Economía Agraria y Recursos Naturales. ISSN: 1578-0732. e-ISSN: 2174-7350. Vol. 19,2. (2019). pp. 29-48

Rural depopulation and income convergence

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ABSTRACT: Panel data models are estimated to highlight the income-gap as a driver of individual decisions to migrate. This procedure allows to testing the hypothesis that the per capita income-gap of rural spaces along with the employment rate and aging explain the fall in the population of rural villages and the concentration of population in functional urban areas (FUA). First, using panel data models, the links between rural depopulation and the income-gap are estimated with data at the municipal level. Second, the effects of the European Structural and Investment Funds (ESIF) on the convergence of income levels for rural inhabitants are evaluated.

Despoblación rural y convergencia en renta

RESUMEN: Estimamos unos modelos de datos de panel para ilustrar cómo la brecha de ingresos impulsa las decisiones individuales de emigrar y los usamos para contrastar la hipótesis de que la brecha de renta per cápita, junto con las tasas de empleo y de envejecimiento, explican la despoblación rural y la concentración de la población en las áreas funcionales urbanas (AFU). Estimamos modelos a nivel municipal para cuantificar la relación entre brecha de renta y despoblación. Seguidamente, estudiamos los efectos de los Fondos Europeos Estructurales y de Inversión para favorecer la convergencia del mundo rural.

KEYWORDS / *PALABRAS CLAVE*: Rural population, income-gap, regional convergence, European Structural and Investment Funds / *Población rural, brecha de renta, convergencia regional, Fondos Europeos Estructurales y de Inversión*.

JEL classification / *Clasificación JEL*: R11, R53, J11, J18, J61.

DOI: https://doi.org/10.7201/earn.2019.02.02.

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Acknowledgements: The authors appreciate the comments of the editors of the magazine. This work has been funded by the Institute of Fiscal Studies, project: "Budget architecture in the EU and Cohesion: Fiscal consequences for Spain of the changes in the CAP and in the European Funds", project number 2018/00389/001 and the Carlos III University of Madrid, Strategic Action in European Economy and Resources Natural number 2009/00426/002.

Cite as: San Juan Mesonada, C. & Sunyer Manteiga, C. (2019). "Rural depopulation and income converge". *Economía Agraria y Recursos Naturales,* 19(2), 29-48. doi: https://doi.org/10.7201/earn.2019.02.02.

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Received on April 2019. Accepted on July 2019.

1. Introduction

The objective of the paper is, first, to identify empirically the links between rural depopulation and the income-gap using the available data at the municipal level. Second, to study the effects of the European Structural and Investment Funds (ESIF) on the catching-up of rural population income. Economic models of migration point to the search for higher incomes as the primary driver behind individual decisions on interregional migrations (Borjas, 1989).

Our hypothesis is that the critical variable for explaining the fall in population density in rural areas is the per capita income-gap with urban areas located in the most dynamic regions. In other words, the population tends to move to areas with higher incomes and to concentrate in urban cores and their surrounding metropolitan areas that Eurostat designates as Functional Urban Areas (FUA).

With this aim, we first develop models where the income-gap appears as a driver for rural depopulation. Then, in the second part, we extend the model and seek to evaluate the effects of ESIFs in Spain for the period 2000-2013. Given that the funds provided explicitly target the reduction of economic disparities among regions, we expect that in the case in which they are correctly allocated, they could improve income in rural areas and ultimately prevent their depopulation.

The primary added value of this research is that it allows comparison of the results in terms of convergence of two budgetary periods covering different phases of the economic cycle and two ESIF operational programs[1]. As explained below, our results, using data from funds that were actually spent, show that the effects on the real convergence of the regions were different after the recession that took place from 2007-13 (FEGA, 2017a and 2017b).

As our objective is to study rural depopulation, the first step is to establish a definition of a rural area. Population, size and density are the most traditionally used indicators to identify rural areas. Moreover, new labels, as mentioned above, have appeared such as FUA, developed in the European project Urban Audit to collect statistical information to compare the quality of life of leading European cities. One result of interest from our work is that this new classification allows us to prove that the highest income density per dwelling is also concentrated in the main FUA in Spain (European Commission, 2004 and 2016). Moreover, the lowest average unemployment rates are currently located in the main cities or nearby in their FUA. (INE, 2019; data for 2016).

In summary, the most recent data show the usefulness of identifying the causal elements of rural depopulation and going beyond the traditional indicators of rural depopulation. At any rate, to work with comparable data at the municipality level, in the present paper we assume the legal definition of a rural municipality, which are towns having fewer than 30,000 inhabitants and a population density lower than 100 inhabitants per square kilometer. Additionally, we excluded municipalities in any of the 150 FUAs.

[1] We use the available data for the period 2000-06 and 2007-13.

2. Data

The importance of data quality is fundamental (Pienkowski & Berkowitz, 2015). One of the main reasons why evaluations of the effectiveness of ESIFs present such disparate results is the quality and source of the data used. A large part of these studies has used data on budgeted expenditure (Becker *et al.,* 2012a and 2012b, among others), ignoring the long lags that exist – even more than three years - between the scheduled spending date and the actual effective spending. Attempts to compensate for this lag have been done with the use of lags in the regressions (Rodriguez-Pose & Fratesi, 2003), obtaining significant results. However, the use of appropriate data, if granted access, is always recommended. Unfortunately, and despite efforts to build databases at the community level (e.g. ESPON and SWECO), the regional nature of the management of these funds and a lack of coordination on the part of the relevant authorities make it a challenge to gather data that maintains a high disaggregation level in the details of budget execution dates.

Fortunately for this study, the Spanish General Management Subdirectorate of the European Regional Development Fund (ERDF) provided us with access to the executed ERDF and Agricultural Fund for Rural Development (EAFRD) expenditures for the operational programs 2000-2006 and 2007-2013, which together account for approximately 75 % of the total amount of the ESIF. On the other hand, the program expenses for all the ESIFs have been obtained from the operational programs of each region.

The data on real GDP (base 2010), the GDP deflator and the population resident in Spain come from the *Spanish Foundation for Applied Economic Research* FEDEA database (FEDEA, 2019). Public investment and the calculation of human capital (as a weighted average of years aimed at studying the population between the ages of 15 and 64) come from the database created by the IVIE[2]; the employment rate comes from EUROSTAT. The public debt of the regions (NUT-2) comes from the website of the Spanish Ministry of Finance; the contribution to the GDP of agriculture comes from the INE. The government quality index, following Rodriguez-Pose & Garcilazo (2013), has been obtained by merging data from the database of the University of Gothenburg and the World Bank Governance Data.

Below we abstract the primary sources of data on rural population used in our models.

1) Income and Gini variables: From the FEDEA database (Personal income of Spanish municipalities and their distribution, years 2004 to 2006 and 2007 update). (FEDEA, 2019).

   FEDEA data from the AEAT (*Spanish Tax Administration Agency*) income tax by municipality that exclude Navarra and the Basque Country because they have an autonomous fiscal administration.

   Regarding the latter source, it is essential to point out that for privacy issues, the database is built with municipalities that have more than 5,000 inhabitants.

[2] IVIE: Valencian Institute of Economic Research (https://www.ivie.es/en_US/).

2) Data on the population by a municipality (men and women, population by age, foreign population (INE, 2019)).
3) Employment: IVIE database (IVIE, 2019):

All data are at the municipal level, except for employment. Working population data are not available by municipalities, but as it is a crucial variable for explaining the depopulation, it was necessary to use the working population of the region as a proxy in the model.

During the real estate boom the employment expanded in certain rural areas. As the construction sector is highly masculinized, we introduced MALE, the proportion of males in the working population, as a control variable attempting to control for municipalities with expansion in the construction sector.

3. Methodology and literature review

Approximately one-third of the EU budget is allocated to the ESIFs, which, after the Common Agricultural Policy (CAP), represent the second largest community policy. Due to the enormous size of these funds and their macroeconomic importance, several studies have investigated their impact on interregional convergence in Europe (see, among others, Ederveen *et al.,* 2002; 2006; Rodríguez-Pose & Fratesi, 2002, 2004; Puigcerver-Peñalver, 2007; Becker *et al.,* 2008; 2010, 2012a and 2012b; Boscá *et al.,* 2016).

However, the empirical results on the effectiveness of the ESIF to achieve real convergence are striking according to the period under analysis. Recent work indicates that in the period 1995-2010 there was an "existence of a regressive process in terms of regional convergence" (Rodil *et al.,* 2014; p. 300).

In the Díaz & Franjo (2016) model, as in the case of the building sector's boom in Spain, the low interest rates in the Eurozone during the expansion before the real estate crisis constrained the growth of the economy's TFP (total factor productivity) by inefficiently allocating a disproportionate share of the investments. The concentration during the economic boom of investments in not internationally tradable goods and services (e.g., real estate) generated the subsequent massive loss of employment in the construction sector in regions lagging behind during the recession, affecting convergence in per capita GDP. The latter may have had relevant effects in the working population changes in rural areas, mainly during the construction sector expansion and a sharp recession later on. In the following section, we present the models that relate the rate of variation of the population in the rural areas with the income-gap, employment, and the aging population. The objective is to exploit the municipal microdata of the declared income in the income tax database of FEDEA at the highest level of disaggregation.

4. Models of rural depopulation

In this section, we relate the rural depopulation rate with the taxpayers' income-gap. We test the hypothesis that the per capita income-gap (together with working population and aging) is a driver of the speed of depopulation. Income-gap is calculated as the distance in per capita income between rural and urban municipalities. Our empirical analysis uses a specification as follows:

$$g_{i,t}=\alpha+\beta_1 * y_{i,t}+\beta_2 X_{i,t}+\varphi_i+\tau_t+\varepsilon_{i,t} \quad [1]$$

Where $g_{i,t}$ is the growth rate of the population calculated as $g=\left(\frac{p_{i,t}-p_{i,t-1}}{p_{i,t-1}}\right)$, p denotes population, with i and t as municipality and time index, respectively; $y_{i,t}$ is the variable of interest, described in the following paragraph; $X_{i,t}$ is a matrix of municipal characteristics that include employment growth (provincial working population), foreign population, aging index, masculinity index and Gini index; φ_i y τ_t are vectors of invariant municipal characteristics and dichotomous time variables that capture permanent differences in population growth rates, respectively; finally, $\varepsilon_{i,t}$ is a vector of i.i.d. residual.

Four models were estimated, as shown in Tables 1 and 2. In the first column, $y_{i,t}$ is per capita income; in the second column, $y_{i,t}$ is the year-on-year growth of per capita income; in the third column, $y_{i,t}$ is the per capita income-gap, calculated as the difference between the average per capita income in each province that has never been Objective 1 (Objective Convergence in the current operational program) and the average income in municipality i; finally, in the fourth column, $y_{i,t}(lag)$ is the year-on-year growth of the income-gap.

In Tables 1 and 2 the same models were estimated but with the introduction of lags in $y_{i,t}$, in order to capture the impact of those decisions with greater precision. Besides this, in the two tables, both control variables, the masculinity index and the employment growth, are always positive. The first arguably indicates that the growth of employment in the highly masculinized sector (construction) has an essential impact on population growth. The second one suggests that higher levels of provincial activity contribute to maintain municipalities' population in the same province since the inhabitants do not need to emigrate because they are close enough to their jobs or may commute.

In Table 1, when we consider all the rural municipalities and the municipalities of the Objective 1 regions, respectively, we obtain very similar results for our variables of interest. However, in Table 2, when we only consider rural municipalities, the variables of interest, especially the lagged growth rates (columns 2 and 4), increase their absolute value considerably, indicating that the impact on migration of having lower income or observing growth in the income distance with respect other municipalities increases considerably after one year.

Regarding the European Agricultural Fund for Rural Development (EAFRD) some regions (Andalusia, the Canary Islands, Valencia, and Murcia) have received less aid per capita than the national average. The foregoing could be due to two factors:

- When considering only the expenditure executed, this may have been delayed in the regions mentioned above, which would overlap with the first payments of the next programming period.
- The EAFRD may be of a less redistributive nature than the ERDF since to promote the convergence of rural areas, regions that are not Objective 1 but where agriculture is of great importance, such as Aragón, Navarra, and Rioja, have received more aid than the national average.

5. The increase in the differences in the working population between regions: σ Convergence

The speed of convergence and whether it is transitory or permanent in nature plays an essential role in characterizing regional disparities in income and, hence, has important implications for the design of agricultural policy. We say that there is β-convergence if regions with lower levels of per capita income tend to grow faster than the income leaders, and σ-convergence if the dispersion of their relative per capita income levels tends to decrease over time.

It follows that β-convergence is a necessary but not a sufficient condition for σ-convergence. An important implication of this result is that income inequality across countries or regions may persist due to shocks (e.g., cyclical fluctuations in economic activity) that tend to increase dispersion.

After disaggregating per capita GDP into two components, income per worker Y/L and percentage of working population (L/n) we observe that although the standard deviation of income per worker has remained constant throughout the period, the standard deviation of the percentage of the employed population increased since 2007.

$$Y/n = Y/L * L/n \qquad [2]$$

The latter indicates that the main engine of divergence for the second sub-period has been the increase in the differences in the working population between regions. Employment and depopulation are co-related in the rural areas, so divergence in income per capita regarding the urban areas may decrease the working population in rural areas. This leads us to study the conditional convergence of the regions.

β Convergence

A second step in understanding the problem is the analysis of the β convergence. To do this in Table 3 Beta convergence and beta conditional convergence, using cross-section data the following regressions have been estimated:

$$g_{it} = \alpha + \beta * \ln(y_{i,t-1}) + u_{it} \quad [3]$$

$$g_{it} = \alpha + \beta * \ln(y_{i,t-1}) + \sigma * k_h + u_{it} \quad [4]$$

where g_{it} represents the average per capita GDP growth rate in the period studied, $y_{i,t-1}$ per capita GDP at the beginning of the period and k_h human capital. We introduce the human capital because it is usually affected by the rural brain drain of metropolitan regions, cities and greater cities.

While $g_{it} = \alpha + \beta * \ln(y_{i,t-1}) + u_{it}$ [3] estimates absolute β convergence, since $g_{it} = \alpha + \beta * \ln(y_{i,t-1}) + \sigma * k_h + u_{it}$ [4] assumes that each region has its own stationary state, and therefore, by including human capital it is about capturing significant and exclusive characteristics of each region to find the conditional β convergence. Our results confirm the hypothesis that regional convergence stopped after the financial crisis and, during the fiscal austerity period, has reverted to divergence (see Table 3 Beta convergence and beta conditional convergence).

In the period from 2000 to 2007, a conditional convergence process of up to 6.44 % is observed, while from 2008 to 2013, the β coefficient not only changed its sign but also ceased to be significant and R^2 fell from 0.68 to 0.13. It can be concluded, therefore, that the 2008 financial crisis negatively affected Spanish regional convergence.

6. Empirical Results: Spanish regional convergence

In this section we attempt to answer the following question: Do ESIFs have a significant impact on Spanish regional convergence in terms of per capita income?

We also observe how the initial per capita GDP level negatively affects growth, which confirms that conditional β convergence has occurred. Specifically, 1 % more in the per capita GDP leads to growth rates that are approximately 0.4 % lower. In general terms, the regressions have an R^2 greater than 50 %. In addition, the F statistic is close to 20, so the variables used can explain changes in per capita GDP growth (Table 4).

Focusing on the ESIFs, we find that both the ERDF expenditure executed and the budgeted expenditure of the funds as a whole have a weakly positive but significant effect. These results are consistent with those offered by Rodríguez-Pose & Fratesi, (2002, 2004) and Rodriguez-Pose & Garcilazo (2013), which also conclude that the funds have an effect in the short term but not in the long run. The latter would mean that the funds have a purely redistributive effect, not a structural one. These findings agree with Becker *et al.* (2010) who also find that the impact of the funds disappear when certain regions of the United Kingdom stop receiving them. But our latest investigation using data for Member States regions allowed identifying permanent effects.

Next, we extend the model to observe if there are spillover effects of the ESIF, in particular of the ERDF, from the receiving region to other border regions. In fact, in Table 3 (estimation of the spillover model and public debt), when interacting this variable with the ERDF variable, the result is a positive and significant coefficient, which implies that a percentage of the aid to the regions Objective 1 ends up having positive effects in other regions.

We also study whether the level of indebtedness in the region, measured as the percentage of public debt to GDP, has some impact on the ability to attract investments through projects co-financed by ESIFs in the region.

$$\frac{\partial l\ Growth}{\partial l\ ERDF} = \beta_2 + \beta_{11} * \text{Debt} \quad [5]$$

The coefficient turns out to be negative and significant, so we conclude that the impact of ESIFs on regional growth is no longer linear and will depend negatively on the degree of public debt held by the Autonomous Regions (Table 5).

This result is robust and matches those of previous studies (Georgescu, 2008; Varga, 2010; Varga & In't Veld, 2011; Esposti & Bussoleti, 2008). Also, its relevance increases due to the crisis, since cuts in public spending have created difficulties when absorbing ESIFs, causing a significant number of them not to be executed in the foreseen date and, therefore, limiting their ability to boost the regional economy (Marzinotto, 2011).

In Table 6, we present the two models to account for the impact of the crisis on growth explicitly, and that is why we include it as an artificial variable "crisis" in the model, taking values of one for dates after 2007 and null for previous years. Effectively the estimated models go from an R^2 of 0.54 to 0.72 increasing, in turn, the F (41.4 and 45.7). From this result, we infer that in the previous model, we were ignoring something fundamental like the change in the economic cycle and that more consistent estimates yield better empirical results. The first model (Table 6 in columns 2 and 3) draws attention is the decrease in the rate of β convergence, passing from a coefficient of -0.41 to another of -0.17. As we already prove that the income per capita divergence is a driver of the rural depopulation, the latter means that crisis would accelerate the concentration of population in urban areas with relatively higher income.

Besides, regarding our variables of interest, all have ceased to be significant, which would imply a sharp decrease of impact on economic growth by European funds during the recession.

In the second model (Table 6 in columns 4 and 5), we present the results for the interaction of the "crisis" variable with the European rural development funds. The coefficient is negative and significant for "crisis * ERDF," indicating the negative impact of the recession in the potential of foster growth of the rally executed projects (ERDF).

But in the interaction of programmed funds with the crisis (crisis * program), the coefficient turns out to be not significant in both models. On the other hand, the coefficient relative to the ERDF becomes slightly negative (-0.04) and meaningful. The latter implies an insignificant contribution to growth, which we suspect may be related to the worsening of the functioning of the regional public administration due, among other factors, to the budgetary restriction. As it seems plausible to think that since the projects are co-financed, by the principle of additionality, through European and national or regional funds, the reduction of public spending to which the Spanish economy has been forced was a relevant factor in hindering the execution of funds budgeted.

The delay in the execution of the projects amounts up to 8,153 million. That means the 31.7 % of the planned expenditure (Program) in the case of the ERDF for the period 2007-2013. Approximately 10 % more than in the period 2000-2006. In this way, both variables "crisis" and public debt ("Debt" in Table 5) seem to have harmed the effectiveness of European funds.

7. Conclusions

The main drivers of rural population's evolution are the income-gap with urban areas, the working population rate of growth, and the aging rate in rural areas.

Urban areas, especially when functional urban areas are included in the data, show a trend toward income concentration, not only because FUA concentrates population and activity, but also because over average income taxpayer density is higher in functional urban areas than in rural areas. Intermediate areas increase their weight in relation to the total population mainly by ex-urbanization as well as residential developments and the clustering of industrial as well as commercial areas.

Within regions, at the municipal level, population decreases in villages and towns with fewer than 30,000 inhabitants in general. Moreover, certain towns concentrate activity such as district centers or become incorporated into nearby functional urban areas.

The economic recession after the 2008 financial crisis halted the income convergence between regions. That meant the end of the real income convergence process operating during the pre-recession period. According to our results, the effects of the European Structural and Investment Funds may change depending on the period of study. Possibly budgetary austerity have had a specific role in those results.

Convergence in income appears as a relevant driver against rural depopulation, and the ESIF appears as one of the leading public investment programs. Especially in lagging regions, the convergence process may have slowed down rural depopulation.

This article estimated the impact of the structural funds on the convergence in per capita GDP between Autonomous Communities, and we have attempted to quantify the effect of the variables that can significantly influence the current rhythm of regional convergence in Spain.

The empirical results show that the convergence process in the study period, 2000-2013, is divided symmetrically into two sub-periods: 2000-07 and 2008-13. While in the first interregional differences decreased, in the second, during the downturn, they increased.

In the period 2000-13, without considering the crisis, the model using the data of both the European Regional Development Fund (ERDF) executed and that of the set of budgeted structural funds (not actually implemented investment) seems to detect a weak impact of these projects on growth. However, by including the delayed effects on investment time, this impact disappears after one year, with the result of redistributing income becoming more apparent.

When we control for the recession, the estimates change substantially (See Table 6: Estimation of the model with the artificial variable crisis included). The rate of convergence and the impact of the ERDF on growth turn out to be slightly negative, and the impact of the budgeted funds as a whole is not significant. In addition, we verify the importance of other factors generally ignored in the literature, such as regional public debt and spillovers. The level of indebtedness in the region has a definite adverse effect on the effectiveness of European projects. Additionally, we identified a clear spillover effect from the funds towards other border regions on those that are formally receiving.

Therefore, our analysis suggests that structural funds function more as a redistributive policy than as a structural policy, as other authors have also suggested (Boldrin & Canova, 2001). This means moving away from its primary objective: To contribute to the long-term creation of a socially and economically cohesive Europe.

On the other hand, changes in economic cycles seem to have a significant impact on the ability of funds to contribute to the growth of the regional economies. Therefore, it is essential to be able to adapt the funds according to the phase of the business cycle, especially during downturns, to ensure their effectiveness. The anti-crisis fund budgeted in the draft budget perspectives for the Multi-annual EU budget 2021-27 could fulfill this function as long as it reaches a sufficient volume to have significant effects. Given that the Eurozone suffered a liquidity trap that lasted three years, an expansion of central government spending in the euro area equal to 1 % of the Eurozone's GDP could increase GDP in the periphery by more than 1 % (Blanchard *et al.,* 2017).

The hypothesis that the per capita income-gap of rural spaces is fueling depopulation has been tested, but working opportunities and aging shows as even more relevant drivers. The role of the ESIF to promote convergence has been different during the expansion than in the downturn.

Notably in Spain, the crisis has asymmetrically hit regions, hindering convergence. Thus, the regions with the most significant public debt problems, which are usually Objective 1, are the ones that have had the most difficulties in adjusting to the budgetary austerity program. In addition, reductions in public spending have had a significant adverse effect.

It is money that was not invested since the project was not applied for due to the lack of available budget to co-finance it. This also implies, according to the European Union principle of additionality, that part of the ESIF funds were not allocated at the critical moment of the great recession.

As a consequence, the potential effectiveness of ESIFs to boost real convergence is severely weakened. As Bonatti & Fracasso (2017; p. 35-36) point out, part of the problems of the peripheral regions are structural, and this should be the objective of the ESIF: Solving the structural issues. However, during the recession, the backward regions have also suffered the consequences of European austerity policies, so they could also recover lost ground in real convergence if there were a fiscal expansion in the future. The latter is consistent with the position of Blanchard *et al.* (2013, 2017), who maintain that the multiplier of public spending grows during recessions, and who also underscore how the liquidity trap in the periphery of the Eurozone could improve the effectiveness of an external fiscal stimulus.

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Appendix

TABLE 1

Population growth versus Income-gap rate with regions objective 1

Dep variable: Population growth	1	2	3	4
Av. Income	$1.3*10^{-9***}$ (0.00)			
Av. Income growth		$2.369*10^{-5***}$ (0.00)		
Gap			$-1.346*10^{-9***}$ (0.00)	
Gap growth				$-5.058*10^{-6*}$ (0.00)
Controls:				
Employment growth	0.047^{*} (-0.02)	0.047^{*} (-0.02)	0.047^{*} (-0.02)	0.047^{*} (-0.02)
Foreigners	-0.194^{**} (-0.07)	-0.194^{**} (-0.07)	-0.194^{**} (-0.07)	-0.194^{**} (-0.07)
Old	-1.367^{***} (-0.21)	-1.367^{***} (-0.21)	-1.367^{***} (-0.21)	-1.368^{***} (-0.21)
Male	0.425^{***} (-0.09)	0.425^{***} (-0.09)	0.425^{***} (-0.09)	0.425^{***} (-0.09)
Gini	-0.021^{**} (-0.01)	-0.021^{**} (-0.01)	-0.021^{**} (-0.01)	-0.021^{**} (-0.01)
Constant	-0.159 (-0.11)	-0.159 (-0.11)	-0.159 (-0.11)	-0.159 (-0.11)
Time effects	Yes	Yes	Yes	Yes
Fixed effects (municipalities)	Yes	Yes	Yes	Yes
Cross-sections included	806	806	806	806
Total panel (balanced) observations	2,418	1,612	2,418	1,612

Source: Own elaboration.

Note 1: Estimates uses a specification as follows:

$$g_{i,t}=\alpha+\beta_1*y_{i,t}+\beta_2X_{i,t}+\varphi_i+\tau_t+\varepsilon_{i,t} \quad [1]$$

Where $g_{i,t}$ is the growth rate of the population , were the subindex of *g* are: *i* for population and *t* as time index, respectively; $y_{i,t}$ is the variable of interest, described in the following paragraph; $X_{i,t}$ is a matrix of municipal characteristics that include employment growth (provincial working population), *Foreigners*, foreign population; Old, ageing index; *Male*, masculinity index as a proxy for construction intensity; *Gini*, the Gini per capita index of the municipality; φ_i y τ_t are vectors of invariant municipal characteristics and dichotomous time variables that capture permanent differences in population growth rates, respectively; finally, $\varepsilon_{i,t}$ is a vector of i.i.d. residual. In the first column, $y_{i,t}$ is per capita income; in the second, $y_{i,t}$ is the year-on-year growth of per capita income; in the third, $y_{i,t}$ is the per capita income-gap, calculated as the difference between the per capita income means of each province that has never been Objective 1 and the average income of the municipality i; finally, in the fourth column, $y_{i,t}$ (lag) is the year-on-year growth of the income-gap. In Table 1, we consider all the Spanish rural municipalities and the municipalities of the Objective 1 regions, respectively, and we obtain very similar results for our variables of interest.

TABLE 2

Rural and urban municipalities only (variables of interest in lags)

Dep variable: Population growth	1	2	3	4
Av. Income (lag)	$1.2*10^{-9***}$ (0.00)			
Av. Income growth (lag)		$6.7*10^{-5***}$ (0.00)		
Gap (lag)			$-1.4*10^{-9***}$ (0.00)	
Gap growth (lag)				$-1.9*10^{-5}$*** (0.00)
Controls:				
Employment growth	0.073^{***} (-0.02)	0.051^{**} (-0.02)	0.073^{***} (-0.02)	0.051^{**} (-0.02)
Foreigners	-0.173^{**} (-0.06)	0.446^{***} (-0.09)	-0.173^{**} (-0.06)	0.446^{***} (-0.09)
Old	-1.358^{***} (-0.19)	-0.806^{**} (-0.3)	-1.358^{***} (-0.19)	-0.807^{**} (-0.3)
Male	0.387^{***} (-0.08)	0.500^{***} (-0.08)	0.387^{***} (-0.08)	0.500^{***} (-0.08)
Gini	-0.021^{**} (-0.01)	-0.040^{***} (-0.01)	-0.021^{**} (-0.01)	-0.040^{***} (-0.01)
Constant	-0.13 (-0.09)	-0.381^{***} (-0.1)	-0.13 (-0.09)	-0.381^{***} (-0.1)
Time effects	Yes	Yes	Yes	Yes
Fixed effects (municipalities)	Yes	Yes	Yes	Yes
Cross-sections included	3,360	2,240	3,360	2,240
Total panel (balanced) observations	1,120	1,120	1,120	1,120

Data source: FEDEA fiscal micro data by municipalities for the pre-crisis years.
Source: Own elaboration.

Note 2: The estimates here use Equation 1, using similar models as in Table 1, but all the variables of interest are lagged, and municipalities data refers to the pre-crisis period only, seeking to identify retarded effects on depopulation paths. Now the variables of interest, especially the delays in growth rates (columns 2 and 4), increase their absolute value considerably, indicating that the impact on migration of having lower incomes or observing a growth in the income differential with other municipalities it increases considerably after one year.

TABLE 3

Beta convergence and beta conditional convergence

	β convergence (absolute)			β convergence (conditional)		
	2000-2013	**2000-2007**	**2008-2013**	**2000-2013**	**2000-2007**	**2008-2013**
$g_{i,t}$	-1.37 (0.79)	-2.56 (-0.89)	**0.902** (1.31)	-4.11 (-3.91)	-6.44 (-5.38)	**2.08** (1.13)
kh				1.2 (3.09)	1.76 (3.83)	**-0.41** (0.7)
R^2	0.2	0.35	0.1	0.52	0.68	0.13

Source: Own elaboration.

Note 3: A second step to understand the problem of depopulation of rural areas is to analyse the β convergence. Table 3 present's the estimated β coefficient for the Spanish regions, on the years 2000-2013, 2000-2007 and 2008-2013, using cross-section data, for the following regressions:

$$g_{it} = \alpha + \beta * \ln(y_{i,t-1}) + u_{it} \quad [3]$$ β convergence (absolute) in columns 2, 3 and 4

$$g_{it} = \alpha + \beta * \ln(y_{i,t-1}) + \sigma * k_h + u_{it} \quad [4]$$ β convergence (conditional) in columns 5, 6 and 7

where: g_{it} represents the average per capita GDP growth rate in the period studied, $y_{i,t-1}$ per capita GDP at the beginning of the period and k_h human capital in Equation 4 the human capital ratio of region.

TABLE 4

Estimation of the model by fixed effects and with the inclusion of time delays

	Current year		Lag1		Lag2		Lag3	
	Coefficient	**t**	**Coefficient**	**t**	**Coefficient**	**t**	**Coefficient**	**t**
GDP pc	-0.410	-7.91	-0.437	-8.12	-0.403	-7.31	-0.386	-7.25
ERDF	0.016	2.54	-0.008	-1.35	-0.003	-0.53	0.004	0.73
EAFRD	0.003	1.35	-0.002	-0.80	-0.004	-1.66	-0.001	-0.69
Program	0.016	3.76	0.017	1.98	0.009	1.09	-0.007	-0.86
Kh	0.028	2.88	0.023	3.11	0.024	3.12	0.0249	3.26
Ip	0.0341	3.34	0.050	3.36	0.055	3.69	0.057	3.91
Employ	0.120	2.62	0.115	2.49	0.108	2.32	0.112	2.42
n + g + δ	-0.024	-1.35	-0.028	-1.66	-0.023	-1.29	-0.032	-1.76
Agr	0.004	0.27	0.003	0.37	0.006	0.67	0.008	0.96
Constant	5.076	8.14	5.475	8.62	5.099	7.83	4.867	7.74
R^2 within	0.54		0.51		0.51		0.51	
F	20.90		18.64		18.03		18.24	
Observations n.º	237		237		236		235	
Groups n.º	17		17		17		17	
Average observations	13.9		13.9		13.9		13.9	

Source: Own elaboration.

Note 4: The dependent variable is the regional income per capita growth. The instant impact on growth of the income per capita of the region in the (current year) and the delayed effects of the investments in the next year (Lag1), after two years (Lag2) and three years later (Lag3) coefficients estimated and t-values are presented in table 4 from left to right columns.

The income per capita growth variation, *GDP pc*, is explained as a function of the executed investment's projects co-financed by the European Rural Development Fund, ERDF and the and the European Agricultural Fund for Rural Development, EAFRD. *Program* is the variable for the budgeted Structural Projects (that may be executed or not in practice).

To them, we add in both models the following control variables: k_h the human capital; i_p the rate of public investment over the GDP; *Employ*, the working population rate of the region; the sum of n (population growth), g and δ, where g is the technological progress and δ the capital depreciation rate; agr, rate of the agricultural production in the region's GDP.

TABLE 5

Estimation of the spillover model and public debt

Dependent Variable : ln (growth GDP pc)				
Independent Variables	**Coefficient**	**t**	**Coefficient**	**t**
GDP pc	-0.473	-8.99	-0.407	-7.50
ERDF	0.005	1.42	0.007	2.65
Kh	0.029	3.89	0.029	3.17
Ip	0.042	2.98	0.049	3.47
Employ	0.150	3.42	0.079	1.65
n + g + δ	-0.023	-1.37	-0.021	-1.20
agr	0.0005	0.07	.009	1.02
Spillover	0.095	1.35		
Spillover*ERDF	0.041	2.97		
Debt			0.244	1.97
Debt *Funds			-0.061	-2.39
Constant	5.97	9.60	5.07	8.20
R^2 within	0.54		0.52	
F	22.94		20.73	
N.º observations	237		237	
N.º groups	17		17	
Average observations	13.9		13.9	

Source: Own elaboration.

Note 5: The income per capita growth variation, *GDP pc*, is explained as a function of the executed investment's projects co-financed by the European Rural Development Fund, *ERDF*. The empirical results of the two panel data model estimates using fix effects are shown. For the first model (in columns 2 and 3) including the following control variables: *spillover*, growth on the border region neighbuors of Objective 1 regions; spillover * ERDF, the interaction of the spillovers with the executed ERDF projects;

In the second model (columns 4 and 5), with similar specification, we include the variable *Debt*, the public debt ratio over the region's GDP; and the interaction (*Debt * Funds*) of the variable debt with the really executed project co-financed by the Structural Funds to capture the effects of the region's level of indebtment in the effectiveness on income growth.

To them, we add in both models the following control variables: k_h the human capital; i_p the rate of public investment over the regions GDP; *Employ*, the working population rate of the region; the sum of *n* (population growth), *g* and *δ*, where g is the technological progress and δ the capital depreciation rate; *agr*, rate of the agricultural production in the region's GDP.

TABLE 6

Estimation of the model with the artificial variable crisis included

Independent variable: ln(growth GDP pc)				
	Coefficient	**t**	**Coefficient**	**t**
GDP pc	-0.175	-3.82	-0.167	-3.76
ERDF	0.002	0.50	0.002	0.97
ERDF	-0.0003	-0.17	-0.002	-1.13
Crisis* ERDF			-0.004	-2.09
Crisis*program			-0.003	-0.83
Program	0.005	1.44	0.005	1.34
Kh	0.021	3.50	0.021	3.61
Ip	-0.001	-0.09	0.005	0.49
Employment	0.028	0.82	0.022	0.66
n + g + δ	-0.038	-2.88	-0.038	-2.85
Agr	-0.010	-1.61	-0.007	-1.15
Crisis	-0.048	-11.44	-0.028	-2.56
Constant	1.845	3.27	5.475	3.27
R^2 within	0.72		0.72	
F	41.39		45.70	
N.º observations	237		237	
N.º groups	17		17	
Average observations	13.9		13.9	

Source: Own elaboration.

Note 6: The income per capita growth, *GDP pc*, is explained as a function of the executed investment's projects co-financed by the European Rural Development Fund, ERDF and the European Agricultural Fund for Rural Development, EAFRD.

The first model estimates are shown for the in columns 2 and 3. The control variables following: Program, the planned investment in the budget; k_h the human capital; i_p the rate of public investment over the GDP; *employ*, the working population rate of the region; rate of the agricultural production in the region's GDP; *crisis* dummy variable with zeros before 2007 year and ones after; To them, we add the sum of *n* (population growth), *g* and *δ*, where *g* is the technological progress and *δ* the capital depreciation rate.

The income per capita growth, *GDP pc*, is explained as a function of the executed investment's projects co-financed by the European Rural Development Fund, *ERDF* and the European Agricultural Fund for Rural Development, EAFRD.

In the second model (columns 4 and 5), with similar specification, we include the interactions of the variable crisis with the really executed project co-financed by the ERDF (*crisis* * *ERDF*) and, also, the interaction of crisis * EAFRD to capture the effects of the change of business cycle in the European Agricultural Fund for Rural Development realized projects.