes further. Decisions on where to locate are no exception to being in constant change, creating fluctuations in population and migration fluxes.

Depopulating, repopulating and population growth are natural demographic behaviours that municipalities – or any populated areas – have experienced through time. Hunter-gatherer societies, at the beginning of human society, did not have fixed instalments, as they were nomads and followed the animals they hunted and moved to areas with available seasonal plants in order to subsist. As agriculture developed and livestock was domesticated, it was possible for early humans to found settlements, who valued areas located in mountains or with a difficult accessibility and good view of the surroundings as a form of defence against possible invaders. However, as Greeks, Romans and Phoenicians took the Mediterranean and commerce grew, many of those locations became abandoned as new commercial cities thrived offering new opportunities. Further ahead, during the Industrial Revolution and during the 50s, 60s, and early 70s many families were prompted to leave the countryside and move to cities, where there were more employment opportunities. All in all, humans have always tried to find the location that best fitted their needs, as these historical cases demonstrate, and they will continue to do so as new necessities emerge.

The COVID-19 pandemic may be the most recent shock to have an impact on demographics. On one hand, the increase in mortality due to the illness has disproportionally affected areas with a larger proportion of older population. On the other, it may have an impact on moving preferences, standing as a unique opportunity to learn and reflect about the unintended consequences of mobility restrictions imposed to stop the spread of the virus (Nathan & Overman, 2020; Phillipson et al., 2020). Many cities registered lower levels of carbon emissions (Baldasano, 2020) and many companies adopted remote-working policies that allowed their employees to work from home (INE, 2020d). With strict confinement rules and the establishment of remote work, life in the countryside may have become more attractive for many urbanites, who may now consider moving from their densely-populated cities to more rural areas in which they can afford more space and be closer to nature (Bayona i Carrasco & Gil Alonso, 2013). Indeed, some

authors have already started to ponder about the likely impact of COVID-19 on future demographic changes (Nathan & Overman, 2020; Phillipson et al., 2020).

Changes in dwelling preferences are not bad per se, but understanding what makes municipalities more or less attractive to retain population is important to design policies that target the weaknesses and ensure that everyone, regardless of where they live, have access to the same opportunities and can have all their necessities satisfied. In this paper, the aim is to understand the current situation concerning municipalities that experienced negative population growth during the first decade of the millennium (2000 to 2010), and how have they changed during the last ten years (2010 to 2020). Thus, providing a baseline analysis of the situation and serving as a benchmark to compare changes that may occur in the future related with COVID-19 or other events. In particular, the paper compares the characteristics of municipalities that experienced negative population growth from 2000 to 2010 and from 2000 to 2020 in Catalonia, a state in the north-eastern part of Spain. The first group, is categorized as *repopulating* municipalities, as they had negative growth only for the first decade. The second group contains the *depopulating* municipalities, that have had negative growth throughout all the period studied.

The paper fills an important gap in the topic of repopulation, which is often understudied. Moreover, municipalities are understood as agents of change, so the analysis focuses on elements to which the municipality has some degree of control and the discussion is oriented towards policymakers and possible policy outcomes. Thus, the focus is removed from individuals and the exact reasons why they may decide to move in or out of a municipality, and it is put on what makes a place more or less attractive to them.

The study is composed of two stages, one of exploration of the processes of population growth, depopulation and repopulation and another for the predicting factors for such movements and how they can be observed in the studied areas. In terms of organization, the paper first provides a brief background about the area of study, Catalonia, and its current general demographic situation. This is followed by an extensive review of the factors that may contribute to the distinct patterns of growth, presented within a push and pull framework, and then an in-depth exploration of each of the demographic trends and their understanding in the context of the research. The following section includes the methodological processes, including the methods that are used, theoretical basis and reasoning for the use of such methods and the process of selection of the data. Next, the collected data is analysed and the results are presented in separate sections for each of the

demographic trends studied. Finally, the paper moves on to the discussion and conclusion, that provides a summary of the main findings and the principal similarities and differences between municipalities with positive and negative growth are discussed. Furthermore, this section also discusses the possible policies that could be implemented in the form of practical advice.

2. Motivation

The paper contributes to a growing literature on depopulation and demographic processes by filling the gap in research in the area of Catalonia, exploring the factors from an institutional perspective and the concept of repopulation throughout a twenty years period. Many studies have been oriented to understanding the motivations of individuals for moving in or out of their original municipalities (Díaz Méndez, 2005; Pérez Morote et al., 2021) as well as the study of the statistical consequences of the demographic changes this has caused (Alamá Sabater et al., 2021; Johnson & Lichter, 2019). Nevertheless, municipalities, understood as an active agent, have been rarely put at the centre of the debate, despite their important role as an institution. Furthermore, they have the capacity to alter the paradigm up to some extent, by offering certain services and opportunities, and thus being able to tackle and improve on some of the key factors that influence depopulation. Therefore, one of the aims of this research is to focus on the institutions and the factors that have a relation with population dynamics in which they may have some degree of autonomy to change.

It could be argued that the changes in living preferences are normal, and that it is there not necessary to take any institutional action. Nevertheless, most administrations are concerned about this topic because of its negative consequences. Indeed, the abandonment of rural areas in particular is a topic of concern in many countries, and it has become the focus of agrarian policies in the European Union (Committee on Regional Development, 2021). Historically, the Spanish administration, similar to other countries' administrations, tried to tackle down the depopulation issue through the use of fiscal incentives to promote the homogeneous distribution of the population (del Romero Renau, 2018b; Á. Paniagua, 2016), with varying degrees of success. Nevertheless, since the 21st century, the population concentrated in big metropolitan areas has increased, while populations in country-side areas have decreased and been left lagging behind. Thus, current policies focus on reducing asymmetries in the access to opportunities. Indeed, the principal objectives of the EU agrarian policies (Committee on Regional Development, 2021) mentioned before include the aim to guarantee equal provision of services and citizens' rights, in order to detach their geographical location from the availability of opportunities and reversing – or at least stopping – current depopulation trends, especially in rural areas.

Some classical arguments arguing for institutional action against depopulation have focused on the cultural losses, but there are also a more nationalistic arguments, expressing concern for the maintenance of the culture or language (del Romero Renau, 2018a; Laborda Soriano et al., 2021). These authors argue that globalization exercises great pressure on municipalities to conform to a certain standard favouring more productive occupations and contributes to the erasure of languages that have a low number of users. Thus, traditional occupations without international relevance may be replaced by more modern ones, despite their importance for the region itself. Other arguments, from a more economic perspective, include the impact of the abandonment of rural spaces and especially its effect on agriculture. Due to rural areas being responsible for most agricultural activities, as population ages and the generational relief goes unmet, the sustainability of food production becomes a challenge (del Romero Renau, 2018a). This results in an increased dependency of the country on foreign food imports (del Romero Renau, 2018b). Furthermore, depopulation has also been linked as contributing to lower economic growth, as it makes those areas less productive (Amcoff & Westholm, 2007).

Finally, from the point of view of livelihood conditions, depopulating municipalities are faced with meeting the expectations of providing high quality services, oftentimes with not enough funding (Christiaanse, 2020). Paradoxically, the unmet demand of services may contribute to lower the attractiveness of a municipality, reducing the population, which in turn leads to an even lower demand that eventually, reduces the availability of job opportunities as well. Thus, as mentioned in the previous paragraph, posing a threat to traditional occupations and cultural heritage, among others. However, an increased interest in repopulating vacant areas may come with negative consequences related to housing if not planned. For instance, the fact that people with higher paying jobs may be able to move out of the city more easily, may cause a disparity between the purchasing power of the new-comers compared to the old inhabitants, triggering processes akin to gentrification (Solana-Solana, 2010).

3. Literature review

Globally, population is increasing, especially in cities, where more than half of the population already lives (UN News, 2014). Indeed, the UN projects that by 2050, 70% of the world population will live in cities (2018). Nevertheless, while these areas grow, others, especially in the rural regions, are becoming abandoned (del Romero Renau, 2018a; Laborda Soriano et al., 2021).

Population growth, positive or negative, is principally determined by the relations between births and deaths and between emigrating and immigrating individuals. However, most of the growth, or lack of it, nowadays seems to be heavily influenced by migration decisions (Johnson et al., 2015; Laborda Soriano et al., 2021). In fact, immigration has been found to have an important role in reverting depopulation (Alamá Sabater et al., 2021; Collantes et al., 2014; González Leonardo & López Gay, 2019) while emigration is a contributor to the negative rate of natural increase (Burholt & Dobbs, 2012; Johnson & Lichter, 2019).

This section explores the context of the area of study as well as the current literature regarding demographic trends and the drivers that have been identified as influencing migration decisions on a context of a push-pull framework of analysis.

3.1. Context of the area of study

The project studies the case of Catalonia, one of the seventeen autonomous communities of Spain, located in the north-eastern part of the Iberian Peninsula. Spain is one of the largest countries in Europe, although it has a relatively low population density, below the total average (Eurostat, 2019). However, there are important differences within the country, with population concentrating in the coastal areas as well Madrid, the country's capital, while the area in the central part has very low population density and is often referred to as the 'void Spain' (Domínguez Álvarez, 2020).

The project chooses to focus on the case of the autonomous community of Catalonia because of the vast heterogeneity existing in Spain, as many autonomous communities have their own culture, language and economic dynamics. Furthermore, they are similar to states in that they have their own regional governments, which can promulgate their own laws and legislate independently from the central government in the competences

they have transferred. For example, agricultural policy is one of the competences that have been assumed by all the autonomies, while Catalonia has its own education and healthcare systems.

Catalonia is located in the north-east coast of the Iberian Peninsula. The Pyrenees make a border at the north with France and Andorra, while the Mediterranean Sea is the natural border at the east and south-east. It also borders with the autonomous communities of Valencia in the south and Aragon in the west. Due to its strategic position, as an entrance to Europe as well as a port to the Mediterranean, it has historically been an important hub for commerce and knowledge. However, there are important differences within Catalonia and among the four provinces that conform it: Barcelona, Girona, Lleida and Tarragona. While sharing the same government and language, there are important differences among the provinces, that contribute to important heterogeneity in the distribution of population and the characteristics of the municipalities. Barcelona is the province with the highest income, bigger population and also the greatest number of municipalities, and its capital, Barcelona, is also the capital of Catalonia and one of the most important cities of Spain. Its income is derived from tourism, but also industry and services. The economy of Tarragona and Girona relies more heavily on tourism and related services, although agriculture and other primary sector activities are important. Finally, the province of Lleida has the biggest share of agricultural activities in its economy, but tourism is also an important source of income especially in winter and for mountain-related activities (Catalunya, n.d.).

Municipalities are the unit of analysis of the project and the smallest administrative level entity in Catalonia. They were constituted on basis of historical dynamics, and their competences in Catalonia are determined by the Legislative Decree 2/2003 approved on April 2003 (Catalan Autonomous Community, 2003). These competences include tax collection, census data collection and the provision of security plans, environment protection and public service management, such as primary health care and public transportation. Nevertheless, it is important to know that these competences must not interfere with the ones from higher-level entities.

The topic of depopulation has been widely studied in Spain, as the situation has been considered particularly concerning, especially in rural and agricultural areas (Alamá Sabater et al., 2021). Extremadura and Galicia, autonomies at the west and north-east of the country, have been thoughtfully studied, as they present the highest population deficits (see Collantes et al., 2014, fig. 3). Catalonia is the second most populated autonomy of

the total of seventeen (plus two autonomous communities), with 16,40% of the total Spanish population. It is also the fourth in GDP after Madrid, the Basque Country and Navarra. Moreover, Catalonia has been an important pole of attraction for migrants from agricultural areas for several decades thanks to its advanced industry and its international communications. Nevertheless, not all areas of Catalonia have been as attractive and, indeed, such attraction has concentrated in its capital, Barcelona, which is the second largest city in the country, with more than 1.5 million inhabitants.

The case of depopulation in Catalonia, while maybe not as extreme as in other communities, is particular due to the great asymmetries and diversity of population among its municipalities, with a more than one million difference in inhabitants from the most populated municipality, Barcelona, to the second, L'Hospitalet de Llobregat. Furthermore, the provinces of Girona and especially Lleida have the highest share of small municipalities, with as few as 30 inhabitants. On the other hand, municipalities in the metropolitan area of Barcelona, constituted by 36 municipalities, have almost half of the population (43%) of the total population of Catalonia (Catalan Institute of Statistics, 2020). Such asymmetries may emphasize the concentration power of bigger cities, where the majority of services and jobs are located, at the expense of smaller municipalities, where some services and income opportunities are more limited (del Romero Renau, 2018b). Thus, it is important for policy-makers to understand the nature of the different municipalities and develop the necessary tools to ensure that demographic differences do not exclude anyone from accessing opportunities.

In summary, this is a case for the study of depopulation and repopulation from the perspective of institutions – and what they might be able to do. It explores the factors that influence the demographic behaviour that municipalities may be experiencing and offers a decision on how to change them, particularly after COVID. Furthermore, this project aims at filling a gap in the knowledge of repopulating municipalities, which are those that used to depopulate but could achieve positive growth in the last decades. Finally, it is important to emphasize that it is not the intention of this paper to argue that depopulation is bad per se, but rather to understand and perhaps offer a possible direction for municipalities that may wish to change their situation.

3.2. Demographic trends

Two distinct trends are compared and studied in this paper: depopulation and repopulation. This categorization results from a theoretical observation exercise rather than a literary revision one: most municipalities grow organically or maintain their populations in response to fluctuations in births and deaths. Some of them lose population instead, becoming a serious issue in some areas. Under this logic, repopulation seems a necessary phenomenon for municipalities that were depopulating but were able to revert their trend.

Previous literature has studied municipal growth, and especially depopulation (López Trigal et al., 2009; see Á. Paniagua, 2016), but literature on repopulating municipalities is much more limited (Collantes et al., 2014). Moreover, there is no consistent methodology to identify each of the trends nor a unique definition. It is for this reason that in this paper they are defined based on multiple approaches used by previous literature.

Depopulation literature often contraposes urban and rural areas, associating the later with processes of population decline (del Romero Renau, 2018a; Díaz Méndez, 2005) and the first with increases in population and cities as a broad concept. Nevertheless, these are complex and subjective concepts. Commonly accepted definitions for rurality relate it to agriculture and country-life. Other, much-broader definitions, uses it as a synonym for an isolated area in decline (Á. Paniagua, 2016), which often relies on agricultural income or just as the contrary of urban area (Díaz Méndez, 2005). Nevertheless, some authors have challenged this dichotomy, presenting these concepts as socially constructed categories and much more similar than initially assumed (Díaz Méndez, 2005). Furthermore, authors like Collantes et al. note that rural can have multiple meanings depending on the context: demographic, referring to low-density areas; occupational, referring to agriculture; cultural, referring to traditional values; or be a social construct and self-definition (Collantes et al., 2014).

The focus of this project is on Catalan municipalities, regardless of their size. Furthermore, it is not the objective of this project to contrapose urban and rural areas nor to explore their intrinsic characteristics. Rather, the aim is to define municipalities only based on their characteristics and their growth behaviour. Therefore, the municipalities of the study are not to be referred as rural, as it is not something that is explored in this paper. However, most literature about depopulation focuses on rural areas, and it is

assumed that the processes identified in such literature may be useful to explain the underpinning logic for depopulation.

3.2.1. Depopulation

As the number of municipalities, both in rural and urban environments, affected by negative population growth increased, depopulation has become a topic of interest (del Romero Renau, 2018b; Martinez-Fernandez et al., 2012).

Depopulation is a process in which sustained negative population growth has led to a decrease in the total population. It may be the result of a decrease in the number of births accompanied by a relative increase in the number of deaths, or be caused by an outflux through migration. The loss of young population, who are the age group that is more likely to emigrate, contributes to lower natality rates and increases the average age, further reinforcing negative growth (Johnson & Lichter, 2019; Laborda Soriano et al., 2021).

The concept of depopulation is strongly linked to the concept of rurality and agriculture-based economies, especially in the study of depopulation in Spain (del Romero Renau, 2018a). However, these are not the only types of municipalities affected by it. Industrially-based municipalities, in which most inhabitants work for the same firm, are also at risk for depopulation if the firm closes or if production is offshored (Johnson & Lichter, 2019). Furthermore, the population of former big cities has started to decline, as their main economic activities have become less powerful magnets and innovation has stalled (Martinez-Fernandez et al., 2012).

Most authors on rural depopulation agree on the fact that, at least in the 20th century, depopulation was caused by the loss of non-agricultural employment that prompted families to move to cities, where jobs were less scarce (Collantes et al., 2014; del Romero Renau, 2018a). But some authors have argued that out-migration trends have changed (Collantes et al., 2014), with higher education being a predictor for mobility in young generations (González Leonardo & López Gay, 2019; López Trigal et al., 2009) and emphasizing the influence that neighbouring municipalities have (Alamá Sabater et al., 2021). Other influencing factors may be the type of economy and the level of skill it requires and the services available in the municipality, as well as how isolated it is (Alamá Sabater et al., 2021). Nevertheless, other studies argue that individual characteristics may be the principal determinants for out-migration (Díaz Méndez, 2005).

3.2.2. Repopulation

The other concept explored in the paper is repopulation. Repopulation does not have a specific definition in the literature, but for the purposes of this paper, it is understood as when something had lost population on the past but it is introduced again.

Repopulating areas must be a different category from those that have not had sustained population declines, as in this case, it is assumed that something must have changed to switch the trend. Such changes may be related to internal or external causes, the first being related to changes in the offer of the city while the external cause may be the result of a change in preferences for the existing population deciding not to leave or migrants deciding to locate there. Moreover, they can be the key to understanding what switches demographic trends.

Repopulating municipalities are generally the product of migration. Migration is often cited as a way of resolving the deep depopulation issues faced in some areas of Spain (Bayona i Carrasco & Gil Alonso, 2013; Collantes et al., 2014), as migrants are generally young people and, if provided with stability, they might choose to establish their family in the municipality, boosting natality rates. Other reasons that might contribute to the repopulation of municipalities is the development of services and a high-quality employment market. Investment in culture and in tourism have also been linked to a probable contributor, but evidence is not clear (Merino & Prats, 2020). Moreover, in the case of tourism, while may contribute to the municipal economy and generate jobs, these can be only seasonal, making it unlikely for workers to change their habitual residence (Bayona i Carrasco & Gil Alonso, 2013). Finally, increasingly flexible labour markets may allow remote job, thus making it possible to settle in municipalities where it would have been mostly impractical before due to long commuting times (Hardill & Green, 2003; Pérez Morote et al., 2021).

In any case, it is important to manage the changes in population dynamics, as to avoid longer-term problems. For instance, a topic of concern may be gentrification and similar problems, that are brought by the introduction of new inhabitants with comparatively higher disposable income, that may affect local commerce and destabilize housing prices, among others, especially in smaller areas more sensitive to such changes (Solana-Solana, 2010).

3.3. Pull and Push Factors

The paper focuses mainly on the role of migration and in particular, its determinants and predictors because they seem to be the primarily driving forces behind Spain's population changes. Indeed, in 2020, Spain had fewer births than deaths, a trend that has been observed since 2015 (INE, 2021). Nevertheless, the negative natural population change is offset by a positive migration balance, which has increased population since 2015 (INE, 2020b). Moreover, migration is a prevalent focus of research in the study of demographic phenomena (Alamá Sabater et al., 2021; Collantes et al., 2014; González Leonardo & López Gay, 2019) and also a significant contributor to negative natural population change (Burholt & Dobbs, 2012; Johnson & Lichter, 2019). Therefore, the factors explored are primarily related to things that infer in individuals' intentions to migrate rather than their decision to have (more) children.

Different theories from multiple fields have attempted to explain the phenomenon of migration especially at the international level (Wimalaratana & Wickramasinghe, 2016). The pull and push factors theory by Everett Lee (1966) is a good choice to identify the factors and how they might interact in motivating the perceived attractiveness of a municipality and, thus, its potential to attract migrants and retain its current population. The pull and push factors theory framework has been used as a theoretical base by several authors (Etzo, 2011; Pérez Morote et al., 2021; Renaud et al., 2011; Van Hear et al., 2018). This framework helps conceptualize migration and the resulting demographic change as the result of the conflict between pull and push factors and argue from the point of view of the institutions. In this case, pull factors are those that make the place of living attractive, such as the standard of living and job opportunities, while push factors are those that motivate migration, such as poverty or lack of services (Lee, 1966).

The following paragraphs offer an in-depth review of the mechanisms through which the labour market, services and lifestyle may interact in influencing the decision of individuals to migrate. The drivers analysed in this review are a non-comprehensive list of factors identified in previous literature within the topics of labour opportunities, services and life choices (see Alamá Sabater et al., 2021; Bayona i Carrasco & Gil Alonso, 2013; Pérez Morote et al., 2021). Nevertheless, it is important to account for the potential interaction effects of each of them as well as their impact not only on migration but on other determinants of population growth, that cannot be accounted for within the scope of this project.

3.3.1. Labour Opportunities

Labour market opportunities are one of the most widely researched and understood drivers for mobility (Alamá Sabater et al., 2021; Pérez Morote et al., 2021), which have mediated mobility decisions for many centuries. However, with the spread of remote-working, the effect of the labour market may become less determinant than it used to be (Hardill & Green, 2003; Pérez Morote et al., 2021), as it allows to access a bigger job market from a small municipality. Therefore, it is expected that municipalities that are able to offer more opportunities in the labour market, as well as more stability, will be more likely to retain or even attract population. On the other hand, a high prevalence of the agricultural sector may be a pushing factor for municipalities, contributing to negative growth rates.

This section explores the different indicators within the topic of labour opportunities and how they may influence migration decisions that result in the studied demographic trends.

Number of Businesses. Individuals have often moved where they could obtain better resources and maintain themselves and their family. In the case of Spain, there have been important migration waves from the countryside to cities, from people who were forced to leave their work in the agricultural sector to pursue a better future. One of the most important migration waves in Spanish recent history was the one in the 50s and 70s that mobilized more than 3 million people (INE, 1958). During those decades already big cities like Barcelona and Madrid, as well as their adjacent municipalities, grew spectacularly while those which relied primarily on agricultural and artisanal activities emptied (INE, 1958).

Once cities have established themselves as places with job opportunities, the initial attraction capacity of the city is exponentially multiplied due to an ever-increasing demand of services as a consequence of the increase in population (del Romero Renau, 2018a; Pérez Morote et al., 2021). In other words, as more individuals move to the city, they create new demands, such as supermarkets, bars and shops, which attract more individuals in a multiplying effect. At the same time, there are more potential consumers, so more brands and businesses are likely to offer their services there, where the highest concentration of potential consumers is. For instance, the city of Barcelona has the highest share of businesses in the service sector in Catalonia with almost 40% of the total (INE, 2020a). Barcelona now has the widest offer of services, ranging from multiple cultural

events throughout the year, to a comprehensive and integrated public transport net, as well as three of the seven public universities of Catalonia, and is an important hub for multiple conferences and conventions.

As a result of this positive feedback process, municipalities with an already high number of businesses are more likely to keep growing, as they have a comparative advantage relative to those whose labour markets are smaller. Thus, as businesses grow, the population is also expected to grow. However, as the possibility of working remotely becomes wide-spread, this variable may become less important in movement decisions, allowing previously depopulating areas to repopulate, as people would be able to access big labour markets within their small municipalities (Hardill & Green, 2003; Pérez Morote et al., 2021).

Employment Stability. Apart from the availability of jobs, the quality of said jobs is also important to attract newcommers and retain possible migrants, as well as for their decisions of raising a family or not.

High chronic unemployment rates among young individuals and the general precarity of jobs that offer low wages in relation to living costs or only temporal contracts (Bueno & García-Román, 2021) have contributed to a sense of financial instability. As a result, they delay the decision of having children until a higher stability can be reached, which results in a lower number of children than it was initially desired or no children at all (Bueno & García-Román, 2021). Job security is an even higher concern for women (Bueno & García-Román, 2021), which might be explained by the fact that women usually expect having to balance work and family responsibilities, thus preferring to focus on getting to their desired job position before having children (Schoppa, 2010).

Job instability, as measured by unemployment rates and the share of permanent over temporary contracts, is expected to be higher in depopulating municipalities. They may have lost people due to out-migration towards more productive areas and, because young people are the ones more likely to emigrate (Johnson & Lichter, 2019) and the ones that stay may not have the means to raise a family, the number of births is also expected to decline and contribute to overall depopulation. Moreover, such jobs are less likely to motivate migrants to establish themselves or form families there.

Skills market. As stated before, the lack of labour opportunities is a known factor that increases the likelihood of moving. However, the type of labour market is also an important characteristic to keep in mind.

Rural towns, which are the ones more at risk for depopulation, are usually based on agricultural activities (del Romero Renau, 2018b), while the economies of urban municipalities, which are assumed to grow the most, are mostly based on services.

Because of this duality, individuals may want to move to job markets where their skills are valued. Areas which concentrate a high share of high-skill jobs and have a highly educated population are likely to attract more people, both for the high-skill jobs and the low-skill jobs that the later generate. On the contrary, areas with primarily low-skill jobs may be less likely to receive foreigners and more likely for the individuals with higher education to leave (Díaz Méndez, 2005). Assuming that the positive feedback effect affects the studied municipalities, it is expected that depopulating areas have jobs that require lower skills or offer worse work conditions.

Population structure. A final characteristic of municipalities that impact the labour market make-up is the size of its population. Rural populations, which are typically small, are traditionally at a higher risk for depopulation because they tend to have more limited labour markets. With a smaller number of potential customers, the demand for services is lower. Moreover, they have important comparative disadvantages with respect to bigger cities, and may be limited to jobs in particular industries (del Romero Renau, 2018b). As a result, the types of job offered, as well as the skills required, may be rather specific and contribute to out-migration movements based on skills. An important exception may be municipalities that have become touristic attractions, as despite their relative size, they are able to generate an important variety of jobs (Bayona i Carrasco & Gil Alonso, 2013) and thus may be increasing their population steadily or recover after some years of decline.

In other words, smaller populations may reinforce the drivers that contribute to out-migration, as smaller job markets may result in higher unemployment rates or a lack of jobs that are adequate to the skills of their population. The contrary happens for bigger populations, which may become hubs and have much bigger labour market. On the other hand, the process of getting a job may be easier in smaller towns, if people know each other and families own their own businesses (Díaz Méndez, 2005).

3.3.2. Services

As cities grow, both in population and in size, they start requiring more services to cater for the demand of their inhabitants and it becomes necessary to have an efficient and comprehensive transport system that connects the different parts of the city, among other services (Bayona i Carrasco & Gil Alonso, 2013). General commercial services are also set to increase as the higher share of potential consumers is a comparative advantage in relation to smaller municipalities. Finally, as more business locate in the city by the mechanisms explained in the previous section, the job market evolves, and may require specific skills or become more competitive in the higher-earning positions resulting in an increase in the demand for education (Pérez Morote et al., 2021).

The following paragraphs explore more in depth the services that may impact mobility decisions, as it is assumed that services are important and that municipalities that are able to offer them have a higher pulling force than those that do not. Therefore, it is expected to be more likely for repopulating municipalities to have access to schools or to healthcare centres compared to municipalities classified as depopulating.

Education offer. Basic education is compulsory for all children under 16 years old in Spain. However, while some schools must increase the number of children per teacher, some close for the lack of demand. There must be a minimum of 6 children attending an education centre for it to remain open. This means that there are some small municipalities without elementary schools, and many more without high schools, furthermore, in some cases their continuity is not guaranteed. The alternative is to attend schools outside the municipality, which may imply high commuting times for students and their parents. Furthermore, the total lack of schools might be an important factor for future families' settling decisions and the attachment of the inhabitants themselves (Boix Tomàs, 2014).

Education offer also includes higher education. Higher education, especially at the non-compulsory level, is more likely to be concentrated in areas with higher population density. In contrast to elementary schools, these often have a higher number of pupils per teacher, making it non-viable in smaller populations. Furthermore, higher non-compulsory education offers specialized training, allowing students to choose their career paths. Nevertheless, it is unlikely for a single centre to offer all the specialties, so in areas with a small number of centres, it is likely that many students must go far from their home-town to study. However, this creates a divide between families that can afford it and those that do not (Díaz Méndez, 2005).

At the same time, higher education availability affects the labour market quite directly by increasing the skill level of workers. Thus, if individuals are able to access higher education, they may have to move out of their home-towns to be able to work in their field (Díaz Méndez, 2005). Moreover, they are more likely to have formed relationships in other municipalities, making it easier for them to leave (Díaz Méndez, 2005; A. Paniagua, 2018).

The availability of education at the elementary level is therefore expected to be strongly correlated with natality rates and migration of young individuals, resulting in a lower likelihood of depopulation. Higher education, on the other hand, may be a good predictor of growth, as it is related with thriving labour markets (Domínguez Álvarez, 2020), so it might be associated with repopulation and a lower likelihood of sustained negative population growth.

Health services. Access to health services is also an important factor preventing depopulation (Christiaanse, 2020). In particular, primary healthcare has been shown to be a key piece in promoting healthy habits and preventing some diseases (Pané i Mena & Vargas Lorenzo, 2002). Furthermore, they can make the healthcare system more efficient by centralizing the information and being the first contact before passing a patient on to a specialist. Even more during the height of the COVID-19 pandemic, in which they took a principal role administering vaccines and tests. Primary health centres, known as CAP, usually employ general practitioners and paediatricians, although some bigger ones also offer dentist and gynaecologic care. Nevertheless, in smaller municipalities there is often no centre but a doctor visiting at patients' home.

Hospitals are the other important part of the Spanish healthcare system. They administer different specialties and take care of patients that require over-night care. Moreover, since the downsizing of CAP in the aftermath of the 2008 crisis, they have assumed emergency care assistance as well, as they remain open all day.

Healthcare services, especially those at the first level, suffer from increased pressure as municipalities change their size. If they experience a big growth burst, they may not be able to efficiently offer the necessary services. If, on the contrary, they lose population, it becomes more difficult to maintain the service and for it to be sustainable, even if due to a relatively higher share of older people the demand for services is higher (Laborda Soriano et al., 2021). Furthermore, the access to health services, and especially in the case

of emergencies reduces the risk of complications and death, so it is important to ensure that they are at a reasonable distance (Nicholl et al., 2007).

Therefore, it is expected that there is a higher prevalence of depopulating municipalities without access to healthcare services than repopulating municipalities.

Internet connection. A good internet connection has become essential for many people. Internet is used by many, including those that work from home, business-owners managing their online business or contacting their providers, as well as students that participate in online learning and use the internet for researching. Moreover, the number of users has been growing during the last years (INE, 2020c).

Nevertheless, the unequal access to internet services (see Ministerio de Asuntos Económicos y Avance Digital, 2020), generates challenges for operating remotely. Incentives to invest in internet connections in small municipalities, especially the ones with a higher share of older people, are low. There is no demand so there is no offer. However, this creates a vicious cycle that prevents those individuals that would live there to do so because of the lack of internet (Pérez Morote et al., 2021).

Internet access may be, however, the key for switching demographic trends, as remote working allows individuals to work from towns without a big job market but it requires reliable internet access (Hardill & Green, 2003; Pérez Morote et al., 2021). In this sense, internet access is expected to be related with positive population growth and viceversa.

Transport connections. Similar to internet access, transport communications are very important for modern societies. In the case of transportation, good roads allowed the establishment of industries, as they were able to easily receive the supplies and distribute the product. At the same time, increased efficiency allowed for lower costs and, consequently generally lower prices. As a result, more isolated municipalities will tend to be smaller and may have higher prices due to the higher distribution costs as well as the lack of competition.

Furthermore, transport connections are also important for social life. As an interviewee in Díaz Mendez's study points out, not having many restaurants or bars in their town is not a problem if they can go to the next one (Díaz Méndez, 2005).

Because smaller municipalities usually have much more limited public transport options, cars are often the only option. However, new regulations that impose a ban on older cars (Ley 7/2021, de 20 de Mayo, de Cambio Climático y Transición Energética,

2021) may have a negative impact on population growth of municipalities that are relatively close to bigger municipalities affected by such a ban. Without a parallel increase in public transport offer, it might be the case that leisure "commuters" decide to go live in a better connected location. Nevertheless, time is needed to assess such impact.

Finally, it is also worth noting that transport connections must be effective but, in some cases, there is a trade-off between the accessibility to a major connection and the amount of pollution and noise related to health problems (Díaz Jiménez & Linares Gil, 2015). Therefore, municipalities that have had important infrastructure changes in recent years might be at higher risk of losing some population.

In conclusion, transport connections are important to ensure that people living in different kinds of municipalities have access to the same opportunities and have their necessities satisfied, but there is a point of equilibrium. Furthermore, bad transportation systems may also make some prices relatively higher, making such municipalities less attractive to migrants. So, it is to be expected that the more isolated a municipality is, the more at risk for depopulation, but the same may be true if there are too many busy roads.

3.3.3. Life choices and values

Dwelling preferences have been traditionally widely influenced by labour market opportunities and the services offered (Alamá Sabater et al., 2021). However, life related choices as well as personal values may also be an important item to factor in (Bayona i Carrasco & Gil Alonso, 2013) for a deeper understanding of population moving dynamics.

Some authors have argued that the differences between urban and rural inhabitants have been erasing over time (Díaz Méndez, 2005). Nevertheless, some differences in lifestyle and values may still exist, or at least are perceived by individuals (Collantes et al., 2014). At the same time, low-density municipalities may have lower levels of pollution and a sense of quietness that cannot be found in the cities, while cities offer daily events that make it attractive for those looking for more active lifestyles.

This section explores how lifestyle and personal values and preferences may influence moving-out decisions, from how the cost of living to how the preference from a certain lifestyle may impact location behaviour.

Values and social exclusion. Personal and life-values, while not the principal determinant for population movements, might have an influence on the final decision (Bayona i Carrasco & Gil Alonso, 2013). Díaz Méndez's qualitative study (2005) found that many women from rural areas feel attachment to their home-towns, but regard them as quite old-fashioned and sometimes difficult to balance with their own personal ambitions. Life in bigger municipalities, on the other hand, awards anonymity and erases some of the expectations for girls (Díaz Méndez, 2005).

In a similar manner, LGBT+ communities, which oppose traditional values may be less likely to exist in smaller, more homogeneous and aged areas as opposed to bigger cities (Jubany et al., 2021); that are less likely to upheld traditional values and also have a lower risk of depopulation. However, there is not much concrete evidence that there is a total rejection of LGBT+ members in smaller municipalities, especially in the case of Spain. Jubany et al. (2021) find that some individuals feel less free because of the lack of anonymity and that they might miss the existence of organized communities, however, these do not seem to be considered important enough obstacles to require changing residency.

All in all, no strong evidence has been found regarding the link of mobility decisions and the clash between traditional values and more modern ones. Indeed, individuals seem to recognize the challenges they face in comparison to bigger municipalities, but they are not a determinant factor for mobility.

Housing preferences. As said in the previous section, the concentration of services in bigger municipalities is an important force of mobility (Bayona i Carrasco & Gil Alonso, 2013). Such availability in terms of variety and quantity leads to relatively lower prices as long as there is enough supply. In the case of the housing market, supply is relatively inelastic, leading to very high levels of demand in relation to existing supply which manifests in the form of high housing prices.

In the case of Catalonia, the price of housing varies widely. Among municipalities with more than 25.000 inhabitants, prices of housing ranged from the 3.300€/m^2 in Barcelona, the biggest Catalan city with 1,5 million inhabitants; to the 800€/m^2 in Tortosa, with about 2% of Barcelona's population in 2020 (see Ministerio de Transportes Movilidad y Agenda Urbana, n.d.). Indeed, the high cost of housing and gentrification in Barcelona and its surrounding area have prompted families to move to less-densely populated areas, in which they can access bigger spaces for the same cost, although most

moved to geographically close areas which offered similar services (Blanco Romero et al., 2018).

Thus, housing availability and cost is expected to be a predictor for out-mobility when costs are high and/or availability is low, while the contrary would be true for areas with the potential to grow their housing supply. Nevertheless, it is important to note that the attractiveness of an affordable housing market must be combined with the existence of services to make it feasible for people to actually move out.

Lifestyle and people preferences. Authors in the past argued that people that lived in urban and rural environments were different, but such dichotomy has been challenged arguing that globalization has made such differences smaller (Díaz Méndez, 2005).

However, it is undeniable that bigger cities concentrate more services and have more diversity of people, resulting in enough demand to make it feasible to offer specific products and services. For instance, the profile of vegans is more highly associated with urban environments (Carmona Díaz, 2012), resulting in a higher population of them and, therefore, the availably of multiple options to support this lifestyle. Nevertheless, it is difficult to assess whether the comparatively low prevalence of veganism in non-urban settings is related to the lack of options or if it is related to cultural differences (Carmona Díaz, 2012). If the first is true, movements from smaller areas would be expected if supply does not increase, but if the second is the case, and thus there is no demand for such services outside of urban areas, it is not likely to have an effect.

On the other hand, lifestyles associated with rural spaces are often attractive to urbanites who wish to be more in tune with nature (Bayona i Carrasco & Gil Alonso, 2013). Therefore, it would be expected that individuals value the natural endowments often found in smaller municipalities, but it seems to have a negative effect on municipality growth (Alamá Sabater et al., 2021).

So, in general, it is difficult to predict the direction of the relation between lifestyle and preferences and moving behaviour. They seem to be only small factors and not critical determinants, but it might be possible that, if smaller municipalities are able to open themselves and offer different options aligning with individuals' values, they can compete with bigger municipalities in attracting migrants or avoiding further population declines.

4. Methodology

The objective of the study is to be able to find which are the characteristics of municipalities with depopulating and repopulating trends to understand what sets them apart. To do so, municipalities are classified according to their typology and their characteristics are assessed using a set of indicators. Finally, they are compared to understand their differences and similarities.

The research is divided in two parts. The first part is a benchmark analysis on the demographic situation of the municipalities of Catalonia. The benchmark analysis is necessary to classify municipalities as depopulating or repopulating based on their population growth, and also includes a brief summary of important demographic indicators. The second part is an in-depth analysis of the indicators that may have a direct impact on depopulation and repopulation. It answers the research question of which are the characteristics that differentiate municipalities that are depopulating from those that are repopulating. Data is collected for each municipality for the indicators and variables that have been identified as having an effect on moving behaviour in literature and the aggregate result is used to compare the two groups.

This section starts by presenting the ethical considerations that have been taken into account in this project. They are followed by an explanation of the data collection methods, in which the final selection of indicators used in the analysis is presented. Finally, a review of the methods used in each part of the analysis is given.

4.1. Ethics of data collection

Ethical aspects are important for all the steps of research, from correctly citing other authors ideas and contributions to the topic to protecting personal data and being transparent in all the processes.

Qualitative data used for the research is collected from public sources, as they allow to access and use all the data they produce. Data collected from public statistics institutes (INE and Idescat) as well as from the different public organisms (Ministerio, Gencat) are available for its exploitation under the Law 37/2007 (Ley 37/2007, de 16 de Noviembre, Sobre Reutilización de La Información Del Sector Público, 2007). This law allows to

repurpose information produced by the public administration as long as it is not denaturalized and the publisher is correctly credited.

Another concern for ethics is the identification of personal data. In the case of data from public sources, it has already been anonymized, so that it is not possible to identify the responders. Moreover, because this project employs data from small municipalities, in which identification of the subjects despite anonymization may be possible, results are presented only as an aggregate for each of the municipalities' categories, which provides another layer for avoiding any personal identification.

4.2. Data collection

The two parts of the analysis require different data. The first part relies on the use of census data for the classification of municipalities. The second part combines some census data, such as the total population, with specific variables corresponding to the indicator of interest. The main source of information for the first part of the research is demographic data from the National Statistics Institute (INE) and the Catalan Institute of Statistics (Idescat). For the second part, data is also extracted from INE and Idescat, as well as other official data sources.

The following paragraphs review the methods and sources used to obtain the data in each case. They also present the final selection of indicators and variables, which are collected and built for every municipality and then aggregated to compare depopulating and repopulating municipalities.

4.2.1. Census and population trends

The first part of the project, which classifies the municipalities as depopulating or repopulating, requires census data. Due to the scope of the project, census data from the last two decades, from 2000 to 2020, is gathered.

The INE records municipal census data, which measures the population of every municipality the 1st of January of every year from 1996 to 2020. The data is presented as an excel file for each province, which contains the total, male and female population. The Idescat also has demographic data, but it is limited to 2003 and the method of obtention is more difficult, thus it is discarded.

Other data obtained from the census and considered interesting is the prevalence of migration and the age and sex distribution of the population in the analysed municipalities. These measures may help understand how populations may evolve, as they have a direct link with depopulation, and may show differences between depopulating and repopulating municipalities.

4.2.2. Indicators

After the municipalities have been grouped using census data and the municipalities of interest have been defined, the analysis of the push and pull factors, in the form of indicators, begins. The indicators are defined according to the literature review, but are limited by the availability of official data for the period of study. The complete list of indicators can be consulted in the annex, *Table 1-Annex. List of indicators*.

The main push and pull factors identified in the literature review were the state of the labour market, the offer of services and the lifestyle differences. However, in this project the focus is on the first two, as they have the biggest support in the literature to assume the existence of a relation between them and population movements. The analysis of indicators related to lifestyle preferences is also discarded due to the lack of available data and because it is considered that the links to dwelling decisions may be better studied through in-depth qualitative research in the form of interviews, for example, which cannot be done within the scope of this project. Data for the indicators is collected principally from INE and the relevant Ministries' data portals for as many years as possible. The particular sources and the years for which data is collected can be observed in *Table 2-Annex. List of sources*.

The following paragraphs offer a review of the indicators that are built to compare depopulating and repopulating municipalities, discussing the methodology used to obtain the data used and the necessary transformations to obtain the final indicator.

Labour opportunities. As discussed in previous chapters, the state of the labour market has been found to be one of the main pushing or pulling factors for individuals when assessing where to live. Within this topic, employment stability and the skills market may influence the likelihood of remaining on the original municipality and indicate whether or not there is an attractive labour market in the municipality for

migrants. The indicators used to evaluate this dimension are explained in detail in the following paragraphs.

Unemployment registration rate (ind. 7). The registered unemployment indicator compares the new unemployment claims to the total working-age population. Data from the new unemployment registrations is obtained from the Public Service of State Employment (SEPE), which maintains a monthly register of the individuals that have signed up for unemployment. In particular, the indicator uses data from the month of January for every year from 2010 to 2020. Data from the working-age population, which is required to make the indicator comparable across different sized municipalities, is obtained from the INE. The minimum working age in Spain is 16 years, retirement age, on the other hand, is not as straight-forward, as it is currently at 67, but individuals may choose to retire before if they have contributed to the more than 35 years to the tax system. For the construction of this indicator, and to simplify computations, it is assumed that the working age is from 16 to 64, coinciding with the "big groups" classification made by the INE. The results of this variable are interpreted as the number of individuals that have registered for unemployment for every 100 individuals that could be working or unemployed. Or, in other words, how many people have filed for unemployment for every 100 that could have done it.

Net generation of contracts (ind. 8). The indicator of the generation of new contracts compares how many new contracts have been made against the new unemployment claims. Data from the new contract registrations is obtained from the SEPE, which registers how many new contracts have been signed each month alongside the new unemployment claimants. Data about unemployment is obtained from the same file. In particular, the indicator uses data from the month of January for every year from 2010 to 2020. The results of the indicator measure whether employment is being created or destroyed and up to which extent. Thus, the result is interpreted as the number of new contracts for every new person unemployed.

Indefinite and temporal contracts (ind. 9 & 10). These indicators compare the number of new contracts that are indefinite with the temporal ones. Indicator 9 observes whether or not the municipality had more indefinite than temporal contracts in 2020. Similarly, indicator 10 observes whether or not the municipality had more indefinite than temporal contracts but for the period from 2010 to 2020 and adds up the year in which there were

more indefinite contracts. Data for both indicators is obtained from the January monthly register of unemployment and contracts from SEPE, which classifies the new registered contracts according to their type. The results of these indicators are straightforward, and the comparison is a useful tool to evaluate the stability of the labour market.

Contracts per sector (ind. 11, 12 & 13). The last indicators from the labour topic are those that compute the prevalence of contracts in different sectors: agriculture, services and industry and construction. The data is obtained from the monthly register of contracts made by SEPE. In particular, data from January 2010 to 2020 is used for the indicator. The resulting indicators measure the percentage of contracts made in each sector, which may help understand which are the sectors with more traction. Nevertheless, it is important to note that because data corresponds to the month of January, it is possible that it does not reflect the reality of the agricultural sector, which may be more active in warmer months. However, due to the presentation of the data files in the SEPE portal, it is not feasible to obtain a yearly average or the total number of contracts of each type.

Other indicators that were planned to include this dimension were the number of active businesses and the current balance between temporal and permanent contracts, as they had been found to have some relevance in dwelling decisions. These would have been useful to understand more deeply the dynamics of the labour market and its stability. Unfortunately, data is incomplete and it is not possible to obtain a reliable measure for the municipalities of analysis.

Services. The other important push-pull factor discussed in the literature is the availability and existence of services. Their existence might be a pulling factor retaining population, while their inaccessibility might result in a pushing effect. Some indicators built to measure this aspect are the accessibility to schools, to healthcare and to public transportation. In all cases, the indicators observe whether there is a service centre within a reasonable distance or in the municipality itself and are built using the *R-Studio* programme[1]. Using another methodology, access to internet is measured as well. The following paragraphs discuss them more in detail.

[1] See full code and session information in *Annex: R-Code*, in page 7 of the Annex.

Primary healthcare (ind. 14, 15 & 16). The indicators measuring the access to primary healthcare are quite similar and use the same database. Indicator 14 observes whether or not there is a primary healthcare centre in the municipality. Indicator 15 observes if the existing primary healthcare centre is within one kilometre from the municipality, considered to be a reasonable walking-distance. Finally, indicator 16 measures the distance to the closest primary centre, in meters.

Data from the centres is obtained from the *2020 Primary Care Centres Catalogue* published by the Ministry of Health the 31st of 2019. The excel file contains information about the location of all the operative primary care centres of Spain. The most important information for the construction of the indicators is the address of such centres. Indicator 14 observes if there is a centre in the municipality, which is done filtering the original data in excel. Indicators 15 and 16 are more complex. They are built in *R-Studio*, in which the geographical coordinates of each of the centres is obtained using the package *tidygeocoder*. Then, the distance between such coordinates and the coordinates corresponding to the geographical centre of the municipality is computed, in meters, with the *geosphere* package. For indicator 15, the resulting output is classified in whether there is at least one centre with a distance smaller than 1,000 meters. For indicator 16, the distance to the closest centre is selected, permitting the observation of the actual distances also for those municipalities that do not have a primary healthcare centre so close. The combined result of these indicators is interpreted as how easy it is to physically go to a healthcare centre.

Hospitals (ind. 17 & 18). Most municipalities do not have a hospital in their territory, but one at a reasonable distance that minimizes the risk of complications in case of emergency. Indicator 17 observes whether there is a hospital within a reasonable driving distance (5 kilometres) while indicator 18 provides the distance to the closest hospital.

The list of operational hospitals is obtained from the *2020 National Hospitals Catalogue*, published the 31st of December of 2019 by the Ministry of Health. These indicators follow the same procedure as the other indicators which measure the distance or determine whether there is a service centre nearby. The addresses of the centres are then used to obtain their geographical coordinates in *tidygeocoder* in *R-Studio*. Then, the distances between those coordinates and the ones corresponding to the municipalities are computed using *geosphere*. Filtering the municipalities with distances below 5,000 meters, indicator 17 is obtained. Indicator 18, on the other hand, is obtained taking the

hospitals with the smallest distance to the municipalities. The combined result of these indicators is interpreted as how easy it is to physically go to the nearest hospital.

Infant and elementary schools (ind. 19, 20, 21 & 22). Accessibility to infant and elementary schools, which cover from age 3 to 12, is measured by a set of indicators registering whether or not the municipalities have a school (indicators 19 and 21) and whether the nearest school is less than 1,000 meters away (indicators 20 and 22*)*.

The data is collected from the *Official Registry of Non-University Education Centres*. Because the data displayed in the website corresponds to the current academic year, the Ministry of Education and Vocational Training was contacted to obtain data from the year 2020. To create the present indicators, data is filtered to get a list of centres that offer schooling for children from 3 to 5 years, for infant; and another for children from 6 to 12 years, for elementary. In both cases, schools that offer schooling also at younger or older ages are included. For indicators 19 and 21, the lists are checked to determine the municipality in which the centres are. For indicators 20 and 22, the procedure is the same that is used in indicators explained in previous paragraphs. Due to their higher complexity, they are computed in *R-Studio*, in which the lists are loaded and the addresses of the centres geolocated using *tidygeocoder*. Then, the distance between the obtained coordinates and the coordinates corresponding to the municipality is computed with *geosphere* and it is observed whether the municipalities have a distance smaller than 1,000 metres to a school. The combined result of these indicators is interpreted as how easy it is to physically go to school, assuming that kids being able to walk there is an advantage.

Secondary and vocational schools (ind. 23, 24, 25 & 26). The physical access to second-cycle education is measured in a similar way than the previous set of education indicators. Indicators 23 and 25 observe whether or not the municipality has a secondary school and vocational school, respectively; while indicators 24 and 26 observe whether or not there is a school of each type within 5,000 meters from the municipality's centre. The increase in distance with respect to the previous education indicators responds to the fact that there are fewer higher education schools because they permit higher pupil-teacher ratios, and because it is assumed that 5-kilometres is still a reasonable distance that may be easily covered by car or public transport.

As before, data is obtained from the *Official Registry of Non-University Education Centres* and corresponds to the academic year 2020. The list of centres is filtered to get a list of secondary centres, which offer schooling from 12 to 16 years, including also centres that offer other educational levels. Similarly, the list of vocational schools includes all the levels of training. Then, for indicators 23 and 25, the lists were checked to determine the municipality in which the centres were. For indicators 24 and 26, the procedure was the same one used in the previous paragraph, but the final result is the observation of whether or not the municipalities have a distance smaller than 5,000 metres to a school. The combined result of these indicators is interpreted as how easy it is to physically go to a higher education centre.

Transport (ind. 27 & 28). The access to transportation is evaluated by two indicators. Similar to the previously discussed indicators, indicator 27 observes whether or not there is any public station at a one-kilometre ratio, which is considered a reasonable walking distance; and indicator 28 registers the distance to the closest public transport station.

Data of the existing public transport stations is extracted from Open Street Maps and processed using *R-Studio* using the API *overpass*. The original data already has the geographical coordinates of each of the stations, so this step can be omitted and the distances from the centre of the municipality to each station can be directly computed. Then, it is observed whether there is a station within a one-kilometre ratio from the municipality's centre and the distance to the closest station. The combined result of these indicators is interpreted as how easy it is to physically access public transportation.

Landline internet connection (ind. 29, 30, 31 & 32). Access to a quality internet network is essential to avoid digital gaps and to allow flexible working models and access to online services. Indicator 29 observes whether or not internet connection is available to every household in the municipality. Indicator 30 goes further away observing if such universal access is to high-speed internet (100Mbps). Finally, indicators 31 and 32 evaluate the actual penetration of connections up to 30Mbps and of high-speed ones, respectively.

Data for the indicators is obtained from the Ministry of Economic Affairs and Digital Transformation, that registers the prevalence of the different types of land-line connections in the Spanish territory in 2020. The data set contains the prevalence of internet in every Spanish locality, a subdivision of the municipalities. To build the

indicators, the prevalence of internet of 30 and 100 Mbps is multiplied by the population of each locality to obtain the number of people covered by it. Then, the total number of people covered by internet in each locality is divided by the total population of the municipality to obtain the total coverage of internet and high-speed internet. Then, the indicators can be computed. Indicators 29 and 30 observe whether or not more than 95% of population has access to land-line internet of 30Mbps and 100Mbps, respectively. Indicators 31 and 32 complement them by showing the actual percentage of individuals who have access to each type of technology in every municipality.

Mobile connection (ind. 33, 34 & 35). To make a complete evaluation of the access to internet, the accessibility through mobile phone is also assessed. Similar to the landline internet indicators, three indicators are used to assess the access to mobile connections. The first one, indicator 33, observes whether or not there is universal access to 4G in the municipality. Indicators 34 and 35 compute the percentage of individuals with access to each technology.

Data for the indicators is obtained from the Ministry of Economic Affairs and Digital Transformation, which maintains an annual register of the coverage of mobile connection in the Spanish territory every year. For these indicators, the data used corresponds to the year 2020. As in the previous case, the first step is to compute the number of people with access to 3G and 4G connections in all the localities of the municipality. Then, these are added up to obtain the total percentage of inhabitants from the municipality with access to each of these technologies. Indicator 33 observes if such percentage is higher than 95%, while 34 and 35 present the actual penetration of 3G and 4G, respectively.

4.3. Methods

The research question of this project is whether there are differences between depopulating and repopulating municipalities and which are those. The methodology has been selected in order to achieve the two necessary goals within that question: first, determining which municipalities are depopulating and which are repopulating; and second, develop a panel of indicators based on push and pull factors to compare the two groups.

In the first part, the average population annual growth is computed for all the municipalities and used to classify the municipalities in the two categories of study:

depopulating and repopulating. Additionally, some measures evaluating the demographic structure of each group of municipalities are computed. For the indicator panel, the indicators mentioned in the previous section, which may be continuous or categorical, are added up for all the municipalities within a group, and the results are expressed as averages or the prevalence of the factor within the municipalities. Then, these are analysed and compared to find differences between the groups. The final objective is to be able to find which characteristics set the different municipalities apart, to then discuss possible reasons and developments.

4.3.1. Grouping municipalities

As mentioned before, the first part of the project consists in the categorization of the Catalan municipalities in the categories of depopulation and repopulation. The categories are the result of observation rather than a theoretical analysis. Thus, depopulation is defined as a process by which municipalities have had mostly negative growth, while repopulating municipalities are those that had a first period of negative growth but have reversed the trend and have been growing in the last part of the analysed period. The remaining municipalities, those that had positive growth in the first period of analysis, are not part of the studied sample.

As mentioned previously, Catalonia has a total of 947 municipalities. However, the study only includes those that had positive population growth in the first decade of the period of study are excluded from further analysis. Different methods were considered to make the classification, such as cluster or peak-population analysis. Nevertheless, these options were discarded. Cluster analysis proved not being useful to make typologies of the ones defined in this paper, as it would not work with the existing period definition. Peak-population analysis, as used by Johnson and Licher (2019) in their analysis of US' depopulation, was also discarded because its classification based on maximum and minimum populations was considered to be too simple and unable to capture important changes.

The final decision was to perform the analysis by computing the average yearly growth of each municipality. The 20-years period of analysis are sub-divided into two 10-year periods. The first one serves as the baseline period, which should be very similar between the two compared groups, and the second period is the one that shows the differences

between them. Thus, the classification is based on the growth trend for the first period (from 2000 to 2010) and for the second period (from 2010 to 2020). This methodology is simple, but it is effective for the purpose of this research, as it allows to account for behaviour within smaller periods of time and compare municipalities that had been behaving relatively similar during a decade but then changed to opposite directions.

The first step is to compute the yearly variation of population for each year, from the change in population from 2000 to 2001 to the change from 2019 to 2020. Then, the average yearly growth is computed for the first period, up until the annual growth from 2009 to 2010. If the result is positive or zero, the municipalities are excluded from any further analysis, as, following the definition used in this project, they do not account as depopulating, so they cannot repopulate either. The same computation is done for the second period, starting with the change from 2010 to 2011 and finishing with the change from 2019 to 2020). In this second step, only the municipalities with negative growth in the first decade were included. If their population growth has been negative also in this decade, they are classified as depopulating. On the other hand, a positive or zero population growth makes them into the repopulating category.

4.3.2. Comparing municipalities

The comparison of municipalities relies on the indicators related to demographics and the push and pull factors. There are two types of indicators in this project: continuous and categorical. Continuous indicators are those whose outcome is a proportion or a numerical outcome such as the distance to a particular service. Categorical indicators, on the other hand, present only two possible results: 1 when the evaluated attribute exists and 0 when it does not.

To determine if the differences between the groups are significant or not, the results are analysed in SPSS, using the Independent Samples T-Test and the Crosstabs functions. The t-test is used for the continuous indicators while the categorical ones are evaluated making a crosstab and performing the chi-square test.

The t-test is a statistical method that is commonly used to asses if two groups are the same or not based on their mean. It requires that the two groups are similarly distributed and, thus, have similar variables. In case this is not possible, Welch's t-test may be used, as it was designed to fit better unequal variances. Performing the analysis in SPSS, the

outcome is presented in three tables. The first table, group statistics, presents the number of observations existing for every indicator within each group as well as the mean, standard deviation and standard error mean. The second table, Independent Samples Test, contains the result of Laverne's test and the test for the equality of the means, which includes the result of t-test and also Welch's t-test. Finally, the third table, Independent Samples Effect Sizes, gives an approximation to how big or small the differences are, although it is omitted for not being a focus point in the scope of the project.

The other statistical method used is the building of a contingency table and the performance of the chi-squared test. The contingency table is a table that adds up all the cases for all the possibilities. In this case, it adds all the positive cases for each group in one column and the negative ones in another. This allows for an easier representation of the distribution of the attribute analysed. In SPSS, the crosstab function produces three tables. The first one, Case Processing Summary, indicates the number of valid cases. The second, Crosstabulation, is a contingency table. The last one is Chi-Square tests, which provides the outcome and significance of various equivalent tests. The most commonly used test, Pearson Chi Test, is used when all the cells in the contingency table have a value of 5 or more. Meaning that there are at least 5 depopulating and repopulating municipalities with and without the attribute. When that is not the case, the significance of the differences is computed with Fischer's method, which is very similar but is particularly designed for smaller samples.

Finally, to be able to compare the differences and similarities of depopulating and repopulating municipalities, the results of the indicators for each group of municipalities are added up, resulting in one outcome for every indicator and group. In the case of continuous indicators, the individual outcomes are averaged out, resulting in a mean. For the categorical indicators, instead of a mean, the aggregated indicator corresponds to the prevalence of the studied attribute in each of the groups. These measures permit the analysis and observation of differences and similarities, as well as determining the direction of the difference.

The following section reviews the results in terms of the aggregate result of each indicator, as well as the significance analysis.

5. Findings

The aim of the project is to find differences and similarities between depopulating and repopulating municipalities, with the intention of providing a deeper understanding on the possible factors that have a pushing or pulling influence. As mentioned in the methodology chapter, the there are two main parts to the analysis. The first being the classification of municipalities and the second the analysis of the push and pull factors.

The classification of the municipalities depends on their population growth trends during the last two decades. Moreover, demographic information is also provided and analysed to better understand the characteristics of each group. Finally, there is a revew of the indicators related to the push and pull factors, that analyse the state of the labour market and the access to fundamental services. The results of the correspondent analysis can be consulted in the annex of the paper, in *Table 3-Annex. List of results (t-test)* and *Table 4-Annex. List of results (chi-squared)*, and more in detail in the following paragraphs.

5.1. Classification of Catalan municipalities

The population of Catalonia increased during the period of study, growing from 6.2 million inhabitants at the beginning of the century to almost 7.8 million by 2020, a change of 24.25%. Nevertheless, such change has not been homogeneous in all the areas of the state nor for all the municipalities. Stark differences can also be observed looking at growth during the first and the last decade included in the study.

Figure 1.
Yearly growth of Catalan provinces (2000 - 2020).

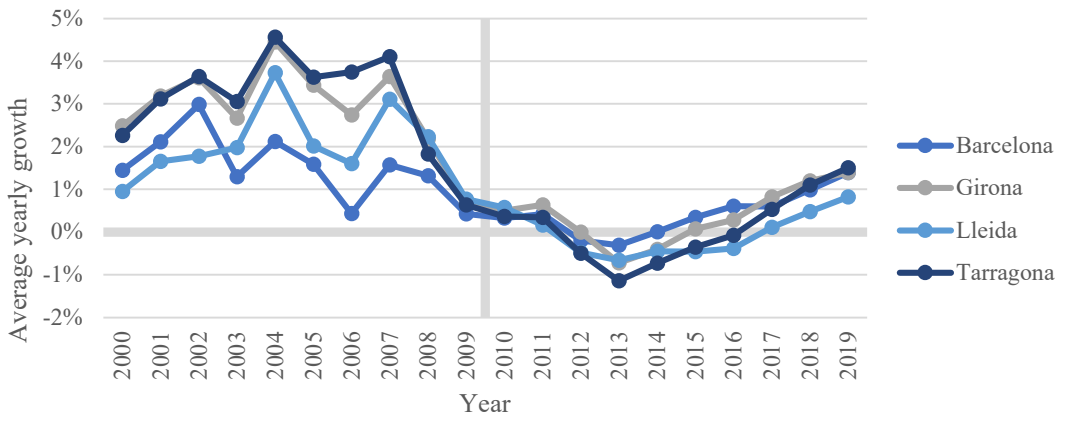
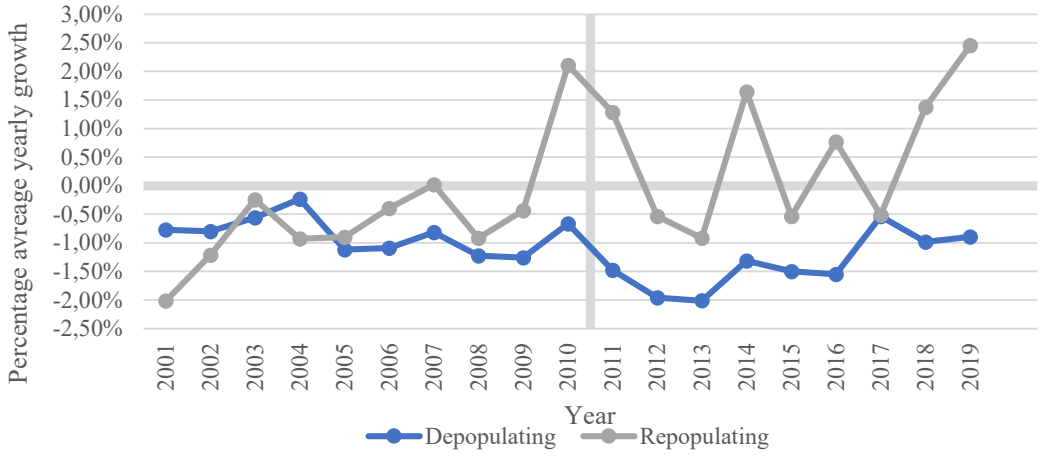


Figure 1 illustrates the yearly growth for the four provinces of Catalonia from 2000 to 2020. As can be observed, the first period was characterized by unstable growth behaviour, with some peaks in 2004 and 2007. Nevertheless, the economic crisis that started in 2008 had an important impact on population growth, with a significant drop in all the provinces. Such general decline lasted until 2013, when the population of the provinces started to grow again, at a relatively similar pace for all provinces, but at a much lower rate. As a result, the average growth rate in Catalonia for the period from 2010 to 2020 was 0.35%, and even slightly negative for Lleida.

The project studies the differences between municipalities that had a prolonged period of negative population growth in the first decade of the 2000's and that during the last decade, until 2020, kept that trend or reversed it.. As explained in the previous chapter, the period is subdivided in two 10-year periods. The first period serves as a baseline for determining which municipalities have to be included in the analysis, as the interest is to know which had experienced depopulation during the first 10 years and, after that, continued to have negative population growth or started having positive growth in the following decade. Figure 2 illustrates the average yearly growth of municipalities that have been classified as depopulating, in blue, and repopulating, in grey, excluding municipalities that had positive growth during the first decade.

Figure 2.
Average yearly growth in analysed municipalities (2000-2020).



As it can be observed, in the first decade, from 2000 to 2010, growth was negative for all the municipalities included in the study. However, there does not seem to be a clear difference between municipalities that are later classified as depopulating or repopulating. While it could be argued that the growth of depopulating municipalities seems to be more

stable over time, this could just be the result of a higher number of municipalities in this group, which would smooth out some irregularities. The second period, from 2010 to 2020, however, shows a much greater difference in the behaviour of both types of municipalities. The following sections describe more in depth the elements analysed during the two studied periods.

5.1.1. Period I: 2000 to 2010

A total of 145 municipalities are included in the analysis, as they present negative growth in the period from 2000 to 2010. In order to understand whether they have any structural similarities and differences, indicators describing their demography, summarized in Table 1, are described in the next paragraphs.

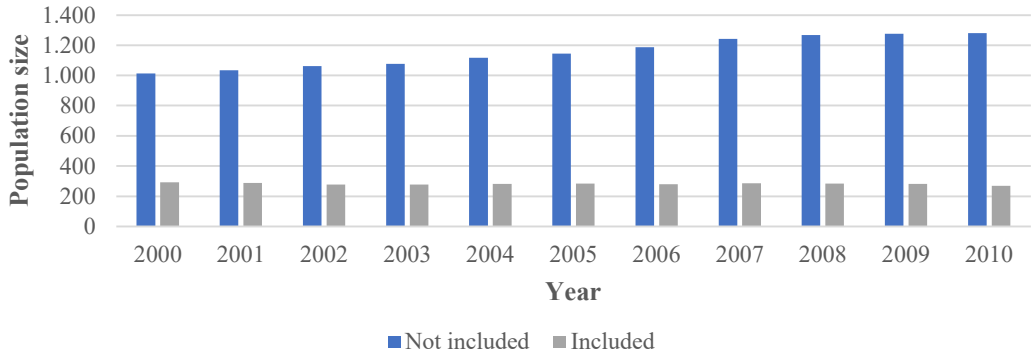
Table 1.
Population indicators results from 2000 to 2010.

Indicator	Period	Result (mean)		Significance (2-sided)
		Depopulating	Repopulating	
1. Population	2000-2010	737.45	324.27	0.176
2. Prevalence of retired people	*2000-2010*	*29.21%*	*27.18%*	*0.078*
3. Prevalence of active age people	*2000-2010*	*60.73%*	*62.43%*	*0.098*
4. Prevalence of women	2000-2010	47.75%	47.86%	0.849
5. Prevalence of active age women	**2000-2010**	**57.67%**	**60.21%**	**0.034**

Note: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in **bold** (if $\alpha \leq 0.05$) or *italics* (if $\alpha \leq 0.10$).

The size for the populations included in the analysis is relatively low, with a mean population of 658, and a median of 277. Especially when compared to municipalities with non-negative growth, as it can be observed in Figure 3. Indeed, the average size for municipalities that had negative growth between 2000 and 2010 was below 1,000, while for those that had positive growth the average size was considerably bigger already in 2000 and grew by 1,000 inhabitants during the following ten years.

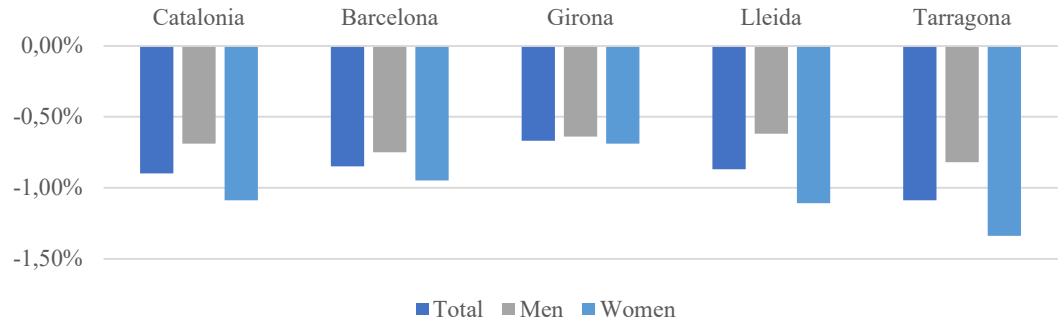
Figure 3.
Median population size Catalan municipalities (2000-2010).



From the municipalities included in the study, only one has more than 10,000 inhabitants, the size at which a municipality is considered a city. By provinces, the biggest municipalities in terms of population are located in Barcelona, with an average of a bit more than a thousand inhabitants. On the opposite side, Lleida has the smallest municipalities with a mean population size of less than 400. Nevertheless, it is worth noting that the median population is relatively similar for all the municipalities regardless of the province, and ranges between 250 and 350 inhabitants. This observation may indicate that most municipalities that had an important negative population growth period are very small.

In terms of growth, during the first decade of the century, Catalan total population increased by 1.84%. Such growth was, however, mainly driven by more sparsely populated areas, such as those outside of the metropolitan areas and in the provinces of Girona and Tarragona. Indeed, the metropolitan area had the smallest average growth, perhaps due to it having arrived at a mature demographic state of lower growth rates. Focusing on the municipalities of study, the average yearly growth was -0.90%, as illustrated in Figure 4. While there are no big differences among municipalities from different provinces, there are between the growth in male and female populations. It is unlikely that there are different birth rates based on sex, thus, the numbers suggest that women may be, up to a point, leading population declines as they might be more likely to migrate out of their municipalities or municipalities fail to pull them in. Furthermore, even though this is a trend in all municipalities, the contrast is much starker in the provinces of Lleida and Tarragona, whose female population is declining at a rate double than male population.

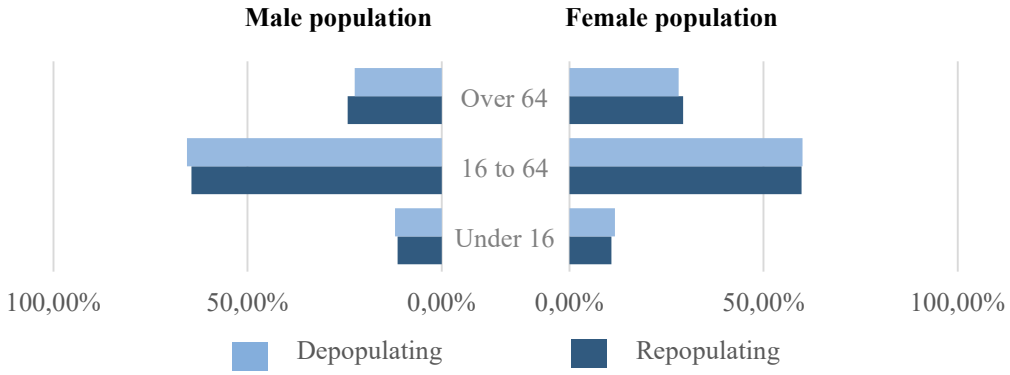
Figure 4.
Average yearly negative growth (2000-2010).



Finally, the age and sex distribution of population from 2000 to 2010 is compared between municipalities classified as depopulating and repopulating. The structure of the population is an interesting factor for analysis. Indeed, measures such as the population size can be a pulling factor if it is very small, as smaller populations are associated to smaller labour markets and opportunities as well as a lack of sufficient critical mass for the municipalities to provide basic services that may be required to ensure a stable population. Other measures, such as the distribution per age can also provide insight on the state of the municipality. A high prevalence of retired people may indicate a relatively lower percentage of people of active age, which is related to negative population growth.

Nevertheless, the results, shown graphically in Figure 5, are very similar between the groups. Surprisingly, there is also not a big disbalance between the masculine and feminine population, as it could have been inferred from previous findings (Figure 4) about the population growth.

Figure 5.
Population structure (2000-2010).



In terms of age, most inhabitants of these municipalities are between 16 and 64 years old, and there are not very important differences between repopulating and depopulating municipalities ($p = 0.098$, indicator 3). Surprisingly, there is a significant difference in

the prevalence of women of active age between the groups (p = 0.034, indicator 5), as it appears that there are more women in repopulating municipalities. In general, there is also a higher percentage of older people relative to young one, which is linked to aged populations and, as mentioned in the literature chapter, a higher pressure of pushing factors that increase the likelihood of depopulation. As in the previous case, there is a significant difference (p = 0.078, indicator 2) with a higher prevalence of older people in depopulating municipalities.

5.1.2. Period II: 2010 to 2020

The second period of analysis is the decade going from 2010 to 2020. In this period, municipalities are classified again, this time in the categories of analysis, as depopulating if they continued the negative population growth, or repopulating, if the growth has not been negative. The following paragraphs describe in detail the results obtained in the analysis of demographic indicators, summarized in Table 2 below.

Table 2.
Population indicators results from 2010 to 2020.

Indicator	Period	Result (mean)		Significance (2-sided)
		Depopulating	Repopulating	
1. Population	2010-2020	671.07	324.38	0.228
2. Prevalence of retired people	**2010-2020**	**29.81%**	**26.50%**	**0.002**
3. Prevalence of active age people	2010-2020	60.15%	61.21%	0.209
4. Prevalence of women	2010-2020	47.09%	47.00%	0.890
5. Prevalence of active age women	*2000-2010*	*57.15%*	*59.11%*	*0.078*
6. Prevalence of migrants	2020	5.91%	6.89%	0.536
	2010-2020	5.49%	4.86%	0.484

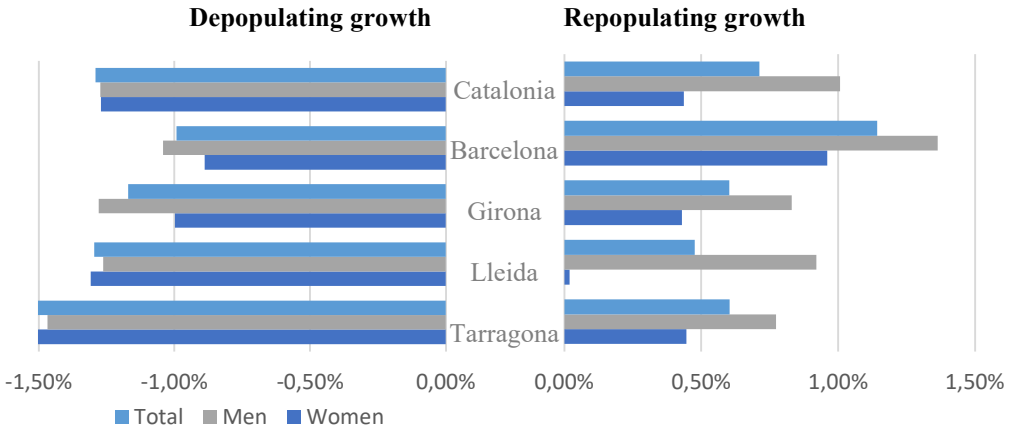
Note: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in **bold** (if $\alpha \leq 0.05$) or *italics* (if $\alpha \leq 0.10$).

From 2010 to 2020 the average size of the municipalities in the sample is close to 700 for municipalities in the depopulating group, and close to 325 in the repopulating one. While the average population varied slightly for the depopulating municipalities, it was very similar throughout the period for the repopulating municipalities. This could indicate that municipalities in this group may have been able to reverse their negative growth or

that they have arrived to a stable size and are no longer changing it. However, it is important to note that the independent t-test is not able to find a significant difference between the two categories in any of the periods. All in all, the results seem to hint at a slightly more regular behaviour for the municipalities classified as repopulating, which also seem to be smaller in population size. Nevertheless, the results are not significant so population size does not seem to be able to predict growing trends.

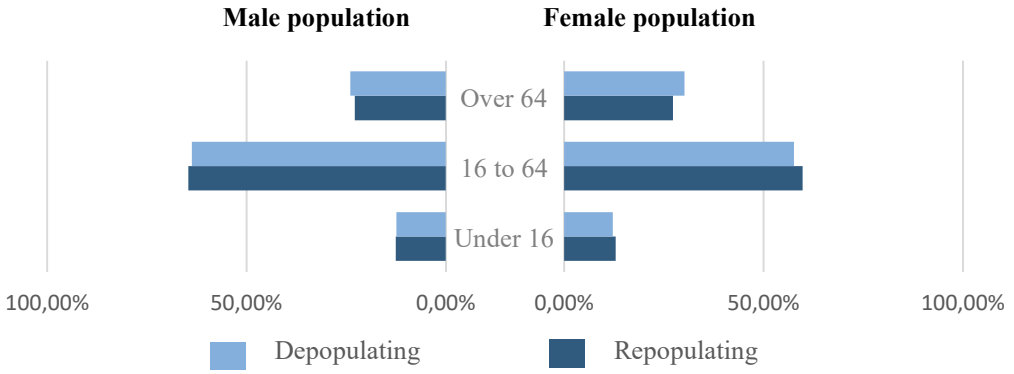
During this decade, the mean growth of depopulating municipalities was -1.29% and 0.71% for the repopulating ones. Moreover, as Figure 6 indicates, there are important differences between the types of municipalities, areas and sex. The first thing that is noticed is that the negative growth of depopulating municipalities is much higher in this decade than in the previous one. Comparing Figure 4 with Figure 6, it is seen that in all the provinces except Tarragona, all municipalities were having negative growth of around or below 1% before 2010, while now most provinces surpass it. Furthermore, differences are not especially big between provinces, and differences in sex have been greatly reduced and male and female populations have now similar de-growing rates. In contrast, municipalities classified as repopulating, which have positive average growth, display important differences among the different provinces as well as sex. Thus, municipalities from Barcelona have had the highest growth, especially in the masculine population, which corresponds to almost the double to the correspondent growth in Tarragona. Furthermore, there are important differences regarding sex. Female population has increased at a lower rate in all the analysed municipalities. The most striking difference, however, is in the case of Lleida, in which female population grew just over 0% and male almost 1%.

Figure 6.
Average yearly negative growth (2010-2020).



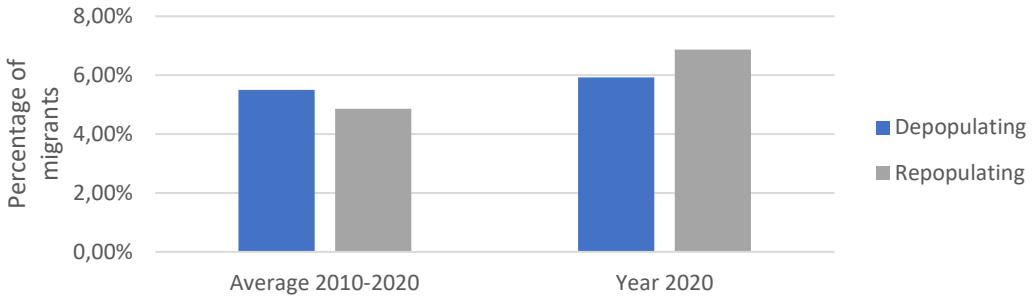
The next point of analysis is the distribution of population, which can be observed in Figure 7. The population structure is not very different from that of the previous decade (see Figure 5). It can also be observed that it is relatively similar between depopulating and repopulating municipalities. The most prevalent age group is from 16 to 64, followed by those over 64. The smallest group is for the interval of people below 16. In this decade, there are no significant differences in the distribution of people of active age ($p = 0.209$, indicator 3) and only slightly for women of that age ($p = 0.078$, indicator 5), but repopulating municipalities have significantly less people of older age ($p = 0.002$, indicator 2).

Figure 7.
Population structure (2010-2020).



Finally, the last point of analysis is the proportion of migrants. As found in the literature of depopulation, migration has been argued to be one of the possible solutions to depopulation (Bayona i Carrasco & Gil Alonso, 2013). Thus, it is expected to observe a difference between municipalities that repopulated and those that did not.

Figure 8.
Prevalence of migrants.



Nevertheless, the prevalence of migrants is relatively small in the studied municipalities, below 8%. Furthermore, from the period of 2010 to 2020, there was a

higher percentage of foreign-born residents in depopulating municipalities than in repopulating ones. The opposite is true looking at only the year 2020, where repopulating municipalities had more migrant population. This difference may be due to an irregular behaviour of migrants. Furthermore, the differences are not significant, so it is assumed that in reality, both groups are the same.

5.2. Push and pull factors

Push and pull factors, as seen in previous sections, contribute to the final decision of individuals to stay in their home-municipalities or consider emigrating. This subsection explores the different indicators that may capture push and pull factors. Following the structure of the previous literature section, the results obtained through the indicators are separated in indicators that measure the state of the labour market and the accessibility to services and described in detail in the following paragraphs.

5.2.1. Labour opportunities

The first push/pull factor is the state of the job market and labour opportunities. It constitutes an important factor in the attraction and retention of individuals, being an important pull factor for municipalities which offer them and a push one for those that do not.

Employment stability. The stability of the job market in depopulating and repopulating municipalities is assessed by the number of new contracts created per every new individual registered as unemployed, the total registered unemployment in relation to the active age population and the prevalence of temporal contracts over the total. Table 3 displays the mean result of the indicators for municipalities in the depopulating and repopulating group and the prevalence of the phenomenon in case it is not possible to compute the average. In this case, there are no significant differences in any of the indicators studied.

Table 3.
Employment stability indicator results.

Indicator	Period	Mean (t-test)		%Affirmative (χ^2)		Sig. (2-sided)
		Dep.	Rep.	Dep.	Rep.	
7. Unemployment registration rate	2010-2020	6.26	5.93			0.526
8. Net generation of contracts	2010-2020	0.49	0.65			0.331
9. The municipality has more indefinite than temporal contracts	2010			61.54%	50.00%	0.264
	2011			61.54%	60.71%	0.936
	2012			47.86%	57.14%	0.378
	2013			82.91%	85.71%	1.000*
	2014			55.56%	57.14%	0.879
	2015			56.41%	53.57%	0.786
	2016			57.26%	42.86%	0.169
	2017			55.56%	46.43%	0.384
	2018			82.91%	85.71%	1.000*
	2019			82.05%	85.71%	0.785*
	2020			85.47%	85.71%	1.000*
10. Years where there were more indefinite than temporal contracts	2010-2020	7.29	7.11			0.765

Note 1: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in **bold** (if $\alpha \leq 0.05$) or *italics* (if $\alpha \leq 0.10$).

Note 2: In some cases, cells had a count lower than expected. They are marked with an (*) and the value displayed as significance corresponds to the Fisher's Exact Test instead of Pearson Chi-Square.

Unemployment registration rate (ind. 7). This indicator measures the number of new unemployment claims relative to the total population of active age. The mean result, shared by both depopulating and repopulating municipalities, is that for every 100 inhabitants of active age, there are 6 monthly claims of unemployment.

Net generation of contracts (ind. 8). This indicator inspects how many new contracts have been made for every new unemployment claim. On average, there are more new contracts generated in repopulating municipalities than in depopulating ones, although the difference cannot be considered to be significant ($p = 0.331$). In the first group, there are 0.5 new contracts per new unemployment claim, while on the second, there are 0.65. The result in both cases indicates that there are fewer contracts than unemployment claims are made, meaning that there is less creation of jobs.

Indefinite and temporal contracts (ind. 9 & 10). Finally, the last set of indicators to inspect the stability consists in two indicators that evaluate the prevalence of indefinite contracts over temporal ones. Indicator 9 observes whether or not there were more indefinite than temporal contracts in the last decade. The prevalence of one type of contract over the other varies over years. The lowest prevalence of indefinite contracts over temporal ones was in 2012 for depopulating municipalities, when less than half had more indefinite than definite contracts. For repopulating ones, the year 2016 had the lowest rate of indefinite contracts, with more than half of the municipalities having more temporal than indefinite contracts. On the opposite end, in 2020 most municipalities (85%) from either group had more indefinite than temporal contracts. Despite the disparities between years, there are no significant differences between the two groups. Similarly, indicator 10 summarizes the results of indicator 9 counting the number of years with more indefinite than temporal contracts, resulting in a total of 7 years for both repopulating and depopulating municipalities.

Skills market (indicators 11, 12 & 13). The type of market existing in the municipality and the demand of skills is assessed by the new contracts generated in the agriculture, service and industry and construction sector.

Table 4.
Skills market indicators results.

Indicator	Period	Mean		Significance (2-sided)
		Depopulating	Repopulating	
11. Total contracts in agriculture	2010-2020	14.92%	12.96%	0.528
12. Total contracts in services	2010-2020	26.65%	26.54%	0.979
13. Total contracts in industry and construction	2010-2020	26.27%	25.68%	0.862

Note 1: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in **bold** (if $\alpha \leq 0.05$) or *italics* (if $\alpha \leq 0.10$).

Table 4, above, shows that for the period from 2010 to 2020, most contracts corresponded to the service sector, regardless of the type of municipality. In particular, 26% of the new contracts in December corresponded to new contracts in the service sector for both repopulating and depopulating municipalities. In the case of agricultural contracts, these represented, on average 15% and 13% of the total contracts, for depopulating and repopulating municipalities respectively. Nevertheless, while there are

less agricultural contracts in repopulating municipalities, the difference is not significant (p = 0.528).

5.2.2. Services

The second topic analysed is the availability of basic services, considered to be healthcare, education, transport and internet connection. They are important pull or push factors, as being close to such services seems to be important to retain population as mentioned in the literature chapter. The indicators from this topic are whether there are services available within the municipality or in a specific ratio and the actual distance to the closest services. As well as the quality of the internet service.

Health care services. One of the most important basic services is the availability of a comprehensive healthcare system. The access to such services is important to prevent health complications and even death (Nicholl et al., 2007). Furthermore, it is a topic that has gained more importance in the last months due to the impact of the pandemic. The following paragraphs discuss the results of the indicators related to this topic, primary healthcare and hospitals. The results of the indicators used in this dimension, displayed as the prevalence of affirmative cases or the average value of the indicator for each group, are shown in Table 5.

Table 5.
Health care services indicators results.

Indicator	Mean (t-test)		%Affirmative (χ^2)		Sig. (2-sided)
	Dep.	Rep.	Dep.	Rep.	
14. The municipality has a CAP			**87.18%**	**64.29%**	**0.010***
15. The municipality has a CAP within 1km			75.21%	64.29%	0.241
16. Distance to the closest CAP (m^2)	1,055	1,674			0.144
17. The municipality has a hospital within 10km			16.24%	14.29%	1.000*
18. Distance to the closest hospital (m^2)	19,104	16,486			0.118

Note 1: The data from the indicators corresponds to the 31st of December of 2019.

Note 2: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in **bold** (if $\alpha \leq 0.05$) or *italics* (if $\alpha \leq 0.10$).

Note 3: In some cases, cells had a count lower than expected. They are marked with an (*) and the value displayed as significance corresponds to the Fisher's Exact Test instead of Pearson Chi-Square.

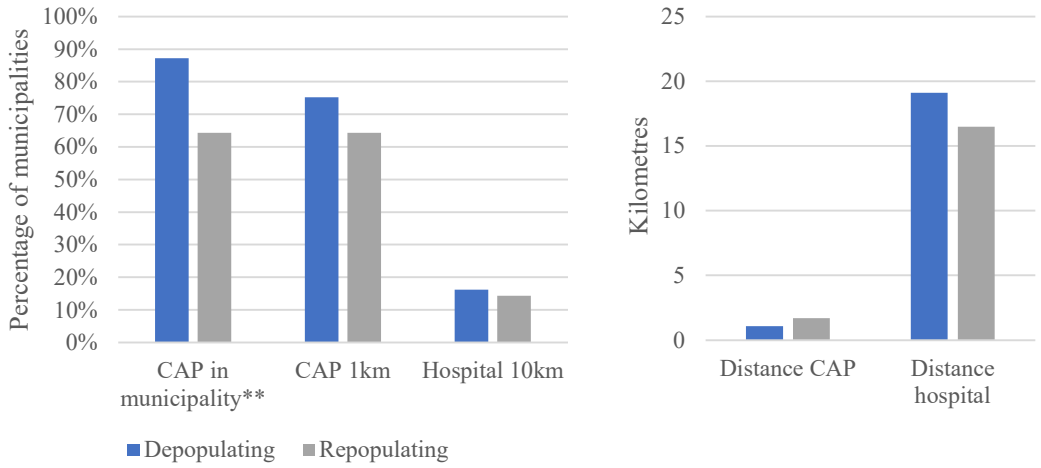
Primary healthcare (ind. 14, 15 & 16). The indicators in this dimension are, whether the municipality has a primary healthcare centre (CAP) (ind. 14), whether it is within a 1-kilometre ratio (ind. 15), and which is the distance to the closest one (ind. 16). Contrary to what could be expected based on the literature review, most municipalities, regardless of their type, have a CAP either in the municipality or near its centre. In particular, 87% of depopulating municipalities have a CAP in their territory, and 75% of them have it within 1-kilometre. In contrast, there are fewer repopulating municipalities with access to CAPs, 64%. Furthermore, despite the surprising result, the difference in the case of indicator 14 is significant ($p = 0.01$), meaning that it is more common for depopulating than repopulating municipalities to have a healthcare centre. Finally, in terms of distance to the closest CAP, there is a non-significant difference ($p = 0.144$, ind. 16) of about 500 metres, with depopulating municipalities having their closest CAP at an average of 1,055 kilometres and repopulating ones at 1,674 kilometres.

Hospitals (ind. 17 & 18). The other aspect of healthcare services is the access to hospitals, measured with the observation of whether or not there is a hospital within 10-kilometres from the municipality (ind. 17); and the distance to the closest one (ind. 18). The results for depopulating and repopulating municipalities were very similar and without significant differences. In particular, 16% of depopulating municipalities had a hospital within 10 kilometres, compared to 14% of repopulating municipalities. This results contrast with literature and the intuition that depopulating municipalities would have worst access to the service. Nevertheless, the results mirror the case with access to primary care, discussed in the previous paragraph. Surprisingly, the average distance to the closest hospital is shorter for repopulating municipalities, for which it is 16 kilometres, compared to the 19 kilometres of depopulating municipalities.

Figure 9 presents the results of the indicators in the form of graph. Overall, access to primary healthcare does not seem to be a problem for the majority of municipalities

included in the study, regardless of their classification. Indeed, depopulating municipalities seem to be more likely to have a primary healthcare centre within the municipality. For hospitals, while it appears that more depopulating municipalities have access to a hospital within 10 kilometres, the average distance to the closest one is higher than for the repopulating municipalities. This contradictory result is complex to interpret, however it is important to take into account that the differences are not significant, so it is not possible to assume that there is actually a difference.

Figure 9.
Healthcare indicators.



Note: The indicators marked with ** show a significant difference of $p < 0.05$.

Education. Education is another one of the basic services, many times essential for young people to establish in a given municipality or area and prevent their exit. Furthermore, at higher levels, it contributes to the formation of social groups from outside of the depressed area and a lower likelihood to stay in the municipality. Access to education is explored with eight indicators that determine whether or not there is a school in the municipality or within a given distance. Table 6 displays the prevalence of each type of education centre within the municipality and within a 1-kilometre ratio for the depopulating and the repopulating municipalities.

Table 6.
Education services indicators results.

Indicator	%Affirmative (χ^2)		Sig. (2-sided)
	Dep.	Rep.	
19. The municipality has an infant school	**59.83%**	**35.71%**	**0.021**
20. The municipality has an infant school within 1km	*51.28%*	*32.14%*	*0.069*

21. The municipality has an elementary school	**58.97%**	**32.14%**	**0.011**
22. The municipality has an elementary school within 1km	*50.43%*	*32.14%*	*0.082*
23. The municipality has a secondary school	6.84%	0.00%	0.354*
24. The municipality has a secondary school within 5km	20.51%	21.43%	0.914
25. The municipality has a vocational school	3.42%	0.00%	1.000*
26. The municipality has a vocational school within 5km	10.26%	14.29%	0.531*

Note 1: The data from the indicators corresponds to the academic year 2020.

Note 2: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in **bold** (if $\alpha \leq 0.05$) or *italics* (if $\alpha \leq 0.10$).

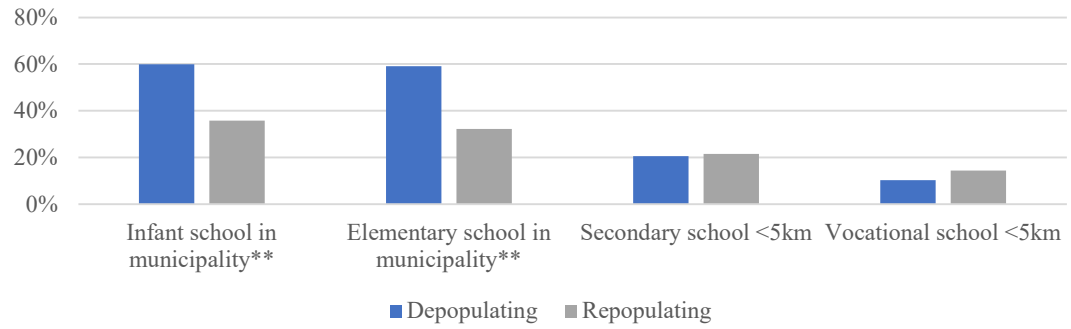
Note 3: In some cases, cells had a count lower than expected. They are marked with an (*) and the value displayed as significance corresponds to the Fisher's Exact Test instead of Pearson Chi-Square.

Infant and elementary education (ind. 19, 20, 21 & 22). The indicators explored in this subtopic are whether there is a school for children up to 3 years in the municipality (ind. 19), a primary school (ind. 21) or if they are within 1 kilometre from the municipality (ind. 20 and 22). The results indicate significant differences between the depopulating and repopulating group. Thus, around 60% of depopulating municipalities have access to an infant and/or elementary school within the municipality, while in the case of repopulating municipalities only half of that (around 30%) have access to them ($p = 0.02$, ind. 19 and $p = 0.01$, ind. 21). The results of whether the schools are within 1 kilometre repeat the former pattern, with municipalities from the depopulating group being more likely to have a centre within this ratio.

Secondary and vocational education (ind. 23, 24, 25 & 26). The other dimension studied as an education factor is the access to high and vocational school. High and vocational school access is measured by whether there is a centre in the municipality offering the service (ind. 23 and 25) and whether there is one within 5 kilometres (ind. 24 and 26). In this case, there are also differences between the depopulating and repopulating group, but they are not significant. First, there are more municipalities that have a high school within the depopulating group (6.84%), compared to none of the repopulating municipalities having one. Similarly, there is not any municipality in the repopulating group with a vocational school, and 3.42% of the depopulating ones have. Regarding the existence of such schools within 5 kilometres, the difference is much smaller and not significant, but there are more repopulating municipalities with secondary and vocational schools in a 5-kilometre ratio than depopulating.

The overall result of the analysis of the indicators related to education, plotted in Figure 10, is that education services for smaller children are more likely to be present in depopulating municipalities than in repopulating ones. However, there is no significant difference when it comes to schools for higher educational levels. Furthermore, there seem to be slightly more vocational schools near repopulating municipalities, but the difference is not significant.

Figure 10.
Education indicators.



Note: The indicators marked with ** show a significant difference of $p < 0.05$.

Public transport. Another important service discussed in the literature and included in the panel of indicators is the access to transport, that is evaluated observing whether or not the municipality has access to a public transport station within a 1-kilometre ratio (ind. 27) and the distance to the closest station (ind. 28).

Table 7 shows the average distance to the closest public transport station and the prevalence of municipalities from the depopulating and the repopulating group that have a station within one kilometre. Figure 11 shows the results in a graphic way.

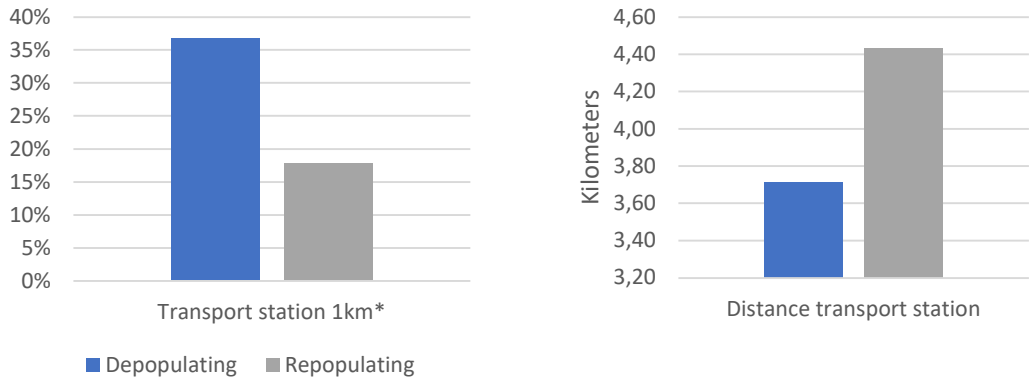
Table 7.
Transportation indicators results.

Indicator	Mean (t-test)		%Affirmative (χ^2)		Sig. (2-sided)
	Dep.	Rep.	Dep.	Rep.	
28. Distance to the closest public transport station (m)	3,710.02	4,433.98			0.294
27. The municipality has a public transport station within 1km			*36.75%*	*17.86%*	*0.056*

Note 1: The data from the indicators corresponds to the year 2022.

Note 2: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in **bold** (if $\alpha \leq 0.05$) or *italics* (if $\alpha \leq 0.10$).

Figure 11.
Public transport indicators.



Note: The indicators marked with * show a significant difference of $p < 0.10$.

According to the analysed data, 37% of depopulating municipalities have a public transport station within a 1-kilometre ratio, while in the case of repopulating municipalities, only 18% have access to it. Moreover, the average distance to the closest station is 3,7 kilometres for depopulating municipalities and 4,4 kilometres for repopulating. Nevertheless, these differences are not significant.

Broadband availability. Finally, the last set of indicators related to the availability of services is the broadband availability, both for land-line connections and mobile. Availability is measured with seven indicators that observe the penetration rate of different technologies. In Table 8, the mean prevalence of the internet services for municipalities in the depopulating and the repopulating group are shown, as well as the prevalence of municipalities with universal connection in each group.

Table 8.
Internet connection indicators results.

Indicator	Mean (t-test)		%Affirmative (χ^2)		Sig. (2-sided)
	Dep.	Rep.	Dep.	Rep.	
31. Prevalence of 30Mbps land-line	51.68%	37.97%			0.109
32. Prevalence of 100Mbps land-line	**18.60%**	**4.57%**			**0.047**
34. Prevalence of 3G	99.16%	99.08%			0.897
35. Prevalence of 4G	93.85%	92.54%			0.696
29. The municipality has 100% land-line connection			20.51%	14.29%	0.453
30. The municipality has 100% land-line high speed connection			8.55 %	0.00%	0.210*

33. The municipality has 100% high-speed mobile connection	82.91%	75.00%	0.334

Note 1: The data from the indicators corresponds to the year 2020.

Note 2: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in **bold** (if $\alpha \leq 0.05$) or *italics* (if $\alpha \leq 0.10$).

Note 3: In some cases, cells had a count lower than expected. They are marked with an (*) and the value displayed as significance corresponds to the Fisher's Exact Test instead of Pearson Chi-Square.

Fixed broadband (ind. 29, 30, 31 & 32). According to the data analysed, 55% of depopulating municipalities and 57% of the repopulating ones can guarantee internet access to all their inhabitants (ind. 29). At the same time, the mean penetration rate of this technology, ie. the percentage of homes in a given municipality with access to internet (ind. 31), is 52% in depopulating municipalities and 38% in repopulating. While these are not significant differences, the results point at a very similar rate of access, but with repopulating municipalities having lower penetration rates. The pattern is the same with high-speed internet (100Mbps), which has a significantly higher penetration in depopulating municipalities. In this case, 8% of depopulating municipalities can guarantee high-speed connections to all the houses but none of the repopulating ones can (ind. 30). In terms of penetration (ind. 32), the rates are 19% in depopulating and 5% in repopulating, constituting a significant difference ($p = 0.05$). For the other indicators, differences appear to be big but they are not significant. Thus, while it seems like internet connection is better in depopulating municipalities, it is not possible to affirm it.

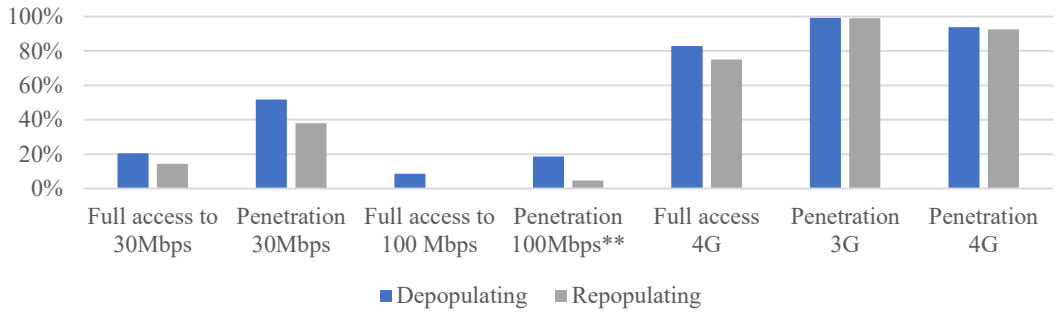
Mobile broadband (33, 34 & 35). In general terms, the situation is very different for the accessibility to mobile internet connection, with virtually all the population (99%) from both depopulating and repopulating municipalities with access to at least 3G (ind. 34) connection and 93% with 4G (ind. 35) access as well. Indeed, none of the municipalities analysed has a 0% availability of these mobile technologies. The universal access (ind. 33) is, surprisingly relatively smaller. Finally, there are only a bit more than half of the municipalities whose population has universal access to internet.

Figure 12 plots the indicators discussed in the previous paragraphs. The percentage of municipalities with full access to land-line and mobile internet is roughly the same across groups. High-speed internet at home, on the other hand, is much less common. Furthermore, there are important differences in the penetration of said services. Mobile

technologies can be accessed by most inhabitants from all populations, while high-speed internet is still rare, even more in repopulating municipalities.

These results may hint at the fact that there is roughly the same number of municipalities with full access to land-line internet in both groups, but there are different coverage rates among them, and that they are lower for repopulating municipalities. In terms of mobile connection, it is possible that there are some spots in which connection cannot be reached, thus preventing full access.

Figure 12.
Broadband indicators.



Note: The indicators marked with ** show a significant difference of $p < 0.05$.

6. Discussion

The project has compared Catalan municipalities that had negative population growth from 2000 to 2010, contraposing the municipalities that maintained a negative rate throughout the period from 2010 to 2020 and those that reverted it. The comparison is done exploring a panel of indicators related to the demographics as well as aspects from the labour market and the availability of services, that are considered to have a pulling-pushing effect. The following paragraphs review in more detail the similarities and differences regarding the configuration of the population, and then pass on to present the key findings in terms of the labour market and the availably of services within a pull-push framework. All while reflecting on possible explanations and the implications of the results obtained.

6.1. Summary of results

The first findings discussed are the differences and similarities in the demographic configuration of the municipalities classified in the repopulating and depopulating groups. Population growth is used to classify the municipalities, but it is not possible to identify a specific pattern for the repopulating municipalities, as their growth is not continuous. Indeed, slightly negative population growth is alternated with years with big population sprouts. On the other hand, it is observed that depopulating municipalities have a similar negative growth level throughout the two decades. The lack of a visible growth pattern for repopulating municipalities may be due to the fact that there are fewer of them, making it not possible to measure normality.

As expected from previous studies (del Romero Renau, 2018b; Pérez Morote et al., 2021), the population size of the analysed municipalities is significantly smaller than the average Catalan population. Municipalities classified as depopulating have slightly bigger populations, but the difference is not significant. The results add to the existing evidence stating that small populations are, generally, at a higher risk of negative growth, and that if it is constant and large enough, it can become very difficult to reverse the tendency and return to positive growth (Johnson & Lichter, 2019; Laborda Soriano et al., 2021).

In addition, it is found that there are important differences in the configuration of the demographics in each group. Municipalities classified as repopulating have a smaller

prevalence of people over the age of 65 compared to municipalities classified as depopulating. This result is coherent with the general assumption that the most mobile population group is that of working-age people (Johnson & Lichter, 2019). Moreover, the relatively bigger old-age population in depopulating municipalities aligns with the greater difficulties to reverse negative growth as the average population age increases, and more inflows of population are needed to offset the inevitable decrease in population due to natural causes.

There are also important differences in the distribution of individuals according to sex. Male populations appear to be able to bounce back at a higher rate and be more resilient in terms of growth than female populations. Indeed, male population growth from the municipalities in the repopulating group is positive throughout the studied period, but feminine negative growth in the first decade offsets it, making total growth negative. Furthermore, in the second decade, male population growth is almost three times larger than female population growth. In contrast, in depopulating municipalities, these differences are smaller, and while female populations shrunk more than male ones during the first decade, in the second one the values are very similar. This difference may be explained by an effort from some the municipalities affected by depopulation to increase their populations through means that are more likely to attract men than women (Díaz Méndez, 2005). For instance, it could be the case that men value access to a job, regardless of nature, much more than women, who may value job stability, access to services or other things (Díaz Méndez, 2005; Schoppa, 2010), not measured in this project.

The last item compared regarding the topic of population and population structure is the prevalence of migrants, which surprisingly shows no differences between the groups. Repopulating municipalities were expected to have a higher prevalence of migrants, as migration is a key growth motivator (Bayona i Carrasco & Gil Alonso, 2013; Collantes et al., 2014). The insignificance of the results and the inconsistency throughout the years might be caused by a distortion due to the small size of populations, that amplifies the effect of subtle movements. Another possible explanation is that migration from inside the country, from less developed areas is more prevalent (González Leonardo & López Gay, 2019), and thus has not been accurately measured.

Labour and service-related indicators are analysed within a push-pull theoretical framework, which applied to the studied case, is interpreted as the existence of some factors that attract population and others having the opposite effect. It is assumed that the absence of services in an area as well as the lack of opportunities in the labour market

contributes to a pushing effect and an increase in the likelihood of individuals deciding to move out in depopulating municipalities, while their existence has a pulling effect, preventing them to leave, which is expected to be observed in repopulating municipalities. Therefore, it is assumed that some of the studied factors often associated with depopulation are either present in repopulating municipalities or absent in depopulating ones.

There are no significant differences in the labour market of the depopulating and the repopulating group, despite assumptions of greater opportunities in the latter group due to the strong correlation between mobility and job opportunities (Alamá Sabater et al., 2021; Pérez Morote et al., 2021). However, despite not being significantly different, unemployment rate is slightly higher in depopulating municipalities, and there are also less contracts generated relative to unemployment claims. The sector that signed less contracts over the years was the agricultural, which, despite non-significant differences, seems more prominent in depopulating municipalities. Finally on the topic of the labour market, the stability in contracts is very similar in both groups, and better than it would have been expected based on previous assumptions (Bueno & García-Román, 2021). The prevalence of indefinite contracts has increased in recent years for all the municipalities included in the studied, reaching 85% of all the contracts. These results are not able to find evidence of the pulling-pushing effect of the labour market, but point at a development of the labour market in the analysed municipalities. It is also possible that repopulating municipalities have slightly more productive labour markets, based on the non-significant differences found, but they need more time to consolidate them.

Indicators related to services are also analysed within the push-pull framework, as it is understood that having access to education, healthcare, transportation and internet is essential for most people (Christiaanse, 2020), so their absence has a pushing effect while its existence might bring a pulling one. Nevertheless, the results are surprising, as it seems like access to services is generally better for municipalities in the depopulating group.

Most municipalities included in the study have access to a primary healthcare centre, at an average distance of 1.3 kilometres. There are no significant differences in the distance between the groups, although it is larger for repopulating municipalities, but there are significantly more depopulating municipalities that have a primary healthcare centre in them. In the case of hospitals, access seems to be more difficult, with very few municipalities having one at less than 10 kilometres, but repopulating municipalities having one at a smaller distance. These results suggest that, in general, depopulating

municipalities are more likely to have, at least, primary healthcare services more accessible. This might be related to the fact that municipalities classified in this project as depopulating are, on average, slightly larger, than repopulating ones. Furthermore, access to such services is regulated by law and if those municipalities are isolated, they might need to have access to a centre within the municipality, while repopulating municipalities might be close to one in a different municipality. Finally, coinciding with Merino and Prats, it is possible that the availability of services has only a residual effect on moving decisions (Merino & Prats, 2020).

The analysis of the access to infant and elementary education facilities offers a surprising result as well. There are significantly more municipalities from the depopulating group that have access to a school within the municipality or a 1-kilometre ratio. For higher education, the differences are not significant, but they are more scarce than infant and elementary schools, especially in the case of vocational schools. These results highlight two things. First, that access to early education seems to be prioritized over higher education, as shown by the prevalence of said centres in both types of municipalities. This could be explained by the different maximum pupils-teacher ratios in different school levels, which may force a higher number of elementary school centres relative to others. Second, school choice is not only based on availably, but other factors such as type of education, price and perceived quality may play an important role and make some parents choose a school that is not close to their municipality. However, it is also important to consider that the fact that there are many municipalities without a school, may correlate with the fact that smaller municipalities have difficulty to offer such service due to its small population.

Access to public transport is also considered an essential service in this project, and its availability is evaluated in terms of distance. The data analysed shows no significant differences between the groups in the average distance to the closest public transport station from the municipality's geographical centre. However, the differences become significant when comparing how many municipalities have a station within a 1-kilometre ratio in each group. It is found that, while most municipalities do not have a station within walking-distance, there are twice as much municipalities in the depopulating group compared to the repopulating one with access to one. These results suggest that, despite the general lack of public transport available, depopulating municipalities have a better access than repopulating municipalities, contrasting with previous assumptions. This might account for other factors not included in the analysis, such as differences in roads,

the frequency of the public transport routes, or the direction of said routes; as it is likely that, especially in areas with low demand of public transport, using a car is more efficient than public transport, thus having a non-existent demand for it.

Internet connection is the last service evaluated. In this case, not only in terms of its availability but also quality. It is observed that high-speed internet is relatively scarce in the analysed municipalities, and even significantly lower among repopulating municipalities, corresponding with previous literature (Pérez Morote et al., 2021). About half of the municipalities included in the study have total broadband internet coverage, but the average penetration rate in the municipalities is very low, especially in the case of high-speed internet. Surprisingly, there are no important differences in mobile internet connection between the groups, and the penetration rates are very high. The results suggest that the main problem with internet connection is related to in-house connection and high speed. This could be explained through different reasonings. One possible explanation is that municipalities with bigger populations may have more power to increase the supply of internet as there is a higher demand for internet, thus explaining differences between the depopulating and the repopulating group. Another alternative explanation is that, in the studied municipalities, the demand of internet, and especially of high-speed, is low due to the preferences of individuals that decide to live there, as they might be older or not need internet in their daily life. Finally, scarcely populated municipalities tend to have relatively low population densities, and it is not infrequent for several isolated houses to be included in the municipality. If this is the case, it might be very difficult to install and maintain quality internet broadbands.

6.2. Limitations of the study

The surprising results of the study and the inability to find evidence of differences between depopulating and repopulating municipalities for the pushing-pulling factors may be explained, at least in part, by the limitations of the study. The limitations arise from the nature of the phenomenon of study, the design of the analysis and the availability of data.

Repopulation is a complex phenomenon and not a linear process, so it might not be accurately captured by the model, thus resulting in inaccurate classification. It is possible that repopulating municipalities are profiting from their proximity to thriving areas, which

supply the labour market opportunities and the services needed. Furthermore, it is also possible that key factors are being omitted when evaluating the availability of services based only on distance, as key aspects such as quality and price are being ignored. The design of the study has resulted in an unequal distribution of the municipalities classified in each group, which might introduce important distortions in the results of the indicators and prevent the observation of patterns.

Another important limitation of the study has been the availability of data and its quality. The data available has ultimately determined which indicators could be built, and thus how each factor has been analysed, sometimes losing important information. For example, despite the role that the availability and affordability of housing has, there is no official register for small municipalities. Moreover, even if the data used to evaluate the existence of services is mostly collected from official sources, there are some errors. Data in the case of healthcare and education services is collected from the centres that offer them, thus resulting in non-homogeneous registers that complicate the processing of information and being able to correctly identify each centre and its exact position with respect to the municipality. In the case of transport stations, not all the data is registered with the same amount of detail, so some information must be lost in the process. For the indicators related to the labour market, data is less prone to errors, but its access is limited and it is only available as single files for every month of every year and every province, making its exploration not possible within the scope of this project. These shortcomings may explain some of the results, and access to better data might be able to reveal important differences that have been masked by the current data used.

6.3. Recommendations

The lack of significant results does not imply that negative population growth is unaffected by the labour market and the availability of services, as the literature suggested. Indeed, the results are unable to prove that there are differences between depopulating and repopulating municipalities, but they do not prove whether or not the factors analysed have any sort of effect on the population growth. Thus, the findings do not constitute an argument to not maintain services or promote the labour market, as other studies have found they are important. Moreover, the analysis has highlighted some opportunities of improvement for all the municipalities of the analysis.

One of the key findings of the study is the difference in the female population of active age in repopulating and depopulating municipalities. The results show that it is important to direct action towards motivating young women to stay in their hometowns. It is important that women can feel like they have career opportunities in their hometown and are not confined to traditional caretaker roles (Díaz Méndez, 2005). Some measures to achieve this are developing opportunities for female entrepreneurship and work options that permit work-life balance, as well as the promotion of co-parenting and gender equality. These can be achieved through the extension of services related to childcare and publicity actions to sensibilize against harmful stereotypes related to gender roles. To improve job opportunities, existing businesses should be promoted and modernized to include new profiles and increase their efficiency. For that, financial aid would be given and the generational replacement promoted, providing training about the sector and studying successful models.

Another point highlighted by the analysis are the opportunities of improvement in the access to internet. While internet access is almost guaranteed for most of the municipalities studied, it is not of high-speed. Moreover, penetration rates are low, especially for repopulating municipalities. This adds to the existing digitalization gap existing between cities and more rural areas. Furthermore, with the normalization of remote working and online shopping, accelerated after the COVID-19 pandemic, access to internet has become a necessity for most people and may set municipalities with and without quality access further apart. Thus, it is essential that municipalities at risk of depopulating invest in the development of infrastructure supporting the access to high quality internet throughout the municipality (Álvarez Álvarez & García Prieto, 2021). Measures to promote digital transition are conceived as a way to improve cohesion and foster the necessary conditions for entrepreneurship and job generation. Moreover, it serves the purpose of attracting and retaining women and young people, key groups necessary for the development and revitalization of depressed areas. More in particular, measures include achieving universal internet coverage, digitalization of public administration to avoid unnecessary travel and promote digital businesses and opportunities.

Some of these concerns have already been identified by the public administration, and initiatives like expanding the number of infant schools in rural municipalities (CCMA, 2022) as well as the introduction of gender and digital-specific measures in the plans for the reactivation of depressed municipalities (Federación Española de Municipios y

Provincias, 2017; Gobierno de España, 2021) show that important advances have been made. In particular, the plan of the Government against depopulation is targeted at small municipalities and rural areas and contains a total of 130 measures that correspond to 10 main goals, among them, digital transition and gender equality and opportunities for women.

The shortcomings of the project have emphasised the need to improve the access to official and reliable data. Access to data is needed to evaluate the situation, detect weaknesses and keep track of possible improvements. For that, data has to be easily accessible from the official sources, include small municipalities in the data collection and automatize the process of data collection to reduce the likelihood of human errors and missing data. Nevertheless, there is still a need to improve the quality and quantity of data, as well as make an effort to measure the qualitative impact of the policies. At the moment, data available for small municipalities is limited and often not updated, making it difficult to analyse and evaluate changes over time. New technologies related to the collection and analysis of data could also be employed to make the report of data more reliable and efficient. They could automatize some processes and reduce the likelihood of errors and lack of inconsistency within centres and time. Moreover, they could be used to extract more information from the one that is collected nowadays and make powerful analysis that provide a clear, consistent and useful picture of the state of every municipality any particular year or period of time.

Finally, there are other important measures that respond to current and future issues, such as the regulation of sustainable tourism and the investment in development of the affected areas. Moreover, these measures are backed by a series of legislative changes that should facilitate life in areas in risk of depopulating. This includes the simplification of bureaucratic and administrative formalities, promote decentralization to allow more decision power to small municipalities, and invest in the empowerment of rural areas through programs to promote entrepreneurism and their role in the country.

7. Conclusions

The objective of the study has been to find whether there are significant differences between municipalities that had a similar population pattern growth up until a point. However, all the municipalities that had negative population growth until 2010 have very similar characteristics regardless of whether or not they changed after 2010. The data has shown that there is not enough evidence to unequivocally say that there are important differences between the municipalities that have had continuous negative population growth since the year 2000 and those that have had positive population growth starting in 2010. Moreover, it is also not possible to determine that, among the factors analysed, there is at least one with a clear push-pull effect and a direct relation with the population growth rate.

Population growth rate has been the variable of interest throughout the project. It has been used to classify the Catalan municipalities as depopulating or repopulating, based on their demographic behaviour before and after 2010. To compare the municipalities from the two groups, several indicators regarding the demographic configuration of the municipalities of each group are created and analysed. Nevertheless, the principal focus of the analysis is in the panel of indicators analysing the state of the labour market and the access to services. The results of the indicators included in the panel are interpreted using a push-pull framework, in which they are assumed to have a retaining or a contrary effect for the municipality.

Over all, the previous section has highlighted that there are few significant differences between depopulating and repopulating municipalities. The municipalities included in the study have similar population sizes, labour markets and availability of most services; regardless of their classification. Nevertheless, they differ significantly in the population structure and in some indicators regarding the availability of particular services.

There are important differences in the growth of male and female populations, with the latter being much lower and more likely to be negative in depopulating municipalities, indicating that negative population growth might be mainly driven by active age women migrating out of their hometowns. At the same time, repopulating municipalities show a more rejuvenized population structure, with less prevalence of older people, and therefore a relatively higher share of people of working age, consistent with a positive population growth trend and previous assumptions.

In contrast, differences in the access to primary healthcare or elementary schooling take a direction opposite to the one that was expected, as access to those services is more prevalent in depopulating municipalities. The results are surprising because they contrast with previous assumptions, as some of the indicators for which there are differences between the groups, led to conclusions opposite to the predicted ones. The absence of some services was expected to be a pushing factor for depopulating municipalities, and their existence a pulling factor from repopulating municipalities. However, the factors that were assumed to be determinants of negative population growth when absent, are on average, more likely to exist in depopulating municipalities compared to repopulating ones.

Despite the lack of significant differences for most of the indicators analysed, the findings point at a need to increase the prevalence of younger people, and especially women, in municipalities with negative population growth to maintain a balanced and sustainable growth. It is possible that up until now efforts against depopulation had focused on improving opportunities in the labour market and providing minimum services to the population. However, it appears that these might not be enough to attract and retain women. This calls for a need to develop policies with gender perspective, that take into account the necessities of women. Policies that have been implemented to stop negative population growth have often relied in the offer of fiscal incentives, agricultural-related activities and entrepreneurship. However, these may ignore the necessities that women and families may have (Díaz Méndez, 2005). Fiscal incentives might decrease the costs of living in a particular area, but the opportunity costs are often not computed, and ignore those faced by women and families with small children. Furthermore, stereotypes associated with the perceived culture of small municipalities, rooted in traditional values may impact women, who could feel excluded from social life or have great difficulties to find a job in a masculinized labour market.

Further research has a lot to explore, as the topic of depopulation, and in particular repopulation, is still understudied and by this project it is not clear which are the exact new mechanisms that influence a municipality with negative growth to flip the trend and have positive growth for a long period of time. Research is open to investigate mechanisms to detect full-recovery repopulation and the drivers that make it possible. For that, the study of the interaction between the different factors as well as the surroundings might be necessary, developing a model that makes it possible to capture the influence of other municipalities. Other ways of research could be to expand the research of the

phenomenon to other parts of the world, and test if the hypotheses developed in this project can be tested in any of them. Complementary, the same project could be replicated with the different regions of Spain to find differences between the repopulating processes in Catalonia and the other areas, or whether there are more or less similarities between depopulating and repopulating municipalities in different areas. Moreover, it could be interesting to analyse the impact that COVID may have had, and how the implementation of remote working, but also the realization of the lack of services, may impact the evolution of the current population patterns. Finally, the reason behind the differences in female and male repopulation has been a puzzling finding of the project, that could be further investigated in future research that focuses on the expectations and realities of men and women living, migrating and emigrating from or to repopulating and depopulating municipalities.

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9. ANNEX

9.1. Table 1-Annex. List of indicators

	Dimension	Indicator	Measure
DEMOGRAPHIC	Population	1. Population	Mean inhabitants
	Age structure	2. Prevalence of retired people	Percentage people over 65
		3. Prevalence of active age people	Percentage people 16 to 65
	Women	4. Prevalence of women	Percentage of women
		5. Prevalence of active age women	Percentage of 16 to 65 women
	Migration	6. Prevalence of migrants	Percentage of foreign-born residents
LABOUR	Employment	7. Unemployment registration rate	New unemployed per active age people
		8. Net generation of contracts	New contracts per new unemployment
	Stability	9. The municipality has more indefinite than temporal contracts	There are (no) more indefinite than temporal contracts
		10. Years where there were more indefinite than temporal contracts	Number of years
	Skills market	11. Total contracts in agriculture	Percentage of new contracts in agriculture
		12. Total contracts in services	Percentage of new contracts in services
		13. Total contracts in industry and construction	Percentage of new contracts in industry
SERVICES	Health	14. The municipality has a CAP	There is (no) CAP in the municipality
		15. The municipality has a CAP within 1km	There is (no) CAP at less than 1km
		16. Distance to the closest CAP	Distance in meters
		17. The municipality has a hospital within 10km	There is (no) hospital at less than 10km
		18. Distance to the closest hospital	Distance in meters
	Education	19. The municipality has an infant school	There is (no) school in the municipality
		20. The municipality has an infant school within 1km	There is (no) school at less than 1km
		21. The municipality has an elementary school	There is (no) school in the municipality
		22. The municipality has an elementary school within 1km	There is (no) school at less than 1km
		23. The municipality has a secondary school	There is (no) school in the municipality
		24. The municipality has a secondary school within 5km	There is (no) school at less than 5km

	25. The municipality has a vocational school	There is (no) school in the municipality
	26. The municipality has a vocational school within 5km	There is (no) school at less than 5km
Transport	27. The municipality has a public transport station within 1km	There are (no) stations at less than 1km
	28. Distance to the closest public transport station	Distance in meters
Internet	29. The municipality has 100% land-line connection	There is (no) land-line connection
	30. The municipality has 100% land-line high speed connection	There is (no) high land-line connection
	31. Prevalence of 30Mbps land-line	Coverage of 30Mbps land-line
	32. Prevalence of 100Mbps land-line	Coverage of 100Mbps land-line
	33. The municipality has 100% high-speed mobile connection	There is (no) high-speed mobile connection
	34. Prevalence of 3G	Coverage of 3G
	35. Prevalence of 4G	Coverage of 4G

9.2. Table 2-Annex. List of sources

Indicator	Source
1. Population	Total population, from: • Official Population Figures referring to revision of Municipal Register 1 January, (2000-2020) - INE
2. Prevalence of retired people	Population over 65 and Total population, from: • Total population Continuous register statistics, Population by Sex, Municipalities, Nationality and Age (large groups), (2003-2020) - INE • Continuous register statistics, Population by Sex, Municipalities and Age (large groups), (2000-2002) - INE
3. Prevalence of active age people	Population over 65 and Total population, from: • Continuous register statistics, Population by Sex, Municipalities, Nationality and Age (large groups), (2003-2020) - INE • Continuous register statistics, Population by Sex, Municipalities and Age (large groups), (2000-2002) - INE
4. Prevalence of women	Total women and Total population, from: • Official Population Figures referring to revision of Municipal Register 1 January, (2000-2020) - INE

5. Prevalence of active age women	Women between 16 and 65 and Total women, from: • Continuous register statistics, Population by Sex, Municipalities, Nationality and Age (large groups), (2003-2020) - INE • Continuous register statistics, Population by Sex, Municipalities and Age (large groups), (2000-2002) - INE
6. Prevalence of migrants	Foreign residents and Total population, from: • Municipal Population Register, Municipal Distribution, (2010-2020) - Idescat
7. Unemployment registration rate	Registered new unemployment, from: • Registered Unemployment and Contracts for Municipalities, (Jan. 2010-2020) - SEPE Population between 16 and 65, from: • Continuous register statistics, Population by Sex, Municipalities, Nationality and Age (large groups), (2010-2020) – INE
8. Net generation of contracts	Registered new contracts and Registered new unemployment, from: • Registered Unemployment and Contracts for Municipalities, (Jan. 2010-2020) - SEPE
9. The municipality has more indefinite than temporal contracts	Registered new temporal contracts and Registered new indefinite contracts, from: • Registered Unemployment and Contracts for Municipalities, (Jan. 2010-2020) - SEPE
10. Years where there were more indefinite than temporal contracts	Registered new temporal contracts and Registered new indefinite contracts, from: • Registered Unemployment and Contracts for Municipalities, (Jan. 2010-2020) - SEPE
11. Total contracts in agriculture	Registered new contracts in agriculture and Registered new contracts, from: • Registered Unemployment and Contracts for Municipalities, (Jan. 2010-2020) - SEPE
12. Total contracts in services	Registered new contracts in services and Registered new contracts, from: • Registered Unemployment and Contracts for Municipalities, (Jan. 2010-2020) - SEPE
13. Total contracts in industry and construction	Registered new contracts in industry, Registered new contracts in construction and Registered new contracts, from: • Registered Unemployment and Contracts for Municipalities, (Jan. 2010-2020) - SEPE
14. The municipality has a CAP	List of operational primary healthcare centres, from: • NHS Primary Healthcare Centres Catalogue, (Dec. 2020) - Ministry of Health
15. The municipality has a CAP within 1km	List of operational primary healthcare centres, from: • NHS Primary Healthcare Centres Catalogue, (Dec. 2020) - Ministry of Health
16. Distance to the closest CAP	List of operational primary healthcare centres, from: • NHS Primary Healthcare Centres Catalogue, (Dec. 2020) - Ministry of Health

17. The municipality has a hospital within 10km	List of operational hospitals, from: • National Catalogue of Hospitals, (Dec. 2020) - Ministry of Health
18. Distance to the closest hospital	List of operational hospitals, from: • National Catalogue of Hospitals, (Dec. 2020) - Ministry of Health
19. The municipality has an infant school	List of infant schools, from: • State Registry of Non-University Teaching Centres, (2020) - Ministry of Education and Vocational Studies (contacted by email)
20. The municipality has an infant school within 1km	List of infant schools, from: • State Registry of Non-University Teaching Centres, (2020) - Ministry of Education and Vocational Studies (contacted by email)
21. The municipality has an elementary school	List of elementary schools, from: • State Registry of Non-University Teaching Centres, (2020) - Ministry of Education and Vocational Studies (contacted by email)
22. The municipality has an elementary school within 1km	List of elementary schools, from: • State Registry of Non-University Teaching Centres, (2020) - Ministry of Education and Vocational Studies (contacted by email)
23. The municipality has a secondary school	List of secondary schools, from: • State Registry of Non-University Teaching Centres, (2020) - Ministry of Education and Vocational Studies (contacted by email)
24. The municipality has a secondary school within 5km	List of secondary schools, from: • State Registry of Non-University Teaching Centres, (2020) - Ministry of Education and Vocational Studies (contacted by email)
25. The municipality has a vocational school	List of vocational schools, from: • State Registry of Non-University Teaching Centres, (2020) - Ministry of Education and Vocational Studies (contacted by email)
26. The municipality has a vocational school within 5km	List of vocational schools, from: • State Registry of Non-University Teaching Centres, (2020) - Ministry of Education and Vocational Studies (contacted by email)
27. The municipality has a public transport station within 1km	List of public transport stations, from: • Public transport elements (key = 'public_transport'), (2022) - Open Street Maps (accessed with *osmdata* package from R)
28. Distance to the closest public transport station	List of public transport stations, from: • Public transport elements (key = 'public_transport'), (2022) - Open Street Maps (accessed with *osmdata* package from R)
29. The municipality has 100% land-line connection	Coverage of 30Mbps land-line connection, from: • Broadband Coverage for Single Population Entities, (2020) - Ministry of Economic Affairs and Digital Transformation

30. The municipality has 100% land-line high speed connection	Coverage of 100Mbps land-line connection, from: • Broadband Coverage for Single Population Entities, (2020) - Ministry of Economic Affairs and Digital Transformationt
31. Prevalence of 30Mbps land-line	Coverage of 30Mbps land-line connection, from: • Broadband Coverage for Single Population Entities, (2020) - Ministry of Economic Affairs and Digital Transformation
32. Prevalence of 100Mbps land-line	Coverage of 100Mbps land-line connection, from: • Broadband Coverage for Single Population Entities, (2020) - Ministry of Economic Affairs and Digital Transformation
33. The municipality has 100% high-speed mobile connection	Coverage of 4G mobile connection, from: • Broadband Coverage for Single Population Entities, (2020) - Ministry of Economic Affairs and Digital Transformation
34. Prevalence of 3G	Coverage of 3G mobile connection, from: • Broadband Coverage for Single Population Entities, (2020) - Ministry of Economic Affairs and Digital Transformation
35. Prevalence of 4G	Coverage of 4G mobile connection, from: • Broadband Coverage for Single Population Entities, (2020) - Ministry of Economic Affairs and Digital Transformation

9.3. Table 3-Annex. List of results (t-test)

Indicator	Period	Result (mean)		Significance (2-sided)
		Depopulating	Repopulating	
1. Population	2000-2020	703.90	324.56	0.200
	2000-2010	737.45	324.27	0.176
	2010-2020	671.07	324.38	0.228
2. Prevalence of retired people	*2000-2010*	*29.21%*	*27.18%*	*0.078*
	2010-2020	**29.81%**	**26.50%**	**0.002**
3. Prevalence of active age people	*2000-2010*	*60.73%*	*62.43%*	*0.098*
	2010-2020	60.15%	61.21%	0.209
4. Prevalence of women	2000-2010	47.75%	47.86%	0.849
	2010-2020	47.09%	47.00%	0.890
5. Prevalence of active age women	**2000-2010**	**57.67%**	**60.21%**	**0.034**
	2010-2020	*57.15%*	*59.11%*	*0.078*
6. Prevalence of migrants	2020	5.91%	6.89%	0.390
	2010-2020	5.49%	4.86%	0.536
7. Unemployment registration rate	2010-2020	6.26	5.93	0.526

8. Net generation of contracts	2010-2020	0.49	0.65	0.331
10. Years where there were more indefinite than temporal contracts	2010-2020	7.29	7.11	0.765
11. Total contracts in agriculture	2010-2020	14.92%	12.96%	0.528
12. Total contracts in services	2010-2020	26.65%	26.54%	0.979
13. Total contracts in industry and construction	2010-2020	26.27%	25.68%	0.862
16. Distance to the closest CAP	2020	1,055.55	1,674.35	0.144
18. Distance to the closest hospital	2020	19,104.33	16,486.31	0.118
28. Distance to the closest public transport station (m)	2022	3,710.02	4,433.98	0.294
31. Prevalence of 30Mbps land-line	2020	51.68%	37.97%	0.109
32. Prevalence of 100Mbps land-line	**2020**	**18.60%**	**4.57%**	**0.047**
34. Prevalence of 3G	2020	99.16%	99.08%	0.897
35. Prevalence of 4G	2020	93.85%	92.54%	0.696

Note: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in bold ($\alpha \leq 0.05$) or italics ($\alpha \leq 0.10$).

9.4. Table 4-Annex. List of results (chi-squared)

Indicator	Period	Result (%yes)		Significance (2-sided)
		Depopulating	Repopulating	
9. The municipality has more indefinite than temporal contracts	2010	61.54%	50.00%	0.264
	2011	61.54%	60.71%	0.936
	2012	47.86%	57.14%	0.378
	2013	82.91%	85.71%	1.000*
	2014	55.56%	57.14%	0.879
	2015	56.41%	53.57%	0.786
	2016	57.26%	42.86%	0.169
	2017	55.56%	46.43%	0.384
	2018	82.91%	85.71%	1.000*
	2019	82.05%	85.71%	0.785*
	2020	85.47%	85.71%	1.000*
14. The municipality has a CAP	**2020**	**87.18%**	**64.29%**	**0.010***

15. The municipality has a CAP within 1km	2020	75.21%	64.29%	0.241
17. The municipality has a hospital within 10km	2020	16.24%	14.29%	1.000*
19. The municipality has an infant school	**2020**	**59.83%**	**35.71%**	**0.021**
20. The municipality has an infant school within 1km	*2020*	*51.28%*	*32.14%*	*0.069*
21. The municipality has an elementary school	**2020**	**58.97%**	**32.14%**	**0.011**
22. The municipality has an elementary school within 1km	*2020*	*50.43%*	*32.14%*	*0.082*
23. The municipality has a secondary school	2020	6.84%	0.00%	0.354*
24. The municipality has a secondary school within 5km	2020	20.51%	21.43%	0.914
25. The municipality has a vocational school	2020	3.42%	0.00%	1.000*
26. The municipality has a vocational school within 5km	2020	10.26%	14.29%	0.531*
27. The municipality has a public transport station within 1km	*2022*	*36.75%*	*17.86%*	*0.056*
29. The municipality has 100% land-line connection	2020	20,51%	14,29%	0.453
30. The municipality has 100% land-line high speed connection	2020	8.55 %	0.00%	0.210*
33. The municipality has 100% high-speed mobile connection	2020	82.91%	75.00%	0.334

Note 1: Indicators in which there are significant differences between the repopulating and depopulating groups are marked in bold ($\alpha \leq 0.05$) or italics ($\alpha \leq 0.10$).

Note 2: In some cases, cells had a count lower than expected. They are marked with an (*) and the value displayed as significance corresponds to the Fisher's Exact Test instead of Pearson Chi-Square.

9.5. Annex: R-Code

```
# Session information
R version 4.2.0 (2022-04-22 ucrt)
Platform: x86_64-w64-mingw32/x64 (64-bit)
Running under: Windows 10 x64 (build 22000)

Matrix products: default

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods
base

loaded via a namespace (and not attached):
 [1] rstudioapi_0.13  knitr_1.39       magrittr_2.0.3
tidyselect_1.1.2 munsell_0.5.0    colorspace_2.0-3 R6_2.5.1
 [8] rlang_1.0.4      fastmap_1.1.0    fansi_1.0.3
dplyr_1.0.9      tools_4.2.0      grid_4.2.0       gtable_0.3.0
[15] xfun_0.30        utf8_1.2.2       cli_3.3.0        DBI_1.1.2
htmltools_0.5.2  ellipsis_0.3.2   yaml_2.3.5
[22] digest_0.6.29    assertthat_0.2.1 tibble_3.1.7
lifecycle_1.0.1  purrr_0.3.4      ggplot2_3.3.6    vctrs_0.4.1
[29] glue_1.6.2       evaluate_0.15    rmarkdown_2.14
compiler_4.2.0   pillar_1.8.0     generics_0.1.3   scales_1.2.0
[36] pkgconfig_2.0.3

# Load packages
library(pacman)
p_load(readxl,
       writexl,
       tidygeocoder,
       magrittr,
       dplyr,
       stringr,
       osmdata,
       geosphere,
       xml2,
       rlist
)

## ~ MUNICIPALITIES ~ ##

# 1. Download the file with the municipalities and save it as
"municipalities_2020".

# 2. Load the file into R.
mun <- read_excel("municipalities_2020")

# 3. Geolocate the municipalities
mun_latlong <- mun %>%
  geocode(Municipality, method = 'osm', lat = lat , long = lon)


## ~ HEALTHCARE ~ ##
```

```
# 1. Download data and save it as "CAPS_2020".

# 2. Read the file.
caps <- read_excel("CAPS_2020", sheet = 1)

# 3. Filter communities/provinces that limit with Catalonia.
caps_cat <- subset(caps, caps$CCAA == "CATALUÑA" |
                         caps$CCAA == "ARAGÓN" |
                         caps$PROVINCIA == "CASTELLÓN/CASTELLÓ")

# 4. Save as excel.
write_xlsx(caps_filter,"caps_filter.xlsx")

# 5. Add three columns to the excel and save it as
"caps_clean.xlsx".
## - FULL_DIR (address, [locality], municipality, province, ccaa,
ESPAÑA) #include the locality only if it's different than the
municipality
## - FULL_LOC ([locality], municipality, province, ccaa, ESPAÑA)
## - FULL_MUN (municipality, province, ccaa, ESPAÑA)

# 6. Geolocate CAPs using column "FULL_DIR".
caps <- read_excel("caps_clean.xlsx")
caps_latlong_d <- caps %>%
  geocode(FULL_DIR, method = 'osm', lat = lat_d , long = lon_d)
write_xlsx(caps_latlong_d,"latlong_caps_d.xlsx")

# 7. Filter NA and geolocate CAPS using column "FULL_LOC" (less
precise).
caps_latlong_na <- caps_latlong_d %>%
filter_all(any_vars(is.na(.)))
caps_latlong_l <- caps_latlong_na %>%
  geocode(FULL_LOC, method = 'osm', lat = lat_l , long = lon_l)
write_xlsx(caps_latlong_l,"latlong_caps_l.xlsx")

# 8. Filter NA and geolocate CAPS using column "FULL_MUN" (less
precise).
caps_latlong_na <- caps_latlong_l %>%
filter_all(any_vars(is.na(.)))
caps_latlong_m <- caps_latlong_na %>%
  geocode(FULL_MUN, method = 'osm', lat = lat_m , long = lon_m)
write_xlsx(caps_latlong_m,"latlong_caps_m.xlsx")


# 9. Paste (manually) the rows in an excel "latlong_caps20.xlsx"
and select the correct latitude and longitude for every case.


## ~ HOSPITALS ~ ##

# 1. Download the data and check for errors. Save the file as
"HOSPITALS_2020".
```

```
# 2. Load revised data.
hosp <- read_excel("HOSPITALS_2020.xlsx", sheet = 1)

# 3. Filter area of interest.
hosp_cat <- subset(hosp, hosp$Provincia == "BARCELONA" |
                     hosp$Provincia == "GIRONA" |
                     hosp$Provincia == "LLEIDA" |
                     hosp$Provincia == "TARRAGONA" |
                     hosp$Provincia == "CASTELLÓN" |
                     hosp$Provincia == "HUESCA" |
                     hosp$Provincia == "TERUEL" |
                     hosp$Provincia == "ZARAGOZA")

# 4. Save as excel.
write_xlsx(hosp_cat,"hosp_filter.xlsx")

# 5. Add three columns to the excel and save it as
"hosp_clean.xlsx".
## - ADD_1 (address, municipality, province, ccaa, ESPAÑA)
## - ADD_2 (municipality, province, ccaa, ESPAÑA)

# 6. Geolocate using address 1.
hosp <- read_excel("hosp_clean.xlsx")
hosp_latlong_d <- hosp_cat %>%
  geocode(ADD1, method = 'osm', lat = lat_d , long = lon_d)
write_xlsx(hosp_latlong_d,"latlong_hosp_d.xlsx")

# 7. Filter out NA and geolocate using address 2
hosp_latlong_na <- hosp_latlong_d %>%
filter_all(any_vars(is.na(.)))
hosp_latlong_l <- hosp_latlong_na %>%
  geocode(ADD2, method = 'osm', lat = lat_l , long = lon_l)
write_xlsx(hosp_latlong_l,"latlong_hosp_l.xlsx")

# 8. Paste (manually) the rows in an excel "latlong_hosp20.xlsx"
and select the correct latitude and longitude.


## ~ EDUCATION CENTRES ~ ##

# 1. Download the data, revise it and save it as "EDU_2020".

# 2. Load revised data.
edu <- read_excel("EDU_2020.xlsx", sheet = 1)

# 3. Filter area of interest.
edu_cat <- subset(edu, edu$Provincia == "Barcelona" |
                       edu$Provincia == "Girona" |
                       edu$Provincia == "Lleida" |
                       edu$Provincia == "Tarragona" |
                       edu$Provincia == "Castellón/Castelló" |
                       edu$Provincia == "Huesca" |
                       edu$Provincia == "Teruel" |
                       edu$Provincia == "Zaragoza")
```

```
# 4. Save as excel.
write_xlsx(edu_cat,"edu_filter.xlsx")

# 5. Add three columns to the excel and save it as
"edu_clean.xlsx".
## - ADD_1 (address, municipality, province, ccaa, ESPAÑA)
## - ADD_2 (municipality, province, ccaa, ESPAÑA)

# 6. Geolocate using the first address.
edu_latlong_d <- edu_cat %>%
  geocode(ADD1, method = 'osm', lat = lat_d , long = lon_d)
write_xlsx(edu_latlong_d,"latlong_edu_d.xlsx")

# 7. Filter the NA and geolocate using address 2.
edu_latlong_na <- edu_latlong_d %>%
filter_all(any_vars(is.na(.)))
edu_latlong_l <- edu_latlong_na %>%
  geocode(ADD2, method = 'osm', lat = lat_l , long = lon_l)
write_xlsx(edu_latlong_l,"latlong_edu_l.xlsx")

# 8. Paste (manually) the rows in an excel "latlong_edu20.xlsx"
and select the correct latitude and longitude.


## ~ PUBLIC TRANSPORTATION ~ ##

# 1. Get data from the public transport of Catalonia.
trans_cat <- opq(bbox = getbb("Catalonia, Spain"), timeout = 60)
%>%
  add_osm_feature(key = 'public_transport') %>%
  osmdata_xml(file = 'transport_cat.osm')

# 2. Save the children of the xml.
trans_cat_xml <- read_xml("transport_cat.osm")
child_transcat <- xml_children(trans_cat_xml)

# 3. Transform the children of the xml in a string and then a
matrix.
transport_cat <- c()
x = 1 #child
i = 1 #position
while (x < length(child_transcat)){
  if(xml_name(child_transcat[x]) == 'node') {
    transport_cat[i] <- xml_attr(child_transcat[x], "id")
    i = i+1
    transport_cat[i] <- as.numeric(xml_attr(child_transcat[x],
"lat"))
    i = i+1
    transport_cat[i] <- as.numeric(xml_attr(child_transcat[x],
"lon"))
    i = i+1
  }
  x = x+1
```

```
}

# 4. Save as the result as a data frame.
trans_latlong <- as.data.frame(matrix(transport_cat, nrow =
length(transport_cat)/3, ncol = 3, byrow = TRUE))
colnames(trans_latlong) <- c("ID", "LAT", "LON")

# 5. Save as excel.
write_xlsx(trans_latlong, "latlong_transport.xlsx")


## ~ DISTANCES ~ ##

# 0. Optional: open the already created excels
mun_latlong <- read_excel("latlong_mun.xlsx")
caps_latlong <- read_excel("latlong_cap.xlsx")
hosp_latlong <- read_excel("latlong_hosp20.xlsx")
edu_latlong <- read_exel("latlong_edu.xlsx")
trans_latlong <- read_excel("latlong_transport.xlsx")

# 1. Define variables
mun_lat <- mun_latlong$lat
mun_lon <- mun_latlong$lon
mun_code <- mun_latlong$Codi

cap_lat <- cap_latlong$lat
cap_lon <- cap_latlong$lon
cap_code <- cap_latlong$CCN

hosp_lat <- hosp_latlong$lat
hosp_lon <- hosp_latlong$lon
hosp_code <- hosp_latlong$CCN

edu_lat <- hosp_latlong$lat
edu_lon <- hosp_latlong$lon
edu_code <- hosp_latlong$CCN

distance_hosp <- c() #empty list
i = 1 #counts the number of iterations
x = 1 #position of the service
m = 1 #position of municipality

# 2. Run the nested for-loop
for (mun in mun_code){
  for (cap in cap_code){
    distance_cap [i] <-
distm(c(mun_lon[m],mun_lat[m]),c(cap_lon[x],cap_lat[x]), fun =
distGeo)
    x = x + 1
    i = i + 1
  }
  x = 1
  m = m + 1
}
```

```
# 3. Save as matrix & then as excel.
distances_cap_cat <- as.data.frame(matrix(distance_cap, nrow =
length(cap_code), ncol = length(mun_code), byrow = FALSE,
dimnames = list(cap_code, mun_code)))
write_xlsx(distances_cap_cat, "distances_cap_cat20.xlsx")

# 4. Repeat steps 2 and 3 for all the variables (hospital,
education and transport).
```