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Diseño y validación de un índice para medir el Desarrollo Rural

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PHD THESIS

Design and validation of an index to measure Rural Development

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Introduction

INTRODUCTION

From the beginning of times, rural and agriculture were intended to be two undissociated concepts, as farming was the almost exclusive means of development of the rural population. The rural world was then looked from a purely agricultural and productive perspective, without any concerns for social issues or the development of other activity sectors.

However, in the last decades we have been watching deep transformations in the rural territories, with agricultural activities being complemented and even substituted by a service economy. These changes have led inevitably to a drastic reduction of agricultural labour needs, and to a mass migration to the cities in search of more rewarding jobs. Not only this "emptying" of villages has deprived them of part of their most active and dynamic population, but also the lack of population itself leads to the disappearance of essential services, which in turn encourages rural exodus. The consequences of the depopulation and increasing aging are also more leveraged by the fact that rural populations are generally less represented and mobilized, and there is a growing disconnection between urban and rural dwellers, with the former ceasing to see the latter as a necessary and fundamental part of society. This leads to a situation where "urban" citizens perceive that they are subsidizing the "rural" ones, without getting any benefit in return as they ignore the valuable environmental, cultural, and social services that the villages and their inhabitants provide.

Despite the efforts of policy makers to reduce the differences that exist between rural and non-rural territories, rural areas still present constraints such as lack of access to services and technology or remoteness from the main population centres, which can limit their development and jeopardize their persistence. The difference between the development levels of both types of territories have become increasingly pronounced, with rural regions tending to lag non-rural areas in several socioeconomics indicators. Although we are talking about most of the European Union's territory, rural areas still have a higher risk of poverty or social exclusion (23.9% in rural areas versus 21% in urban areas), a lower level of education (levels of tertiary educational attainment below 40% while in the most urbanized regions this figure amounts up to 60-80%), and lower level of digital skills among adults (49 % with basic or above basic skills in

rural areas, versus 63% for those living in cities) (Eurostat 2019). And all this in spite of the fact that 44% of the world population lives in rural areas, a figure even more significant in developing countries, where it reaches 55% (Caruso et al. 2016a).

So, when the Rural Development (RD) concept arises -consisting of a series of tools to maintain population and activity in those regions that are lagging more prosperous and active places- it can be seen as a response to the limitations of rural areas and as an attempt to offset them. In this context, we can define Rural Development as the set of initiatives aimed at fostering the modernization of rural areas, the creation of new job opportunities, the sustainability and efficiency of farms, and the preservation of ecosystems (I. Abreu and Mesias 2020; UPA 2016). And so, the European Union recognised the importance of the RD public policies - even with agriculture and agri-food activities being still a major component of RD policies (European Commission 2017a) - and defined on 2013 Rural Development as the Second Pillar of the Common Agricultural Policy (CAP). This fact meant to base it on multiannual national or regional EU-funded programmes, to which local contributions must be added in different percentages, depending on the levels of development of the various regions of the European Union.

Nowadays, the divergences between rural and urban areas have been decreasing, changing the traditional approach of rural development policies. For example, the dependence on agriculture, even with its lower profitability as an economic activity and its offer of lower quality jobs, is increasingly seen as an opportunity because of its greater resilience in crisis situations (as we experienced in the last 2 years on Covid-19 pandemic context).

But many problems remain to be addressed by diverse, adapted, and adaptable rural development policies to respond to current and potential future challenges, as these policies must be broad and diverse to answer the diversity of problems that they may face. Moreover, they must be measurable to make possible to analyze whether the objectives for improvement are being achieved, and to create a decision-making framework that allows giving up objectives that are no longer relevant, while strengthening those that enable the new challenges to be met.

This task is not easy to undertake, as despite the existence of different development indexes, there is a scarcity of tools specifically focused on the evaluation of RD policies. In fact, several indices have been created to measure development in general terms, but none of them was specifically designed for the assessment of rural areas - we can highlight the Gross Domestic Product (World Bank 1997), the Human Development Index (HDI) (UNDP 2010a) (UNDP 2010a), the Social Development Framework (Davis 2004) or the Multidimensional Poverty Index (Oxford Poverty and Human Development Initiative 2010a). An index specially designed to the rural areas has a twofold importance: 1) these areas have major asymmetries which hamper the assessment of their level of development, and; 2) in European Union more than 80% of the territory is classified as rural areas, where almost 30 % of EU's population live (Comission 2021). Full understanding of the main determinants of economic and social growth of rural areas remains one of the chief policy issues (Bryden 2002), and given the multiple dimensions of rural development, there is a huge interest among policy makers to learn more about the magnitude and trends in the overall welfare in rural regions (Michalek and Zarnekow 2012a).

Bearing in mind that rural development is a multi-dimensional process, RD indexes must be based on the use of several indicators representing its different dimensions. Moreover, given that the implementation of a policy does not only affect the targeted activity but also contributes to the modification of the entire human environment, it cannot be monitored merely by verifying compliance with its objectives (Carraro et al. 2009). Therefore, a composite index must be used which compiles individual indicators into a single index on the basis of an underlying model (OECD 2008), better capturing the different and multi-faceted nature of development. To measure progress, the composite index must incorporate enough indicators so that multidimensionality is captured, but without compromising its interpretability. Hence, the selection of underlying indicators is the result of a trade-off between possible redundancies caused by overlapping information and the risk of losing information (Kynčlová et al. 2020).

Ideally, a composite rural development index has to measure multi-dimensional concepts that cannot be captured by partial indicators alone and therefore embrace all the most important domains of rural development (DEFRA 2004a). While the main

areas of policy concerns related to rural development have been relatively easily identified, i.e.: i) economic structure and performance, ii) social well-being and equity, iii) population and demographics, and iv) environment and sustainability, overcoming these constraints in individual rural areas through precise targeting of policy interventions has proven to be a complex policy task, mostly due to their local/regional specificity as well as complex links among individual growth components and their constraints (Michalek and Zarnekow 2012a).

The definition of a set of RD indicators will thus provide an effective tool for both policymakers and managers of RD programs, thereby enabling the adaptation and development of new policies as well as the evaluation of the existing ones, something crucial in an increasingly changing environment and where adaptation is synonymous with survival.

For these purposes, two specific indices were developed to attempt to assess RD: Kageyama's Rural Development Index (Kageyama 2008) and Abreu's Rural Development Index (I. Abreu 2014). Examples of the use of both indices can be found in the work of (Haag 2009), who applied Kageyama's index to measure the effectiveness of public policies in Brazil, and in that of (I. Abreu et al. 2019), which applied the second index to measure the RD of 15 Portuguese municipalities. Both indices are based on the use of different indicators that are grouped into four dimensions (demography, economy, social welfare, and environment), but one fundamental difference -apart from the number of variables used- is that Kageyama's uses a simple arithmetic mean of the four dimensions to aggregate the different indicators, while Abreu's uses the geometric mean in order to avoid the substitution effect that a very high score in one of the dimensions could eventually cause.

As both indices include not only indicators related to economic and demographic aspects (the "traditional" dimensions of development), but also those linked to social and environmental factors that have great relevance to RD, this makes them into stronger tools to the objective pursued when compared to the generalist indices mentioned above. However, they also share the limitation that the selection of the indicators is endorsed by the literature, but do not necessarily include those elements

that stakeholders would consider to be truly relevant to rural development.

So, it was realized that these indexes would not necessarily include those elements that should be given importance when assessing RD. It has therefore been considered that the best strategy for addressing this problem is the use of qualitative research, as it involves less structured tasks than the quantitative methodologies and is a more flexible and versatile type of research. Thus, it is appropriate for the initial stages of a research process, to study the nature of a problem or to identify action alternatives as well as relevant variables and hypotheses (Eldesouky and Mesias 2014; Vaca and Mesías 2014).

With this purpose, and among the available methodologies, it was decided to use the Delphi method for the selection of the indicators that would compose an effective rural development index, as Delphi methodology relies on the use of a panel of experts who must reach a consensus on the problem studied (Escribano et al. 2018; H.A. Linstone and Turoff 2002). The Delphi technique poses clear benefits in uncertain environments, for example where the initial information is excessively diverse or difficult to access, or where the lack of clear and objective information makes it difficult to apply other methodologies (Landeta and Barrutia 2011). The Delphi method has been widely used in various areas of agri-food research due to its versatility. Thus, applications can be found regarding the use of irrigation techniques (Alcon et al. 2014), the effect of climate change on food production (Kirezieva et al. 2015), the adoption of organic production in rangelands (Horrillo et al. 2016), or the identification of indicators to measure sustainability in agroforestry systems (Escribano et al. 2018).

Another aspect that must be considered is the fact that the way in which the indicators are combined in a rural development index is as relevant, if not more, than its selection. A review of the literature allows us to find different aggregation methods accepted by the scientific community, namely: simple aggregation of indicators through geometric/arithmetic mean, as used in the Human Development Index (Conceição 2019) or in the Rural Development Index proposed by (I. Abreu et al. 2019); weighted arithmetic average of the indicators using the weights provided by a panel of RD experts through a Delphi approach (I. Abreu and Mesias 2020); and

Principal Component Analysis (PCA), widely used by different authors such as (Bolcárová and Kološta 2015; Jollife and Cadima 2016; Yilmaz et al. 2010).

Therefore, and to overcome the above-mentioned limitations, this Thesis assessed the use of these three aggregation methods, and then applied them to nine different Portuguese NUTS III territories (a lower level than the regional, but at which rural development policies are applied), using the most recent data available for the whole set of variables from the National Statistical Institute of Portugal.

The final objective was to determine the best way to aggregate the indicators, which implied again the collaboration of a panel of Portuguese RD experts. These experts received the results of the different RD indexes obtained through the above-mentioned aggregation methods and identified the most accurate aggregating methodology to create a Rural Development Index (RDI). Therefore, this Thesis provides an innovative and effective tool for both policymakers and managers of rural development programs, as its base (the indicators) have been selected by the stakeholders and therefore may be more comprehensive than those previously used in other studies. Furthermore, the way the indicators are brought together to synthetize the Rural Development Index has been objectively selected, and it can be expected that the results can provide a more accurate view of the needs for the rural areas development. Due to its composite nature, this Thesis proposes a Rural Development Index that can be applied to analyse the main determinants of rural/regional development in individual rural areas and used to measure the impact of cohesion policy and RD/structural programmes at various regional levels, what is particularly important in a context where the rural environment and the policies that promote its development are gaining more and more importance.

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General Structured Summary

GENERAL STRUCTURED SUMMARY

In the context of the discussion of the European Union's Multiannual Financial Framework 2021-2027 the importance that the European Union gives to rural areas has become clear with Rural Development (RD) being considered as the Second Pillar of the Common Agricultural Policy. This increasing importance of RD makes even more relevant the evaluation of Rural Development policies, which is fundamental to assess their impact in a particular territory, or, in an ex-ante perspective, to identify the areas where the use of public funds will be more effective.

This process, which is complex for any policy, is even more complex in the case of rural development, because it deals with such diverse aspects like employment, modernization, sustainability, and environment. Therefore, an index that can measure rural development must be a composite one in order to capture the different and multi-dimensional natures of development.

This doctoral thesis hence proposes a tool to measure rural development, that can be used by those involved in the different levels of rural development policies. This rural development index could be used to assess the impact of public policies applied to a particular territory and to identify the areas where the use of public funds will be more effective. It is based on a collection of three publications papers, two of them published in international JCR journals and the third one published in arXiv.org.

The first article starts with the analysis of the most widely existing development indexes such as, for example, Gross Domestic Product and UN Human Development Index, and their suitability to evaluate the development of rural areas. As none of them are specially designed for the evaluation of small territories (e.g., at a municipal level) nor considers the particularities of the rural areas, they could not be considered as feasible tools to identify the issues where public investment can more effectively influence the private sector in these territories.

Therefore, this paper proposed the design of a Rural Development Index (RDI) which would cover the defining characteristics of each region's development.

Taking as starting point an existing index used to measure the effectiveness of public policies in Brazil and based on four dimensions (Population, Social welfare, Economic and Environmental), a new Rural Development Index (RDIAbreu) was

designed. RDIAbreu considers that all the four dimensions have equal importance and selects four different indicators for each one among the most common development indicators. Another innovation was the aggregation of the dimension's values through a geometric mean (instead of the arithmetic mean as on the Brazilian index), avoiding the substitution effect that a very high score in one of the dimensions could cause. Another strength of this new index was also the inclusion not only of indicators related to economic and demographic aspects, but also of those linked to social and environmental factors that have great relevance to rural development.

To test its real applicability, the Index was then applied to 15 municipalities in a Portuguese NUTS III region (Alto Alentejo) using data available from the Portuguese Census. The application of RDIAbreu to Alto Alentejo municipalities has allowed to highlight some factors with special relevance for Rural Development, such as the buffer role of agricultural activities—which can help to soften the impact of economic crisis—or the link between specialized education and development. The index here designed would also allow to make a comparative analysis of values of each territorial unit in different years, providing relevant information about the effectiveness of the implementation of public policies. It also made it possible to identify the dimensions in which the public development policies can improve their results, and how these dimensions contribute to different development levels of the territories.

The paper also proposes ways to improve the index in the future, for example with the inclusion of new variables. However, the availability of information will always be a constraint.

The second paper arose as a natural follow-up to the first one, as the indicators selected from the literature could not necessarily include those elements that stakeholders consider to be truly relevant for rural development. It was therefore assumed that new indicators reflecting stakeholders' points of view should therefore be incorporated when calculating these indices.

To overcome this constraint, the work tried to perform, in an objective way, the selection of the attributes that should be taken into account for the measurement of rural development and the impact of related policies. Considering the heterogeneous

nature of rural areas and, therefore, of rural development, traditional approaches can be difficult to apply as there is not a previous framework which can be used as a starting point for this task. It has, therefore, been considered that the best strategy for addressing this problem was the use of qualitative research, i.e., the Delphi methodology.

Using this method, the answers from a panel of experts with different roles in rural development defined a set of indicators from the four dimensions (demographics, environmental, economic, and social welfare indicators) that could be used to assess rural development and related policies. Based on the consensus of the experts and starting from an initial proposed group of 88 indicators selected from the literature, 25 indicators were finally selected.

This research found that, in addition to the economy, social welfare is one of the areas that contributes most to the development of rural areas, thus contradicting "traditional" indices based solely on economic and demographic indicators. All this points to the need to evolve towards an index based on the results of this paper.

Additionally, the indicators were also weighted within each dimension according to the importance granted by the panel, enabling the subsequent implementation of an appropriate rural development index.

So, when compared to previous research on the assessment of rural development, the use of a Delphi approach provided some additional benefits, such as adaptation to the needs and views of different stakeholders and prioritization of indicators and dimensions.

Finally, the third article studied the best method to aggregate the indicators previously select through the Delphi approach on a Rural Development Index (RDI). To do that, three widely accepted aggregation methods were tested: a mixed arithmetic/geometric mean without weightings for each indicator; a weighted arithmetic mean using the weights previously generated by the Delphi panel; and an aggregation through Principal Component Analysis. These three approaches originated three different indexes, respectively, RDI Abreu, RDI Delphi and RDI PCA.

To test the validity of the different methodological approaches, each one was applied to nine Portuguese NUTS III regions. The results were very similar to the first two aforementioned indexes (RDI Abreu, and RDI Delphi), which was confirmed by the existence of a strong correlation between them.

In the final part of this study, the group of experts received information about the RDI results with the three different methodologies for the NUTS III regions analysed and were asked to indicate which of the results had been most relevant for their answers.

The final conclusion was that the unweighted arithmetic/geometric mean was the most accurate methodology for aggregating indicators to create a Rural Development Index. Regarding the reasons provided by the experts to support their decisions, the main points of disagreement with RDI PCA were the relative position of the regions of Coimbra and Açores. Açores got the highest rating in RDI PCA, while Coimbra (one of the most industrialized and developed regions of Portugal) went down to the fifth position, below Alto Minho region (a low-density territory, strongly marked by aging) raising some doubts between the experts about its reliability.

On the other hand, Açores is the Portuguese region with one of the worst health services indicator and highest income inequality, therefore its top position on RDI PCA was not well accepted by the experts.

In view of these results, other indexes that rely on the use of statistical techniques to aggregate the variables composing a rural development index or to determine their weight, but where no validation of their accuracy has been performed, should rethink their formulation according to the results presented in this paper.

This research therefore provides an effective tool for both policymakers and managers of rural development programs, which due to its composite nature can be applied to analyse the main determinants of rural/regional development in individual rural areas. Furthermore, it can also be used to measure the impact of cohesion policy and rural development/structural programmes at various regional levels.

Chapter I. Can rural development be measured? Design and application of a synthetic index to Portuguese municipalities

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Resumen

Al comenzar la discusión sobre el periodo 2021-2027, y teniendo en cuenta la creciente importancia dada a las zonas rurales por la Unión Europea (UE), la multifuncionalidad de la agricultura y sus externalidades positivas pueden ser el factor de influencia para un desarrollo rural sostenible. Por ello es crucial identificar los aspectos de éxito en estos territorios donde la inversión pública puede con más eficacia influenciar al sector privado. A pesar de la existencia de muchos índices de desarrollo, ningún de ellos esta específicamente pensado para la evaluación de las zonas rurales. Esta falta de medidas de desarrollo rural dificulta el proceso de evaluación del impacto de las políticas públicas aplicadas en un territorio especifico, o, en una perspectiva ex-ante, la identificación de las áreas donde la utilización de fondos públicos sería más eficaz. Este trabajo propone por ello la creación de un Índice de Desarrollo Rural que cubriría las características que definen el desarrollo de cada región. El índice ha sido construido en base a cuatro dimensiones: Poblacional, Social, Económica y Ambiental, estando cada una de ellas compuesta de diferentes indicadores. Finalmente, el índice es aplicado a 15 municipios de la región portuguesa NUTS III (Alentejo Norte) utilizando los datos más recientes disponibles del Censo Portugués de 2011.

El uso del índice permitió un análisis comparativo de valores de cada unidad territorial en diferentes años, produciendo algunas conclusiones sobre la eficacia de la implementación de las políticas públicas. También fue posible identificar las dimensiones en las cuales las políticas de desarrollo público pueden mejorar sus resultados, y como estas dimensiones contribuyen a los diferentes niveles de desarrollo de los territorios.

Can rural development be measured? Design and application of a synthetic index to Portuguese municipalities

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Abstract

Starting the discussion about the framework 2021-2027, and regarding the increasing importance given to rural areas by the European Union (EU), multifunctionality of agriculture and its positive externalities can be the leverage factor to a sustainable rural development. It is therefore crucial to identify the success issues in these territories where public investment can more effectively influence the private sector.

Despite the existence of many indices of development, none of them is specifically designed for the evaluation of rural areas. This lack of rural development measures hampers the process of assessing the impact of public policies applied in a particular territory, or, in an ex-ante perspective, the identification of the areas where the use of public funds would be more effective. This work hence proposes the design of a Rural Development Index (RDI) which would cover the defining characteristics of each region's development. The index has been constructed based on four dimensions: Population, Social, Economic and Environmental, with each of them being composed of different indicators. The index is finally applied it to 15 municipalities in a Portuguese NUT III region (North Alentejo) using the most recent data available from the 2011 Portuguese Census.

The use of the index has allowed a comparative analysis of values of each territorial

unit in different years, producing some conclusions on the effectiveness of the implementation of public policies. It was also possible to identify the dimensions in which the public development policies can improve their results, and how these dimensions contribute to different development levels of the territories.

KEYWORDS: Rural Development; Index; Public funds; Effectiveness; Alentejo; Portugal.

1.1. Introduction

Rural areas have some characteristics -such as a predominantly agricultural activity- that have typically allowed their definition and identification. However, nowadays their current economic structure and distribution of working population by sector are no longer so different from that of non-rural areas -although the weight of the agricultural sector is still clearly higher than in the cities (Abreu, 2014). Nevertheless, rural areas present constraints such as lack of access to services and technology or remoteness from the main population centres, which can limit their development and jeopardize their persistence.

Until the beginning of the twentieth century, agriculture was the main and almost exclusive means of development of the rural population. The rural world was then viewed from a purely agricultural, productivity perspective, with no concerns for social issues or the development of other activity sectors in these areas. However, in the last decades deep transformations in rural areas took place, with the shift from a subsistence agricultural economy to a service economy and with a drastic reduction of agricultural labour, who moved to cities looking for more rewarding jobs. These migration processes have led to a depopulation of rural areas, together with an increasing aging of rural population which adds even more difficulties to those areas.

In fact, the different levels of development of rural and non-rural areas have become increasingly pronounced, with rural regions tending to lag behind non-rural areas in a number of socioeconomic indicators such as: a higher risk of poverty or social exclusion (25.5% versus 22.1% for those living in towns and suburbs, according to 2015 data), less highly-educated people (27.9% versus 48.1% among city-dwellers)

and the lowest proportion of people making use of the internet on a daily basis (EUROSTAT, 2017). Although the reasons for this "urban bias" are numerous, one the most important is that rural populations are generally less represented and mobilized, with urban elites dominating political discourse and institutions and organizations which deal with urban concerns.

Hence, rural spaces, populations and practices have been neglected both in development theories and practices as well as in the historical studies on development (Jones and Corbridge, 2010). This is even more remarkable if we consider that until quite recently most of the world's population lived in rural areas and depended on agriculture. Nowadays 44% of the world population live in rural areas, a figure even more significant in the case of developing countries, where it amounts up to 55% (Caruso et al., 2016), although rural problems persist in many parts of the world: poverty, little or no access to basic needs and resources, and lack of representation.

Once accepted the fact that rural areas face great and increasing disadvantages compared with urban areas -the so called, farm problem- the concept of rural development starts to be coined as the set of actions designed to try to compensate those shortcomings and therefore improve life quality and economic welfare in rural areas. It is a complex and sometimes vague concept which should be implemented through the so called "rural development policies" which would be the tool to maintain population and activity in those regions that are lagging behind more prosperous and active places.

The traditional approach to rural development and rural development policies was focused on agriculture and agri-food activities, a logical line considering that they were the main source of jobs and income in rural areas. For example, in the EU not only the starting initiatives in rural development were closely linked to the Common Agricultural Policy (CAP), but this relationship can also be found in the last proposals regarding the design of the CAP (European Commission, 2017).

This emphasis, however, is no longer valid as rural areas are more and more defined not by their dependence on agriculture, but by their under-urbanization and their alienation from the current urban economic flow. Although this can be a positive

aspect for many of their inhabitants, it entails specific problems such as difficult access to services, low implementation of business initiatives or lack of generational renewal of their residents. In this context, rural development policies must be broad and diverse so that they can answer the various problems that may be met. But in addition, they should be monitorable in order to determine if the objectives of improving the living conditions of rural areas and their population are being reached. It is therefore needed to develop tools capable of measuring the rural development of different areas, which is the objective this paper deals with through the creation of a rural development synthetic index.

The importance of an index especially directed to rural areas is twofold: 1) these areas have major asymmetries which hamper the assessment of their level of development, and, 2) in Europe more than 91% of the territory is classified as rural areas, where more than 56 % of its population live[1].

Since, so far, there is no tool to support the policy makers' decisions at various levels, the Rural Development Index proposed in this paper (RDI_{Abreu}) is now trying to fill a gap felt by those who work in rural development. Fully understanding of the main determinants of economic and social growth of rural areas remains one of the chief policy issues (Bryden, 2011), and given the multiple dimensions of rural development, there is a huge interest among policy makers to learn more about the magnitude and trends in the overall welfare in rural regions (Michalek and Zarnekow, 2012a). Nevertheless, the structure of RDI_{Abreu} allows its applicability to any territorial dimension region of the world with minimal adaptations. Hence, in this paper the RDI_{Abreu} is applied to 15 Portuguese rural municipalities to test its applicability. The objective of this paper is therefore to provide a tool that can be used by those involved in the different levels of Rural Development policies and that would allow assessing the impact of public policies applied to a particular territory and the identification of the areas where the use of public funds would be more effective.

[1] https://ec.europa.eu/agriculture/statistics/indicators/rd-2013/c2_en.pdf

1.2. Theoretical Framework

Within the various indexes that have been created to measure development in a broad sense, the Gross Domestic Product (GDP) (World Bank, 1997) has become for years *the* indicator to measure the economic activity of a region or country. However, GDP presents serious limitations to measure rural development (RD), as this concept goes thus much beyond the measurement of economic growth, and although there are other indexes that could be used for this task, such as the UN Human Development Index (HDI) (UNDP, 2016), the Social Development Framework (Davis, 2004) or the Multidimensional Poverty Index (Oxford Poverty and Human Development Initiative, 2010) none of them is specifically designed for the evaluation of the rural areas. So, it's difficult to assess the impact of public policies applied to a particular region or, in an *ex-ante* perspective, the identification of the areas, or types of investment, where the use of public funds will be more effective. Furthermore, some additional challenges must also be considered, such as the scarce availability of reliable development indicators and the cost of collecting and analysing data (Horsley et al., 2015).

In this context, this paper proposes a Rural Development Index which is intended to be as comprehensive as possible, including not only economic and demographic aspects but also social and environmental ones. Even if it is easy to identify these four aspects as those concerning rural development policy, overcoming rural areas´ constraints through precise targeting of policy interventions has proven to be a complex policy task. This is mostly due to their local/regional specificity as well as complex links among individual growth components and their constraints (Michalek and Zarnekow, 2012b).

In order to construct an aggregate rural development index, several methodological issues must be taken into account as it is demonstrated by various empirical studies on this matter: selection of appropriate variables/ coefficients and balancing between objective vs. subjective indicators; weighting the variables/indicators according to their relative importance; using unbiased aggregation techniques; making the index useful for policy purposes (i.e. in programme evaluation) (Berger-schmitt and Noll, 2000; Black and Henderson, 1999; Kaufmann et al., 2007).

Ideally, the composite should measure multi-dimensional concepts that cannot be captured by partial indicators alone, and should therefore embrace all the most important rural development domains, e.g. economic output (including agriculture, food industry, rural tourism, etc.), investment, employment, poverty, education, health, housing conditions, crime, environment, urbanization and land use, etc. (DEFRA, 2004).

With this concerns and based on the OECD assumptions for the definition of rural areas and their basic indicators[2], Kageyama proposed a Rural Development Index, which will be the working base for the Rural Development Index here presented (Kageyama, 2008). Kageyama´s Rural Development Index has four different dimensions or sub-indexes: demography (Population Index), economy (Economic Development Index), social welfare (Social Welfare Index) and environment (Environment Index) - in order to classify the territorial units according to their Rural Development. Selecting some indicators representing these four areas, the sub-indexes are then joined by a simple arithmetic average of four dimensions[3]:

$$\mathrm{RDI}_{\mathrm{Kageyama}} = \frac{POP+SOC+ECO+ENV}{4}$$

Kageyama's index varies in a range from 0 to 1, meaning that the closer it is to 1, the higher is the rural development level of the territory in question. The strengths of Kageyama's index are mainly related to the inclusion not only of the economic and demographic pillars - which are the basis of the above-mentioned indexes - but of the social and environmental aspects that are also very relevant regarding the development of rural areas. An example of its application was the evaluation of the effectiveness of public policies in Brazil (Haag, 2009).

However, its design presents serious weaknesses, mainly due to its additive nature. Unbalanced rural development is not the solution to the problems of rural areas, and therefore, an index which allows fully compensation among the different pillars of development will not provide a sound and realistic measurement. It is therefore

[2] Regions are classified as Predominantly Rural if the share of population living in rural local units (with population density below 150 inhabitants per square kilometre) is higher than 50% (OECD, 2010).

[3] Where necessary, the variables were standardized.

necessary to design a new tool that can overcome those shortcomings, delivering adequate information to both policy makers and stakeholders, and allowing the implementation of more accurate policies.

1.3. Materials and Methodology

1.3.1. Construction of the Rural Development index RDI_{Abreu}

The Rural Development Index here proposed (RDI_{Abreu}) is based on Kageyama's proposal, although its construction evolved in a differentiated way, especially regarding the variables included within each pillar:

Population – introducing the Demographic Dependency Index which reflects the relationship between the total and the working population (weighing the future in Rural Development);

Social – The importance of Education has been strengthened with two variables, assuming that this issue is as important as the lack of basic health and sanitary conditions, for example (this is also the interpretation of the Human Development Index from UNO, also with 2 education variables);

Economy – introducing the Employment Rate as an important contributor to the RDI value;

Environment - although it's not very easy to get environmental data, 4 variables were selected as the increase of income and productivity normally lead to agricultural modernization, but then also to environmental degradation.

The detailed descriptions of the variables included in the index, together with their relative importance within each pillar are presented in Table 1.1.

Table 1. 1 Description of the variables included in the index, together with their relative importance within each of the pillars of Rural Development

		Abbreviation	Weight
POPULATION	Population density (inhab/km^2) – the intensity of population settlement expressed as the ratio between total population and surface area. A more developed territory is more attractive. The higher is its value, the lower the isolation of territories, therefore increasing the RDI value	PopDens	0.25
	Rate of natural increase (%) – The difference between the number of live births and the number of deaths occurring during a given period, usually a calendar year divided by the mid-year population of that period	NatInc	0.25
	Net migration (No.) – The difference between immigration into and emigration from the country or region during a given period, reflects the attractiveness capacity of each territory. It is assumed that a higher development will lead to a higher capacity on attracting populations	NetMig	0.25
	Demographic Dependency Index - the ratio of the elderly (ages 65 and older) plus the young (under age 15) to the population in the working ages (ages 15-64). Changes in the dependency ratio provide an indication of the potential social support requirements resulting from changes in population age structures	DmgDep	0.25
SOCIAL	Literacy (ratio, values from 0 to 1) – being education one of the most undisputed variables of development, the literacy rate is its base. Although we are in the 21st century, illiteracy rates are still significant in some rural areas	Lit	0.25
	Proportion of resident population with at least the lower secondary education 3rd. cycle completed (%) – proportion of resident population with 15 and more years old with at least the lower secondary education 3rd. cycle completed. While literacy can be seen as a condition for minimum integration in society, compulsory education can be seen as a minimum condition to ensure employability. Not only a more developed society has the means for its youth to follow compulsory education, but higher levels of education also lead to higher productivity and living conditions	Educ	0.25
	Physicians (No.) per 1000 inhabitants - this variable introduces the dimension of basic health conditions in the territory under study	Phys	0.25
	Proportion of conventional dwellings of usual residence (ratio, values from 0 to 1) with installation existence (electricity, water, toilet, bath/shower and heating) - to include dwellings quality in rural areas	Instal	0.25
ECONOMY	Proportion of family agricultural population with remunerated activity outside agricultural holding (%) – introducing the concept of activities diversification in the agricultural environment	OthRem	0.25
	Average monthly earnings (€) – assessing the differences in labour remuneration between the various municipalities of the territory under study	Earn	0.25
	Per capita purchasing power (€/inhab) – for the inclusion of other forms of household income beyond remuneration	PurcPw	0.25
	Employment rate (%) - ratio between the employed population and the working age population (population aged 15 years old and over). It's one of the most significant variables for the economic sustainability of a territory	EmplR	0.25

ENVIRONMENT	Environmental expenditure of municipalities per inhabitant (€/inhab) – with limited measures of environmental quality, public expenditure may be seen as a proxy. The higher is the expenditure per capita in areas as waste management, protection of biodiversity and landscape, the higher is assumed to be the environment quality	EnvExp	0.25
	Proportion of wastewater treated (%) - the larger the volume of wastewater treated, the less the contamination of natural resources, thus increasing the environment quality	WaterW	0.25
	Proportion of urban waste selective collected (%) - waste subject to separate deposition by the holder in order to be recycled, what contributes in a positive way to the conservation of natural resources and to the environmental quality	UrbW	0.25
	Proportion of Natura 2000 Network area (%) - Natura 2000 is the European ecological network of special conservation areas which aims to ensure biodiversity through the conservation and restoration of natural habitats and flora. It can be seen as a proxy to environmental quality of a given territory	Natura	0.25

SOURCE: Own elaboration, from Instituto Nacional de Estatística de Portugal

Although the number of variables included within each dimension is smaller than that found in other indexes such as the Genuine Progress Indicator (GPI) (Bagstad and Shammin, 2012), it was considered that the design of RDI_{Abreu} offers a more balanced approach, with more dimensions and a number of variables whose data can be easily obtained.

The Index here proposed uses a geometric mean within each dimension (population, social, economy and environment) in order to gather the variables, instead of the arithmetic mean, avoiding a substitute effect. With the geometric mean, a territory with significantly lower values in a dimension will have its RDI significantly penalized, instead of having the final result biased by extreme values (as when we use the arithmetic mean) – in fact, this is the same reason why, in 2010, the geometric mean replaced the use of the arithmetic mean in HDI (UNDP, 2010). The underlying concept is that one region cannot be considered to have a high level of development if it has a poor performance in one of the dimensions of development, for what RDI_{Abreu} considers that the four dimensions (Population, Social, Economy and Environment) with equal importance in the evaluation of a territory's Rural Development. This is a particularly important characteristic as we consider that all the chosen variables should have the same weight/contribution for the final Index.

The Rural Development Index is thus obtained by the equation below:

$$RDI_{Abreu} = \sqrt[4]{POP} \times \sqrt[4]{SOC} \times \sqrt[4]{ECO} \times \sqrt[4]{ENV}$$

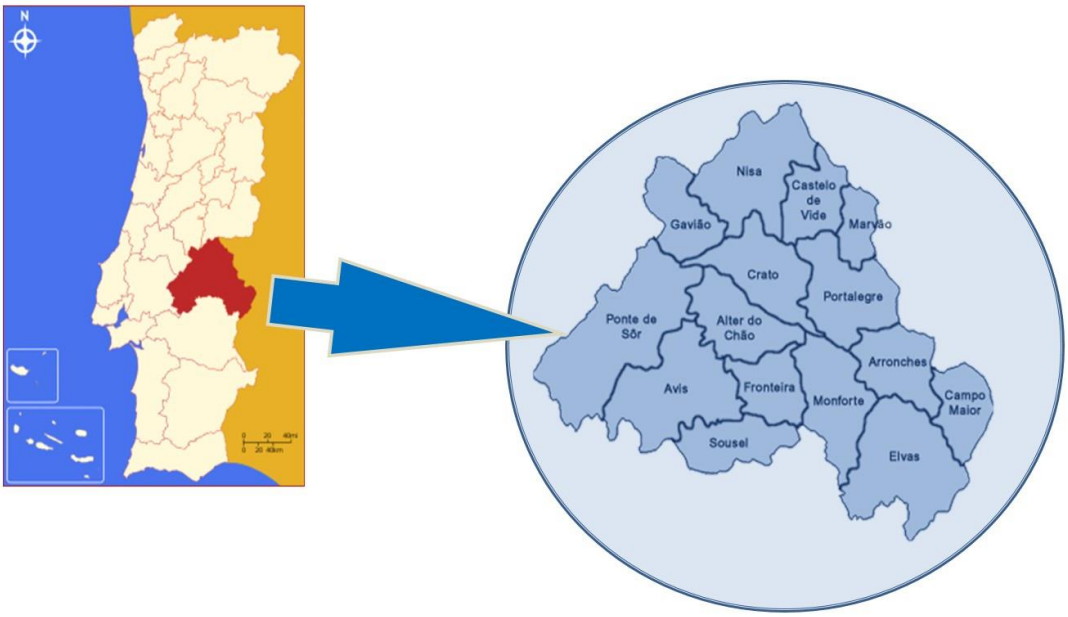
The nature of the values used to calculate the Index (standardized data) provides index values between 0 and 1.

1.3.2. Data collection

In order to test the designed index, it was decided to select a less-favoured region, where Rural Development Policies have been and are currently being applied. It was considered that the adequate level of detail would be Local Administrative Unit (LAU), as it will allow the collection of the requested data, while at the same time providing an appropriate level of disaggregation of the results. It is also the smallest geographical dimension to which public policies are applied and it has also been also used in other studies about rural development (Mitrică et al., 2017; Sánchez-Zamora

et al., 2014). Therefore, the usefulness of the RDI_{Abreu} to support policy making, namely the decisions of public expenditure, is most adequate at this level. The RDI_{Abreu} is then applied to the NUTS III Alto Alentejo, Portugal (Central East Portugal, Figure 1.1), at a municipality level (LAU). We have used the most recent data available for the whole set of variables (2011) from the Portuguese National Statistics Institute (Instituto Nacional de Estatística de Portugal, 2012, 2018).

Figure 1. 1 Portugal, Alto Alentejo and its municipalities



SOURCE: Own elaboration

Alto Alentejo is a rural territory located in the inner board with Spain, with 6,043 km^2, 118,506 inhabitants (Instituto Nacional de Estatística de Portugal, 2012) and where almost 80% of the people live in rural areas (in fact, only 4 parishes[4] of the whole district are not considered rural by the OECD definition -with more than 150 inhabitants/km^2-) (OECD, 2010). The index here presented was applied to the 15 municipalities (LAU) of Alto Alentejo. The municipalities selected (Figure 1.1) reflect

[4] Corresponding to the former LAU 2

the different types of villages that can be found the Eastern Portugal, regarding their population, services, economic development, etc. Data were produced in 2011and were directly collected from the official website of INE (www.ine.pt). Table 1.2 shows the values for each indicator for the 15 municipalities analysed.

Table 1. 2 Values for each indicator for the 15 municipalities analysed

LAU	POPULATION				SOCIAL				ECONOMY				ENVIRONMENT			
	PopDens	NatInc	NetMig	DmgDep	Lit	Educ	Phys	Instal	OthRem	Earn (€)	PurcPw	EmplR	EnvExp (€)	WaterW	UrbanW	Natura
Alter do Chão	9,800	-1,2%	11	79,100	87,6%	35,8%	1,400	93,6%	34,1%	808,800	70,150	34,3%	132,000	85,0%	24,0%	3,2%
Arronches	10,100	-2,4%	33	79,400	83,5%	34,5%	2,200	92,8%	22,3%	743,700	68,060	34,9%	61,000	100,0%	11,0%	78,7%
Avis	7,500	-1,0%	35	72,800	86,7%	34,7%	0,900	94,1%	28,0%	870,300	69,350	33,8%	53,000	91,0%	24,0%	39,0%
Campo Maior	34,200	-0,3%	-18	59,300	90,3%	45,0%	6,400	94,8%	36,9%	1073,500	90,000	38,8%	66,000	98,0%	12,0%	99,9%
Castelo de Vide	12,900	-1,3%	-7	76,200	86,9%	41,8%	2,400	93,9%	16,1%	796,500	76,080	35,2%	50,000	100,0%	19,0%	94,3%
Crato	9,300	-2,2%	0	80,500	86,7%	31,7%	0,500	94,9%	27,3%	749,100	68,570	33,5%	64,000	100,0%	33,0%	0,5%
Elvas	36,600	-0,2%	-173	60,200	91,8%	47,3%	4,800	93,9%	27,5%	828,800	84,870	36,0%	20,000	95,0%	17,0%	33,7%
Fronteira	13,700	-1,0%	-27	69,500	87,3%	38,3%	1,200	95,0%	35,9%	808,100	71,960	37,2%	36,000	96,0%	17,0%	0,0%
Gavião	14,000	-1,8%	-13	97,800	84,7%	28,5%	0,500	94,2%	27,6%	743,300	63,360	27,1%	136,000	77,0%	14,0%	0,0%
Marvão	22,700	-1,1%	-8	74,000	86,8%	34,3%	2,000	89,6%	21,6%	711,600	61,230	34,7%	44,000	100,0%	19,0%	99,9%
Monforte	7,900	-0,6%	-12	76,600	82,7%	33,6%	1,500	92,8%	26,5%	888,800	63,950	33,4%	78,000	100,0%	26,0%	7,2%
Nisa	12,900	-1,7%	-22	90,100	87,2%	34,1%	1,400	94,7%	19,0%	792,800	67,430	31,0%	70,000	100,0%	16,0%	56,5%
Ponte de Sor	19,900	-0,8%	-61	61,400	87,8%	37,8%	1,700	94,5%	28,2%	909,000	80,640	35,0%	55,000	100,0%	17,0%	22,4%
Portalegre	55,800	-0,7%	-214	57,100	92,3%	51,5%	4,500	94,0%	23,6%	941,300	102,010	40,0%	32,000	96,0%	26,0%	51,0%
Sousel	18,200	-1,3%	-15	78,000	86,0%	37,3%	1,200	94,9%	30,0%	756,400	66,060	36,0%	35,000	98,0%	12,0%	0,0%

SOURCE: Own elaboration, from Instituto Nacional de Estatística de Portugal

1.4. Results and Discussion

Taking as a starting point the data by municipality shown above, and using the RDI_{Abreu}, the values of the different dimensions of the rural development index have been calculated by municipality, together with the final value of the index (Table 1.3).

Table 1. 3 Alto Alentejo's municipalities values for the Rural Development Index and its dimensions

	POP	SOC	ECO	ENV	RDI
Campo Maior	0,592	0,869	0,903	0,589	0,723
Portalegre[5]	0,448	0,874	0,749	0,530	0,628
Elvas	0,461	0,821	0,535	0,348	0,515
Ponte de Sor	0,429	0,512	0,555	0,450	0,484
Alter do Chão	0,508	0,430	0,477	0,484	0,474
Castelo de Vide	0,475	0,536	0,307	0,642	0,473
Avis	0,501	0,398	0,433	0,469	0,449
Fronteira	0,458	0,505	0,566	0,309	0,449
Crato	0,393	0,384	0,331	0,596	0,415
Monforte	0,525	0,247	0,386	0,563	0,410
Nisa	0,498	0,454	0,205	0,556	0,400
Sousel	0,505	0,456	0,402	0,272	0,398
Arronches	0,398	0,307	0,291	0,535	0,372
Marvão	0,535	0,232	0,215	0,643	0,362
Gavião	0,552	0,263	0,173	0,284	0,291

SOURCE: Own elaboration

From an initial analysis, it can be observed that the most developed municipalities according to RDI_{Abreu} are those with the highest population density -which are also the most populated (Portalegre and Elvas) or more industrialized (Campo Maior). The latter is an especially significant case because although is a small municipality (less than 9,000 inhabitants), it holds the main factory of an international company –with local origins- which employs more than 1,600 workers, many of them natives of Campo Maior. As it has been stated by different authors (Black and Henderson, 1999),

[5] Portalegre is the capital city of this NUTS III (which is also designated, from the administrative point of view, as Portalegre District).

economic activity make the cities the drivers of economic growth and therefore of rural development. Furthermore, the economic dependence of rural areas on agricultural activities decreases when other sources of economic activity are present, as is the case of the biggest municipalities and Campo Maior. As it has been stated by different authors, those areas with more diversified economies are more resilient and therefore will suffer less in the event of a shock –such as the economic crisis of 2010-2014 (Christopherson et al., 2010; Sánchez-Zamora et al., 2014).

It is also possible to analyze these results more in depth from several perspectives, looking for any correspondence between in the characteristics of the different territories and its RDI values. For example, with an analysis at municipalities with similar RDIs, it's possible to identify the dimensions in which the public development policies can improve the results, while with an analysis of each variable we could see how the different dimensions contribute to different territories development levels.

However, it has been considered that a first analysis should involve the evolution over time of the RDI_{Abreu}, comparing the current data with those of 2001 (year of the previous Portuguese Census) (Table 1.4).

Table 1. 4 RDIAbreu values for the municipalities of Alto Alentejo's NUTS III (2001 and 2011)

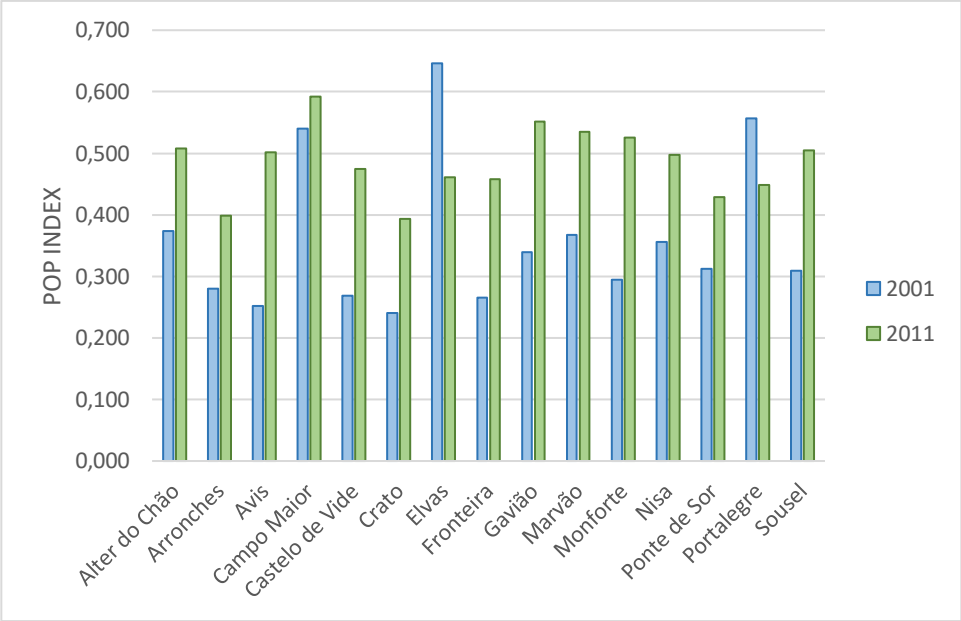
	2001	2011	% increase
Alter do Chão	0,360	0,474	32%
Arronches	0,287	0,372	30%
Avis	0,359	0,449	25%
Campo Maior	0,650	0,723	11%
Castelo de Vide	0,469	0,473	1%
Crato	0,318	0,415	31%
Elvas	0,517	0,515	0%
Fronteira	0,350	0,449	28%
Gavião	0,211	0,291	38%
Marvão	0,264	0,362	37%
Monforte	0,334	0,410	23%
Nisa	0,321	0,400	25%
Ponte de Sor	0,379	0,484	28%
Portalegre	0,629	0,628	0%
Sousel	0,159	0,398	150%

SOURCE: Own elaboration

Comparing the values for two periods (2001 and 2011), we can see all municipalities have increased its Rural Development Index values, although the smaller villages in a more significant way (like Sousel and Gavião). Regarding the causes of this evolution, it can be observed that both municipalities were those with the lower RD indexes in 2001, and therefore their increase has been more marked. The present figures for Sousel and Gavião are not easy to explain, but according to Table 1.2 it can be observed that Gavião presents the highest Demographic Dependency Index while in Sousel the increases in Average monthly earnings and Per capita purchasing power were relatively significant with the settlement of a regional slaughterhouse where many locals work. Gavião still relies on agriculture, and its employment rate is the lowest of the analysed municipalities –even though this figure could also be related to the aging process reflected by the Demographic Dependency Index. These findings are in line with other studies (Mitrică et al., 2017) that have found that the socio-economic development of rural areas is positively related to positive natural increases in local population and negatively linked to aging populations. Regarding the different

dimensions of the index (Population, Social, Economy and Environment), Figures 1.2-1.5 show their evolution between 2001 and 2011, in order to delve in the study.

Figure 1. 2 Evolution the Population dimension for each municipality between 2001 and 2011

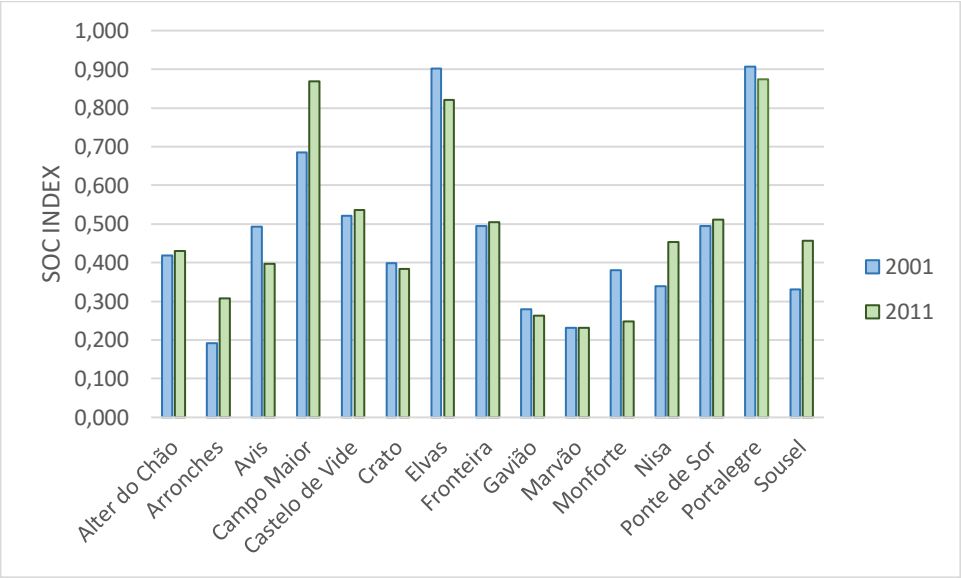


SOURCE: Own elaboration

Regarding the Population dimension, it can be highlighted that in most of the studied municipalities the values have increased in the analysed period, although the two biggest cities (Portalegre and Elvas) have shown substantial reductions. These findings can be mainly explained by a reduction in net migration to these cities during the economic crisis, as the disappearance of jobs in the industry and service sectors affected to a higher degree the most urban areas. However, the smaller municipalities, more dependent on agriculture, where also more resilient in those troubled times, and then presented a less negative evolution on variables like Net migration and Demographic Dependency Index. These results highlight the role of agriculture as a source of resilience in rural areas, acting as a buffer to generate jobs and income in

times when other economic activities are expelling workers. This can be a positive fact in certain times –as described above- but that can also become an obstacle for changes and evolution of these regions when rural stakeholders are not able to adapt to their new socio-economic environment (Lebel et al., 2006; Schouten et al., 2012). Figure 1.3 shows the changes in Social dimension of the RDI_{Abreu} for Alto Alentejo's municipalities.

Figure 1. 3 Evolution the Social dimension for each municipality between 2001 and 2011



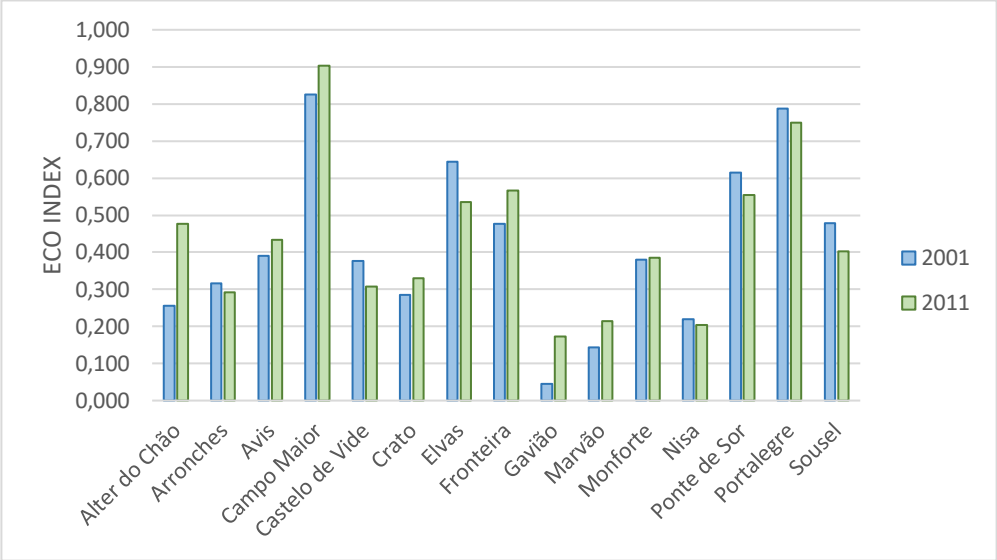
SOURCE: Own elaboration

Regarding the Social pillar of rural development, it should be expected that all the variables included in this dimension would have increased as a natural trend in a developed country (the general levels of education and literacy increase steadily in western societies). Obviously, these changes are less noticeable in the biggest cities (Portalegre and Elvas) which had the highest levels already in 2001. For example, both cities had Higher Education Institutions, dating from the 1980s-1990s. The other interesting result in this dimension is the evolution of Campo Maior, a town where a

Portuguese coffee roasting and packaging firm is headquartered and that become Portugal's coffee market leader for the past two decades, hiring nowadays more than 3000 highly qualified people and with a strong relationship with its birthplace. Accordingly, it has been found a relationship between education and development in the context of specialization, which is less relevant in large and already diversified urban areas (Portalegre, Elvas and Campo Maior) but which can be an impossible alternative in the most small, rural and isolated towns, where simple lack of enough resources –educated people- can block the development generated by new economic approaches (Mccann and Ortega-Argilés, 2015; Naldi et al., 2015). There is therefore a need to change the traditional focus of education networks, including as a new variable the specific needs of rural areas.

The evolution of the Economic indicators is shown in Figure 1.4 and can be traced down to the world economic crisis, with increasing unemployment rates, reduction of the family budgets and decreasing consumption from both individuals and institutions.

Figure 1. 4 Evolution the Economic dimension for each municipality between 2001 and 2011



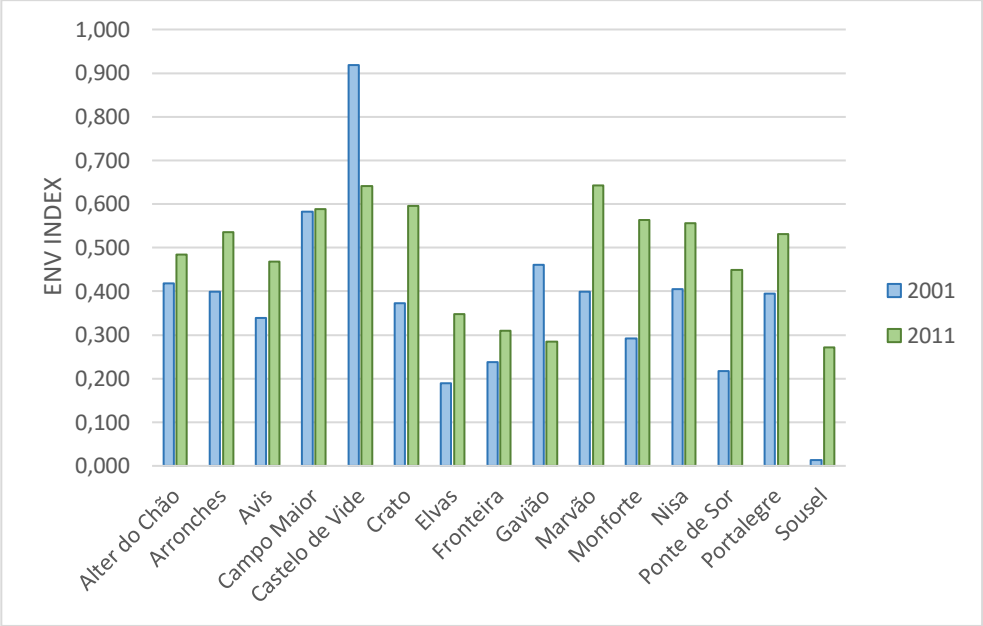
SOURCE: Own elaboration

Nevertheless, there are some exceptions, especially again Campo Maior – whose evolution has already been explained – but also Alter do Chão and Fronteira, both small towns with major changes in their historical heritage between 2001 and 2011. The development of Alter do Chão Stud Farm at a tourist and pedagogical level (with the implementation of its professional school of rural development), and a major remodelling of a facility of a sulphurous spa in 2007 in Cabeço de Vide (Fronteira) were facts that leveraged the local employment and economies. These examples are in line with other research (Hashemi and Ghaffary, 2017) where tourism in rural areas has been seen as an opportunity for development while also highlight the role of education that was previously stated.

Finally, and regarding the Environmental pillar (Figure 1.5), the general upward trend is clearly linked with the growing environmental concerns of citizens and –reluctantly sometimes- politicians, which is reflected in increasing expenditure in environmental-related works and a reduction in the tolerance towards polluting activities. This findings are in accordance with other research showing the positive impact of Rural

Development policies for the environment (Gottero and Cassatella, 2017).

Figure 1. 5 Evolution the Environmental dimension for each municipality between 2001 and 2011



SOURCE: Own elaboration

However, it can be observed that in two of the analysed municipalities (Castelo de Vide and Gavião) the value of this component has declined sharply. In Castelo de Vide municipality it was observed that the expenditure in environmental protection has declined by more than half from 2001 to 2011, a behaviour not matching that of Portuguese regions, which devote more than 50% of their rural development budget to environmental actions (Uthes et al., 2017). On the other hand, Gavião is the only municipality between the 15 in study that has decreased the proportion of wastewater treated. Finally, Table 1.5 presents data regarding expenditure from LEADER Programme[6] in the different municipalities between 2007 and 2013 in order to check

[6] LEADER (Liaison Entre Actions de Développement Rural) was a Community Initiative launched in 1991, based on the idea that rural development strategies are more effective and efficient when designed and implemented by local actors at a local level (a bottom-up

for relationships between the evolution of RDI_{Abreu} and EU initiatives in rural development.

Table 1. 5 Investment and expenditure from LEADER Programme in Alto Alentejo

	Public expenditure (only from LEADER Programme) (euros)	Jobs created by the Programme (no.)	Total investment (euros)	Expenditure/ inhabitant (€/inhab)
Alter do Chão	815,942.84	2.0	1,260,887.86	235.69
Arronches	764,563.67	6.0	1,238,668.89	246.63
Avis	1,905,255.75	22.0	3,214,968.00	422.92
Campo Maior	1,209,194.91	8.0	1,960,911.35	144.55
Castelo de Vide	1,031,500.29	9.0	1,664,780.73	317.58
Crato	908,663.61	6.0	1,468,918.83	258.00
Elvas	1,075,097.82	14.0	2,091,681.72	48.33
Fronteira	945,382.67	6.0	1,644,388.50	293.41
Gavião	752,745.51	12.0	1,225,400.89	194.36
Marvão	1,634,273.01	16.5	2,728,054.17	484.09
Monforte	266,650.79	0.0	429,089.70	82.61
Nisa	1,223,781.00	9.0	2,083,637.71	174.35
Ponte de Sor	1,329,642.15	17.5	2,034,610.05	82.16
Portalegre	1,443,181.99	22.5	2,450,423.50	60.35
Sousel	292,132.73	3.0	463,266.28	59.95
	15,598,008.74	153.5	25,959,688.18	

SOURCE: Own elaboration

Although UE recognizes that integrated local approaches are more effective than sectorial subsidies/support to generate endogenous rural development growth (Nuñez, 2008), the integration of the Community Initiative LEADER as a mainstreaming policy took away its flexibility and the possibility to support innovative projects since 2007. What it seemed to be a good idea made LEADER loose autonomy and flexibility, increased the amount of bureaucracy, and reduced its innovative nature by avoiding risk taking in the projects supported.

approach). Its success led LEADER to be "mainstreamed" in national rural development programmes since 2007.

1.5. Conclusions

Although RDI_{Abreu} has been developed taking into consideration the Portuguese rural world and the data available there, it can be used in any region of the world with minimal adaptations, thus providing an interesting tool for researchers and policy makers.

Despite the existence of many indices of development, none of them is specifically designed for the evaluation of the rural areas. This lack of rural development measures hampers the process of assessing the impact of public policies applied in a particular territory, or, in an ex-ante perspective, the identification of the areas where the use of public funds would be more effective. As none of the existing indexes solves the problem of the applicability to small territories (e.g., at a municipal level) or considers the particularities of the rural areas, RDI_{Abreu} can become a useful tool for national and local policy makers. RDI_{Abreu} is therefore an index especially conceived for the rural areas, where there are major asymmetries which hamper the assessment of their levels of development, and it tries to fill a gap felt by those who work in the rural development by generating results and allowing analysis not available until now.

The application of RDI_{Abreu} to Alto Alentejo municipalities has allowed to highlight some factors with special relevance for Rural Development, such as the buffer role of agricultural activities –which can help to soften the impact of economic crisis- or the link between specialized education and development. The index proposed here might be improved in the future for example with the inclusion of new variables, although the information provided by the National Statistics Institutes will always be a constraint. It may also be interesting to make a comparative analysis of the RDI values of each municipality in different years allowing some conclusions on the effectiveness of the public policies implementation. This comparison is certainly a strong argument in an attempt to convince the decision-makers to use the RDI when considering which type of public investment is more suitable for each territory.

With the increasing importance of rural areas as a potential way of facing global economic crisis, the multifunctionality of agriculture and its positive externalities can

be a leverage factor for sustainable rural development. Rural and agriculture are no longer synonyms, and the positive externalities generated by the multifunctionality of agriculture are unanimously recognized, supporting other economic activities and promoting the development of the region (with rural tourism being a good example). However, the fact that the rural world is composed of a wide range of small territorial units with their own specificities, leads to difficulties in finding adequate metrics for rural development, which should always allow to take into account the particularities of the different territories under study.

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Chapter II. The assessment of rural development: identification of an applicable set of indicators through a Delphi approach

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Resumen

A pesar de las decrecientes diferencias entre zonas rurales y urbanas (por ejemplo, en sus estructuras económicas), siguen existiendo diversas limitaciones con las cuales el mundo rural tiene que convivir. En un mundo en constante cambio, las políticas de desarrollo rural son un aspecto crucial para responder a los desafíos actuales y potenciales de las zonas rurales. Estas políticas tienen por ello que ser flexibles para reforzar o descartar objetivos a medida que surgen nuevos desafíos, permitiendo las necesarias adaptaciones en los territorios. Todo esto justifica la necesidad de un conjunto de indicadores que permitan una evaluación precisa de estas políticas y programas. Este artículo presenta una serie de indicadores demográficos, económicos, ambientales y de bienestar social que deben de ser tomados en cuenta para evaluar el desarrollo rural y las políticas relacionadas. Utilizando la metodología cualitativa Delphi, un grupo de expertos analizó 88 indicadores propuestos, después de lo cual un grupo de 25 fueron seleccionados en base a su importancia y al consenso del panel. El panel también estimó el peso relativo de cada una de las cuatro dimensiones consideradas (población, bienestar social, economía y medioambiente) dentro de un índice para medir el desarrollo rural. Se ha encontrado que, además del plano económico, el bienestar social es una de las áreas que más contribuye al desarrollo de las zonas rurales, contradiciendo de esa forma los índices "tradicionales" basados exclusivamente en indicadores económicos y demográficos. Todo esto apunta a la necesidad de evolucionar en dirección a un índice basado en los resultados de este trabajo.

The assessment of rural development: identification of an applicable set of indicators through a Delphi approach

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Abstract

In spite of the decreasing differences between rural and urban areas (e.g., in their economic structures) there are still several limitations that the rural world has to deal with. In a constantly changing world, rural development policies are a crucial issue to respond to current and potential future challenges of rural areas. They must therefore be flexible to reinforce or discard objectives as new challenges arise, enabling the necessary adaptations in the territories. All this justifies the call for a set of indicators that allow an accurate evaluation of these policies and programs.

This paper presents a set of demographic, economic, environmental and social welfare indicators that must be taken into account to assess rural development and related policies. Using the qualitative Delphi methodology, a group of experts analyzed 88 proposed indicators, after which a set of 25 was selected based on their importance and on the consensus of the panel. The panel also estimated the weight of each of the four dimensions considered (population, social welfare, economy, and environment) within an index to measure rural development. It has therefore been found that, in addition to the economy, social welfare is one of the areas that contributes most to the development of rural areas, thus contradicting "traditional" indices based solely on economic and demographic indicators. All this points to the need to evolve towards an index based on the results of this paper.

KEY WORDS: Rural development; assessment; indicators; Delphi method; qualitative research

2.1. Introduction

Rural development (RD) can be defined as the set of actions aimed at promoting the modernization of rural areas, generating new employment opportunities, the sustainability of agricultural holdings, the efficiency of resource management and the preservation of ecosystems (UPA 2016).

The concept of RD arises in response to the limitations of rural areas and in an attempt to offset them. The origin of this imbalance between urban and rural areas can be explained, among other reasons, by the traditional concentration of production factors with low opportunity costs (land and labor) in rural areas, unlike what has happened in the cities.

This situation was exacerbated from the second half of the twentieth century with the abandonment of subsistence farming economies and the growth of the service economy. However, there have also been intense migration movements towards industrial and urban centers in search of better paid jobs. All of this has generated processes of depopulation and ageing that have added even more difficulties to these areas (I. Abreu et al. 2019).

In fact, the imbalance in the level of development of rural and non-rural areas has become increasingly pronounced, as reflected for example in indicators such as the higher risk of poverty or social exclusion (23.9% in rural areas versus 21% in urban areas), the level of education (most of the European Union (EU) rural regions present levels of tertiary educational attainment below 40 % while in the most urbanized regions this figure amounts up to 60-80%), or the lower level of digital skills in among adults (49 % having basic or above basic skills in rural areas versus 63% for those living in cities) (Eurostat 2019).

However, neither the economic structure nor the distribution of the labor force by economic sector is currently so different between urban and rural areas -although the weight of the agricultural sector is still clearly higher in rural areas- (I. Abreu 2014).

Nevertheless, rural areas still face limitations such as poorer access to services (health, water treatment, transport) and technology (e.g., broadband internet), which may hamper their development and endanger their persistence.

In this context, RD and RD policies as tools to materialize and achieve such development have become increasingly relevant in the face of growing challenges such as climate change, in which rural areas and the maintenance of activity in them can play an outstanding role.

This ongoing identification of agrarian with rural has meant that the implementation of RD policies has traditionally been linked to agricultural policies. In line with this, the focus of these policies has been on agriculture and agri-food activities, which is logical given the contribution of agri-food to both the economy and employment in rural areas (I. Abreu et al. 2019). In the EU, RD makes up the "second pillar" of the Common Agricultural Policy (CAP) and is based on multiannual national or regional EU-funded programs, to which local contributions must be added in different percentages, depending on the levels of development of the various regions of the European Union.

In some countries (Portugal, for example) without strong national policies, the rural policy is basically structured according to the EU's CAP and without a direct relationship with the Cohesion Policy. This means that a territory classified as rural is the target of both RD policies (CAP) and regional development policies (Cohesion Policy). Those policies pursue objectives and support initiatives that often overlap and create loopholes due to the lack of a clear identification of the distribution of institutional responsibilities (Ferrão 2014).

However, due to the decreasing divergence of rural and urban areas discussed above, this approach to RD policies is no longer valid. The dependence on agriculture, even with its lower profitability as an economic activity and its offer of lower quality jobs, is increasingly seen as an opportunity because of its greater resilience in crisis situations. But obviously many problems remain to be addressed by diverse, adapted, and adaptable RD policies to respond to current and potential future challenges.

But, in addition, these policies must be measurable in order to be able to analyze

whether the objectives for improvement are being achieved and to create a decision-making framework that allows giving up objectives that are no longer relevant while strengthening those that enable the new challenges to be met. However, this task is not easy to undertake, as despite the existence of different development indexes, there is a lack of tools specifically focused on the evaluation of RD policies.

A first approximation to this RD index would come from the use of the different indices created to measure overall development, such as the Gross Domestic Product (GDP) (World Bank 1997), the UN Human Development Index (UNDP 2016b) or the Multidimensional Poverty Index (Oxford Poverty and Human Development Initiative 2010a). However, and among other limitations, none of them is designed for application in rural regions. This means that their use to measure the effectiveness of RD policies, the identification of areas of action for public investment or decision-making in very diverse contexts cannot guarantee adequate results.

In this context, two specific indices have been developed to attempt to assess RD: Kageyama's Rural Development Index (Kageyama 2008) and Abreu's Rural Development Index (I. Abreu 2014). Examples of the use of both indices can be found in the work of (Haag 2009), who applied Kageyama's index to measure the effectiveness of public policies in Brazil and in that of (I. Abreu et al. 2019), which applied their index to measure the RD of 15 Portuguese municipalities.

Both indices are based on the use of different indicators that are grouped into four dimensions: demography, economy, social welfare and environment. The fundamental difference is that in Kageyama´s index the aggregation of the different indicators is additive (simple arithmetic mean of the four dimensions) while Abreu's uses a geometric mean in order to avoid the substitution effect that a very high score in one of the dimensions could cause.

The strengths of both indices, compared to the generalist indices mentioned above, are the inclusion not only of indicators related to economic and demographic aspects, but also those linked to social and environmental factors that have great relevance to RD. However, both indices share the limitation that the selection of their indicators, although endorsed by the literature, does not necessarily include those elements that stakeholders consider to be truly relevant to RD and which should therefore be given

weight when calculating these indices.

This piece of research, therefore, tries to overcome this constraint by performing, in an objective way, the selection of the attributes that must be taken into account for the measurement of RD and the impact of related policies. This development can lead to more accurate monitoring adapted to the demands and needs of rural populations, which can improve the efficiency of policies and the response to the demands of the rural world.

It should not be ignored that one of the main political issues is the understanding of the key drivers of economic and social growth in rural areas (Bryden 2002), especially after the rise of community movements fighting against the abandonment and depopulation of rural areas (Alonso 2020; Ramírez 2020). In addition, and given the manifold facets of RD, policymakers are keen to know more about the extent and trends of overall welfare in rural regions (Michalek and Zarnekow 2012a).

The definition of a set of RD indicators will thus provide an effective tool for both policymakers and managers of RD programs, thereby enabling the adaptation and development of new policies as well as the evaluation of existing ones, something very necessary in an increasingly changing environment and where adaptation is synonymous with survival.

In this sense, this work has tried to identify a group of demographic, environmental, economic and social welfare indicators from which RD and related policies can be assessed. However, and taking into account the heterogeneous nature of rural areas and, therefore, of RD, traditional approaches can be difficult to apply, as there is not a previous framework which could be used as a starting point for this task. It has therefore been considered that the best strategy for addressing this problem was the use of qualitative research. Qualitative research involves less structured tasks than quantitative methodologies and is hence a more flexible and versatile type of research. Thus, it is appropriate for the initial stages of a research process, to study the nature of a problem or to identify action alternatives as well as relevant variables and hypotheses (Eldesouky and Mesias 2014; Vaca and Mesías 2014).

With this purpose, and among the available methodologies, it was decided to use the

Delphi method, which relies on the use of a panel of experts who must reach a consensus on the problem studied (Escribano et al. 2018; H.A. Linstone and Turoff 2002). The Delphi technique poses clear benefits in uncertain environments, for example where the initial information is excessively diverse or difficult to access, or where the lack of clear and objective information makes it difficult to apply other methodologies (Landeta and Barrutia 2011).

The Delphi method has been widely used in various areas of agri-food research due to its versatility. Thus, applications can be found regarding the use of irrigation techniques (Alcon et al. 2014), the effect of climate change on food production (Kirezieva et al. 2015), the adoption of organic production in rangelands (Horrillo et al. 2016), or the identification of indicators to measure sustainability in agroforestry systems (Escribano et al. 2018).

This paper is structured as follows. First, the following section presents the Delphi method and provide details about the data collection procedure applied for this piece of research. In Section 3, the paper deals with the main findings of this piece of research and discusses them considering previous research on the topic. Finally, Section 4 outlines the main conclusions of the study and indicates some recommendations for stakeholders, and policymakers.

2.2. Material and Methodology

2.2.1. The Delphi Method

The Delphi method, named after the Greek oracle of Delphos, is a qualitative forecasting technique developed in the 1950s by the Rand Corporation. It was devised to carry out a United States Defense project called "Project Delphi", where a panel of experts had to select, from the point of view of a Soviet strategic planner, an estimate of bombing requirements (Dalkey and Helmer 1963).

After such unpromising beginnings, its use was initially limited to environments where rapid technological advances made mere trend extrapolation a poor and insufficient predictive technique, such as the aerospace and electronics sectors (Horrillo et al. 2016). Nevertheless, in the last decades the Delphi method has become a popular tool to make predictions and help in decision-making, having recently been

applied to such diverse areas as food consumption (Chamorro et al. 2012), sustainability assessment (Escribano et al. 2018; Roy et al. 2014), environmental issues (Martínez-Paz et al. 2016; Strand et al. 2017) or business innovation (Egfjord and Sund 2020).

The rationale for this method is: (i) a group of experts in the field, who do not communicate with each other to avoid bias, are selected; (ii) the experts are requested to indicate their agreement/disagreement with some statements or the probability of occurrence of certain events by means of a questionnaire; iii) limited information and feedback is provided to the experts, either specific information regarding some of the issues under study and/or the average ratings provided by the panel; iv) several rounds of questionnaires with updated feedback are delivered to the panel, with experts being requested to revise their answers on the light of the new information provided (Almansa and Martínez-Paz 2011; Harold A. Linstone and Turoff 2011).

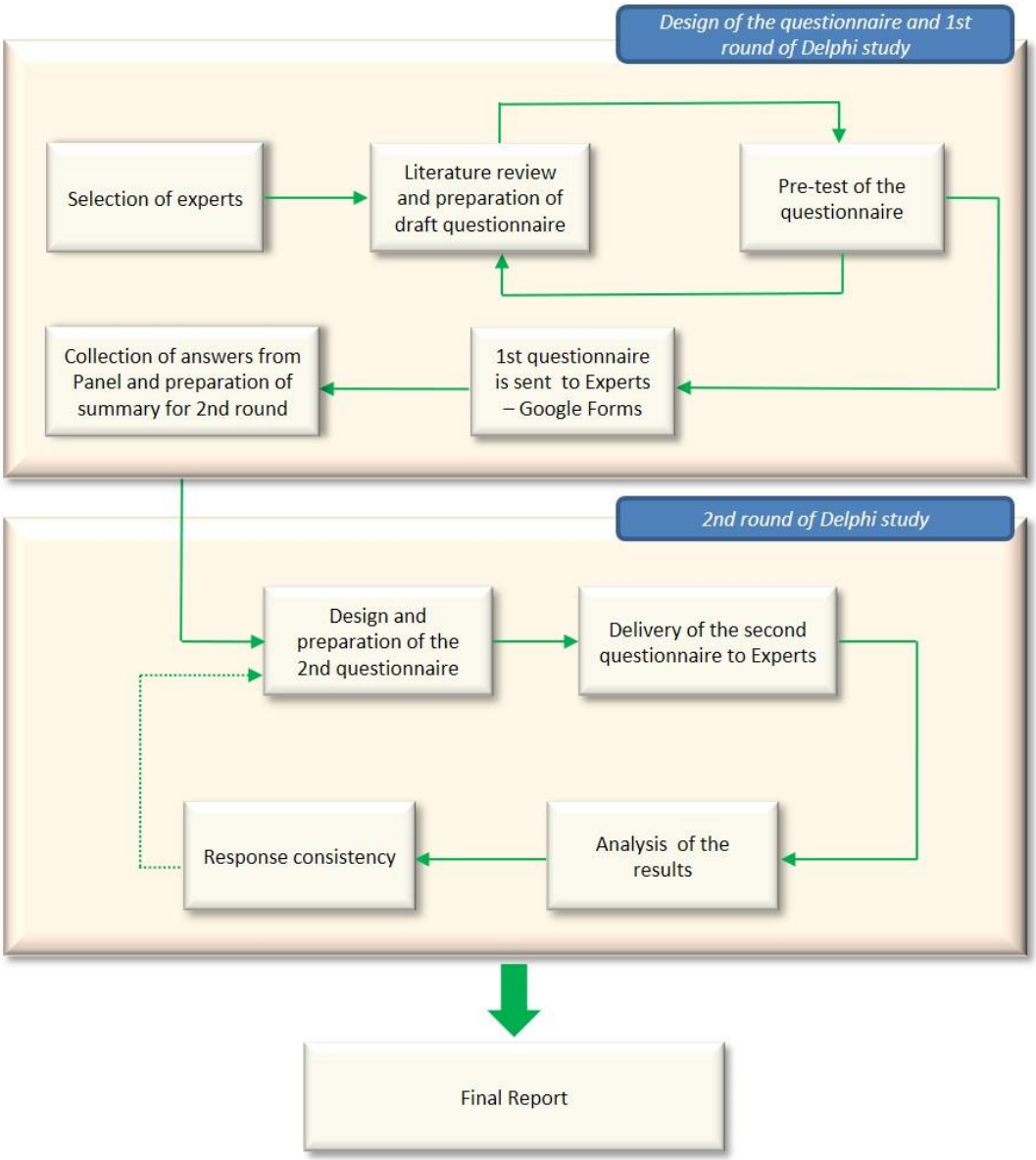
The output of a Delphi study is usually a single forecast from the expert panel and therefore the procedure outlined in the previous paragraph -the inclusion of several rounds and the provision of feedback between rounds- is intended to encourage the experts to reconsider their original estimates and move towards a consensus (or to give reasons in case they want to keep their previous answers). The process should continue with new rounds of the questionnaire and additional feedback being sent till an acceptable consensus is reached or stability of answers is achieved, although most the studies stop after the second or third rounds as it is difficult to keep the experts engaged for too long (Harold A. Linstone and Turoff 2011; Wentholt et al. 2009).

Consensus was initially essential to the Delphi method (Dalkey and Helmer 1963), although further methodological developments have loosened this restriction, focusing instead on achieving stability in expert responses (Harold A. Linstone and Turoff 2011). It can therefore be concluded that the researcher's aim after a Delphi study is to obtain an opinion, agreed at least to some extent, from a panel of experts. The reliability of the predictions would come not so much from the degree of consensus obtained but from other aspects of the methodological process, such as the selection of the experts (Hasson and Keeney 2011).

2.2.2. Development of the study

Figure 2.1 presents the Delphi procedure followed in this paper.

Figure 2. 1 Delphi methodology



The selection of the panelists is one of the most relevant issues regarding future validity of the outcomes of a Delphi study. Therefore, and following the guidelines

outlined by (Mauksch et al. 2020), the leading criteria for expert selection in this research was familiarity with RD and RD policies, either as managers of Local Action Groups (LAG), policy-makers and senior officers with responsibilities in RD, rural entrepreneurs, associations and local politicians. The aim was to get a heterogeneous group, which provides higher quality solutions than homogeneous ones (Powell 2003).

A preliminary list of 90 experts was drawn, with panelists being contacted prior to the submission of the questionnaire in order to let them know the objectives of the study and to get their commitment to participate. Despite this procedure, and although the first round questionnaire was finally sent to those 90 experts, only 46 of them sent their answers for the first round and 30 for the second, figures which are in line with other Delphi studies (Escribano et al. 2018; Jónsson et al. 2016; Olaizola et al. 2012; Orsi et al. 2011). The complete procedure was carried out between January–March 2020 (1st round) and April–May 2020 for the 2nd round. Table 2.1 shows the characteristics of the final group of experts.

Table 2. 1 Composition of the panel for the first and second rounds

	Number of Experts	
Area of expertise	First Round	Second Round
Local Action Group	17	13
Consultant	2	1
Public administration	12	7
University /Investigation	4	2
Entrepreneur	11	7
TOTAL	46	30

While selecting and refining group of experts, the research team started to design the 1st round questionnaire through an in-depth literature review on RD and RD policies. This first stage allowed the selection of 88 indicators which were included in the first draft of the questionnaire. Selected indicators were grouped into four different blocks or dimensions (i – population; ii – social welfare; iii – economy; iv – environment).

Some final questions were added regarding the experts' opinion about the final weight of each dimension on the RD index and classification variables. A preliminary version of the first-round questionnaire was sent to 3 experts (not included in the final sample) who carried out a final review. The second-round questionnaire was based on the first-round questionnaire including the average score of each question from the first round.

In accordance with the procedure developed in other papers that have used the Delphi method (Almansa and Martínez-Paz 2011; Escribano et al. 2018; Olaizola et al. 2012), experts were asked to indicate, by using a 5-point Likert scale from -2 (not important) to +2 (very important), the degree of importance they granted to the different indicators proposed for the construction of a RD index.

The complete procedure of submitting questionnaires and feedback and collecting information was carried out using Google Forms (www.docs.google.com/forms), in which the questionnaires were designed and the responses from the panel were initially collected before moving on to the analysis stage.

2.2.3. Consensus

To analyse the variation in the level of agreement among the experts from the first to the second round, a consensus indicator was calculated for each variable. The formula used to calculate this indicator was the difference between the standard deviation of the ratings of the first and the second rounds, as used in other Delphi studies (Alcon et al. 2014; Escribano et al. 2018; Horrillo et al. 2016),. We have positive values whenever the consensus among experts has increased between the two rounds (because the difference between standard deviations has decreased), and negative values otherwise.

2.3. Results and Discussion

2.3.1. Population

Table 2.2 shows the results of the panel of experts for the indicators of the Population dimension. As it can be observed, the indicators with the highest values in round 1 (therefore those with greatest importance according to the experts) were "*Population*

density" and "*Demographic Dependency Index*"[7] (the ratio between the population aged below 16 years and above 65 years old). This latter indicator also presents the highest value in round 2, along with "*Proportion of population aged 65 or over*", which shows a concern for considering the future within a Rural Development Index. On the other hand, "*Infant mortality rate*" was not given relevance, being the only indicator with a negative value in the first round (and zero value in round 2).

Table 2. 2 Average ratings for Population dimension. Results of 1st and 2nd rounds and consensus

	Average 1st round	Average 2nd round	Consensus
Population density (inhab/km^2)	1.22	1.03	0.29
Rate of natural increase (%)	1.14	0.97	0.09
Weight of net migration in the total resident population (%)	0.73	0.53	0.15
Proportion of population aged 16 or under (%)	1.09	1.07	0.28
Proportion of population aged 65 or over (%)	1.13	1.10	0.20
Infant mortality rate (per 1,000 inhabitants)	-0.05	0.00	0.24
Weight of population variation in the total resident population (%)	0.85	0.47	0.22
Demographic Dependency Index	1.21	1.10	0.21

Ageing and renewal rate of rural populations have been considered as the most relevant factors regarding RD and maybe linked to the human potential of a rural region, where the lack of active population might restraint development intents. In this sense, (Spellerberg et al. 2007) pointed out that the potential of the population and the infrastructural factors are the drivers of differences between rural areas. These results are also in agreement with different studies (I. Abreu et al. 2019; Mitrică et al.

[7] The Demographic Dependency Index is the ratio of the elderly (ages 65 and older) plus the young (under age 15) to the population in the working ages (ages 15-64). Changes in this index show the potential social support requirements resulting from changes in population age structures.

2017) stating that the development of rural areas is negatively related to population ageing but positively to natural increases in the local population.

The role of population density has been widely studied and has to do with the fact that variables related to economic growth, such as innovation, or productivity are greater in more densely populated areas, which is commonly known as agglomeration economies (Naldi et al. 2015). In fact, population density is one of the most commonly used indicators of rurality (Straka and Tuzová 2016) although with regard to RD it may be more relevant to consider those density levels so low that they may imply an inability of the rural region to reactivate and respond.

2.3.2. Social welfare

Table 2.3 shows the scores agreed by the experts for those indicators linked with the Social Welfare dimension.

Twenty-five indicators were proposed, with "*Coverage of essential health services*" and "*Share of workforce with higher qualification*" being the two that obtained, respectively, the first and second highest positions of relevance for the panel. This gives us an indication of the importance that has been given to the health and education areas in order to assess the social equity of the populations of the different rural areas. On the other hand, indicators such as "*Proportion of women in managerial positions*" and "*Number of ATMs per 100,000 adults*" were the least scored.

Table 2. 3 Average ratings for Social Welfare dimension. Results of 1st and 2nd rounds and consensus

	Average 1st round	Average 2nd round	Consensus
Literacy (%)	1.28	1.57	0.27
Proportion of resident population with at least lower secondary education (%)	1.11	1.30	0.23
Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months (%)	1.09	0.97	0.32
Proportion of youth (aged 15–24 years) not in education, employment or training (%)	1.11	1.17	0.14
Proportion of youth and adults with information and communications technology (ICT) skills (%)	1.39	1.50	0.10
Share of university students (%)	1.24	1.50	0.05
Share of workforce with higher qualification (%)	1.43	1.59	0.14
Physicians (No.) per 1000 inhabitants	1.31	1.23	0.05
Coverage of essential health services (%)[8]	1.53	1.60	-0.07
Density of health workers (No. per 1,000 inhabitants)	1.20	1.27	0.00
Share of full-time workers (%)	0.87	0.83	0.07
Share of employees on long-term contracts (%)	0.86	0.93	-0.09
Share of workforce self-employed (%)	1.00	1.13	0.25
Proportion of total government spending on essential services (%)	1.11	1.28	0.28

[8] Average coverage of essential services based on tracer interventions that include reproductive, maternal, new-born and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population.

Proportion of conventional dwellings of regular residence with facilities (electricity, water, toilet, heating …) (%)	1.16	1.38	0.23
Proportion of population that has convenient access to public transport (%)	1.13	1.14	0.23
Proportion of the rural population who live within 2 km of an all-season road (%)	1.20	1.03	0.07
Proportion of population that feel safe walking alone around the area they live (%)	0.84	0.90	0.08
Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically (%)	0.89	0.79	0.02
Proportion of women in managerial positions (%)	0.53	0.38	0.19
Proportion of population covered by a mobile network (%)	1.09	1.37	0.21
Fixed Internet broadband subscriptions per 100 inhabitants (%)	1.02	1.10	0.20
Proportion of individuals using the Internet (%)	0.98	1.13	0.21
Number of commercial bank branches per 100,000 adults (Nº/100,000)	0.57	0.27	-0.02
Number of automated teller machines (ATMs) per 100,000 adults (Nº/100,000)	0.54	0.37	0.08

As can be observed from Table 2.3, health, education and ICT skills and infrastructure are the key issues for the experts regarding the social dimension of RD.

Health was expected to be one of the indicators with highest ratings, as it is one of the most relevant factors regarding quality of life, especially when dealing with ageing populations, as it is the case of developed countries. In fact, different studies (Boncinelli et al. 2015; Ramos 2009) have indicated that availability and accessibility to health care services is a significant factor in the development of rural areas.

Studies such as that of (Agarwal et al. 2004) have highlighted the important role that education plays in the development of rural areas. However, not only do rural areas need to be able to provide quality education and training, but also must manage to attract and retain educated and trained people, both aspects being covered by the selected indicators.

The importance of ICT for rural regions has already been highlighted by the European Commission (European Commission 2010) and is linked to its role to allow access to external knowledge, which in turn opens possibilities for rural areas in sectors such as knowledge intensive businesses, higher education or cognitive and creative occupations (Naldi et al. 2015).

2.3.3. Economy

Table 2.4 shows the results obtained from the panel's scores for the indicators linked to the Economy dimension.

"*Per capita purchasing power*" indicator was the most scored in the first round, in line with the highest scored indicator in the second round, "*Average monthly earnings*". "*Unemployment rate*", although one of the main concerns for EU citizens (European Commission 2019), comes in 5th place in both rounds.

Among 31 proposals, the panel gave middle relevance to the population's source of income (the fact of being from an activity inside or outside agricultural holding). "*Total annual value of tree felling*" and "*Share of women among owners or rights-bearers of agricultural land*" do not seem to be relevant (once again that there are no gender differences significantly valued by experts.

Table 2. 4 Average ratings for Economy dimension. Results of 1st and 2nd rounds and consensus

	Average 1st round	Average 2nd round	Consensus
Average earnings per capita (€/inhab)	1.39	1.40	-0.05
Gross family income (€/year)	1.33	1.33	-0.13
Average hourly earnings of employees (€/hour)	1.13	1.13	0.05
Per capita purchasing power (€/inhab)	1.53	1.33	-0.13
Proportion of people living below 50 per cent of median income (%)	1.14	1.03	0.43
Annual growth rate of real GDP per capita (%)	0.91	0.71	0.16
Annual growth rate of real GDP per employed person (%)	0.81	0.57	0.16
Unemployment rate (%)	1.33	1.30	0.08
Proportion of households receiving social payments (%)	0.86	0.77	0.22
Proportion of family agricultural population engaged in off-farm income generating activities (%)	1.07	0.97	0.41
Proportion of total agricultural population with ownership or secure rights over agricultural land (%)	0.86	0.70	0.09
Share of women among owners or rights-bearers of agricultural land (%)	0.38	0.30	0.02
Weight of average income of small-scale food producers in total GDP (%)	1.02	0.80	0.07
Average size of agricultural holdings (ha/agricultural holding)	0.80	0.67	0.29
Rural employment rate (%)	1.19	0.97	0.42
Total income primary sector (€)	1.18	1.27	0.09

Total primary sector GVA[9] (% of GDP)	1.12	1.27	0.16
GVA per holding (€/holding)	1.09	1.00	0.30
GVA per hectare (€/ha)	1.02	1.03	0.27
GVA per UAA (Utilised Agricultural Area[10]) (€/ha)	1.10	1.20	0.31
Agricultural employment weight in total employment (%)	0.93	0.83	0.33
Total annual value of tree felling (€)	0.15	-0.30	0.17
Net revenue by enterprise sector (€)	1.12	1.04	0.27
Share of pluriactive farm households (%)	1.02	0.83	0.23
Share of income from non-farming activities (%)	1.05	0.93	0.24
Weight of manufacturing GVA in GDP (%)	0.81	0.83	0.40
Manufacturing value added per capita (€/inhab)	0.82	0.80	0.50
Proportion of employment in manufacturing firms (%)	0.76	0.57	0.37
GVA's tourism weight in GDP (%)	1.00	0.90	0.30
Beds in Rural Tourism per 1,000 population	1.05	0.86	0.10
Weight of employment in Rural Tourism (%)	1.13	0.86	0.11
Research and development expenditure as a proportion of GDP (%)	1.29	1.25	0.07

[9] Gross Value Added
[10] Area used for farming, including arable land, permanent grassland, permanent crops and other agricultural land such as kitchen gardens.

As for the economic dimension, it is worth pointing out that the panel did not attribute much relevance to activities linked to rural tourism, unlike Research and development expenditure which ranked in the first places in the two rounds

It should be noted that the indicators related to income level (personal or family) are those that have received the highest scores from the experts within this dimension. In fact, it is frequent that all or part of these indicators are included in the different tools designed to measure rural development (I. Abreu et al. 2019; Michalek and Zarnekow 2012a). In addition, (I. Abreu et al. 2019) found a clear relationship between income and rural development, since the municipalities with the highest level of per capita income were those that obtained the highest rural development indices.

Economic diversification, measured as the contribution of the primary sector to the economy, has been highly considered by the panelists. This fact reflects the previous findings stating that economic diversification is a key element in promoting RD and which can also contribute to the resilience of rural areas in crisis situations (S. Christopherson et al. 2010; Sánchez-Zamora et al. 2014b).

Regarding rural tourism, authors such as (Hashemi and Ghaffary 2017b) have indicated that tourism can promote local development and can therefore be regarded as a tool to generate rural development. Even though many RD actions carried out in recent years in the EU have resulted in activities related to rural tourism, the experts involved in this study seem to indicate that the diversification of the rural economy does not necessarily have to be limited to this sector, which is why indicators referring to rural tourism have been undervalued.

Something similar can be said about agricultural-related indicators, which have not been considered of relevance by the panelists, although various pieces of research have included agricultural activities as one of the drivers of rural development (Bulderberga 2013; Ramos 2009).

2.3.4. Environment

Finally, Table 2.5 shows average ratings granted by the experts to the indicators included in the Environment dimension.

Table 2. 5 Average ratings for Environment dimension. Results of 1st and 2nd rounds and consensus

	Average 1st round	Average 2nd round	Consensus
Proportion of bodies of water with good ambient water quality (%)	1.20	1.27	0.06
Proportion of treated wastewater (%)	1.24	1.30	0.04
Index of water eutrophication[11] (%)	0.95	0.63	0.22
Forest area as a proportion of total land area (%)	0.85	0.70	0.09
Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas (%)	1.21	1.28	0.19
Proportion of land that is degraded over total land area (%)	0.89	0.79	0.25
Mountain Green Cover Index (%)	0.86	0.54	0.22
Proportion of Natura 2000 Network area (%)	0.87	0.62	0.22
Proportion of agricultural area under productive and sustainable agriculture (%)	1.23	1.27	0.21
Proportion of local breeds classified as being at risk (%)	0.95	0.83	0.25
Weight of electricity consumption by sector of economic activity in total consumption (%)	0.96	0.67	0.05
Renewable energy share in the total final energy consumption (%)	1.30	1.33	0.09
Environmental expenditure of municipalities per inhabitant (€/inhab)	1.07	0.96	0.08
Proportion of urban waste selective collected (%)	1.00	1.07	0.12
Tons of material recycled per capita (Ton/inhab)	0.95	0.81	0.01

[11] Increase in the amount of nutrients and/or organic matter, resulting in higher primary productivity and, generally, on a decrease in the total volume of the ecosystem

Total expenditure per capita spent on the preservation, protection and conservation of all cultural and natural heritage (€/inhab)	1.21	1.22	0.04
Weight of municipal expenditure in the environment (%)	1.05	1.11	0.05
Consumption of natural gas per inhabitant (m^3/hab)	0.33	0.15	0.07
Water distributed or consumed per inhabitant (m^3/hab)	0.82	0.50	0.00
Proportion of rural fires in the total number of fires (%)	0.70	0.57	0.24
Proportion of burnt area (%)	0.76	0.47	0.24
Firefighters per inhabitant (Nº/hab)	0.52	0.27	0.06
Environmental Non-Governmental Organizations (ENGO) (Nº)	0.35	0.10	0.33

The highest score was for "*Renewable energy share in the total final energy consumption*" in both rounds, with the lowest importance being given to the "*Number of Environmental Non-Governmental Organizations (ENGO)*" existing in the territory as a contributory factor for a RD Index. These results are in line with other studies which explored the impact of renewable energy projects on rural development and concluded that renewable energy was indeed an opportunity to stimulate economic growth in the host communities (Cebotari et al. 2017; OECD 2014).

It should be noted that several of the indicators selected are related to natural resources and environmental quality. This is in accordance with that stated by other authors (Sánchez-Zamora et al. 2014b) on the influence of the environment and natural resources on the dynamics and development of rural territories. But it is also necessary to take into account the increase in "green" tourism and leisure[12] that has taken place in recent years and which has created opportunities for many rural areas, particularly those with high quality natural assets.

Studies in the UK on successful rural areas have shown that a high-quality natural environment boosts the local economy by encouraging immigration, business creation and tourism. However, it also requires good land-use planning to ensure a balanced and mutually reinforcing relationship between conservation and development (Agarwal et al. 2004).

Although landscape could be considered as a relevant factor por rural tourism -and therefore, for RD- landscape indicators such as degraded land or forest areas have not been rated as important by the panel. This result is in accordance with (Gottero and Cassatella 2017), who highlighted the weaknesses of RD programs regarding landscape and farmland enhancement and preservation.

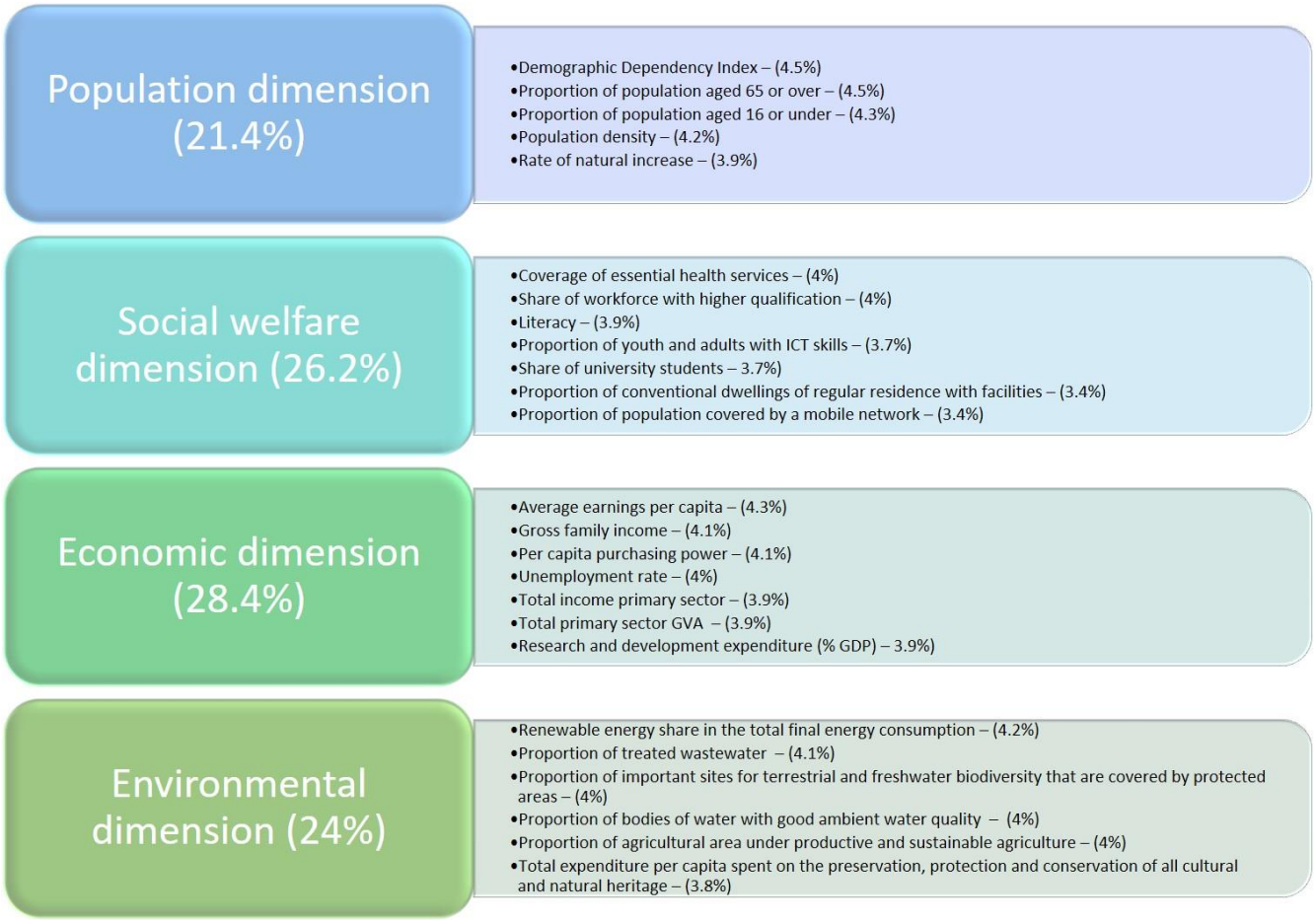
[12] The term green tourism and leisure refers to "tourism activities that can be maintained, or sustained, indefinitely in their social, economic, cultural and environmental contexts" (UNWTO 2012).

2.3.5. Selected set of indicators

The questionnaire included a final question requesting the experts to estimate the weighting that each of the four dimensions considered should have within a rural development index. More than 70% of them considered that the 4 dimensions should be given a different weight, thus differentiating their contribution to Rural Development, with Economy being the one that acquires greater relevance (28.4%), Social Welfare ranking second with 26.2%, followed by Environment (24%) and lastly the Population dimension with 21.4%.

Finally, and within each dimension, those indicators with the highest scores were chosen, while allowing for a multifaceted evaluation and keeping the total number of indicators within a reasonable level to facilitate the assessment process. Figure 2.2 presents the final set of indicators selected, together with their weight within each dimension.

Figure 2. 2 Set of selected indicators to build a Rural Development Index



2.4. Conclusions

Nowadays, there are increasingly fewer differences between rural and urban areas (e.g., in their economic structures), but the former still have serious limitations which may hamper their development. In this context, RD and RD policies have become ever more important, although it is essential to be able to accurately monitor them, enabling adaptation in an increasingly changing environment whenever such a need is identified. All this justifies the call for a set of indicators that allow for an accurate evaluation of RD policies and programs.

To this aim, this paper has used the qualitative Delphi methodology, based on the opinion of a panel of experts with different roles in RD in order to define a set of demographic, environmental, economic and social welfare indicators that can be used to assess rural development and related policies.

Based on the consensus of the experts, and starting from an initial group of 88 indicators, 25 were finally selected, covering the 4 dimensions on which rural development analysis has been structured (population, economy, social welfare, and environment). Only 2 of the proposed indicators obtained negative average values, which may indicate that a sound selection process has been followed regarding the input submitted to the experts.

The experts have determined the importance that each of the dimensions considered should have in the construction of an index to measure rural development. It has therefore been found that, in addition to the economy, social welfare is one of the areas that contributes most to the development of rural areas, thus contradicting "traditional" indices based solely on economic and demographic indicators. All this points to the need to evolve towards an index based on the results of this paper. In addition, and within each dimension, the indicators have also been weighted according to the importance granted by the panel, which will enable the subsequent implementation of an appropriate tool.

Compared to previous research on the assessment of rural development, the use of a Delphi approach has provided some additional benefits, such as adaptation to the needs and views of different stakeholders and prioritization of indicators and

dimensions. However, the process needs to be improved by ensuring that the required data are available and accessible, and that feedback is provided once the selected indicators are applied and problems are identified, for example due to lack of updated data or difficulty in accessing data.

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Chapter III. Design and validation of an index to measure development in rural areas through stakeholder participation

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Abreu, I., Mesías, F. J., Ramajo, J., 2021. Design and validation of an index to measure development in rural areas through stakeholder participation.

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Resumen

En el contexto de la discusión del Marco Financiero Plurianual 2021-2027 de la Unión Europea, y siendo el Desarrollo Rural (DR) el Segundo Pilar de la Política Agrícola Común, es urgente evaluar las políticas de Desarrollo Rural, a pesar de su menor peso frente a las actividades agrícolas y agroalimentarias. Sus características multidimensionales que mezclan aspectos tan diversos como el empleo, la modernización, la sustentabilidad o el ambiente hacen imprescindible la utilización de un índice compuesto formado por diferentes indicadores, cuyo número no comprometa ni el cálculo ni la interpretabilidad del índice. Por ello este artículo propone el desarrollo de un índice para evaluar el desarrollo rural basado en un conjunto de 25 indicadores demográficos, económicos, ambientales y de bienestar social previamente seleccionados a través de un enfoque Delphi. Posteriormente se probaron tres métodos de agregación ampliamente aceptados: una media mixta aritmética/geométrica sin ponderaciones para cada indicador; una media aritmética ponderada utilizando los pesos previamente generados por el panel Delphi y una agregación mediante un Análisis de Componentes Principales. Estas tres metodologías se aplicaron posteriormente a 9 regiones NUTS III portuguesas, presentándose posteriormente los resultados a un grupo de expertos en desarrollo rural quienes indicaron cuál de las tres formas de agregación medía mejor los niveles de desarrollo rural de los diferentes territorios. Finalmente, se concluyó que la media aritmética/geométrica no ponderada era la metodología más precisa para agregar los indicadores que constituyeran un Índice de Desarrollo Rural.

Design and validation of an index to measure development in rural areas through stakeholder participation

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Abstract

In the context of the discussion of the European Union's Multiannual Financial Framework 2021-2027, and with Rural Development (RD) being the Second Pillar of the Common Agricultural Policy, it's urgent to evaluate Rural Development policies despite their lower weight compared to agricultural and agri-food activities. Its multi-dimensional characteristic - dealing with such diverse aspects as employment, modernization, sustainability, or environment - makes it essential to use a composite index made up of different indicators, whose number doesn't compromise the calculation and interpretability of the index.

This paper therefore proposes the development of an index to assess rural development based on a set of 25 demographic, economic, environmental, and social welfare indicators previously selected through a Delphi approach. Three widely accepted aggregation methods were then tested: a mixed arithmetic/geometric mean without weightings for each indicator; a weighted arithmetic mean using the weights previously generated by the Delphi panel and an aggregation through Principal Component Analysis.

These three methodologies were later applied to 9 Portuguese NUTS III regions, and the results were presented to a group of experts in rural development who indicated which of the three forms of aggregation best measured the levels of rural development of the different territories. Finally, it was concluded that the unweighted arithmetic/geometric mean was the most accurate methodology for aggregating indicators to create a Rural Development Index.

KEY WORDS: Rural Development; Index; indicators; Delphi; Portugal

3.1. Introduction

In a world that is increasingly developed and urbanized and where population movements from the rural areas to the cities have been taking place for decades, the rural environment has found itself in an increasingly unfavourable situation with respect to the urban areas (I. Abreu et al. 2019). Not only this "emptying" of villages deprives them of part of their most active and dynamic population, but also the lack of population itself leads to the disappearance of essential services, which in turn encourages rural exodus.

This is reflected in an increasingly pronounced imbalance between the level of development of rural and non-rural areas. Thus, indicators such as the risk of poverty or social exclusion (23.9% in rural areas vs. 21% in urban areas), the level of education (60-80% of city-dwellers have tertiary education, but less than 40% in most rural areas) or the level of digital skills among adults (49% adults have basic or higher skills in rural areas vs. 63% of those living in cities) show worse values in rural areas than in urban areas (Eurostat 2019), aspects that clearly influence the job opportunities and life development of citizens.

Moreover, there is a growing disconnection between urban and rural dwellers, with the former ceasing to see the latter as a necessary and fundamental part of society. This leads to a situation where "urban" citizens perceive that they are subsidizing the "rural" ones, without getting any benefit in return. Thus, they ignore, out of unawareness derived from urban life, the valuable environmental, cultural, and social services that the villages and their inhabitants have provided and continue to provide to their fellow citizens in the cities.

It is within this framework that the concept of Rural Development (RD) arises, which could be defined as the set of initiatives aimed at fostering the modernization of rural areas, the creation of new job opportunities, the sustainability and efficiency of farms and the preservation of ecosystems (I. Abreu and Mesias 2020; UPA 2016). Rural development has been promoted for decades in different parts of the world, such as the European Union, where the Rural Development Policy, also known as the Second Pillar of the Common Agricultural Policy, has been gaining importance over

agricultural policies, even though agriculture and agri-food activities are still a major component of RD policies (European Commission 2017a). Like any other policy, RD needs to be evaluated to determine the effectiveness of the measures implemented, to analyse new initiatives or to decide which areas need more attention (I. Abreu et al. 2019). This process, which is complex for any policy, is even more so in the case of rural development, because, as it has been mentioned, it deals with such diverse aspects like employment, modernization, sustainability, and environment.

Several indices have been created to try to measure both development in general terms and rural development specifically. Among the former we can highlight the Gross Domestic Product (World Bank 1997), the Human Development Index (HDI) (UNDP 2016b), the Social Development Framework (Davis 2004) or the Multidimensional Poverty Index (Oxford Poverty and Human Development Initiative 2010a). However, none of them is specifically designed for the assessment of rural areas. Therefore, several authors have tried to develop specific indices to measure rural development, such as the one by Kageyama (Kageyama 2008), which was applied, for example, to assess the effectiveness of public policies in Brazil (Haag 2009) or the one by Abreu (I. Abreu 2014) which measured RD in different Portuguese municipalities (I. Abreu et al. 2019).

Since RD is a multi-dimensional process, RD indexes should be based on the use of several indicators representing its different dimensions. Moreover, given that the implementation of a policy does not only affect the targeted activity but also contributes to the modification of the entire human environment, it cannot be monitored merely by verifying compliance with its objectives (Carraro et al. 2009).

An indicator is a quantitative or a qualitative measure derived from a series of observed facts that can reveal relative positions (e.g., of a country) in a specific area. Thus, when evaluated at regular intervals it can point out the direction of change across different units and through time. A composite index is formed when individual indicators are compiled into a single index on the basis of an underlying model (OECD 2008).

For this reason, policy analysts and policy makers turn to composite indexes, which are better equipped to capture the different and multi-dimensional natures of development. If composite indexes are to measure progress, they need to incorporate

enough indicators so that multidimensionality is captured without compromising the interpretability of the index. Hence, the selection of underlying indicators is the result of a trade-off between possible redundancies caused by overlapping information and the risk of losing information (Kynčlová et al. 2020).

Ideally, the composite RD index should measure multi-dimensional concepts that cannot be captured by partial indicators alone and should therefore embrace all the most important rural development domains (DEFRA 2004a). While the main areas of policy concerns related to rural development have been relatively easily identified, i.e.: i) economic structure and performance, ii) social well-being and equity, iii) population and demographics, and iv) environment and sustainability, overcoming these constraints in individual rural areas through precise targeting of policy interventions has proven to be a complex policy task, mostly due to their local/regional specificity as well as complex links among individual growth components and their constraints (Michalek and Zarnekow 2012a).

In this context, it can therefore be noted that the selection of the indicators included in the RD index is as relevant, if not more, than the way in which they are combined. Thus, although indices such as those of Kageyama (2008), Abreu (2014) or Michalek and Zarnekow (2012b) use different indicators related to economic, demographic, social and environmental aspects, all of which are highly relevant for RD, they all suffer from a selection of indicators based on the literature and not on what stakeholders in rural areas consider to be really relevant for their development. Furthermore, the calculation of the values obtained by these indices is based on different methodological approaches whose validity has not been tested.

Therefore, and to overcome these limitations, this paper proposes the development of a RD index using the indicators selected by a panel of experts through a Delphi approach (I. Abreu and Mesias 2020). Subsequently, different aggregation methods accepted by the scientific community are used to build the RD index: simple aggregation of indicators through geometric/arithmetic mean, as used on the HDI (Conceição 2019) or on the RD Index proposed by (I. Abreu et al. 2019); weighted arithmetic average of the indicators using the results of a panel of RD experts through a Delphi approach (I. Abreu and Mesias 2020); Principal Component Analysis (PCA), widely used by different authors such as (Bolcárová and Kološta 2015; Jollife and

Cadima 2016; Yilmaz et al. 2010). The 3 methodologies have been then applied to 9 different Portuguese NUTS III territories (a lower level than the regional, but at which RD policies are applied by countries), using the most recent data available for the whole set of variables from the National Statistical Institute of Portugal.

At a final stage, the results of the different RD indexes were revised by a panel of Portuguese experts on RD, who identified the most accurate methodology for aggregating the indicators when creating a Rural Development Index (RDI). This research therefore provides an effective tool for both policymakers and managers of RD programs, which due to its composite nature can be applied to analyse the main determinants of rural/regional development in individual rural areas. Furthermore, it can also be used to measure the impact of cohesion policy and RD/structural programmes at various regional levels.

3.2. Materials and Methodology

3.2.1. Data collection

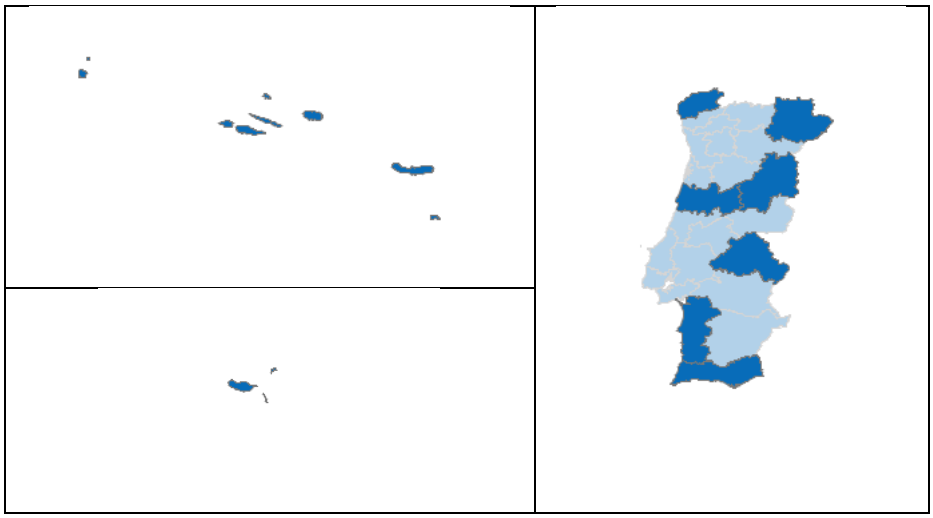
As previously stated, the aim of this paper is to test different RD indexes and select the one which would provide the more comprehensive results. Therefore, the intention was not to obtain an evaluation of the level of rural development in an entire country or a comparison between different regions of that country, but to apply the RD indexes to various regions with substantial differences in levels of development so that the results provided could be compared.

In this context, and among the different administrative levels (NUTS I, NUTS II, NUTS III and LAU), it was chosen to apply the study at the NUTS III level in Portugal. The choice of the NUTS III level was due to this being the minimum level at which rural development policies are generally applied. In fact, the only exception is the Community-Led Local Development (CLLD), applied at a Local Administrative Unit (LAU) level by the Local Action Groups (LAG).

In administrative terms, in Portugal there are 3 NUTS I, 7 NUTS II and 25 NUTS III regions. For this paper, and in order to reflect the different realities of the country, it was decided to select a total of 9 NUTS III regions: 2 from each of the NUTS II regions Norte, Centro and Alentejo, plus the Algarve, Autonomous Region of Madeira and

Autonomous Region of Açores (where the NUTS II and NUTS III levels coincide). Figure 3.1 presents the different NUTS III regions which have been used in this research.

Figure 3. 1 The nine NUTS III selected (Portuguese islands and continental Portugal)



SOURCE: Own elaboration

The indicators selected for this research were identified in a preliminary study by the authors (I. Abreu and Mesias 2020). The Delphi qualitative methodology was used to objectively identify the indicators that should be included in a Rural Development Index that would allow the accurate monitoring and evaluation of RD policies and programs. Based on the results of a panel of experts with different roles in RD, 25 indicators were selected -from an initial group of 88- to describe the four basic dimensions/pillars of RD: population, social welfare, economy, and environment. The experts also assigned different weights to the selected indicators. Table 3.1 lists the selected indicators, together with the year of the data collected for this research.

Table 3. 1 Description of the indicators to be included in the index

		Abbrev.	Data year
Population	Demographic Dependency Index (%) - ratio between those 65 and older plus those under 15 and the population in the working ages (ages 15-64)	DmgDep	2019
	Proportion of population aged 65 or over (%)	Pop65	2019
	Proportion of population aged 16 or under (%)	Pop16	2019
	Population density (inhab/km^2)	PopDens	2019
	Rate of natural increase (%)	NatInc	2019
Social welfare	Coverage of essential health services (%)	HlthServ	2019
	Share of workforce with al least post-secondary education completed (%)	WorkQual	2011
	Literacy (%) – Proportion of the population aged 10 or more who can read or write	Lit	2011
	Proportion of youth and adults with ICT skills (%)	ICT	2020
	Share of university students (%) - Proportion of population in universities	Univ	2011
	Proportion of conventional dwellings of regular residence with facilities (%)	Facil	2011
	Proportion of population covered by a mobile network (%)	MobNet	2011
Economy	Average earnings per capita (€/inhab)	Earn	2018
	Gross family income (€/year)	FamInc	2018
	Per capita purchasing power (%)	PurcPw	2017
	Unemployment rate (%)	Unemp	2011
	Total income primary[13] sector (Million €)	IncPrim	2018

[13] Agriculture, Forestry, and Fisheries, aquaculture & fish processing

	Total Gross Value Added of the primary sector (% of GDP)	PrimGVA	2018
	Research and development expenditure as a proportion of GDP (%)	R&D	2017
Environment	Renewable energy share in the total final energy consumption (%)	RenEn	2011
	Proportion of treated wastewater (%)	WasteW	2009
	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas (%)	ProtectA	2019
	Proportion of bodies of water with good ambient water quality (%)	WatQlt	2018[14]
	Proportion of agricultural area under productive and sustainable agriculture (%)	SustAgr	2009
	Total expenditure per capita spent on the preservation, protection and conservation of all cultural and natural heritage (€/inhab)	ExpHer	2019

SOURCE: Own elaboration, from Instituto Nacional de Estatística de Portugal and (I. Abreu and Mesias 2020)

[14] Açores e Madeira: 2015. Continental Portugal: 2016-2018

Data were directly collected from the official website of the National Statistical Institute of Portugal (INE) (www.ine.pt) and the Portuguese Communications National Authority (www.anacom.pt) and are the most recent data available. For some of the indicators retrieved from INE, and due to the type of data provided, some methodological adjustments had to be made as detailed below.

- *Coverage of essential health services*. As in Portugal there is a National Healthcare Service covering all the population, it is the quality of the service which can differ from one place to another. Therefore, a composite indicator resulting from the arithmetic average between the normalized values per 1,000 inhabitants of Medical doctors (No.) and Beds (No.) in hospitals was used.
- *Proportion of youth and adults with ICT skills*. As there are no Portuguese data available at NUTS III level, this value was estimated through the proportion of people aged between 16 and 74 years old using Internet in the 12 months prior to the interview by INE.
- *Proportion of bodies of water with good ambient water quality*. As there were no data available at NUTS III level for Açores and Madeira, an indirect source was used to obtain data for Açores (Governo Regional dos Açores 2021). The figures for Madeira were then extrapolated from those of Açores since both NUTS III regions are very similar due to their island nature.

3.2.2. Aggregation methods

The variables presented above were subsequently combined to create RD Indexes through the application of different aggregation methods selected after literature research and considering (or not) weightings for the indicators. Thus, in a first classification it is possible to find indexes in which simple aggregation of indicators is used through arithmetic or geometric averaging (I. Abreu 2014; Kageyama 2008), while other studies use PCA as an aggregation technique (Bolcárová and Kološta 2015; Jollife and Cadima 2016; Michalek and Zarnekow 2012b). Another classification approach comes from the way of weighting the indicators: i) they can be assigned the same weight, as in the Human Development Index (HDI) (UNDP 2010b) or in several Rural Development Indexes (I. Abreu 2014; Kynčlová et al. 2020); ii) the weighting itself is derived from the loading of the PCA factors; iii) a weighting

specifically developed for this task -e.g. through a preliminary Delphi study, as in the case of (I. Abreu and Mesias 2020)- can be used.

Within the first group, the Kageyama and Abreu indexes are quite similar since the former uses an arithmetic mean of all the indicators while the latter performs an arithmetic mean of the indicators within each pillar of the RD, and then aggregates the scores of each pillar through a geometric mean, thus avoiding the substitution effect of Kageyama's arithmetic approach. For this reason, within this first type of indicators that use simple aggregation of indicators, it was decided to use Abreu's RD index (*RDI Abreu*) for this research, as it is considered an evolution of Kageyama's index. Additionally, two others indexes will also be analysed, one that uses the PCA for aggregation and weighting of indicators (*RDI PCA*) and finally another based on a weighted arithmetic average of the indicators, using the weights generated by the Delphi panel of experts and retrieved from (I. Abreu and Mesias 2020) (*RDI Delphi*). The aggregation methodology in the three indexes is detailed below.

3.2.2.1. RDI Abreu

RDI Abreu was proposed in 2014 (I. Abreu 2014) and considers four different dimensions or sub-indexes: demography (Population Index), economy (Economic Index), social welfare (Social Welfare Index), and environment (Environment Index). Normalized values of the indicators are used and first it is calculated the arithmetic mean of the indicators belonging to each dimension. After that, the scores of the 4 dimensions are aggregated by means of a geometric mean, avoiding a substitution effect that would come from the use of arithmetic average. This is also the method used since 2010[15] in HDI. With the use of the geometric mean, a territory with significantly lower values in one dimension will have its RDI significantly penalized, instead of having its result biased by extreme values (as in arithmetic mean). The underlying concept is that one territory cannot be considered to have a high level of development if it has a poor performance in one of the dimensions of development. Therefore, the four dimensions (Population, Social, Economy and Environment) will have the same importance in the evaluation of a territory's Rural Development.

As a drawback, this method considers that all the chosen indicators have the same

[15] Until 2010, HDI used the arithmetic mean to aggregate the dimensions (UNDP 2016b).

weight/contribution to the final Index, which is not necessarily true.

3.2.2.2. RDI PCA

When a composite index is to be constructed, PCA can be used when each pillar of the index is intended to describe a specific aspect of the latent phenomenon to be measured - in this study, Rural Development. In this case, the dimensions would be again Population, Social Welfare, Economy and Environment, and within each of them the indicators would be allocated. These are considered as proxies and are related to that dimension and to each other, which justifies the use of the technique (Annoni and Dijkstra 2019).

PCA is a statistical multivariate technique that transforms an original set of variables, initially correlated with each other, into a substantially smaller set of uncorrelated factors that contains most of the information in the original set. The underlying idea is simple: to reduce the dimensionality of a dataset, while preserving as much "variability" (i.e. statistical information) as possible or, in other words, finding new variables (the Principal Components) uncorrelated with each other and that are linear functions of the original variables (Jollife and Cadima 2016).

A two-step procedure was followed in this piece of research: First, PCA was used to aggregate the indicators within each pillar; subsequently, a PCA was performed again using as inputs the ratings previously generated for each RD pillar, which are therefore weighted according to their own factor loadings (Bolcárová and Kološta 2015).

In the first step, a maximum of 3 factors were considered for each dimension, depending on the number of factors needed to explain at least 80% of the variance of the dimension. The final percentages of variance explained for each dimension were: 96% for Population with 2 factors; 81% with 2 factors for Social Welfare; 88% with 3 factors for Economy; finally, 84% with 3 factors for Environment. The individual PCA pillar sub-indexes were then calculated by weighting the respective factors according to the variance explained by each one of them in its pillar.

To aggregate the values of the 4 sub-indexes obtained in the first stage into a single RDI for the 9 NUTS III studied, the PCA technique was used again with a maximum of two factors. The process concluded with an explanation of variability of 94%, 80% collected by the first factor and 14% by the second one.

Similar to Abreu's approach, the PCA method has also some weaknesses such as the fact that correlations do not necessarily represent the real influence of individual indicators on the phenomena being measured or the minimisation of the contribution of individual indicators which do not move with other individual indicators (OECD 2008). Also the derivation of weights through PCA can be seen as neither straightforward nor transparent, because pure statistical approaches may lead to inappropriate normative results such as, for example, the assignment of negative weights to some dimensions (Decancq and Lugo 2008).

3.2.2.3. RDI Delphi

(I. Abreu and Mesias 2020) carried out a Delphi study in order to select the most relevant variables to be included in a RDI, as well as to obtain the weighting that each indicator should have in the final Index.

Out of 30 experts who took part in the study, more than 70% stated that the 4 dimensions proposed (Population, Social welfare, Economy and Environment) and their corresponding indicators should have different weights, thus differentiating their contribution to RD. Detailed values for each indicator and dimension can be found in (I. Abreu and Mesias 2020). Nonetheless, and to summarize, we can indicate that the Economy pillar was considered the most relevant (28.4% weighting) followed by Social Welfare (26.2%), Environment (24%) and Population (21%).

In this study, *RDI Delphi* was calculated as a weighted arithmetic mean using the weights previously generated for each of the indicators by the Delphi experts panel (I. Abreu and Mesias 2020).

3.2.3. Assessment by experts

The results generated by the three RDIs were then assessed by a panel of 25 Portuguese experts on Rural Development who had also previously taken part in the preliminary selection of the indicators (Abreu and Mesias, 2020). Experts had different backgrounds, although all of them were linked to RD and RD policies (13 worked for Local Action Groups, 5 in Public Administration, 5 were entrepreneurs and 2 were researchers). This number of experts is in line with other Delphi studies (Bélanger et al. 2012; Benitez-Capistros et al. 2014; Escribano et al. 2018; Horrillo et

al. 2016).

Experts were contacted by email and a summary of the results of the three RDIs for the nine NUTS III Portuguese regions analysed was sent to them. They were requested to indicate the index that, from their point of view, most accurately reflected the level of rural development of the different regions and to give some reasons supporting their answer.

3.3. Results and Discussion

Table 3.2 presents the original values for each indicator prior to their aggregation in the RD indexes.

Table 3. 2 Values of each indicator for the NUTS III regions analysed

		Alto Minho	Terras de Trás-os-Montes	Região de Coimbra	Beiras e Serra da Estrela	Alentejo Litoral	Alto Alentejo	Algarve	Região Autónoma dos Açores	Região Autónoma da Madeira
POPULATION	DmgDep	57.60	67.10	60.00	64.40	62.80	63.60	58.40	43.50	43.00
	Pop65	25.33%	30.27%	25.69%	29.17%	26.49%	27.46%	21.91%	14.94%	16.98%
	Pop16	11.22%	9.90%	11.81%	10.01%	12.09%	11.41%	14.95%	15.37%	13.11%
	PopDens	103.80	19.40	100.10	33.60	17.60	17.20	87.70	104.60	317.20
	NatInc	-0.65%	-1.00%	-0.56%	-1.09%	-0.59%	-1.15%	-0.16%	-0.06%	-0.31%
SOCIAL WELFARE	HlthServ	285.14	368.97	927.47	347.18	164.13	315.20	323.67	325.79	400.58
	WorkQual	21.14%	26.72%	30.42%	23.86%	18.41%	21.38%	23.71%	19.61%	23.32%
	Lit	96.76%	95.93%	97.12%	95.68%	94.52%	94.45%	96.40%	96.43%	95.00%
	ICT	75.90%	75.90%	76.20%	76.20%	77.10%	77.10%	82.50%	79.70%	82.00%
	Univ	11.36%	13.82%	17.81%	12.58%	10.28%	11.21%	13.51%	10.77%	12.54%
	Facil	88.02%	96.65%	92.72%	95.58%	85.42%	93.72%	74.06%	40.16%	21.84%
	MobNet	66.73%	60.48%	67.69%	67.98%	56.71%	79.45%	82.17%	88.27%	83.75%
ECONOMY	Earn	978.10	918.10	1,052.50	934.80	1,184.00	968.20	999.00	1,065.40	1,096.40
	FamInc	15,061.00	15,774.00	18,743.00	15,546.00	16,512.00	15,958.00	16,025.00	17,484.00	17,337.00
	PurcPw	79.65%	79.55%	93.69%	78.49%	92.45%	85.92%	99.10%	87.29%	86.51%
	Unemp	11.84%	10.87%	10.27%	13.18%	10.90%	15.66%	15.74%	11.13%	14.65%
	IncPrim	104.73	111.06	317.81	116.53	520.11	258.57	312.10	346.32	85.53
	PrimGVA	2.20%	10.81%	2.72%	4.01%	20.95%	8.64%	3.89%	9.24%	1.52%
	R&D	0.54%	0.76%	2.24%	1.08%	0.10%	0.40%	0.30%	0.30%	0.36%
ENVIR	RenEn	0.21%	0.15%	0.20%	0.16%	0.21%	0.11%	0.38%	0.25%	1.43%
	WasteW	100.00%	77.56%	90.33%	100.00%	100.00%	90.00%	100.00%	46.00%	87.00%

ProtectA	16.00%	24.40%	0.19%	19.00%	10.30%	9.30%	9.40%	24.20%	58.20%
WatQlt	75.20%	68.00%	45.00%	40.70%	54.90%	26.90%	76.20%	65.00%	65.00%
SustAgr	0.49%	2.49%	0.20%	5.78%	0.34%	3.95%	0.89%	0.14%	2.15%
ExpHer	65.53	111.17	67.34	84.97	98.19	142.36	138.59	50.16	118.67

SOURCE: Own elaboration, from Instituto Nacional de Estatística de Portugal and (I. Abreu and Mesias 2020)

From the previous table, some relevant aspects can be observed that may help to understand the subsequent results. Thus, it can be seen that Trás-os-Montes is the most aged region and has the highest dependency index, while Madeira and Açores have the lowest values.

Within the social dimension, the region of Coimbra stands out as an industrialized area with strong urbanization cantered in the city of Coimbra, which is reflected in good indicators with respect to health services, labour force qualification or the percentage of people with university studies.

These aspects are reflected in the economic pillar. Thus, although the highest per capita incomes are found in Alentejo Litoral, Madeira and Açores (probably due to the high impact of tourism in the economy of these areas), Coimbra is the region with the highest income per family unit, the lowest unemployment rate (which is reflected in a higher number of people working in the family units and in the income per family) and the highest expenditure on R&D.

Finally, and regarding the environmental dimension, the urban and industrial character of Coimbra is also noteworthy, which is reflected in its data on protected areas, water quality or sustainable agriculture, which are among the worst of the regions analysed.

Subsequently, all the data were normalized, a procedure required prior to any data aggregation, as the indicators often have different measurement units (OECD 2008) and it wouldn't be possible to comparable them otherwise. A range of [0-1] was used to normalize the variables, although an "inverse" normalization was applied to the indicators *Demographic Dependency Index, Unemployment rate* and *Proportion of Population Aged 65 or over* by assigning the value of 0 to the NUTS III with the highest values in these indicators and 1 to those with the lowest values, as applied by other authors (Kynčlová et al. 2020).

Table 3.3 presents the normalized results of the three RD Indexes obtained by applying the aggregation methods explained in the Methodology section to the data presented in table 3.2.

Table 3. 3 RDI results with the different 3 methodologies for the NUTS III regions analysed

	RDI Abreu	RDI Delphi	RDI PCA
Alto Minho	0.34	0.13	0.29
Terras de Trás-os-Montes	0.00	0.11	0.00
Região de Coimbra	0.78	0.89	0.27
Beiras e Serra da Estrela	0.05	0.02	0.01
Alentejo Litoral	0.37	0.38	0.18
Alto Alentejo	0.17	0.00	0.09
Algarve	0.94	0.84	0.70
Região Autónoma dos Açores	0.74	0.73	1.00
Região Autónoma da Madeira	1.00	1.00	0.99

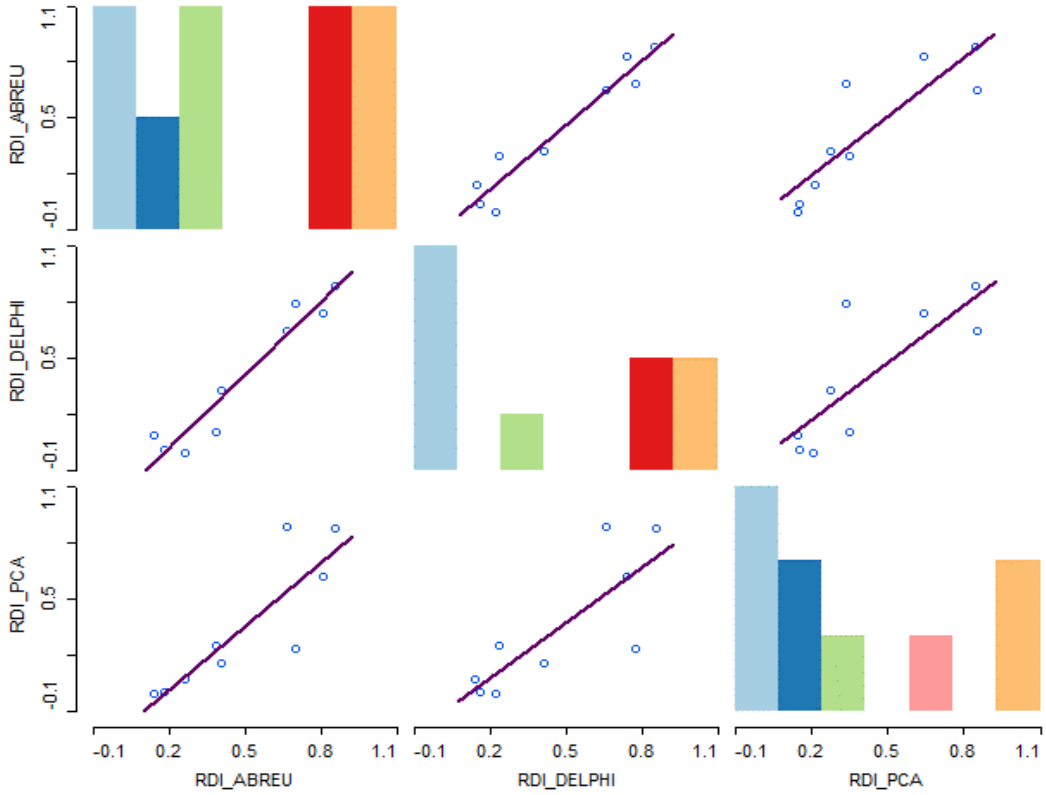
SOURCE: Own elaboration

The results in Table 3.3 clearly show that there is a strong relationship between *RDI Abreu* and *RDI Delphi*, with the NUTS III ranked similarly, even though *RDI Delphi* seems to penalize the least developed regions which get lower ratings than in *RDI Abreu*, and therefore, are comparatively worst positioned. In fact, using the Pearson's correlation coefficient, the most common measure of association between two continuous variables (Tabatabai et al. 2021), the value obtained between the *RDI Abreu* and *RDI Delphi* indexes (r=0.96) suggests that these two methods generate very similar results, almost as when there is a perfect positive linear relation (Sari et al. 2017)[16]. On the other hand, the Pearson's values calculated between *RDI Abreu*/*RDI PCA* and *RDI Delphi*/*RDI PCA* are, respectively, r=0.86 and r=0.80, meaning that they are both feasible methodologies, as they have a high positive correlation with an accurate method as it is *PCA*.

As a complementary analysis, the linear relationship between each pair of indices can be seen in Figure 3.2:

[16] The closer this value to zero, the smaller is the degree of linear relation (Sari et al. 2017).

Figure 3. 2 Scatter Plot Matrix

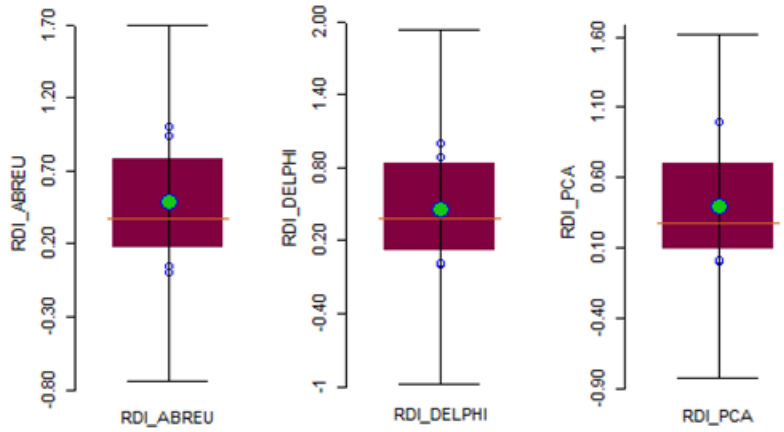


SOURCE: Own elaboration

To display the distribution of the values between the three RDI indices and to obtain an indication of how these values are spread out, the results shown in Table 33 were also represented in boxplots[17] in Figure 3.3, which displays the minimum (*min*), first quartile (*Q1*), mean and median, third quartile (*Q3*), interquartile range (*IQR*), standard deviation (*s.d.*), and the maximum (*max*) values:

[17] In a boxplot, a box is drawn from the first quartile (*Q1*) to the third quartile (*Q3*) and a vertical line goes through the box at the median (green circle). Also, the *Q1*-1,5**IQR* and *Q3*+1,5**IQR* values are represented as black horizontal lines, and the mean value is represented as a red line.

Figure 3. 3 Boxplots representing the three RDI values regarding the 3 methods



	RDI_ABREU		RDI_DELPHI		RDI_PCA
min	0	min	0	min	0
max	1	max	1	max	1
Q1	0.1700	Q1	0.1100	Q1	0.0900
median	0.3700	median	0.3800	median	0.2700
Q3	0.7800	Q3	0.8400	Q3	0.7000
IQR	0.6100	IQR	0.7300	IQR	0.6100
mean	0.4878	mean	0.4556	mean	0.3922
s.d.	0.3844	s.d.	0.4088	s.d.	0.4005

SOURCE: Own elaboration

From the information presented in Figure 3.3 we can conclude that there are no major differences in the range and distribution of the three calculated indices. The index with the greatest variability is *RDI Delphi* (*IQR*=0.73, s.*d.*=0.41), and it is also observed that the highest average value corresponds to *RDI Abreu* (*mean*=0.49) while the lowest median value is that of *RDI PCA* index (*median*=0.27).

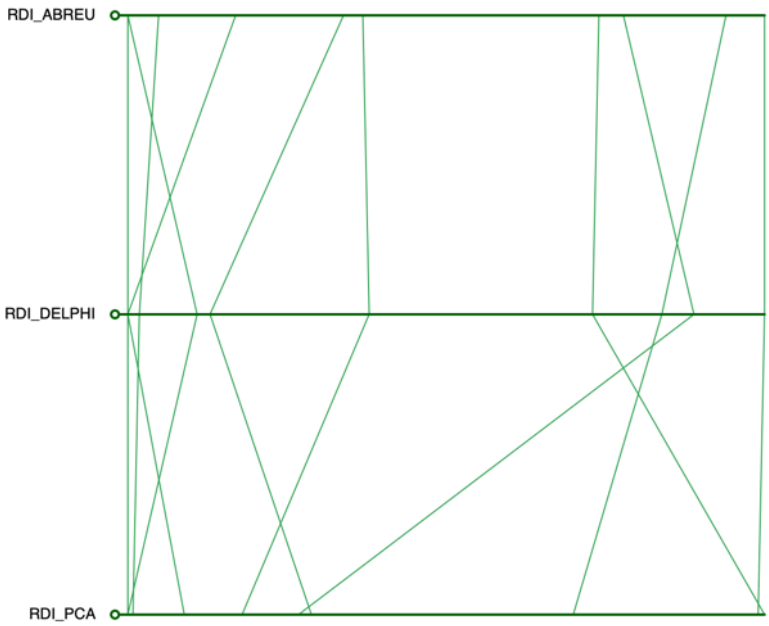
However, the NUTS III with the lowest value is different when applying *RDI Abreu* and *RDI PCA* (Terras de Trás-os-Montes), or *RDI Delphi* (Alto Alentejo), although in fact both regions are strongly needed for public policies to reverse depopulation and aging, which leverage their development.

Regarding the NUTS III with the highest value, both *RDI Abreu* and *RDI Delphi* grant the highest rating to the Região Autónoma da Madeira. However, when applying *RDI PCA* this is the territory with the second highest value, giving the first place to Região Autónoma dos Açores, but with a result really close to the first one.

Nevertheless, although the results are similar in the extreme values, the situation is different for the middle ones. For example, when analysing Região de Coimbra, *RDI Abreu* and *RDI Delphi* rank it in the third and second place, respectively, but the *RDI PCA* positions this NUTS III in the fifth position, after Alto Minho. This result raises some doubts about its reliability, as Coimbra is one of the most industrialized and developed regions of Portugal. In fact, *RDI Abreu* and *RDI Delphi* rank Alto Minho on the seventh place, a figure that matches with a low-density territory, strongly marked by aging.

These conclusions are again verified through the use of a parallel coordinates plot (Figure 3.4), one of the most popular techniques for visualization and analysis of multidimensional data (Fu et al. 2016). On Figure 3.4 we can observe the different RDI results presented by the three methodologies with the relationships that exists between them: comparing the position of the 9 NUTS III RDI values generated by *RDI Abreu* and *RDI Delphi*, the lines mostly don't cross each other, meaning that there is a strong relation between the different values. But when we introduce the results of *RDI PCA*, we can see that the situation is very different, with a lot of changes in its relative positions.

Figure 3. 4 Parallel coordinates plot



SOURCE: Own elaboration

3.3.1. Assessment by experts

In the final part of this study, the group of experts received the information presented in Table 3.3 together with a ranking of the regions prepared from the same table. They were also provided with an introductory text where the issue of developing indexes to measure rural development was briefly presented, together with an explanation of the selection of the 9 NUTS III regions. After this information, the experts were asked to assess each of the RDI methods:

"*On a scale of 1 to 5 and taking into account the results presented to you, how adequate do you consider each of the methods to be for measuring rural development, with 1 being "not at all adequate" and 5 being "very adequate"?*"

They were also asked to indicate which of the results had been most relevant for their answers. Table 3.4 presents the ratings granted for the experts to each of the three aggregation methods.

Table 3. 4 Experts' adequacy rating for the different 3 aggregating methodologies (1: not at all adequate; 5: very adequate)

Expert	RDI Abreu	RDI Delphi	RDI PCA
1, 13, 16	3	3	3
2, 10, 25	4	4	2
3	4	2	3
4	4	1	3
5	3	3	4
6	2	4	1
7	5	5	5
8	4	3	4
9	3	4	4
11	1	4	3
12	4	4	3
14	4	4	4
15	5	3	3
17	5	1	1
18	3	2	2
19, 21	3	4	2
20, 22	4	3	2
23	3	5	4
24	3	4	3

SOURCE: Own elaboration

The results in Table 3.4 show that the most adequate aggregating methodology from the point of view of the experts is *RDI Abreu*, which has got a total score of 88 points (median=4) followed by *RDI Delphi* with a score of 84 points (median=4). The worst-scoring methodology is the one based on the weighting granted to the different indicators through the PCA (*RDI PCA*), which scored 70 points (median=3).

Considering the ranking, the difference between *RDI Abreu* and *RDI Delphi* is minimal, (17 experts granted the first position to *RDI Abreu* vs 16 to *RDI Delphi*; 6 experts granted the 2nd position to *RDI Abreu* vs 7 to *RDI Delphi*):

Table 3. 5 Ranking granted by the experts to the three RD indexes

Ranking position	RDI_ABREU	RDI_DELPHI	RDI_PCA
1º	17	16	8
2º	6	7	12
3º	2	2	5

SOURCE: Own elaboration

When analyzing the reasons provided by the experts to support their decisions, the main points of disagreement with *RDI PCA* come from the relative position of the regions of Coimbra and Açores. Açores gets the highest rating in *RDI PCA*, while Coimbra goes down to the fifth position below Alto Minho region, raising some doubts between the experts about its reliability. In fact, Coimbra, according to 2018 data from INE, is one of the most industrialized and developed regions of Portugal, whereas Alto Minho is a low-density territory, strongly marked by aging (Conselho Estratégico de Desenvolvimento Intermunicipal 2021). On the other hand, Açores is the Portuguese region with one of the worst health services indicator and highest income inequality (Diogo 2019), therefore its top position on *RDI PCA* is not well accepted by the experts.

The result of the experts' assessment is consistent with the more usual trend in composite index construction (Greco et al. 2019; OECD 2008). Furthermore, it provides a basis for the use of those indexes which have considered that the different dimensions of RD have similar importance, such as those developed by (Ristić et al. 2019) or (I. Abreu et al. 2019). However, other indexes that rely on the use of statistical techniques to aggregate the variables composing the RD index, or to determine their weight (Bolcárová and Kološta 2015; Kiryluk-Dryjska and Beba 2018; Ma et al. 2020), but where no validation of their accuracy has been performed, should rethink their formulation in view of the results presented in this paper.

3.4. Conclusions

Despite the relevance of rural development for current policies and society, the lack of indexes specifically designed for its evaluation in rural areas hinders the design and

implementation of policies, or the adjustment of those that, being already implemented, may not generate the expected results. It also makes it difficult to identify areas where the use of public funds would be more effective, resulting in less efficient rural development policies.

In addition, the various approaches used in the design of those indexes tend to suffer from a lack of stakeholder involvement, both in the selection of the indicators to be included in the study and in the different ways of combining them to generate a unit of measurement.

The approach taken in this paper aims to bridge these gaps by using a series of indicators previously generated by a panel of rural development experts, which have become the inputs to generate several rural development indices by applying different aggregation methodologies (arithmetic/geometric mean with and without weighting -*RDI Abreu* and *RDI Delphi*) and aggregation by means of principal component analysis -*RDI PCA*).

The results have shown the statistical similarity of two of the proposed indexes (*RDI Abreu* and *RDI Delphi*) compared to the one obtained by *RDI PCA*. Finally, a panel of rural development experts have reviewed the scores generated by the three indexes for a set of 9 NUTS III Portuguese regions. *RDI Abreu* was considered to reflect more accurately the different levels of rural development, while the experts disagreed with some of the results generated by *RDI PCA*. Thus, this work offers an objective rationale for the definition of indexes used to assess rural development, which can be widely used in a context where the rural environment and the policies that promote its development are gaining more and more importance.

3.5. Credit Authorship Contribution Statement

Isabel Abreu: Conceptualization, Visualization, Validation, Methodology, Investigation, Formal analysis, Writing - original draft. Francisco J. Mesías: Conceptualization, Visualization, Validation, Methodology, Supervision, Writing - review & editing. Julián Ramajo: Methodology, Formal analysis, Software, Supervision, Writing - review & editing.

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General Conclusions

GENERAL CONCLUSIONS

With the increasing importance of rural areas as a potential way of facing global crisis (either economic or health crisis like the Covid-19 pandemic), the multifunctionality of agriculture and its positive externalities can be a leverage factor for sustainable rural development. Although increasingly fewer differences between rural and urban areas are currently being observed, the former still have serious limitations which may hamper their development, which is aggravated by the fact that the rural world is composed of a wide range of small territorial units with their own specificities.

Despite the relevance of rural development for current policies and society, the lack of indexes specifically designed for its evaluation in rural areas hinders the design and implementation of policies, or the adjustment of those that, being already implemented, may not generate the expected results. It also makes it difficult to identify areas where the use of public funds would be more effective, resulting in less efficient rural development policies. As none of the existing indexes solves the problem of the applicability to small territories (e.g., at a municipal level) or considers the particularities of the rural areas, it was proposed to work on an index especially conceived for the rural areas. Also, the various approaches used in the design of the "traditional" indexes tend to suffer from a lack of stakeholder involvement, both in the selection of the indicators to be included in the study and in the different ways of combining them to generate a unit of measurement. These issues have been addressed by this work through the use of the qualitative Delphi methodology, based on the opinion of a panel of experts with different roles in rural development, who allowed to define a set of demographic, environmental, economic and social welfare indicators that could be used to assess rural development and related policies.

Based on the consensus of the experts, 25 indicators were selected, covering the 4 dimensions on which rural development analysis has been structured

(population, economy, social welfare, and environment). The experts also determined the importance that each of the dimensions considered should have in the construction of an index to measure rural development. Contradicting "traditional" indices based solely on economic and demographic indicators, it was concluded that, in addition to the economy, social welfare is one of the fields that contributes most to the development of rural areas.

Compared to previous research on the assessment of rural development, the use of a Delphi approach has provided some additional benefits, such as adaptation to the needs and views of different stakeholders and the prioritization of indicators and dimensions.

In a subsequent phase, the indicators selected by the panel of experts were used to generate three different rural development indices, by applying different aggregation methodologies (arithmetic/geometric mean with and without weighting -RDI Abreu and RDI Delphi) and aggregation by means of principal component analysis -RDI PCA). The results obtained showed the statistical similarity of two of the proposed indexes (RDI Abreu and RDI Delphi) compared to the one obtained by RDI PCA.

Finally, a panel of rural development experts reviewed the scores generated by the three indexes for a set of 9 NUTS-III Portuguese regions. RDI Abreu was considered the one that reflected the different levels of rural development in a more accurate way, while the experts disagreed with some of the results generated by RDI PCA. Thus, this Thesis offers an objective rationale for the definition of indexes applied to assess rural development, which can be widely used in a context where the rural environment and the policies that promote its development are gaining more and more importance.