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DETERMINING FACTORS IN THE HISTORICAL DECLINE IN MARITAL FERTILITY IN SPAIN

FACTORES DETERMINANTES DEL DESCENSO HISTÓRICO DE LA FECUNDIDAD MARITAL EN ESPAÑA

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Abstract

Some doubts have been cast on the results of research carried out within the Princeton European Fertility Project, as the changes in fertility over time may not have been measured appropriately. We set out to test the explanatory capacity of some socioeconomic variables which have been used to interpret the historical decline in fertility in traditional demographic transition theory: mortality, education, economic development, urbanisation and employment. We collected information for 49 Spanish provinces over a very long period of time (1860-2001) and we carried out panel cointegrating regressions (FMOLS and DOLS). We show that the decline of mortality, the increase in educational level and the economic factors played a leading role in the historical decline in fertility (first demographic transition). The demographic transition theory was dramatically shattered as a result of the research carried out in the course of the Princeton European Fertility Project, but analyses using new econometric techniques show that socioeconomic variables did indeed have a major role in the historical decline in fertility. When modern statistical methods are used, the role of socioeconomic factors in the historical decline of fertility is restored. In the debate surrounding the causes of fertility transition, the results obtained from our analysis of Spanish data oblige us to position ourselves among those experts who maintain that changes in socioeconomic conditions have encouraged couples to have smaller families (adjustment theories).

Keywords

Economic factors; First fertility transition; Spain; Panel data; Provincial level.

Resumen

Los resultados del Proyecto Europeo de Investigación de Princeton han sido cuestionados puesto que los cambios temporales en los niveles de fecundidad pudieron haberse hecho de manera inadecuada. Hemos comprobado la capacidad explicativa de algunas variables socioeconómicas usadas por la teoría tradicional de la transición demográfica para interpretar el descenso histórico de la fecundidad: mortalidad, nivel educativo, desarrollo económico, nivel de urbanización y empleo. Hemos recogido información para 49 provincias españolas durante un largo período temporal (1860-2001) y hemos llevado a cabo regresiones de cointegración (FMOLS y DOLS en sus siglas en inglés). Mostramos que el descenso de la mortalidad, el incremento en los niveles educativos y los factores económicos desempeñaron un papel fundamental en el descenso histórico de la fecundidad (primera transición demográfica). La teoría de la transición demográfica fue puesta en entredicho como resultado de las investigaciones llevadas a cabo por el Proyecto Europeo de Fecundidad de Princeton, pero los análisis que utilizan nuevas técnicas econométricas muestran que las varia-bles socioeconómicas sí tuvieron realmente un papel des-tacado en el descenso histórico de la fecundidad. Cuando se utilizan modernos métodos estadísticos, el papel que los factores socioeconómicos vuelve a cobrar protagonis-mo. En el debate sobre las causas de la transición de la fecundidad, nuestros resultados obtenidos del análisis de los datos españoles nos obligan a posicionarnos con los expertos que mantienen que los cambios en las condi-ciones socioeconómicas animaron a las parejas a tener familias más pequeñas (teorías del ajuste).

Palabras Clave

Datos de panel; España; Factores económicos; Nivel provincial; Primera transición demográfica.

Introduction

The decline in fertility that took place in western countries in the late 19th and early 20th centuries has been compared in terms of its importance with other great events in the history of humankind, such as the onset of agriculture, the industrial revolution, the process of urbanisation, or the increase in life expectancy. Fierce debate has raged in the literature over the reasons behind this decline. Broadly speaking the theories about the decline in fertility fall into two categories: A) adjustment (socioeconomic, demand) theories, which hold that changes in socioeconomic conditions encouraged couples to have smaller families (Carlsson 1966), and B) innovation (diffusionist, ideational) theories, which take the view that the decline came about as a result of new birth control methods and new ideas about the benefits of having fewer children (Bengtsson and Dribe 2014). Although most scholars accept that both aspects are important, controversy still rages as to which predominates (Bryant 2007).

William Leasure's PhD thesis (1962) not only made a great contribution to our understanding of the fertility transition in Spain, but also helped to inspire what was to become the Princeton European Fertility Project (PEFP). Leasure (1962 and 1968) reached the conclusion, in direct contradiction to the main tenets of demographic transition theory, that economic factors (industrialisation, urbanisation and level of education) were not the main catalyst that sparked the transition, and emphasised cultural variables as the main explanatory factor that accounted for disparities in the decline in marital fertility in different areas of Spain. He found that there were marked regional patterns which coincided with homogeneous linguistic areas. Later research conducted within the PEFP supported Leasure's conclusions about Spain and, using standard aggregated demographic measures collected for 1229 provinces and smaller districts in Europe at various points in time from the late 18th century to the mid-20th century, called into question the principal hypotheses on which the traditional theory of demographic transition was based. These studies yielded ambiguous or even contradictory results: neither infant mortality, nor industrialisation, nor levels of literacy or urbanisation or any other socioeconomic indicators had the clear relationship with the decline in fertility that might be expected. These researchers maintain that economic theories are insufficient to account for the fertility transition in Europe, and they believe that the spread of birth control methods and new social behaviours were the main underlying reason (Coale 1973; Coale and Watkins 1986; Cleland and Wilson 1987).

Other scholars have questioned this strong focus on innovation (of a cultural or religious nature) in the conclusions of the PEFP. Applying more advanced statistical methods, they point to socioeconomic variables to explain the mechanisms which triggered the historic decline in fertility (Crafts 1984; Galloway, Hammel and Lee 1994; Galloway, Lee and Hammel 1998). Brown and Guinnane (2007) carried out an excellent, highly instructive critique of the methodology used in the PEFP. In particular, they criticised the way in which changes in fertility rates were measured over time. The statistical evaluation of changes in demographic phenomena over time is no easy matter; at present, state-of-the-art panel analyses are used, as well as econometric techniques or time series analysis. These methods were practically unknown at the time of the PEFP. Brown and Guinnane point out that when these statistical methods are used, the role of socioeconomic factors in the historical decline of fertility is restored.

One criticism that is sometimes levelled at studies which use aggregated data is that they do not provide the most appropriate material for analysing individual fertility decisions, as a result of the so-called "ecological fallacy"[1] (Freedman 2002). Brown and Guinnane (2007) argued that the aggregated data referring to very large units of analysis masked considerable internal heterogeneity. Some researchers (Reher 1999; Brown and Guinnane 2002; Reher and Sanz-Gimeno 2007; Cummins 2009; van Poppel et al. 2012) have expressed great scepticism as to the usefulness of aggregated data for understanding changes in reproductive behaviours in the past, and have recommended using information about individual cases obtained through family reconstruction techniques. In recent years, admirable efforts have been made to reconstruct various populations within Europe over longer or shorter periods of time (Knodel, 1988; Wrigley et al. 1997; Alter et al. 2007; Schellekens and Van Poppel 2012; Bras 2014; Schulz et al. 2015; Reher et al. 2017).

Nonetheless, family reconstruction techniques also have their limitations, as they are unfortunately unable to cover large geographical areas or lengthy periods of time. This type of technique often yields partial information which only provides limited insights into the nature of the transition. Moreover, the doubt always remains as to whether the family reconstruction information gathered for one village or group of villages is representative of the country as a whole. In short, it is complex to establish general explanatory theories about demographic behaviours on the basis of the results obtained in a small number of locations. One added difficulty is that family reconstitutions have been undertaken only rarely in urban settings due to the high mobility of historical urban populations (Davenport 2016). This means that we forfeit the possibility of being able to conduct studies comparing demographic behaviour in rural and urban areas. It is therefore essential to complement the results of family-reconstruction research with other types of analysis (which must necessarily use aggregated data) that enable us to contrast urban and rural areas, and which cover sizeable geographical areas over lengthy periods of time.

Recently, several studies using national aggregated data have been published in which modern econometric techniques are used to analyse the determining factors in the historical decline in fertility over long periods of time and in a wide range of countries. Ángeles (2010) analyses 118 countries for the period between 1960-2005; Herzer et al. (2012) focuses on 20 countries spanning the 20th century; Murtin (2013), covers 70 countries from 1870 to 2000; and Sánchez-Barricarte (2017) uses data from 25 developed countries for the period of 1890-1990. But some of these studies are based on a series of indicators that might prove problematic. For example, in their models, Herzer et al. (2012), Murtin (2013) and Ángeles (2010) use indicators of total fertility (such as the total fertility rate or the crude birth rate). Until just a few decades ago, the vast majority of births in the Western world took place within marriage, and so the historical ups and downs in birth rates could have been due to fluctuations in marital fertility, but also to those in the marriage rate itself. For instance, Sánchez-Barricarte (2018a) estimated that most of the baby boom in developed countries could be accounted for by the increase in marriage rates. To identify factors that influenced reproductive decisions in Spain over a specific historical period, while avoiding distortions caused by nuptiality, we here use information of the Princeton marital fertility index (I_g).

Murtin (2013) and Herzer et al. (2012), also use mortality indicators that may be problematic, namely the crude death rate (CDR) and the infant mortality rate. The former is heavily affected by the age structure of the population, and its use is not advisable for analysing lengthy periods of time in which the age structure undergoes substantial changes, as was the case in Western countries over the 20th century. Equally, it is not recommended to use it when comparing countries or regions with different demographic structures. Some authors have also pointed out that it is too risky to use the infant mortality rate alone as a general indicator of mortality (Matthiessen and McCan 1978; Wrigley 1969; Reher 1999).

The goal of this study is threefold. First, we present an analysis with a large time frame (1887-2001) which is disaggregated (by provinces) so as to detect both changes and regional differences in the evolution of marital fertility. Secondly, we contextualise the historical trends in marital fertility in Spain within the Western world as a whole. And finally, we contrast the information on marital fertility with other variables from the provincial socioeconomic sphere in order to examine the factors that could have had an influence on these changes over the decades when the first fertility transition took place. In other words, we aspire to identifying the long-term principles determining historical reproductive behaviour in Spain (an analysis of the more recent developments in marital fertility falls beyond the scope of this study).

Another study which bears a strong resemblance to this one in its focus and methodology is that by Dribe (2009). Using county-level data and panel regressions techniques, he analyses the importance of supply and demand factors in the Swedish fertility transition. His results lend fairly strong support to theories of fertility decline emphasising socioeconomic variables as important determinants of historical fertility decline.

The Spanish case

The historical decline in fertility in Spain has long attracted scholars' attention. In general, their research has provided us with significant insights into the major differences between areas as far as both the intensity and timing of this decline are concerned. Nonetheless, very few studies have contributed to explaining the reasons for the fertility transition[2]. Livi-Bacci (1968) considers that the main reasons for the descent in fertility in Spain were factors that were endogenous to the demographic system itself. In detail, this author stresses the complementary relationship between the nuptiality index and marital fertility, finding that regions attain the same level of overall fertility through different combinations of nuptiality and marital fertility.

Iriso-Napal and Reher (1987) and Reher and Iriso-Napal (1989) performed multiple factor analysis to assess the causes that might exert an effect on marital fertility, which include demographic, socioeconomic and cultural variables, over the period 1887-1920. Their models work reasonably well for rural areas, but not for cities. One of their main limitations is the presence of strong multicollinearity in their statistical models, which means that their estimates of net effects become unstable.

Reher (1990) and Vidal-Bendito (1991) studied the impact of the process of urbanisation on Spanish demographic parameters. While they relate the modernisation of demographic trends (like the decline in fertility) to the phenomenon of urbanisation, they both provide evidence for considerable interaction between the rural and urban spheres.

In a comparative study on demographic transitions in Spain and Belgium, Lesthaeghe and López-Gay (2013: 128) found that in Spain regional differences with respect to the manifest control of marital fertility "tend to mirror the maps of secularization". Recently, a study by Requena and Salazar (2014) explored the effects of educational level on the historical change in fertility rates among women born in the first half of the 20th century in Spain.

Family reconstructions of various Spanish villages have also been carried out, which have contributed valuable information about the fertility transition in this country. Recent publications report the reconstruction of families in Iznájar (1780-1919), Sangüesa (1680-1994), Vera de Bidasoa (1825-1994), Yesa (1750-1994) and Aranjuez (1871-1970) carried out by Ramírez-Gámiz (2001), Sánchez-Barricarte (2002 and 2006), Reher and González-Quiñones (2003), Reher and Sanz-Gimeno (2007) and Reher and Sandström (2015).

Nicolau-Nous et al. (2010: 652), using individual data from information in several Spanish censuses, concluded that in the history of marital fertility in Spain "we should not regard birth control as a completely novel behaviour […] given that most Spanish families were aware of these methods and many used them even before the rapid drop in fertility in the first half of the 20th century". They are inclined to think that it was the change in families' needs in response to the decrease in child mortality that played a central role in the historical trends in fertility rates and the spread of fertility control, rather than the knowledge or availability of new contraceptive methods or behaviours (Nicolau et al. 2010: 648).

In sum, previous studies on the Spanish fertility transition provide a good picture of demographic development, but there is considerably less in terms of explanatory analyses. Even though a large amount of ground has been covered, there is still a significant volume of research to be done before we can say that we really understand the reasons underlying the historical decline in fertility in Spain.

Data and sources

We gathered socioeconomic and demographic data for 49 Spanish provinces[3] from 1860 to 2001 from different sources (for some variables, the earliest data are from 1900). Our aim was to collect all the relevant data available within the provincial sphere that could help us to test at least some of the main hypotheses that have traditionally been put forward to explain the historical decline in fertility. We constructed a large database with the following indicators:

- The Princeton marital fertility index I_g: It is the ratio of the number of births occurring to married women to the number that would occur if married women were subject to maximum fertility (married Hutterite women). The Princeton nuptiality index I_m is an index of the proportion of potentially fertile women who are currently married; it is the ratio of the number of births currently married women would experience if subject to marital Hutterite fertility to the number of births all women would experience if subject to Hutterite fertility. This index is not a measure of fertility but rather an index of nuptiality. It is a fertility-weighted aggregate index of marriage that gives more weight to the proportions married at the prolific ages than at the less prolific ages (Watkins, 1986). Period covered: 1860-2001. See Coale and Watkins (1986: 153-162) for information on how these indices are calculated. Data are available from the University of Princeton website: http://opr.princeton.edu/archive/pefp/. The author of the present paper calculated the Spanish provincial indices for 1970, 1981, 1991 and 2001.
- Probability of dying in the first five years of life ($_5q_0$) (both sexes). Period covered: 1866-2001. Sources: 1866, Dopico (1987); from 1900 to 1930, Dopico and Reher (1998); 1940 and 1950, calculated by the present author; from 1960 to 2001, Blanes (2007).
- Gross domestic product at factor cost per capita in constant 1995 pesetas (old Spanish currency) (GDPpc). Period covered: 1860-2001. Sources: from 1860 to 1920, Rosés, Martínez-Galarraga and Tirado (2010) and Díez-Minguela, Martínez-Galarraga and Tirado (2016); from 1930 to 2000, Alcaide-Inchausti (2003).
- Percentage of urban population (Urbpop). Period covered: 1900-2001. Source: Mas-Ivars et al. (2006).
- Percentage of illiterate population (unable to read or write) aged over 10 years (Illit). Period covered: 1860-2001. Source: Author's calculations based on Spanish census data.
- Total employment rate (TER) (percentage of the total labor force that is employed). Period covered: 1900-2001. Source: from 1900 to 2000, Alcaide-Inchausti (2007).

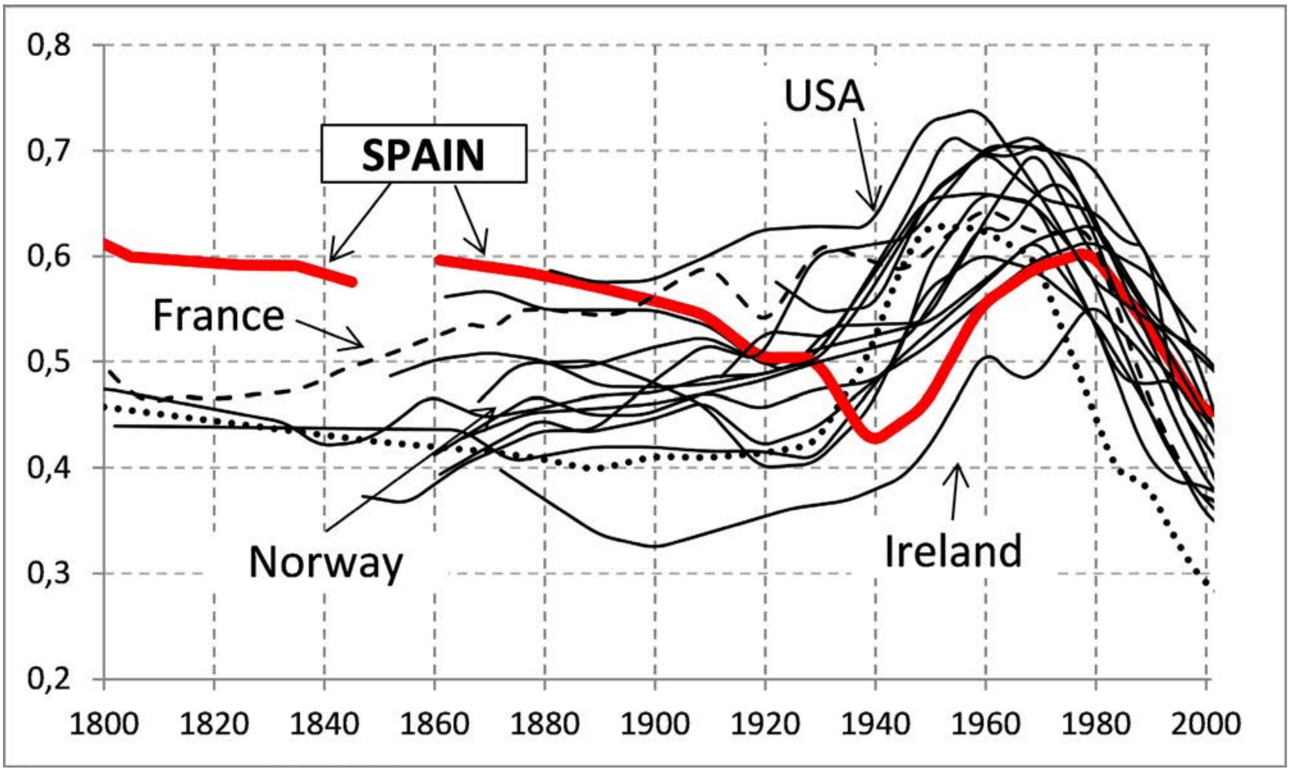
The Princeton indices designed by Ansley Coale (Coale and Watkins 1986: 156-162), which are in widespread use in studies of historical demography, have the advantage of being calculated in such a way that it is possible to use the often limited census and vital registration data available[4].

Many of the data used were only from census years[5] and that is why we had to interpolate the annual data between-census years in a linear fashion. All variables have been transformed in order to have yearly values of time series.

Short description of the decline in marital fertility (I_g): Spain in the international context

As is generally known (Sánchez-Barricarte 2018d: 41), until the 1980s, in western countries the percentage of births outside marriage was very low (below 10%). Access to marriage has therefore historically acted as an important mechanism that regulates overall fertility. That is, until a few decades ago, the total birth rate of a country depended largely on how easy it was for young people to marry. This was also true in Spain. From the late nineteenth century until 1940 (that is, during the decades when the historical decline in marital fertility took place), Spain saw a considerable decline in the marriage rate (Sánchez-Barricarte 2018b and 2018c). From 1940 onwards, however, a genuine *marriage boom* began, which was to last until 1981, when the high marriage rate began to fall. As Figure 1 shows, the historical changes in the marriage rate in Spain measured using the Princeton nuptiality index I_m differed notably from those in other western countries.

Figure 1.
Developments in the Princeton nuptiality index Im in selected Western countries.



Countries included in the figure: Australia, Belgium, Canada, Denmark, England and Wales, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and USA.

Source: Sánchez-Barricarte 2018c: 246.

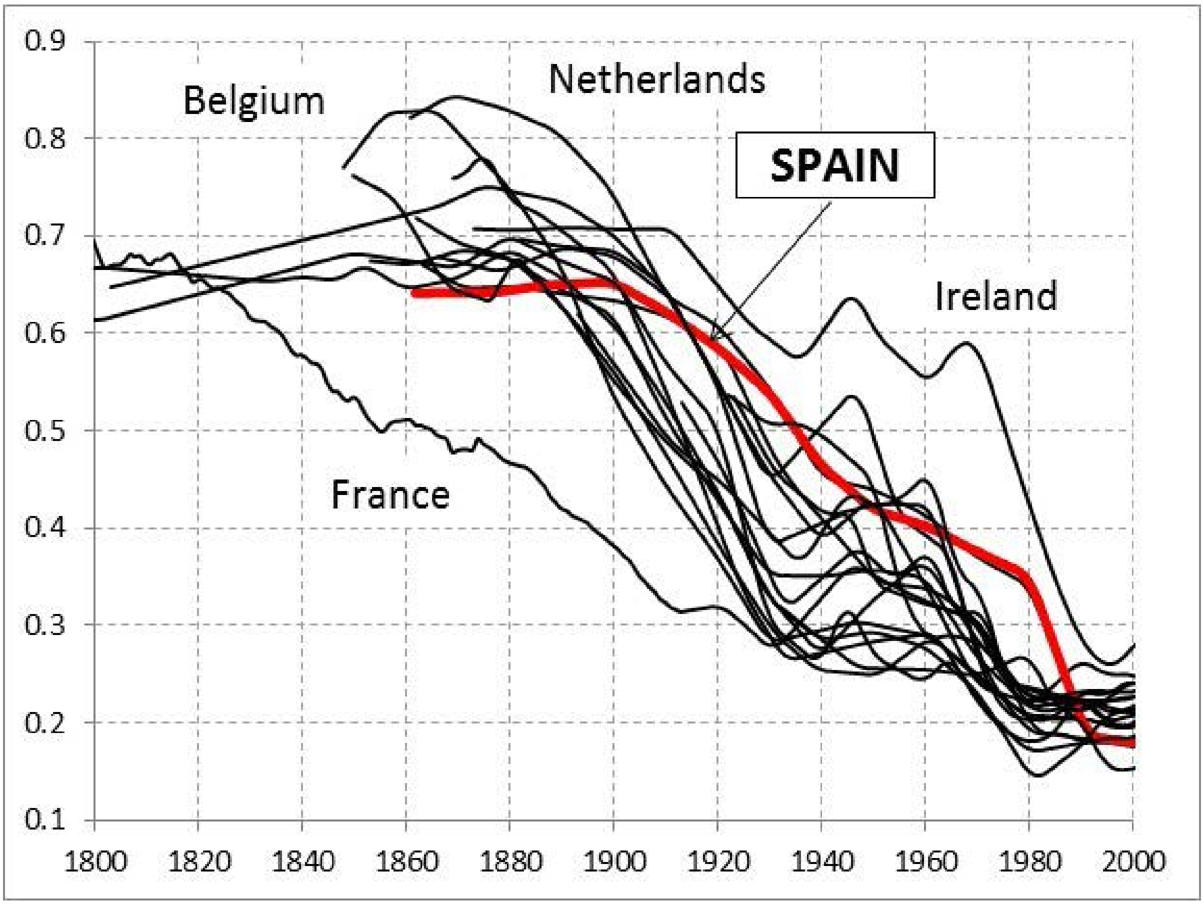
Since the aim of this research is to analyse the causes underlying the change in reproductive patterns, we consider that it is essential to focus on studying and analysing the indicators of marital fertility. Given the diverse historical trends in marriage rates across Spanish provinces and across western countries as a whole, it would not be appropriate to make use of total fertility indicators to this end, since these are conditioned both by factors that specifically affect reproductive decisions, and by others that determine the likelihood of being able to marry. It is highly probable that the variables that influence reproductive decisions are not necessarily the same as those that explain the intensity of nuptiality, which means that it is inappropriate to use total fertility indicators to analyse why people decide to have more, or fewer, children. For this reason, in the present paper we shall concentrate exclusively on analysing fertility within marriage, since this is not affected by the nuptiality rate.

Figure 2 shows the historical trends in marital fertility in Spain, in comparison with those in other Western countries. Regarding marital fertility (I_g), the most striking point is that, except for France, Spain was the country with the lowest levels until 1890. The fall in these values (around 1900) set in later than in most other countries, and for several decades, this decline was much less pronounced. These two circumstances meant that, between 1920 and 1981, Spain (with Ireland) became one of the Western countries with the highest levels of marital fertility. From 1981 onwards, the decline was so steep that within only 10 years it came to be part of the group with the lowest marital index. Another noteworthy aspect is that the typical boom in legitimate births observed in other countries did not occur in Spain.

The aggregated national data generally mask considerable regional diversity. To analyse provincial differences in marital fertility and their historical development, we calculated the coefficient of variation[6] (CV) for different Western countries over various years. Figure 3 shows that Spain occupies a medium level as far as the diversity of marital fertility is concerned. All countries have an initial phase in which the values of the coefficient of variation increase. It is quite logical that this should happen, as once the process of decline sets in, some provinces take the lead, while others are left behind. The differences in I_g between the two groups increase, and this is reflected in the values of the CV. Historically, Spain has been characterised by major contrasts between regions as far as nuptiality patterns are concerned. Between 1887 and 1960, Spain headed the list of Western countries

Figure 2

Evolution of the Princeton marital fertility index (Ig) in selected Western countries.



Countries included in the Figure: Australia, Belgium, Canada, Czechoslovakia, Denmark, England and Wales, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, USA.

Source: see text.

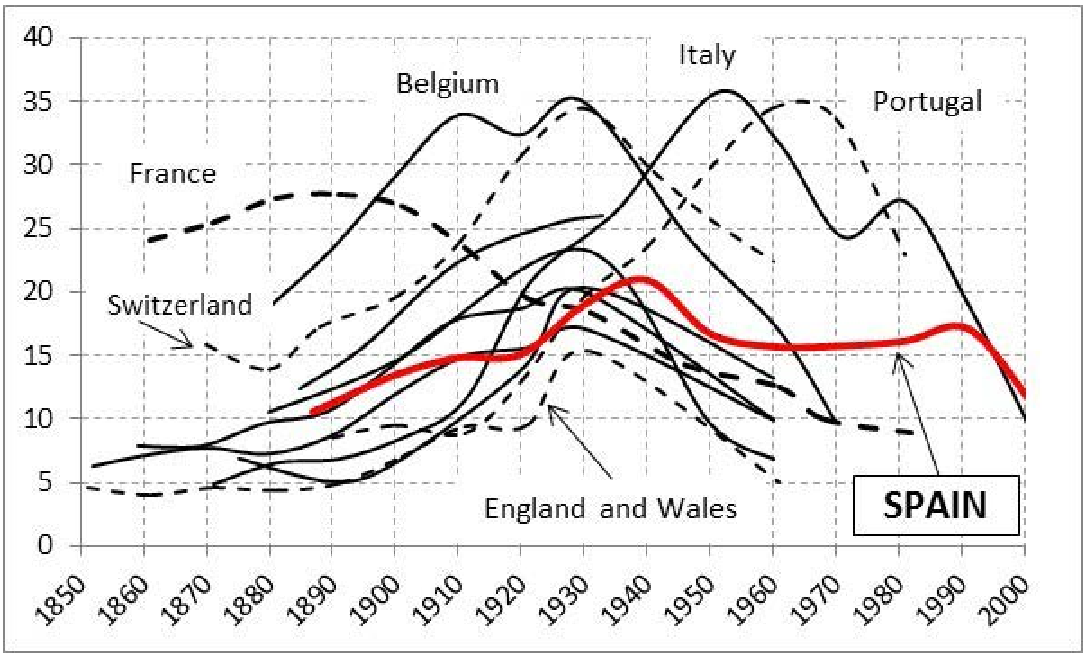
with the highest provincial CV for the Princeton nuptiality index (I_m) (Sánchez-Barricarte 2018c). None the less, variation in marital fertility between provinces remained medium to low. That is to say, in historical terms, overall fertility in Spain was fundamentally regulated by controlling access to marriage, rather than by controlling fertility within marriage.

Map 1 shows the marital fertility rates in the different Spanish provinces at four points in time: 1900, 1930, 1960 and 1991. One glance suffices to show us the geographical differences in each year, which represent the different phases of the first fertility transition. In the first decades of the twentieth century we can see that there was a marked difference between the north east and the north west of the peninsula. The former had higher birth rates, while those closer to the Mediterranean (and also Madrid) had lower marital fertility rates. As the birth rates fall, more striking geographical differences can be observed between the provinces in the north and those in the south. In 1991, when the transition is over, Spain can practically be divided into two halves: the north, with the lowest marital fertility rates, and the south, where these are higher.

It is usual for regional fertility patterns to remain constant over time. Table 1 shows the correlation coefficients of the provincial values for different years with reference to the baseline year (*circa* 1887). That is, the provincial values for the marital fertility indices observed in successive years are correlated with the values for the baseline year. When the correlation is high, and is statistically significant, this means that the geographical patterns found in 1887 (baseline year) are still being maintained. We can see that in Spain, the geographical patterns from the late nineteenth century were maintained until the mid-twentieth century. This stability is not exclusive to Spain, since with the exception of Italy, the other countries shown in the table also maintained the reproductive patterns observed at the end of the nineteenth century for several decades into the twentieth century.

Figure 3

Evolution of the coefficients of variation in provincial Ig values (in percentages) for different developed countries.



Countries included in the Figure: Belgium, Denmark, England and Wales, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland.

Source: see text.

Map 1.

Values of the Princeton marital fertility index (Ig) in different years (provincial level).

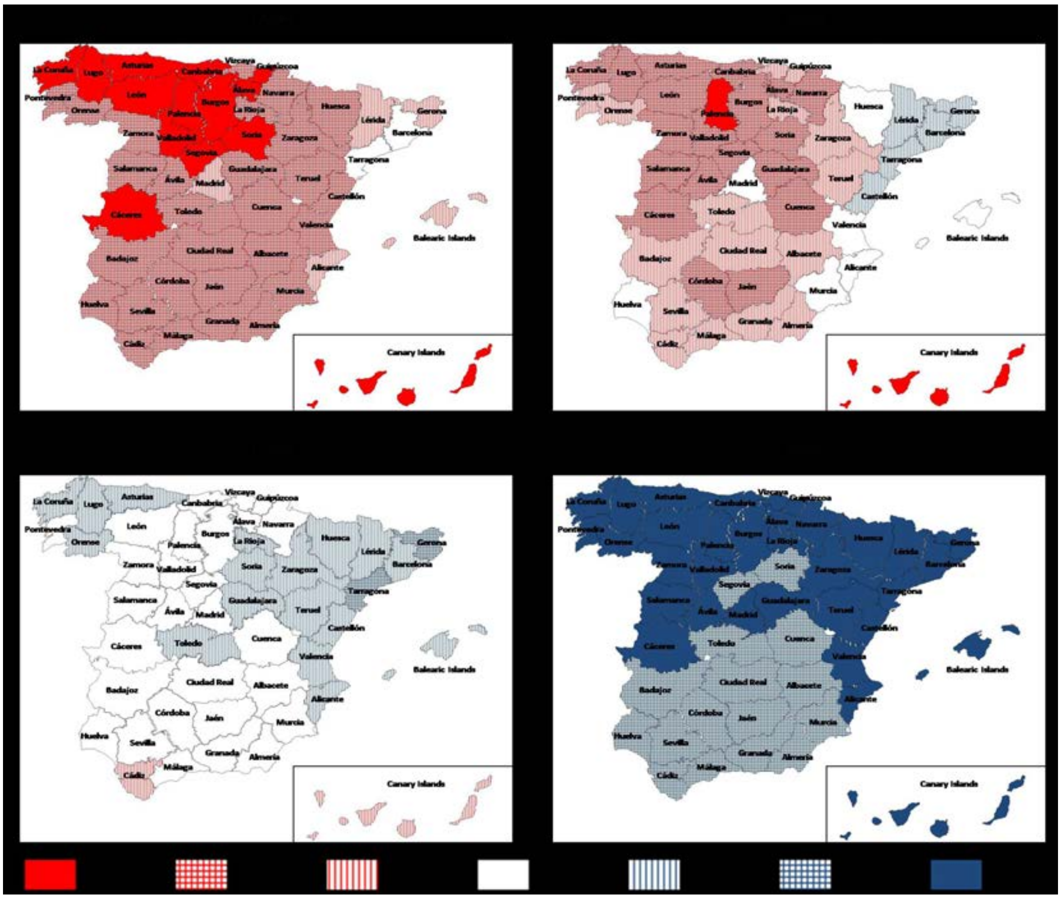


Table 1.
Bivariate correlation coefficients for marital fertility (Ig). Reference year: circa 1887.

	Spain	Belgium	Denmark	England and Wales	France	Germany	Italy	Netherlands	Portugal	Switzerland
1887	1	1	1	1	1	1	1	1	1	1
1900	0.93*	0.97*	0.95*	0.84*	0.98*	0.98*	0.93*	0.95*	0.68*	0.94*
1910	0.86*	0.92*	0.95*	0.56*	0.94*	0.86*	0.68*	0.87*	0.77*	0.88*
1920	0.76*	0.81*	0.93*	0.62*	0.86*	0.72*	0.50	0.74*	0.83*	0.78*
1930	0.78*	0.70*	0.93*	0.40*	0.70*	0.69*	0.39	0.66*	0.74*	0.69*
1940	0.61*				0.43*		0.40		0.83*	0.65*
1950	0.56*	0.61*					0.37		0.75*	0.61*
1960	0.28	0.53*	0.84*	0.06	0.45*		0.31	0.39	0.73*	0.54*
1970	0.00	0.12			0.33*		0.37		0.65*	
1981	0.05				0.44*		0.27		0.66*	

Signif. codes: p-value <0.05 '*'
Source: see text.

Methodology

To test our hypotheses, we used a cointegration panel which analysed the relationship between variables in the long term. When time series are used to measure the relationship between two trending variables one often gets spurious regression results (that is, although the variables are apparently not related, statistically significant effects are obtained). Often detrending helps to eliminate spurious regression results, but this technique does not work either when the variables are difference-stationary, also labeled *I*(1). Tests of cointegration can be used to test whether the relationship between two *I*(1) variables is true or spurious (Engelhardt et al. 2004).

Many of the studies conducted so far have employed traditional estimation methods rather than modern-day econometric methods like Dynamic Ordinary Least Squares (DOLS), Fully Modified Ordinary Least Squares (FMOLS), Vector Error Correction Model (VECM), and Autoregressive and Distributed Lag (ARDL). Recently a series of studies has been published which apply these modern panel cointegration techniques to analyse the impact of different socioeconomic variables on fertility in the long term (Hondroyiannis and Papapetrou 2002 and 2005; Narayan and Peng 2006; Hondroyiannis 2010; Ángeles 2010; Frini and Muller 2012; Herzer et al. 2012; Hafner and Mayer-Foulkes 2013; Murtin 2013; Bakar et al. 2014; Hartani et al. 2015; Sánchez-Barricarte 2017). We utilise the Fully Modified Ordinary Least Squares (FMOLS) and the Dynamic Ordinary Least Squares (DOLS) techniques on the database constructed for this study. These models indicate the long-term impact of the different determinants of fertility. The FMOLS is a non-parametric estimation which helps us to correct the problem of the serial correlation, while the DOLS is a parametric estimation which controls for the effect of endogeneity. This type of multivariate analysis can clearly estimate heterogeneous cointegrating relationships in province-by-province and panel bases.

To perform these models, we first had to check that all our variables were *I*(1). Secondly, we obtained the cointegration equations by using tests such as those of Kao (1999) and Fisher (1932) (the Appendix provides more details about the process of calculating these panel dynamics).

Consider the following simple panel regression model:

$$y_{it} = \alpha_i + \beta_i x_{it} + \varepsilon_{it} \quad (1)$$

$$x_{it} = x_{i,t-1} + \varepsilon_{it} \quad (2)$$

Equation (1) expresses the relationship of cointegration of the independent variables with respect to the dependent variable (we also assume that the dependent variable is difference-stationary). Subscript *i* corresponds to the provinces and *t* to time. ε is the error term and reflects non-observable factors. Since this is a cointegration equation, we aim for these errors to be stationary to order *I*(0). Equation (2) indicates that the independent variables are difference-stationary.

From equation (2), Kao and Chiang (2000) expressed that FMOLS and DOLS are asymptotically normal. The coefficient of the FMOLS estimator could be obtained from the following equations:

$$\hat{\beta}_{FMOLS} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_i)'\right]^{-1}\left[\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(x_{it}-\bar{x}_i)\hat{y}^{+}_{it} + T\hat{z}^{+}_{\varepsilon\mu}\right)\right] \quad (3)$$

Where $\hat{z}^{+}_{\varepsilon\mu}$ is the serial correlation term and $\hat{y}^{+}_{it}$ is the transformation of y_{it} to achieve the endogeneity correction[7]. The serial correlation and the endogeneity can also be corrected by using the DOLS estimator.

In order to obtain an unbiased estimator of the long-run parameters, the DOLS estimator uses parametric adjustment to the errors by including the past and the future values of the differenced *I*(1) regressors. The dynamic OLS estimator is obtained from the following equation:

$$y_{it} = \alpha_i + x'_{it}\beta + \sum_{j=-q_1}^{j=q_2} c_{ij}\,\Delta x_{i,t+j} + v_{it} \qquad (4)$$

where c_{ij} is the coefficient of a lead or lag of first differenced explanatory variables. The estimated coefficient of DOLS is given by:

$$\hat{\beta}_{DOLS} = \sum_{i=1}^{N}\left[\sum_{t=1}^{T} z_{it} z'_{it}\right]^{-1}\left[\sum_{t=1}^{T} z_{it}\hat{y}_{it}^{+}\right] \qquad (5)$$

where

$$z_{it} \text{ is } 2(K+1)\times 1,\ \ddot{z}_{it} = (x_{it} - \bar{x}_i) \qquad (6)$$

The unit root tests, the central basis for proceeding to panel cointegration modelling, were performed to find the order of integration of the different variables. We obtained information from provinces for the period from 1887 to 2000 for the different variables outlined in section 2 (Data and sources). In the Appendix we also provide details of the steps we followed to construct the models represented in Table 2 which shows the results found for the long-term equilibria.

Results: back to economic factors

The issue of regional differences in fertility has been discussed by many scholars (Mönkediek and Bras 2015; Vitali and Billari 2015). One area of particular interest centres on whether the associations between fertility and a series of indicators of secularisation, female occupation or economic development change across space and over time. It is evident that multilevel studies linking regional social contexts with fertility behaviour are needed (Hank 2001).

The decline in fertility over the last century was certainly influenced by a large number of factors related to the profound socioeconomic changes that took place in developed countries (including Spain) from the late 19th century onwards (Tomka 2013). However, we believe that certain factors were particularly important in this context (Reher 2004). Without ruling out the possible influence of other variables, we think that the fall in mortality and ongoing economic changes played a leading role.

Our results in Table 2 are robust, and the inclusion of more variables changes neither the sign nor the significance of the coefficients (in almost all cases). The variables ${}_5q_0$, Illit and TER have a positive sign, which indicates that, in the long term, the decline in these variables leads to a decline in the values of I_g. On the other hand, the variables GDPpc, Urbpop and I_m have a negative sign which means that, in the long term, an increase in these variables means a decrease in the values of marital fertility I_g.

As the traditional theory of demographic transition posits, the increase in the expectation of life at birth discourages reproduction, in that parents decide to have smaller families when they observe that a larger percentage of their children survive to become adults (Notestein 1945; Davis 1945). The PEFP did not manage to prove that this fundamental hypothesis was true. In the book which summarises the project's results, van de Walle (1986: 233) states that: “At the end of this quest, we cannot report that the historical evidence confirms that the declines of infant mortality led to the decline of fertility”. The results obtained from the provinces of Spain contradict the PEFP's conclusions and confirm the hypotheses proposed by the demographers who devised the classic demographic transition theory: the increase in survival (especially among the youngest age groups) led families to adjust the number of offspring by controlling their fertility. In the 8 models shown in Table 2 the sign of the variable ${}_5q_0$ is positive and statistically significant, which indicates that the Spanish provinces with higher mortality rates among children aged under 5 years were those which had the higher marital fertility rates, by way of compensation.

As the income per capita of families increased, we consider that parents gained economic independence from their children, which again tended to discourage reproduction. Historically, having children was practically the only means of saving for the future: by having offspring, couples could ensure that they would have support when they were ill, had an accident, were unable to work, or simply grew old. The increase in average family income made it possible to save more, and thereby develop new strategies to face future challenges. Couples with a higher income and a greater capacity for saving began to show less interest in having large families. Moreover, as the income per capita rose, the opportunity cost for parents also increased, and taking care of children became more expensive. To summarise, an increase in the gross domestic product per capita (GDPpc) brings down the fertility rates (for a more detailed development of this theory on the basis of aggregated data from a group of 25 western countries, see Sánchez-Barricarte 2017). The eight models presented in Table 2 leave little room for doubt concerning the long-term negative effect of the rise in GDPpc on the marital fertility index (I_g) in the different provinces of Spain, thus running counter to Leasure's conclusions (1962 and 1968).

Adsera (2004) and Shreffler and Johnson (2013) consistently show a negative association between unemployment and fertility rates. Adsera (2010 and 2011) shows that when unemployment rates go up, couples put off having their first and second child. We gathered information on the total employment rate (TER)[8] in each Spanish province in the expectation of finding a positive relationship between this figure and the fertility rates: the higher the TER, the higher the levels of fertility. The availability of employment means that married people can have more children, and that single people (particularly young people) can form a family, which means that both marital and total fertility will rise. The results for Spain (models 4 and 8 in Table 2) indicate that, even when we control for other variables, the provinces with the highest TER were those which usually had the highest levels of marital fertility.

The traditional demographic transition theory also establishes that the percentage of urban population (Urbpop) has a major impact on the changes from high to low fertility (Notestein, 1945). The move to cities changed the role of the family and reduced economic incentives for having more children. In most of Western Europe, the massive migratory flows from the countryside to the towns over the 20th century occurred at the same time as the decline in marital fertility. City life tends to discourage people from having children for various reasons: housing is more expensive in cities than in country areas, it is less likely that children will be able to help out in the parents' economic activities as they did in villages, it is more important for children to study longer (which increases the cost of having children), the opportunity cost for parents is higher in cities, etc. Even though the PEFP concluded that the "urban-rural fertility differentials have limited value for the study of the demographic transition" (Sharlin 1986: 260), we think that the move to the towns could be an important explanatory variable when considering the historical decline in fertility in Spain. A negative relation between urbanisation and fertility is to be expected. In fact, Table 2 shows that the variable Urbpop in the Spanish provinces has the expected value, and that it remains highly significant even when new variables are included.

The percentage of illiterate population (Illit) is another variable that has traditionally been associated with changes in fertility (Cleland and Wilson, 1987). It is to be expected that a decrease in the illiteracy rate goes hand in hand with a reduction in the fertility rate. According to Caldwell (1980: 227-228), education has an impact on fertility through different mechanisms: it reduces the child's potential for work inside and outside the home, increases the cost of children far beyond the fees and uniforms, creates dependency within the family and within the society, speeds up cultural changes, etc.

It is a widespread phenomenon in almost every country that women with higher levels of education have fewer children. Education can affect preferences for fertility timing, raise female autonomy, increase contraceptive use and raise the opportunity costs of childbearing. Education can also reduce fertility strongly if opportunity costs increase with schooling (United Nations 1997; Jejeebhoy 1995; Skirbekk, Kohler and Prskawetz 2004; Gustavsson 2006). Hicks and Martínez-Aguado (1987) and Requena and Salazar (2014) found a clear negative association between education and fertility in Spain in the 20th century. Once again, the statistical analyses of our database for the Spanish provinces confirm the classical hypotheses underlying the theory of demographic transition (Table 2): in the long term, the drop in the percentages of illiteracy also accompanies a decline in marital fertility (I_g).

Is there a relationship between the nuptiality rate and the marital fertility rate? According to Livi-Bacci (1977: 191), "the underlying hypothesis is that, at least in the initial phase of the decline, the lower the I_m, the higher the I_g". That is, a priori, we would expect that those provinces where people married later (which generally corresponds to a low I_m value) would need to increase their fertility levels among married women during the later part of their fertile years (between the age of 30 and 45) in order to reach a certain number of offspring. Conversely, in the provinces where people married earlier, they would be able to have the same number of children across a longer part of the fertile years, and therefore make a lower use of their fecundity during their marriage. That is, according to Livi-Bacci, regulating access to marriage would act as a substitute for controlling marital fertility when I_m is higher. In confirmation of Livi-Bacci's intuition, Table 2 shows that the sign of this variable is negative.

All the variables in Table 2 have the sign that would be expected, and are statistically significant.

The analysis based on data from the Spanish provinces yields the same results as published by Dribe (2009), Ángeles (2010), Herzer et al. (2012), Murtin (2013) and Sánchez-Barricarte (2017) using aggregated data for a large number of western countries. These analyses based on different levels of aggregation (national and provincial) in turn are consistent with the conclusions of many studies that have used family reconstructions to obtain individual data in order to analyse historical reproductive behaviour (Reher and Sanz-Gimeno 2007; Schellekens and van Poppel 2012; Bengtsson and Dribe 2014; Reher and Sandström 2015; Reher et al. 2017). That is, by proper application of modern econometric techniques, analyses using aggregated data (on both a national and a provincial level) also confirm the bases of the theory of the Demographic Transition and lead to the same conclusions as the research based on individual data.

So we can conclude that the data we gathered confirm that the European Fertility Project incorrectly and prematurely dismissed the impact of classic “demand” variables on fertility, and that the decline in Spanish fertility was (at least in part) an adjustment to changed social and economic circumstances.

Conclusion

We compiled a rich and diverse database with sociodemographic and economic indicators from the 49 provinces of Spain over a long period of time (1887-2001). The structure of this database enabled us to apply panel analysis techniques, which allowed us to exploit the potential of this vast information source to the maximum. Our results confirm our hypotheses, which are based on the traditional demographic transition theory posited in the mid-twentieth century. Brown and Guinnane (2007) were right in their critique of the way changes in fertility over time were analysed within the framework of the Princeton European Fertility Project (PEFP). In fact, when modern statistical techniques are applied here (FMOLS and DOLS), the role of socioeconomic factors in the historical decline of fertility is restored. In our models, per capita income, life expectancy at birth, educational level, urban population and the employment rate are the variables which are shown to be statistically significant and extremely robust in their relationship to marital fertility values in the long term.

Some earlier studies applying modern statistical techniques (Dribe 2009; Ángeles 2010; Herzer et al. 2012; Murtin 2013; and Sánchez-Barricarte 2017) reached the same conclusions, but some doubt must be cast on the usefulness of their results, because they used aggregated data about whole countries. Unfortunately, when aggregated data from large geographical areas are used, this tends to mask the considerable regional diversity that is usually present in such contexts, which could consequently undermine the validity of the results obtained. We found that when the same kind of analysis is applied to much smaller areas (such as provinces) which tend to be much more homogeneous, the results point to the existence of similar patterns to those found on a national scale. It is therefore clear that many of the conclusions drawn within the framework of the PEFP, which called into question the classical demographic transition theory, were probably based on an inappropriate analysis of the changes in fertility rates over time.

Table 2.

Spanish provinces: panel cointegrating regressions (Ig dependent variable)

	FMOLS[1]					DOLS[2]				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
GDPpc	-1,39E-04 ***	-1,12E-04 ***	-7,81E-05 ***	-6,64E-05 ***	-4,03E-05 ***	-1,50E-04 ***	-9,98E-05 ***	-4,42E-05 ***	-4,96E-05 ***	-5,20E-05 ***
	6,05E-06	*6,44E-06*	*8,53E-06*	*8,50E-06*	*1,00E-05*	*6,54E-06*	*7,63E-06*	*9,40E-06*	*9,92E-06*	*1,17E-05*
$_5q_0$	7,58E-01 ***	5,27E-01 ***	4,70E-01 ***	4,68E-01 ***	5,14E-01 ***	7,48E-01 ***	3,42E-01 ***	2,96E-01 ***	2,95E-01 ***	3,17E-01 ***
	2,11E-02	*3,79E-02*	*3,86E-02*	*3,77E-02*	*3,78E-02*	*1,76E-02*	*3,68E-02*	*3,78E-02*	*3,84E-02*	*4,08E-02*
Illit		1,77E-03 ***	1,71E-03 ***	1,25E-03 ***	1,19E-03 ***		3,07E-03 ***	2,99E-03 ***	2,60E-03 ***	2,10E-03 ***
		2,43E-04	*2,40E-04*	*2,42E-04*	*2,41E-04*		*2,53E-04*	*2,54E-04*	*2,77E-04*	*2,76E-04*
Urbpop			-1,86E-03 ***	-1,84E-03 ***	-1,91E-03 ***			-2,33E-03 ***	-1,98E-03 ***	-2,34E-03 ***
			3,24E-04	*3,16E-04*	*3,15E-04*			*3,55E-04*	*3,78E-04*	*3,79E-04*
TER				2,98E-03 ***	3,73E-03 ***				1,80E-03 ***	2,67E-03 ***
				3,81E-04	*4,35E-04*				*3,52E-04*	*4,62E-04*
I_m					-1,49E-01 ***					-5,87E-02 *
					3,49E-02					*3,81E-02*
Adjusted R^2	0,87	0,88	0,88	0,89	0,89	0,91	0,93	0,95	0,95	0,97
Obs.	4459	4459	4459	4459	4459	4432	4430	4421	4411	4410
Units	49	49	49	49	49	49	49	49	49	49
Period	1901-1991	1901-1991	1901-1991	1901-1991	1901-1991	1901-1991	1901-1991	1901-1991	1901-1991	1901-1991

Signif. codes: p-value <0.01 ‘***’ <0.05 ‘**’ <0.1 ‘*’

Standard error in italics.

[1] Panel method: Pooled estimation. Cointegrating equation deterministics: C. First-stage residuals use heterogeneous long-run coefficients. Coefficient covariance computed using default method. Long-run covariance estimates (Prewhitening with lags = -1 from AIC maxlags = -1, Bartlett kernel, Newey-West fixed bandwidth).

[2] Panel method: Pooled estimation. Cointegrating equation deterministics: C. Automatic leads and lags specification (based on AIC criterion, max=*). Coefficient covariance computed using sandwich method. Long-run variances (Bartlett Kernel, Newey-West fixed bandwidth) used for coefficient covariances.

Notes

[1] The ecological fallacy is a logical fallacy in the interpretation of statistical data where inferences about the nature of individuals are deduced from inference for the group to which those individuals belong.

[2] Most of them are predominantly descriptive in character (Sáez 1979; Nicolau-Nous 1991; Delgado et al. 2006; Delgado 2009). Gil-Alonso (2011) provides a bibliographical review of the contributions made by different authors to the study of the fertility transition in Spain, going back to the earliest researchers in the first half of the 20th century.

[3] In 1927 the province of the Canary Islands was divided into two (Santa Cruz de Tenerife and Las Palmas), but we kept it as a single unit throughout the entire period of this study.

[4] Coale himself admitted that these indices have their limitations, as they are influenced by the age structure of the female population. Various authors have also drawn attention to the difficulties of using these indices (Burch and Ashok 1986; Guinnane, Okun and Trusell 1994; Brown and Guinnane 2007).

[5] The Spanish censuses used as sources of information were those for the years: 1860, 1877, 1887, 1900, 1910, 1920, 1930, 1940, 1960, 1970, 1981, 1991 and 2001.

[6] The coefficient of variation, also known as relative standard deviation, is a standardized measure of dispersion of a frequency distribution. It is often expressed as a percentage, and is defined as the ratio of the standard deviation to the mean (or its absolute value)..

[7] An endogeneity problem occurs when an explanatory variable is correlated with the error term. Endogeneity can arise as a result of measurement error, simultaneous causality and omitted variables.

[8] The percentage of the total labour force that is employed.

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Appendix

Panel cointegration equation to analyse marital fertility (I_g) (Table 2)

As we can see from Table A1, all the variables are *I*(1), in spite of some differences in the tests that were performed. We found that five variables show an unequivocal result in rejecting the null hypothesis of a unit root in first difference. These variables are I_g, Illit, Urbpop and TER. The other two variables (GDPpc and $_5q_0$) only reject the null hypothesis when the Philip-Perron test is used (PP).

The second step which we performed was to analyse whether cointegration exists between the variables: these results are included in Table A2. In this phase, the reader should consider that the results of our models have to be interpreted with caution. This is because the cointegration tests performed display contrary results. Given that the Kao test and ADF test indicate that cointegration is present, we consider the modelling of the relations in the long term using FMOLS and DOLS.

Table A1.

Cross-sectional unit root test for Spanish provinces (period 1900-2000).

		Statistic	Prob.		Cross-section	Obs.
ΔI_g	Im, Pesaran and Shin W-stat	-5.99	0.000	***	49	4949
	ADF - Fisher Chi-square	172.30	0.000	***	49	4949
	PP - Fisher Chi-square	206.03	0.000	***	49	4949
$\Delta _5q_0$	Im, Pesaran and Shin W-stat	3.23	0.999		49	4401
	ADF - Fisher Chi-square	37.32	1.000		49	4401
	PP - Fisher Chi-square	248.52	0.000	***	49	4851
ΔGDPpc	Im, Pesaran and Shin W-stat	1.90	0.972		49	4949
	ADF - Fisher Chi-square	59.82	0.999		49	4949
	PP - Fisher Chi-square	188.84	0.000	***	49	4949
ΔIllit	Im, Pesaran and Shin W-stat	-5.61	0.000	***	49	4949
	ADF - Fisher Chi-square	162.08	0.000	***	49	4949
	PP - Fisher Chi-square	211.15	0.000	***	49	4949
ΔUrbpop	Im, Pesaran and Shin W-stat	-3.02	0.001	***	49	4821
	ADF - Fisher Chi-square	116.42	0.099	*	49	4821
	PP - Fisher Chi-square	135.21	0.008	***	49	4851
ΔI_m	Im, Pesaran and Shin W-stat	-2.96	0.002	***	49	4949
	ADF - Fisher Chi-square	116.86	0.094	*	49	4949
	PP - Fisher Chi-square	145.16	0.001	***	49	4949
ΔTER	Im, Pesaran and Shin W-stat	-9.35	0.000	***	49	4681
	ADF - Fisher Chi-square	258.71	0.000	***	49	4681
	PP - Fisher Chi-square	506.67	0.000	***	49	4851

We reject the null hypothesis if Prob. < 0.05. Null: Unit root (assumes individual unit root process) Exogenous variables: Individual effects. Automatic selection of maximum lags. Automatic lag length selection based on SIC: 0 to 10. Newey-West automatic bandwidth selection and Bartlett kernel.

Table A2.
Cointegration test (period 1900-2000)

Series: I_g, ${}_5q_0$, GDPpc, Illit, Urbpop, TER, I_m			
Obs.		4949	
Cross-sections included		49	
Pedroni	Alternative hypothesis: common AR coefs. (within-dimension)		
		Prob.	
	Panel v-Statistic	0.619	
	Panel rho-Statistic	1.000	
	Panel PP-Statistic	1.000	
	Panel ADF-Statistic	0.007	***
	Alternative hypothesis: individual AR coefs. (between-dimension)		
		Prob.	
	Group rho-Statistic	1.000	
	Group PP-Statistic	1.000	
	Group ADF-Statistic	0.010	**
Kao	ADF	0.000	***

Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
Use d.f. corrected Dickey-Fuller residual variances
Automatic lag length selection based on SIC with a max lag of 12
Newey-West automatic bandwidth selection and Bartlett kernel

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