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A SPATIAL VIEWPOINT ON FERTILITY BY REGIONS IN PORTUGAL*

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RESUMO:

Em termos gerais, Portugal caracteriza-se por um forte declínio na natalidade, sendo este um fenómeno que requer uma análise que sirva de base a uma intervenção, certamente necessária, dados os custos associados àquele fenómeno. Não obstante aquela tendência a nível nacional, uma observação dos dados suficientemente desagregada do ponto de vista regional permite verificar que, em determinadas regiões, o problema da baixa natalidade parece ser (bem) menos grave do que noutras, onde a desertificação humana parece eminente. Tendo em conta este contexto, o objectivo deste trabalho consiste em determinar, através de técnicas de econometria espacial, as variáveis determinantes das taxas de fecundidade nas regiões (concelhos) de Portugal continental. Mostra-se que a própria estrutura demográfica, os factores relacionados com a saúde assim como as condições económicas são importantes na explicação das diferenças nas taxas de fecundidade que se podem observar ao longo do território de Portugal continental.

Palavras-chave: Demografia Regional; Econometria Espacial; Fecundidade; Portugal.

Códigos JEL: C50, J11, R11

ABSTRACT:

Portugal is characterised by a strong decline in fertility. The significant costs associated with this require an intervention by the public authorities. However, effective public policy requires recognition of the fact that fertility differs across regions. Sufficiently disaggregated data reveals that in some regions the decline in fertility is less problematic than in others, where extinction of human beings seems eminent. The objective of the paper is to shed light on the Portuguese fertility problem from a regional viewpoint. I employ a spatial econometrics model to analyse the determinants of the fertility rates of the municipalities of the Portugal mainland. I find that differences in demographic structure, health care factors (outcomes), as well as economic factors are important in explaining fertility.

Keywords: Regional Demography, Spatial Econometrics, Fertility, Portugal.

JEL Codes: C50, J11, R11.

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1. INTRODUCTION

Portugal has witnessed an alarming decline in fertility. For instance, in the beginning of the 1970s about 500 babies were born per day in Portugal. Today about 300 babies are born every day. The average number of children per woman has decreased from 3.1 in 1960 to 1.4 in 2005. There are significant costs associated with the decline in fertility, notably the implied pressure on social security systems (in the long run).[1] However, the success of public policy measures to reverse the declining trend in fertility depends on an intimate understanding of the phenomenon.

This paper tries to understand the fertility problem from a regional perspective. Even a brief look at regional data reveals that public policy cannot ignore the geographic dimension of the problem because the fertility rates are and always were different across regions. Until the beginning of the 1980s, the Portuguese fertility rate was still above the point of replacement of generations (unlike that of other European countries). However, there was a clear difference in fertility across regions. By and large the north of the mainland and the islands had higher fertility rates than the south of the mainland, where the decline in fertility started a longer time ago (e.g. ; Mendes 1994; or Bandeira, 1996). From the 1980s onwards, the quick decline in overall fertility essentially happened because the higher-fertility regions registered higher decreases in fertility. Thus, nowadays there are no obvious clusters of regions with distinct levels of fertility as in the 1980s (Mendes, 1994). Yet, sufficiently disaggregated data shows that there are still regions where the problem seems to be much smaller than in others, where a human extinction seems imminent.

Figure 1 represents the fertility rates – defined as the annual number of live-births per 1000 women between 15-49 years old – for the municipalities of the mainland of Portugal in 2005, the last year for which data is available.[2]

In order to complement Figure 1, the information on the deviations between the observed fertility rates in each municipality and the average of the fertility rates of the neighbouring municipalities is given in Table 1. A positive/negative deviation indicates that the municipality is better/worse positioned than its neighbours in terms of the fertility rates. To put it clearer, Table 1 shows the relative and absolute frequencies of those deviations, defined as:

$$D_i = FR_i - WFR_i,$$

where, for i = 1,…,278 (municipalities), FR_i is the fertility rate of municipality i and WFR_i is the average of the fertility rates of the neighbouring municipalities of municipality i.

[1] Another consequence is an increase in the political power pensioners. Lesthaeghe and Neidert (2006), for example, show that the, so-called, "second demographic transition" an explanatory factor of (the spatial patterns in) the electoral results in the United States. See also Caleiro (2007a) for an analysis of the electoral consequences of the ageing of the population.

[2] All data used in this paper is taken from the *Instituto Nacional de Estatística*, particularly the Statistical Yearbooks of the NUTS II regions.

FIGURE 1

Fertility Rates by Municipalities in 2005

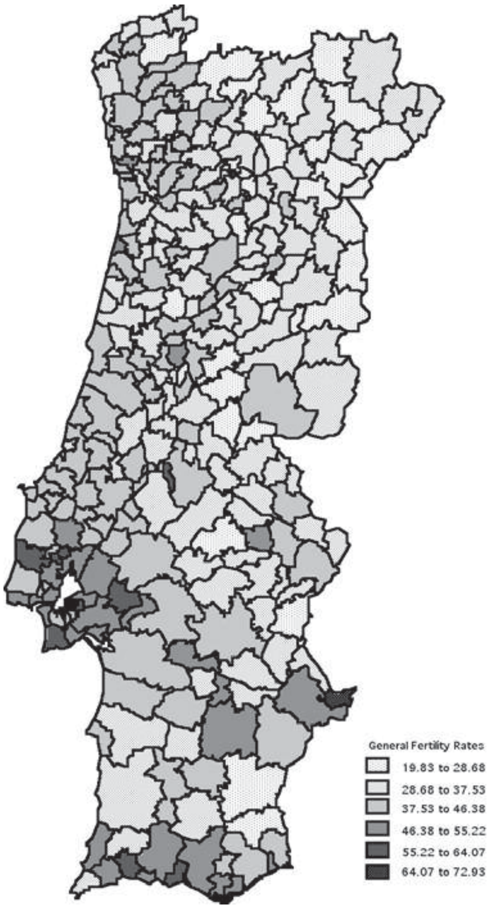

TABLE 1

The deviations on the fertility rates by municipalities (vis-à-vis the neighbours) in 2005

Deviations, D_i	Relative frequencies, %	Absolute frequencies, #
-17.431 – -11.621	3.61	10
-11.621 – -5.810	12.27	34
-5.810 – 0	35.38	98
0 – 10.238	43.68	121
10.238 – 20.476	4.69	13
20.476 – 30.714	0.36	1

If, as Table 1 indicates, there are municipalities where the fertility rate is clearly lower – for instance, around 16% of the municipalities possess a fertility rate smaller than their neighbours in, at least, 5.8 p.p. – , and others where the fertility rate is clearly higher than the average of their neighbouring municipalities – for instance, around 5% of the municipalities possess a fertility rate higher than their neighbours in, at least, 10.2 p.p. –, it is our view that there must be factors explaining these apparent differences.

The objective of the paper is thus to shed some light on the problem of low fertility in Portugal, for that assuming a regional viewpoint, taking space into account. This is done by the analysis of the determination of the explanatory factors of fertility rates in the municipalities of Portugal mainland by the use of a spatial econometrics model. It is shown that, in general, the demographic structure, the health system factors as well as the economic factors are important in explaining the differences that can be observed on the fertility rates throughout the Portuguese mainland territory.

The remainder of the paper is structured as follows. Section 2 presents the literature that stresses the importance of a regional viewpoint on fertility rates. Section 3 presents the spatial econometrics techniques that will be used to explain the fertility rates. Section 4 describes the data. Section 5 presents and discusses the results. Section 6 concludes and presents possible fertile avenues for further research.

2. LITERATURE

The literature on the topic is obviously vast. From it we would like to highlight a strand that considers economic factors as relevant in the explanation of fertility. Before doing so, it should be acknowledged that, obviously, there are other several factors that also explain fertility such as: (*a*) the demographic structure of the population, namely the relative ageing, marriage aspects; (*b*) health-system conditions; and (*c*) legal aspects, namely laws resulting from demographic policies, *etc.*.

In fact, the demographic structure of the population, which has been subject to a so-called second demographic transition, is certainly important to explain the evolution of fertility rates when physiological and cultural aspects are taken into account. For the obvious reasons, the relative ageing of populations is a physiological factor that is contrary to fertility. Furthermore, postponements of marriages, especially in case of catholic nature, as well as an increase in the rate of divorce, are cultural aspects that should be taken into account. This is especially true from a regional perspective given the cultural distinction that can be observed at the regional level as the result of rural/urban processes of regional development.

Regions are also, usually, characterised by distinct levels of health-system conditions, which may act as depressive factors of fertility, especially in the regions poorly served by facilities that couples consider to be relevant.

Demographic policies are usually taken at a national level but there are also particular measures taken by regional authorities, in order to stop the human desertification process, that make it indispensable to assume a regional perspective when determining the factors explaining fertility.

All those non-economic factors can be complemented by what Macunovich (2000) subsumes under the designation of "values", namely the growth of individualism, the declining of religious values and of marriage rates, the increasing materialism in a consumer society, improved contraceptives, environmental concerns, and the increasing desire for ‘quality’ over ‘quantity’ in children, are still related with economic aspects.[3]

As a matter of fact, the alleged inclination for having less, but ‘better’, children, i.e. a postponement of childbearing has been pointed out as a crucial factor explaining the decrease in fertility that characterises occidental countries (see Sobotka, 2004 for a discussion of this phenomenon in Europe).

In what concerns a unified economic theory of fertility, the seminal contributions of Gary Becker are to be mentioned (among many other contributions of this author see Becker, 1960).[4] It was considered that, in what concerns the decisions of timing and number of children, microeconomic theory could be applied, as those decisions would be of rational kind.

Reflecting the importance of that approach, some authors have declared the predominance of economic aspects in the first theories of demographic transition given that was admitted that economic forces would be decisive in social changes in general and in changes of demographic behaviours in particular (see Cleland and Wilson, 1987 and Robinson, 1997).[5]

Consequently, in accordance with that approach, the existence of distinct economic conditions, throughout time but also throughout space, should lead to distinct fertility rates throughout time and also space. As above mentioned, there are certainly also other factors explaining fertility, where the regional perspective indeed gains importance, but the importance of context, as it shows in the economic theory of fertility, is also evident in these other factors.[6] From this point of view it seems a paradox to verify that fertility is generally studied at a national level, being frequent the comparison among different countries but not among regions of the same country, even in a country where, historically, regions have been behaving differently, such as it is the case of Portugal.

Hence, as Mendes *et al*. (2006), we also consider that a regional dimension should be included in the analysis of the explanatory factors of fertility in Portugal. In this sense, the spatial/geographical dimension may reveal to be decisive in fertility as well as can also be related with other factors whose geographical localisation is also decisive.

As a matter of fact, the importance of the explanatory factors of fertility may vary from region to region, not only because that influence may reflect distinct socio-economic regional contexts but also because the geographical proximity may imply imitation of behaviours. In fact, the individual behaviour may be influenced by the other people in the community (see Kravdal, 2003), this being a relevant factor in the explanation of fertility.

Besides that factor, there are also some models of family creation, in particular for the intensity and mean age of marriage that reflect some spatial features. The interaction between the individual and the socio-regional context has been receiving a higher attention from the demographics of the family (see Hank, 2002), where the differences in fertility are a function of distinct socio-economic factors.

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[3] For instance, Kaplan and Bock (2001), when discussing Caldwell’s theory of intergenerational wealth flows, as an explanation of fertility, emphasise the structure of family as a mechanism allowing for transferences of wealth among generations within the family. In accordance with this theory, in ‘primitive’ or ‘traditional’ societies, net wealth would flow from younger to older generation whereas in ‘developed’ societies the flow would be in the opposite direction given that parents are expected to provide for children’s economic well-being.

[4] See Robinson (1997) for a detailed analysis of the evolution of the economic theory of fertility.

[5] The prominence of the socio-economic explanations is still considered to be true nowadays (see Bollen et al. 2007).

[6] For example, Sander (1992) considers the marginal effect of catholicism in the economic explanations of fertility.

3. THE SPATIAL ECONOMETRICS TECHNIQUES

Given the importance that spatial phenomena such as spillover effects, location and distance assume in regional science, it is clear that spatial dependence is a phenomenon that plays an important role in this science. Consequently, if the values observed by some variable do reflect some spatial dimension, as the result of some of those phenomena, which may be theoretically explained or simply data driven, the use of statistical techniques that take that dimension into consideration is obviously desirable (see Anselin (1988) as (one of) the first comprehensive textbook(s) on these matters and/or Arbia (2006) for a recent textbook contribution).

The application of spatial statistics techniques can thus be justifiable when it exists a theoretical model supporting the existence of spatial dependence, and/or the data shows evidence of spatial autocorrelation after being detected by suitable tests.

As such, the detection of spatial dependence is of obvious importance in these matters. The use of a neighbouring matrix makes it possible the computation of a statistic for the Moran's I test, which is, roughly speaking, the correlation coefficient between the values of the variables by each spatial unit and the mean values of that variable in neighbouring spatial units.

That computation, in turn, requires the determination a neighbouring matrix, which can be related with distance or just contiguity relationships. In this last case, two kinds of contiguity can be considered: (a) a 'rook' kind, which considers a spatial unit j to be a neighbour of spatial unit i when it shares a common border and (b) a 'queen' kind, which considers a spatial unit j to be a neighbour of spatial unit i when there is a, at least one, point that is common in the borders of both spatial unit. In each of the two cases, one may construct a neighbourhood matrix $W= [w_{ij}]$, where $w_{ij} = 0$ if spatial unit j is not a neighbour of spatial unit i (and if $i = j$) and $w_{ij} = 1$ if spatial unit j is a neighbour of spatial unit i.

If so, an approximation of the Moran's I will be given by the correlation coefficient between the variable and its spatial lags as, for instance, the mean value of all its neighbours, $i.e.$ for all $j \neq i$ where $w_{ij} = 1$. The Moran's I is then computed as:

$$I = \frac{n}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij} z_i z_j}{\sum_i z_i^2}$$

where z_i represents the deviation in relation to the mean.

The two usual forms of spatial dependence occur when:

1. The value assumed by the variable of interest, y, depends upon the values assumed by some exogenous variables, X, as well by the values assumed by that variable in neighbouring locations as, for instance, a theoretical model of spatial contagion predicts. This spatial dependence may thus result from spatial diffusion of effects at the explanatory variables level or because of spillover effects leading to a systematic spatial dependence among neighbouring variables. In this case, a spatial autoregressive/lag model is usually considered as follows:

$$y = \varrho W y + X \beta + \varepsilon, \qquad (1)$$

where ϱ is a spatial autoregressive coefficient and W is a neighbouring matrix. Given that the error terms, ε, are correlated with the spatial lag term $W y$, an OLS estimation of (1) leads to (simultaneity) biased and inefficient estimates of β. In fact, given the endogeneity of the spatial lag term, the maximum likelihood method can be used in the estimation of (1), as it avoids those problems.

2. The error terms across spatial units are correlated leading to some sort of spatial error model. The spatial dependence on the errors leads to a model of the type:

$$y = X\beta + u, \quad (2)$$

where $u = \lambda N u + \varepsilon$, where λ is a spatial autoregressive coefficient and N is a neighbouring matrix. Given that the error terms, u, are non-spherical, an OLS estimation of (2) leads to unbiased but inefficient estimates of β. The maximum likelihood method can be used in the estimation of (2), as it avoids this problem of inefficiency.

4. THE DATA

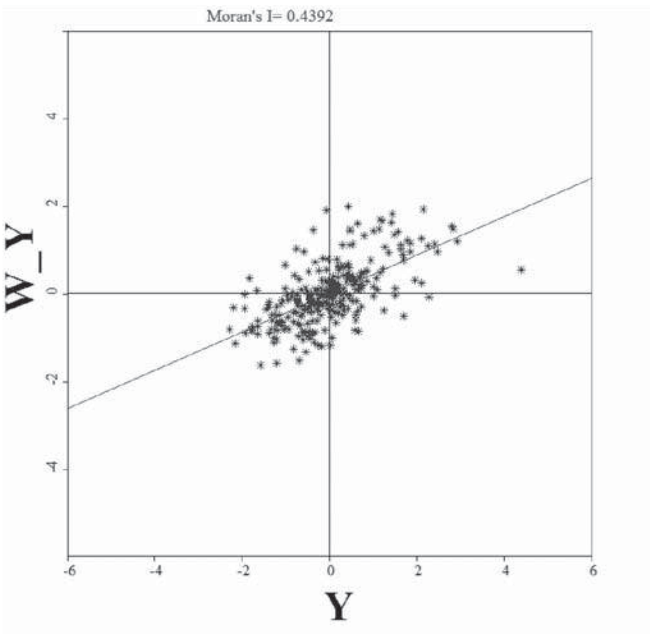
The variable of interest, i.e. the one to be explained, is the (general) fertility rate for the 278 municipalities of Portugal mainland in 2005, as the last year for which there is data on that variable (see figure 1).[7] In what concerns this variable it seems interesting to start by noticing the apparent spatial autocorrelation as indicated in figure 1. A Moran's *I* scatterplot is given in figure 2.[8]

The value of Moran's *I* reported in figure 2 indicates a significant positive spatial autocorrelation.[9]

Based upon the usual theoretical explanations of fertility and having into account the availability of data, we continue by proposing an explanation of regional

FIGURE 2

The Moran's I for the fertility rates, Y



[7] As mentioned before, the general fertility rate is defined as the number of live-births by 1000 women under fertile ages, i.e. between 15-49 years old

[8] At this point it is fair to point out that all the computations in this paper were done by the use of the free software GeoDATM 0.9.5-i of Luc Anselin, available at https://www.geoda.uiuc.edu. The use of this software required the use of a shapefile corresponding to the *Carta Administrativa Oficial de Portugal* by municipalities, which is freely available at http://www.igeo.pt/produtos/cadastro/caop/inicial.htm.

[9] Using 999 permutations the expected value is around -0.004 with a standard deviation of 0.037.

fertility rates in Portugal as follows. The presumable explanatory variables are divided into four groups:[10]

▪ Demographic variables, namely *the ageing ratio* – defined as the percentage ratio between people over 65 years old and people between 0 and 14 years old –, and *the crude marriage rate* – defined as the number of marriages per 1000 inhabitants;

▪ Context variables, namely *the crude divorce rate* – defined as the number of divorces per 1000 inhabitants –, *the proportion of catholic marriages* – defined as the percentage of catholic marriages over the total of marriages –, *the success rate at secondary regular education level* – defined as the percentage of students at the secondary regular education level that conclude this level of education –, and *local administration total expenditures on cultural activities per inhabitant*;

▪ Health system variables, namely *the number of nurses*, *the number of physicians*, *the number of pharmacies*, *the number of hospitals*, *the number of health centres*, *the number of medical appointments of family planning*, and *the number of mobile depots and pharmacies*, all these variables being made relative to 1000 inhabitants;[11]

▪ Economic variables, namely *the mean monthly earning*, *the mean value of unemployment benefits*, *the mean number of days of unemployment benefit*, *the mean value of family allowances*, *the proportion of women in the total of recipients of unemployment benefits*, and *the per capita purchasing power index*.

In order to avoid possible simultaneity problems, the values of these alleged explanatory variables give respect to 2004, as the year closest (but previous) to the one for the variable of interest.[12]

5. THE RESULTS

A step before the formulation of the model to be estimated consists on detecting possible multicollinearity among the explanatory variables. In fact, as expected, some of the explanatory variables are quite correlated, such as the number of hospitals, health centres and mobile depots and pharmacies, which present a correlation coefficient of about 90%, as well as the number of nurses with the number of physicians, which present a correlation coefficient of 80.1%. Two other possible sources of multicollinearity problems could be the correlation between the number of medical appointments of family planning and the number of mobile depots and pharmacies, as well as the correlation between the number of physicians and the number of hospitals. In both cases the correlation coefficient is around 70%. Notwithstanding, the use of these variables in relative terms alleviated these possible problems.

To sum up, some caution about multicollinearity, which, in fact, was detectable only among the group of health variables, was taken before the estimation of the models. To put it clearer, in each general model, i.e. the enlarged one from which all the non-significant variables were sequentially dropped off, only one of each pair/triplet of variables was considered, and retaining the most congruent model from the point of view of fitness and robustness to the tests.

[10] This division is to be viewed with some flexibility given that some variables do reflect more than one dimension.

[11] I thank one of the referees for having called the attention for the advantage of considering these variables in relative terms. In fact, in the original version of the paper, the last four of these variables were considered in absolute values.

[12] The only exception is the mean monthly earning, for which the last year of available of information was 2003.

Following the procedure recommended by Anselin, Florax and Rey (see Anselin *et al*. 2004) the first model to be estimated was one not taking account the spatial dimension. In doing so, we adopted a general-to-specific econometric methodology. In accordance to this methodology we started by considering an enlarged model, i.e. one containing all the alleged explanatory variables – taking into account the multicollinearity issues as mentioned above – and subsequently reducing the model by eliminating the less significant variable (from the set of non-significant ones), until reaching a model where a further reduction is no longer possible.

Having adopted that methodology, the final estimated model can be consulted in Table 2.[13]

Of noticeable interest is the existence of unexpected signs for the influence of the proportion of catholic marriages and a mix of signs at the significant health-system variables.[14] As a matter of fact, it is interesting to note that, in what concerns the health-system, the variables related with persons (nurses and physicians) seem to exert a negative effect on fertility whereas the opposite case happens with the variables related to facilities (hospitals and health centres).

Besides that fact, the model seems to be flawed from the point of view of regression diagnostics.

First of all, in what concerns the diagnostics for heteroskedasticity, all the three tests (Breusch-Pagan, Koenker-Bassett and White) support the existence of heteroskedastic errors (see Annex 1).

TABLE 2

The estimation results of the models

Explained variable: *Fertility Rate by Municipalities (2005)*		
Explanatory variables:	Non-spatial model (OLS)	Spatial lag model (ML)
Constant	**19.819** (3.596)	**5.054** (0.896)
Ageing ratio	**-0.032** (-5.133)	**-0.023** (-3.997)
Marriage rate	**1.317** (3.348)	**1.337** (3.684)
Proportion of catholic marriages	**-0.093** (3.228)	**-0.051** (-1.908)
Number of nurses per 1000 inhabitants	**-0.458** (-1.978)	**-0.220** (-1.011)
Number of physicians per 1000 inhabitants	**-0.723** (-1.932)	**-0.639** (-1.850)
Number of hospitals per 1000 inhabitants	**24.063** (1.940)	**26.027** (2.273)
Number of health centres per 1000 inhabitants	**16.923** (2.883)	**14.920** (2.753)
Proportion of women in the total of recipients of unemployment benefits	**0.166** (2.920)	**0.160** (3.043)
Per capita purchasing power index	**0.189** (7.670)	**0.145** (6.075)
Spatial lag	--	**0.365** (5.548)
Log Likelihood	-881.272	-868.092
AIC	1782.54	1758.18
SC	1818.82	1798.09

13 More detailed results are available in the annex 1.

14 Notice however that the effect of the number of physicians and of the number of hospital is only significant at a level around 94.6% and 94.7%, respectively.

Furthermore, in what concerns the tests against spatial autocorrelation, the model also shows some signs that spatial issues should not be ignored. For instance, the value of Moran's *I* statistic for the residuals, around 0.1419, is highly significant, indicating a relevant positive spatial autocorrelation.[15] This means that controlling for spatial dependence is supposed to improve the performance of the model. Following the procedure *a la* Anselin, the Lagrange Multiplier test (and the robust version) statistics indicate that both the spatial lag and spatial error models are better explanations than the classic OLS as estimated above, as both LM-lag (for a missing spatially dependent variable) and LM-error (for error dependence) are highly significant, being also evident a better performance of the spatial lag version (27.670 versus 13.706 for the test statistics). This result and especially the fact that the robust LM-error statistic is not significant indicate that the best model is the spatial lag one.

The results of the (maximum-likelihood) estimation of the model adding a spatial lag dimension are given in Table 2. [16]

A comparison between the spatial regression model and the classic OLS estimated model is in place. First of all, the spatially regression model fits the data better. The value of the log-likelihood function increases from -881.272 to -868.092 and the better performance is also revealed by the decrease of both the AIC (from 1782.54 to 1758.18) and the SC (1818.82 to 1798.09), and the highly significant value of the likelihood ratio test statistic.

Second, the signs of the variables in the OLS model and the spatial regression model are all the same, however their magnitudes differ sometimes considerably. As pointed out in Franzese and Hays (2007), when the relevant spatial component is added, all other explanatory variables generally lose importance in quantitative terms. In our regressions, the value of the constant in the spatial regression model is lower and also becomes insignificant. This result is not surprising given that we found a high (and positive) spatial autocorrelation coefficient (0.365). We also find that the number of nurses becomes insignificant, and the proportion of catholic marriages and the number of physicians marginally significant.

The spatial lag model indicates that fertility in the regions of the mainland of Portugal is essentially explained by spatially lagged values, such as demographic structure, by marital status, by the quality of the health care provision, and by economic conditions.

Besides the importance of space, the ageing of population is a depressive factor of fertility. Marriage, but not necessarily of catholic type, is also significant, indicating that marriage is still viewed as a pre-condition for child-bearing.

Concerning health care provision, it is interesting to note that the number of nurses and physicians appear inversely related to the fertility rate. Note, however, that these variables have a strong positive correlation with the number of facilities such as hospitals and health centres, and that these are *significantly* related with fertility rates.

[15] Using 999 permutations the expected value is around -0.004 with a standard deviation of 0.04.

[16] More detailed results are available in the annex 2.

Finally, fertility is explained by economic factors. First, per capita purchasing power raises fertility especially in municipalities already characterised by high fertility rates (see also Caleiro, 2007b). Second, the proportion of women who receive unemployment benefits also has a positive effect on fertility. Unemployed may be associated with more free time, which may in turn be propitious for fertility decisions.

6. CONCLUDING REMARKS

The objective of the paper was to show that variation in regional data can be exploited to learn about the determinants of fertility at the regional and national level. Our analysis showed that fertility is explained by demography, marital status, the quality of health care provision, economic factors, as well as spatially lagged values of fertility rates.

Our analysis suggests that fertility rates tend to persist over time, showing that several Portuguese regions face a long-run challenge. Regions where the population is relatively older are generally also the ones with low marriages rates, thus also low fertility rates. Low fertility, in turn, may depress future levels of the per capita purchasing power, which negatively affects fertility directly and through reduced access to health care facilities.

In order to combat the fertility problem demographic policy measures are required. The fact that the fertility rates by regions also depend, in a direct way, on the fertility rates of the neighbouring regions may indeed be a crucial factor in the spatial diffusion of the (positive) effects of those policy measures.

Future research of fertility should address the fertility problem more explicitly as a dynamic problem. Another promising possibility is research that combines the spatial lag model with the spatial error one. Research may again require analysis at a cluster level seen that low-fertility municipalities turn out to be different from high-fertility municipalities. Finally, an interesting and innovative avenue is to explore non-linear models, such as spatial splines.

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ANEXO 1

```
REGRESSION
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set          rper_3
Dependent Variable  :     Y Number of Observations:  278
Mean dependent var  :     37.9474  Number of Variables   :   10
S.D. dependent var  :    7.95227  Degrees of Freedom    :  268
R-squared           :   0.475183  F-statistic           :     26.9615
Adjusted R-squared  :   0.457558  Prob(F-statistic)     :5.84959e-033
Sum squared residual:     9226.47  Log likelihood       :   -881.272
Sigma-square        :    34.4271  Akaike info criterion :     1782.54
S.E. of regression  :    5.86746  Schwarz criterion     :     1818.82
Sigma-square ML     :    33.1887
S.E of regression ML:     5.76097
--------------------------------------------------------------------
   Variable    Coefficient     Std.Error    t-Statistic   Probability
--------------------------------------------------------------------
   CONSTANT       19.8188       5.512004       3.595571    0.0003852
        X1   -0.03175347    0.006186107     -5.133029    0.0000005
        X2      1.316928      0.3933556      3.347932    0.0009309
        X3   -0.09304899     0.02882829     -3.227698    0.0014032
        X6    -0.4583507      0.2317128     -1.978099    0.0489416
        X7    -0.7226967      0.3740287     -1.932196    0.0543895
       X17      0.166299     0.05696106      2.919521    0.0038036
       X18     0.1894295     0.02469834      7.669728    0.0000000
       X9R      24.06331       12.40314      1.940098    0.0534169
      X10R       16.9227       5.870443      2.882696    0.0042624
--------------------------------------------------------------------

REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER   49.0433
TEST ON NORMALITY OF ERRORS
TEST                DF         VALUE          PROB
Jarque-Bera          2         67.88428       0.0000000

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                DF         VALUE          PROB
Breusch-Pagan test    9         181.7511       0.0000000
Koenker-Bassett test  9         91.38156       0.0000000
SPECIFICATION ROBUST TEST
TEST                DF         VALUE          PROB
White               54          132.913       0.0000000

DIAGNOSTICS FOR SPATIAL DEPENDENCE
FOR WEIGHT MATRIX :concv6r.GAL(row-standardized weights)
TEST                        MI/DF      VALUE          PROB
Moran's I (error)          0.141888     4.1477549      0.0000336
Lagrange Multiplier (lag)       1       27.6695235      0.0000001
Robust LM (lag)                 1       15.3168847      0.0000909
Lagrange Multiplier (error)     1       13.7063561      0.0002137
Robust LM (error)               1        1.3537173      0.2446293
Lagrange Multiplier (SARMA)     2       29.0232408      0.0000005
======================== END OF REPORT ==============================
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ANEXO 2

REGRESSION
SUMMARY OF OUTPUT: SPATIAL LAG MODEL - MAXIMUM LIKELIHOOD ESTIMATION
Data set rper_3
Spatial Weight concv6r.GAL
Dependent Variable : Y Number of Observations: 278
Mean dependent var : 37.9474 Number of Variables : 11
S.D. dependent var : 7.95227 Degrees of Freedom : 267
Lag coeff. (Rho) : 0.365293

R-squared : 0.536023 Log likelihood : -868.092
Sq. Correlation : - Akaike info criterion : 1758.18
Sigma-square : 29.3412 Schwarz criterion : 1798.09
S.E of regression : 5.41676

Variable	Coefficient	Std.Error	z-value	Probability
W_Y	0.3652929	0.06584118	5.548092	0.0000000
CONSTANT	5.054446	5.638329	0.896444	0.3700156
X1	-0.02356858	0.005897093	-3.996643	0.0000643
X2	1.337802	0.3631819	3.68356	0.0002301
X3	-0.05111526	0.02679459	-1.907671	0.0564336
X6	-0.2202923	0.2179632	-1.010686	0.3121670
X7	-0.6387094	0.345325	-1.849589	0.0643727
X17	0.1601002	0.05261848	3.042661	0.0023451
X18	0.1445605	0.02379459	6.075352	0.0000000
X9R	26.02682	11.45154	2.272779	0.0230395
X10R	14.91963	5.419654	2.752874	0.0059076

REGRESSION DIAGNOSTICS
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS

TEST	DF	VALUE	PROB
Breusch-Pagan test	9	207.511	0.0000000

DIAGNOSTICS FOR SPATIAL DEPENDENCE
SPATIAL LAG DEPENDENCE FOR WEIGHT MATRIXconcv6r.GAL

TEST	DF	VALUE	PROB
Likelihood Ratio Test	1	26.35942	0.0000003

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