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A METHODOLOGICAL NOTE FOR LOCAL DEMOGRAPHIC PROJECTIONS: A SHIFT-SHARE ANALYSIS TO DISAGGREGATE OFFICIAL AGGREGATED ESTIMATIONS

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ABSTRACT: Population projections are used as a common framework to orientate different policies and planning in several fields including public retirement systems, health care and education. They would be also needed for the urban planning as well as for other local policies such us social services but these projections are usually made at a certain level of spatial aggregation, national level or large regions but they are rarely are calculated at the local level. In this note a simple procedure, based in Shift-Share analysis, is proposed as a possible way to approximate local projections from official estimations. It allows us to estimate the future size and age structure of the population at a more disaggregated level, local-level, getting data consistent with those produced at national and regional level by the official institutions. These data come to be a valuable source of information in the design of local policies, especially for those concerned to urban and housing planning.

Keywords: demographic projections, disaggregated data, local population and Shift-Share analysis.

RESUMEN: Las proyecciones demográficas son habitualmente usadas para orientar y planificar políticas económicas en distintas áreas, especialmente en Seguridad Social, servicios sanitarios y educación. También serían necesarias para la planificación y ordenación urbana así como para otras políticas locales como los servicios sociales pero normalmente las proyecciones demográficas se estiman para unidades espaciales agregadas, países o grandes regiones, no siendo habitual disponer de esta información a escala local. En esta nota se propone un procedimiento sencillo, basado en el Análisis Shift-Share, para estimar proyecciones demográficas locales a partir de la información oficial agregada. Con ello es posible disponer de estimaciones precisas del tamaño poblacional y la estructura por edades de las proyecciones a una escala local consistente con los datos oficiales estimados a escalas más agregadas. La aplicación de esta metodología permite orientar la planificación urbana al posibilitar fieles estimaciones de demanda de servicios y vivienda y ayuda a prever las necesidades que irán produciéndose en el entorno local pudiendo anticiparse a las mismas.

Palabras clave:proyecciones demográficas, información desagregada, población local y Análisis Shift-Share.

1. Introduction

Population projections have become a key instrument used in the design and implementation of several public programs, especially those ones related to sustainability of public retirement systems, health care, education and other public policies where the knowledge of the size and the composition of population in the future is a relevant factor. The official statistical institutes offer estimations of population evolution and structure by sex and age in a specific place in the future using certain mathematical models based on pre-existing demographic data. These estimations are usually made at a certain level of spatial aggregation, national level or large regions, but they are rarely calculated at the local level.

For instance, the Spanish National Statistics Institute provides every two years this type of projections by means of a statistical simulation of the population that will reside in Spain and in its regions. The projection is made at the national level, by Autonomous Communities (NUTS II) and provinces (NUTS III), but not at the local level (municipalities). Most of the provinces contain a large internal heterogeneity: inside them urbanized areas with higher population grow coexist with rural areas, which present severe problems of ageing and population loss. This heterogeneity is hidden in the aggregated projection. In many cases local demographic projections of specific areas or cities are elaborated but these estimations are not comparable between them because they use different methodologies and are focused on different issues and even more important is the fact that they are not necessarily consistent with the official national projections. However, finding a right projection at local level and comparable data between municipalities becomes a key question in the design of local policies and urban planning.

The objective of this note is to propose a simple procedure based on shift-share analysis to disaggregate the national population projections at the local level. The advantage of this approach is the simplicity of the estimation, easily adaptable to different context, and that the estimations at the local level are coherent with the national projections. The procedure has been applied, as an example, to the Asturias case in Spain. This is a small province that contains large internal heterogeneity with a central urban area high urbanized that coexists with very rural environments.

The note is structured as follows. First, the adaptation of the shift-share analysis to the demographic projections desegregation is presented. Second, the example with the Asturian case in Spain with demographic projections till 2029 is shown and briefly analyzed. Main conclusions are summarized in a final section.

2. A procedure to disaggregate demographic projections at a local level based on the shift-share analysis

Shift-Share analysis has been usually applied in the field of regional studies in order to explain the influence of different components on the change experienced by a magnitude. Dunn (1960) could be consulted for the basics of this technique.

Usually it is applied to the context of an economy that is divided into i=1,2,…k economic sectors and j = 1, ..., n territories. The key idea is that the variation experienced by a z_{ij} variable between two moments depends on the performance of three factors: the drag effect due to the development of the national economy, the influence of specialization in a given sector i and, finally, an effect that reflects the specific characteristics of that sector in the region j. These aspects are summarized in the following expression:

$$\Delta z_{ij} = EN + ES + ER \tag{1}$$

Being $\mathrm{EN} = \mathrm{r}z_{\mathrm{ij}}^{0}$, $\mathrm{ES} = (\mathrm{r} - \mathrm{r_i})z_{\mathrm{ij}}^{0}$ and $\mathrm{ER} = (\mathrm{r_{ij}} - \mathrm{r_i})z_{\mathrm{ij}}^{0}$, where r is the growth rate of the nationwide magnitude, r_i represents the growth rate of this magnitude in this sector nationally, and r_{ij} is the growth rate between the two time points considered:

$$\mathrm{r} = \frac{z^{1}}{z^{0}} - 1 \tag{2}$$

$$r_i = \frac{z_i^1}{z_i^0} - 1 \tag{3}$$

$$r_{ij} = \frac{z_{ij}^1}{z_{ij}^0} - 1 \tag{4}$$

This method has commonly been used to decompose the observed change in employment and income levels. However, it can be suitably modified to obtain predictions of future values of any other variable of interest, in our case, population changes.

Specifically, we define as P_t the total population in a country or region (large area) in a given period t. The total population is divided into k=18 five-year age groups, being P_{it} the population group I in the period t. Additionally, that region could be divided into n local areas. P_{ij} represents the population of the age group i in the local area j and in the period t. Note that

$$\sum_{i=1}^{18} \sum_{j=1}^{n} P_{ij}^t = \sum_{i=1}^{18} P_i^t = P^t \tag{5}$$

and

$$\Delta p_{i,j} = EReg + EAge + ELocal \tag{6}$$

where,

$$EReg = gP_{ij}^0 \tag{7}$$

$$EAge = (g - g_i)p_{ij}^0 \tag{8}$$

$$ELocal = (g_{ij} - g_i)p_{ij}^0 \tag{9}$$

allowingus to express (6) as

$$\Delta p_{ij} = gp_{ij}^0 + (g - g_i)p_{ij}^0 + (g_i - g_{ij})p_{ij}^0 \tag{10}$$

In this reformulation of the Shift-Share classic expression, g denotes the growth rate for the total population of the whole territory; g_i is the growth rate of the age group in the local area and g_{ij} represents the growth rate of the population of the age group in the town between the two time points. That is

$$g = \frac{p^t}{p^0} - 1 \tag{11}$$

$$g_i = \frac{p_i^t}{p_i^0} - 1 \tag{12}$$

$$g_{ij} = \frac{p_{ij}^t}{p_{ij}^0} - 1 \tag{13}$$

where

The Regional Effect (EReg) shows the variation that the population of the age group i in the town j would have experienced if its growth rate had been equal to the regional average in the considered period.
The Age Effect (EAge) measures the differential with the regional average growth rate for the age group i.
The Local Effect (ELocal) measures the effect of the specific characteristics of the local area j comparing the growth rate of this age group i in the municipality with that observed at the regional level.

Thus, whereas the local effect during the forecast horizon should be similar to those observed in recent periods, so, a constrained optimization problem is outlined:

$$\text{Min } \sum_{i=1}^{18}\sum_{j=1}^{78}\left[\left(\tilde{g}_{ij}-\tilde{g}_i\right)-\left(g_{ij}-g_i\right)\right]^2 p_{ij}^0 \tag{14}$$

subject to:

$$\sum_{j=1}^{78}\tilde{g}_{ij}\,p_{ij}^0=\tilde{p}_i;\ \ i=1,\dots,18 \tag{15}$$

$$\sum_{j=1}^{n}\left(\tilde{g}_{ij}-\tilde{g}_i\right)=0;\ i=1,\dots,n \tag{16}$$

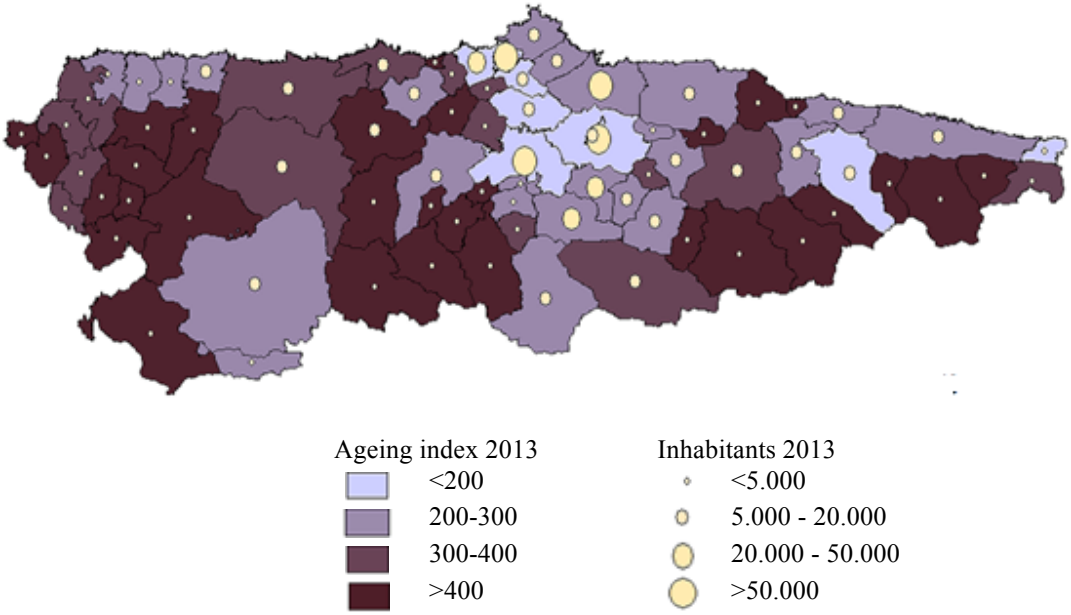
Equation (14) sets the distance criterion in terms of quadratic differentials between expected and observed, weighted by the size of the population in the local area and age group considered. This expression is minimized subject to two constraints: the equation (15) ensures that projected rates at the local level are consistent with those for the whole region; while (16) preserves the interpretation of local effect as a difference from the regional average for the age group considered, hence the sum of these differences have to be zero.

Once this optimization program is solved, both for males and for women, the rates of change of population g_{ij} for each age group i and each local area j could be calculated. The advantage of predicting this effect rather than trying to project the population directly is twofold: first, as discussed above, ensures that the predictions will be consistent with national or regional predictions. Moreover, as the local effect is justified on the basis of certain characteristics at the local level, it is easy to assume that these local characteristics are stable over time.

3. Case study: application to Asturias region in Spain

In order to illustrate why it is necessary to provide information of population projections at local level we use the case of Asturias: a small region in the north of Spain divided into several municipalities with significant differences between them, as it happens in many other regions, especially in the north-west of Spain. In this region, rural areas –which present severe problems of ageing–, coexist with other urbanized areas that are attiring population. Figure 1 shows the current distribution of population in Asturias. As it can be observed, Asturias is divided into 78 municipalities, and at present, only four municipalities have more than 50.000 inhabitants while most of municipalities have less than 5.000 inhabitants. As well, the ageing index –calculated as the number of persons 64 years old or over per hundred persons under age 15– is very different between municipalities (see Figure 1).

The Spanish National Statistics Institute (INE) has estimated that Asturias will lose in the forward 15 years almost 9% of the current population. However, considering the structure and last evolution of population data, it is probable that population will follow different dynamics inside Asturias. As the Spanish National Statistics Institute (INE) provides an estimate of the size and age structure of the population that will reside in Asturias in the next 15 years and official data concerning the evolution of the population in each municipality during the period 1996-2013, a Shift-Share analysis as the one presented in the previous section could be used to determine the growth rates of the population for each age group at a municipal level considering the trend followed for different demographic items –births, death and migration– during the last 18 years. So different projections were made to the period 2014-2029 in such a way that they are as similar as possible to those observed in the period 1996-2013 and consistent with the population prediction elaborated by the INE to Asturias.



Source: INE (2013)

Figure 1. Distribution of population and aging structure of Asturias (2013)

Figure 2 shows how population in Asturias municipalities will change, considering the data produced by the Shift-Share analysis. As it was expected, municipalities will not follow the same dynamic: while almost all the municipalities will lose an important percentage of population and continue ageing, five municipalities, sited at the center of the region, will attire population, and younger population.

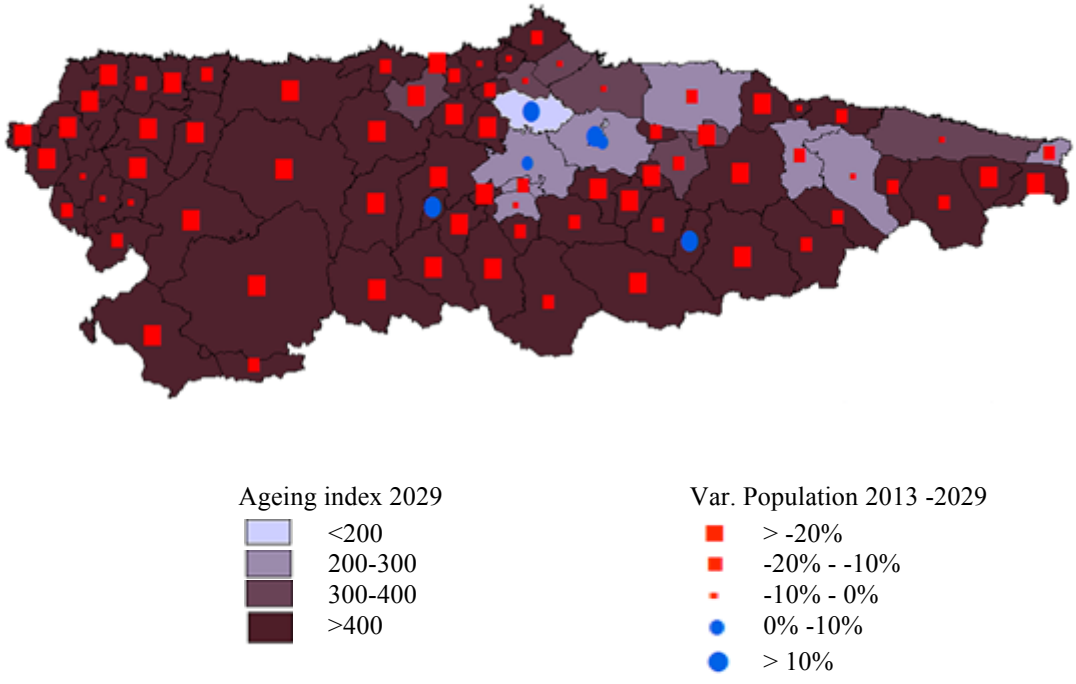


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Figure 2. Local projection of population and aging stricture in Asturias for 2029.

Thanks to the application of this procedure we can estimate local population pyramids for each one of the municipalities. In the case of Asturias it is possible to calculate 78 pyramids, one per municipality. Just to show it with an example, Figure 3a and 3b illustrates the population pyramid that shows the age-sex distribution of population in Asturias in 2029 and it is compared with population pyramid for those municipalities in Asturias with less than 50.000 inhabitants and those with more than 50.000 inhabitants, considering the data produced by the shift share analysis.

There, several differences can be observed. Even when the whole province will continue experiencing an increasing ageing problem, municipalities with less than 50.000 inhabitants are expected to lose younger people and to experience a more pronounced ageing problem than municipalities with more than 50.000 inhabitants.

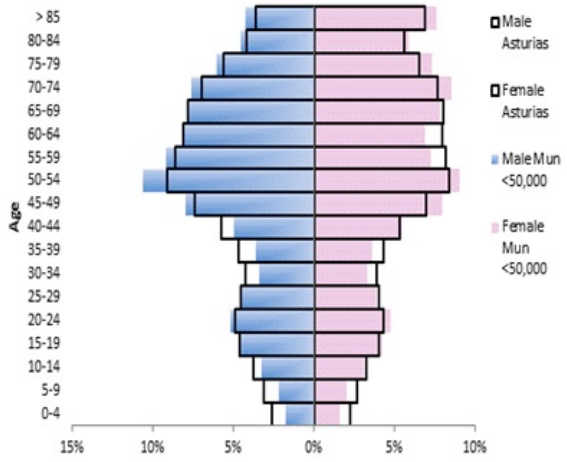

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Figure 3.a Population pyramid in Asturias in 2029, differencing municipalities with less than 50.000 inhabitants and more than 50,000

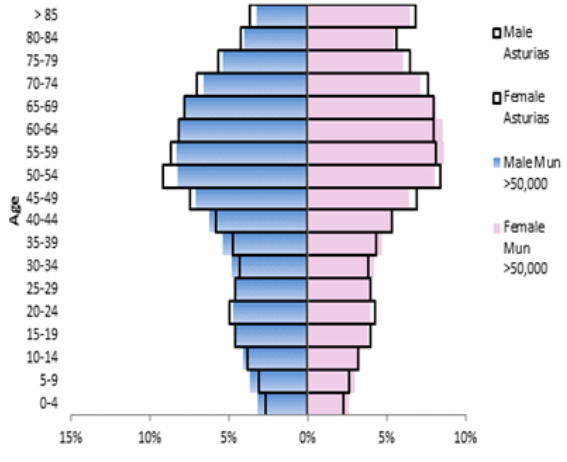

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Figure 3.b Population pyramid in Asturias in 2029, differencing municipalities with less than 50.000 inhabitants and more than 50,000

These changes in population surely will affect the actual system of public services such as health services. Data provided by projections can serve as an advice for planning future policy programs as they offer a forecast of the most expected trend that the territory will continue if current circumstances do not change (especially demographic trends: births, deaths, migration), but it must be taken into account that outcomes can fluctuate because of political and social evolution so this analysis should be taken with caution, especially in the long term.

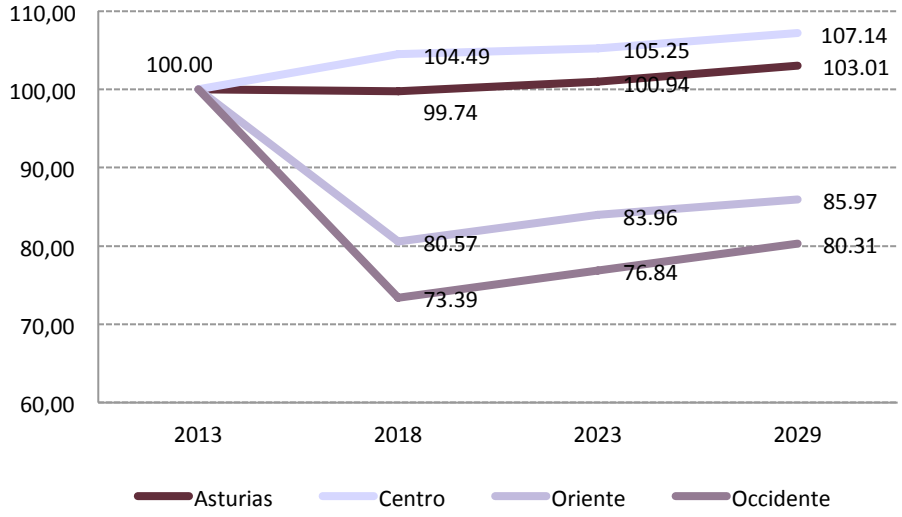

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Figure 4.Projections on the hospitalization by areas using the demographic estimations (2013-2019, 2013=100)

As an example of the possibilities of these projections in the advise of local and regional governments Figure 4 shows the forecasting of the hospitalization using the age structure projected by areas. Assuming that the behavior of hospitalization by ages will be the same we can project the future numbers considering the changes in the demography by local areas. We can estimate the hospitalization evolution in each municipality. To present the results in Figure 4 we distinguish between central Asturias, the more urbanized area, and the occidental and oriental rural and peripheral municipalities. As can be seen we can identify clear different behaviors that would be hidden in the aggregated estimations. These differences could be much more relevant in larger regions or in those cases in which the demographic projections are only available at the national level. The anticipation to these behaviors could help in the definition of the necessaries by local areas.

4. Conclusions

Population projections can warm about eventualities that may affect economic development and help policymaker's craft policies that can be adapted in various projection scenarios. Their knowledge will help to know where and why an action is more necessary and urgent, but, as above argued, it is necessary to develop new techniques that can help to understand future changes in any territorial area at a more disaggregated level than regional or national, because different dynamics can coexist into the same region.

A Shift-Share analysis is a simple and easy methodology that allows us to disaggregate information provided from regional to local level, assuring the consistency of projections reached at municipal level with the figures projected for a region, something difficult to achieve using other traditional techniques. The advantage of predicting this effect rather than trying to direly project the population is double: on one hand, it is ensured that the predictions will be consistent with those produced by official statistic

institutes; on the other hand, as the Municipal effect is justified on the basis of certain characteristics at the municipal level, it is easy to assume that local characteristics will be stable over time.

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