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Research Article

The long-term determinants of marital fertility in the developed world (19th and 20th centuries): The role of welfare policies

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Abstract

BACKGROUND
Demographic transition theory was shattered dramatically as a result of the research carried out in the course of the Princeton European Fertility Project. There is still no consensus among demographers as to the causes underlying the fertility transition.

OBJECTIVE
We set out to test the explanatory capacity of certain variables which have traditionally been used to interpret the historical decline in fertility (mortality, level of education, economic development, urbanization) as well as the role played by the rise of the welfare state.

METHODS
We collected information on different kinds of socioeconomic variables in 25 developed countries over a very long period of time. We carried out panel cointegrating regressions and country panel fixed and time effects generalized least squares.

RESULTS
We show that the decline in mortality, the increase in educational level, and economic factors all played a leading role in the historical decline in fertility. We found that the present welfare system places a remarkable burden on those who decide to have a family.

CONCLUSIONS
A new kind of public social transfer model needs to be designed which will minimize the damaging consequences that our current welfare states have had with regard to fertility.

CONTRIBUTION
1) The emphasis on the causal impact of the emergence and maturation of the social welfare system using Lindert's data on social transfers since the late 19th century to

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1990. 2) The enormous amount of historical data compiled, as documented in the Appendix. 3) The modern panel cointegration techniques used to analyze the long- and short-term impacts of the different determinants of fertility.

1. Introduction

Although demographic transition (the process by which much of Europe and North America went from high to low fertility in the 19th and early 20th centuries) could be described as one of the most important processes affecting society in the last 500 years (on a level with the industrial revolution, migration to the cities, or the spread of education), there is still no consensus as to its causes.

The first researchers to devote their attention to demographic transition saw the decline in fertility as the result of various social and economic changes, such as industrialization, urbanization, education, and decline in mortality (Landry 1933; Notestein 1945; Davis 1945). This theory, traditionally regarded as one of the most popular sociological theories, was shattered dramatically as a result of research carried out in the course of the Princeton European Fertility Project (PEFP). The PEFP's outcomes (Coale and Watkins 1986) clearly pointed to a cultural interpretation of fertility, in contrast to the economic factors which had been emphasized by demographic transition theory (Cleland and Wilson 1987). However, the conclusions drawn from PEFP were based on flawed statistical methodology: "the project [PEFP] itself never used these tools [panel data techniques]. These tools were not in widespread use when the project was undertaken, so noting this drawback is not a criticism of the PEFP authors. But advances in econometric modelling have made clear the limitations of their approach" (Brown and Guinnane 2007: 585).

John Caldwell (1976, 1982) proposed a new definition of demographic transition theory which emphasized the role of cultural changes. He associated the fertility transition with a change in the direction of "intergenerational wealth flows." According to his theory, decisions about reproduction in all societies are economically rational responses to family wealth flows. Other widely recognized theories that purport to explain the demographic decline are those developed by economists Gary Becker (1981) and Richard Easterlin (1975, 1987). Becker built on the idea that variations in fertility can be understood within the framework that economists use to analyze long-lasting goods.

Many of these theories have come in for harsh criticism and their validity has been called into question (Turchi 1975; Westoff 1983; Kirk 1996; Guinnane 2011). Even though they try to explain the timing of and reasons for the onset of the fall in fertility, in no sense do they account for the baby boom and the baby bust that happened later. Both the beginning and the end of the baby boom came as a surprise to demographers and social scientists (Macunovich 2002) and although various theories have been devised to shed light on this unexpected phenomenon (most of which center on the specific case of the United States), there are still many unanswered questions, like the causal role played by male and female labor force participation, how socioeconomic groups contributed to higher fertility, what the effects of education were, and why the recovery of fertility started before World War II (Van Bavel and Reher 2013: 270–271). It is necessary to continue work on developing a new theoretical framework, since, as Cummins says (2009), the fertility transition in Europe is still one of the great enigmas of economic history. There is no consensus among demographers about the causes of this ‘fertility revolution’ or on the complex set of motives which triggered this change. The new theoretical framework has to come up with answers to explain the onset of the decline in fertility, as well as its later fluctuations (the baby boom and baby bust).

Using aggregate country-level analysis on a large dataset from 25 developed countries, and applying tests of cointegration and panel analysis techniques, we set out to test the explanatory capacity of certain variables which have traditionally been used to interpret the historical decline in fertility (mortality, level of education, economic development), as well as the role played by the rise of the welfare state.

2. Our hypothesis: The socioeconomic factors

The social, economic, and political transformations that developed countries have undergone since the late 19th century have been extraordinary. Western societies have experienced dramatic changes regarding family and gender roles, the position of women in the workplace, new forms of partnership and family, life expectancy, social inequalities and mobility, politics, work, consumption, and leisure, accompanied by the generalized move to the cities and major changes in education, religious practice, and culture (Tomka 2013). Since fertility behavior takes place in a multilevel setting of biological, psychological, social, economic, cultural, and political conditions, the level of fertility observed in a country over time is the result of a complex interaction between many factors from different areas of life (Esping-Andersen 2013; Huinink, Kohli, and Ehrhardt 2015). We do not rule out the possibility that any one of the socioeconomic transformations that have happened in the Western world over the last 150 years might have influenced declining fertility levels.

Broadly speaking, theories about the decline in fertility fall into two categories: adjustment (socioeconomic, demand) theories, which hold that changes in socioeconomic conditions encouraged couples to have smaller families; and 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 (Carlsson 1966).[2] Although most scholars accept that both aspects are important, controversy still rages as to which predominates (Bryant 2007). Building on our analysis of the data set out in this article, we come down firmly on the side of the first category, that is, that socioeconomic conditions played the most important part in the historical decline in fertility. While accepting that the decline in fertility is due to a huge number of factors, our hypothesis is that, as demographic transition theory originally maintained, decline in mortality and economic factors both played a leading role in this change. Another of our main hypotheses is that increased social spending per capita on transfer payments to older people was also a determinant of lower fertility.

The main variables that we shall consider are as follows:

Mortality level: Since mortality decreased before fertility in most countries, many demographers believe that the former decline caused the latter. However, the available econometric evidence yields a mixed picture. The first researchers to question the relationship between these two variables were those working on the PEFP (van de Walle 1986; Watkins 1986). Recent empirical evidence shows that the drop in child mortality was not the trigger for the decline in fertility during demographic transition (Doepke 2005; Fernández-Villaverde 2001).

Common sense tells us that mortality should be the cornerstone of demographic systems – in both the past and the present – and, despite the questions raised by the research associated with the PEFP, some recent studies have confirmed that the onset of the historical decline in fertility was linked to an earlier drop in mortality rates (Mason 1997; Galloway, Lee, and Hammel 1998; Cleland 2001; Reher and Sanz Gimeno 2007; Dyson 2010; Van Poppel et al. 2012; Schellekens and van Poppel 2012). In a recent article we also showed the important role of mortality in conditioning reproduction over the last two centuries (Sánchez-Barricarte 2017).

Some experts (Reher 1999) consider that one of the main shortcomings of the PEFP was that it used the infant mortality rate as the sole indicator of the intensity of mortality. Matthiessen and McCann (1978) and Wrigley (1969) indicated that in most European countries the mortality rate among children aged 1 to 14 years fell long before the infant mortality rate. There is a sizable group of researchers who consider that it is impossible to assess the effect of mortality on the drop in fertility by taking only infant mortality into account. Parents' main aim as far as reproduction is concerned was, and

[2] It is, of course, a gross oversimplification to group these theories into two competing paradigms. Coale's (1973) Ready-Willing-Able model and the later refinement of this model by Lesthaeghe and Surkyn (1988) made a much more nuanced argument about the relationship between different explanations of fertility decline, linking adjustment and innovation. A considerable amount of literature also stresses that innovation and adjustment should not be seen as competing explanations but are largely complementary (Cleland and Wilson 1987; Casterline 2001a and 2001b; Palloni 2001).

still is, to reach a number of "surviving children who will reach adulthood," not simply "children who survive their first year." At the very least, taking into account only the deaths of children aged less than one year would be inadequate to capture the desired effects, since this figure cannot possibly tell us much about the whole story. We think that a reasonable indicator of the mortality rate that parents would take into account when deciding the size of their family is ${}_{25}q_0$ (i.e., the likelihood of dying in the first 25 years of life). We chose 25 because this is roughly the average age at which people marry/have children (and thus leave the household to form their own families) and because we consider that survival to this age would be a good indicator of the way couples perceived the patterns of mortality around them when they took decisions concerning reproduction.

Economic development: We assume that the gradual economic development of the societies in question was an outstanding factor in discouraging reproduction because it gave parents greater economic independence from their children. In historical times, in societies with a high poverty rate, children were a way of saving for the future and protecting oneself against unforeseen circumstances (accidents, diseases) as well as preparing for old age. As the income per capita rose, couples were able to save more, acquired greater independence, and became less dependent on their children.

At the same time, when people's per capita income rose, so did the opportunity cost for parents (above all, for mothers, when they entered the workplace). The increase in per capita income was due in large measure to industrial development, which was concentrated in cities. The rise in income is therefore also a reflection of the process by which the population came to be concentrated in urban areas (traditionally, fertility rates have been lower in cities than in the countryside).

It is hardly surprising that over a century before the general decline in fertility in Europe set in, it had already begun in a few economically privileged social groups, as Livi Bacci (1986: 198) pointed out: "In the aristocracies and in the prominent social classes, the decline begins to be evident by the end of the seventeenth century." It is our belief that at the same time as economic development came to benefit a larger percentage of the population, fertility rates (measured by the number of children surviving to adulthood) dwindled.

There is no shortage of empirical evidence disproving the theory that economic development leads to a decline in fertility. As Guinnane says (2011), some researchers maintain that the synchronous nature of the fertility transition in all Western European countries is proof that economics has little to do with the fertility transition. Cleland and Wilson (1987: 18) maintain that "clearly the simultaneity and speed of the European transition make it highly doubtful that any economic force could be found which was powerful enough to offer a reasonable explanation." Murtin (2013) (based on a panel of countries in the period 1870–2000) shows that per capita income was positively correlated with fertility rates (once mortality and educational levels have been factored in).

The emergence of the welfare state: As Boldrin and Jones state (2002: 786), "in poor, agricultural societies, the impetus for having children in the first place is as an investment rather than as consumption. That is, children are borne out of a need to staff the farm when the parents grow older." In other words, in contrast to most researchers, who assume that parents are concerned about their children's welfare (Becker 1960; Becker and Barro 1988), they think that, historically, parents tended to have children because this was the means available for ensuring that they themselves would be cared for in their old age. Neher (1971) was one of the first to defend this point of view, which sees "children as an investment."

The old-age security hypothesis suggests that in the absence of capital markets children serve as an asset that permits parents to transfer income to old age. From this theoretical perspective, parents had children only to guarantee economic support in their old age (Ehrlich and Lui 1991; Raut and Srinivansan 1994; Chakrabarti 1999; Boldrin, De Nardi, and Jones 2015). This meant that when efficient private financial markets developed, the demand for children dropped.

Along the same lines, when states began to implement social security measures around the end of the 19th century, particularly intended to protect mature and elderly people (health care, unemployment benefits, accident insurance, legal aid, old age pensions, etc.), couples started to lose interest in having a large number of children. As these social security measures came to benefit a larger number of elderly people, the need for children fell. Moreover, as Van Groezen, Leers, and Meijdam (2003) show, the pension systems developed in Western countries mean that people who have not had children can receive a pension without having contributed economically to future generations.

Historically, mutual support between spouses and solid parent–child relationships (the strong family) made it easier for people to survive. Parents had children, fed them, and brought them up, secure in the knowledge that they would be able to count on them when, in the future, they needed someone to care for them – if they were poor or physically incapacitated, because of either illness or accident, or simply as a result of old age. When, in the late 19th century, some states established social security measures that gave priority to the needs of adults and the elderly rather than those of children and young couples of childbearing age, the historical balance in family relationships was lost. When economic security in old age, which was traditionally provided by children, was replaced by state benefits, the incentive to have a large number of children was reduced.

There are as yet no empirical studies which link the historical decline in fertility in the late 19th or early 20th century to the emergence of welfare policies that protect the adult or elderly population. Various researchers have discussed the influence which public policies have had on fertility rates since World War II (McDonald 2006; Vos 2009; Neyer 2013). In the relevant literature, several authors voice the opinion that the decrease in fertility is a consequence of the pension system (Van Groezen, Leers, and Meijdam 2003; Sinn 2007; Cigno and Werding 2007; Ehrlich and Kim 2007; Van Groezen and Meijdam 2008; Gahvari 2009; Cigno 2010; Fenge and von Weizsäcker 2010; Regös 2014; Boldrin, De Nardi, and Jones 2015). However, all these studies focus on periods later than 1960. We think that it might be interesting to establish whether at the very beginning of this process, in the late 19th century, public policies concerning social care (social transfers) may have had an impact on people's reproductive decisions.

Since bringing up children requires parents to make great sacrifices (not only in terms of money), social benefits designed to reduce the cost and effort of bringing up children (family allowances, education, nurseries) should obviously have a positive effect on fertility levels. Many studies have analyzed the positive effects of family policies on fertility (Gauthier and Hatzius 1997; D'Addio and Mira d'Ercole 2005; Hilgeman and Butts 2009; Adsera 2011; Thévenon and Gauthier 2011; Luci-Greulich and Thévenon 2013). So it is also our hypothesis that social benefits intended to protect the adult or elderly population have a completely different impact on fertility rates from those designed to care for the child population: the former have a negative effect on fertility, the latter a positive one. The fertility rates of different countries should therefore vary as a function of the resources they devote to covering the needs of one or other extreme of the demographic pyramid.

Education level: According to Caldwell (1980: 227–228), an increase in the educational level in a society reduces the chances of children working (at home or outside), increases the cost of bringing them up, and therefore brings down the fertility rate. We believe that it is important to measure the impact of the educational level of the population in a given country, because this has traditionally been thought to affect fertility: it can affect preferences for fertility timing, raise female autonomy, increase contraceptive use, and raise the opportunity costs of childbearing, and reduces the child's potential for work inside and outside the home. Education can also reduce fertility strongly if opportunity costs increase with schooling (Caldwell 1980; Jejeebhoy 1995; Gustafsson and Kalwij 2006; Skirbekk, Kohler, and Prskawetz 2004). Empirical evidence demonstrates that investment in education was a dominating force in the decline in fertility (Doepke 2004; Becker, Cinnirella, and Woessmann 2010; Murtin 2013).

Urbanization: Traditional demographic transition theory also establishes that the percentage of the urban population (Urbpop) has a major impact on the changes from high to low fertility (Notestein 1945). 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 towns could be an important explanatory variable when considering the historical decline in fertility.

We tried to obtain information on the development of the urban population in our group of countries. Unfortunately, the United Nations does not use its own definition of 'urban population' but follows the definition used in each country (United Nations Population Division 2014). Some countries consider settlements with more than 1,000 inhabitants to be urban, others set the limit at 2,500, and others at 10,000. Despite the lack of a consistent definition of what an urban population is in each country, we decided to include this variable in some of our statistical analysis.[3] We took the definition of urban in each country at face value. Since what we are interested in is an idea of "urban-ness," we considered that this would be satisfactory (the same amount of "urban-ness" may be consistent with different actual population totals in different countries).

3. Data

Some recent researchers working on the long-run determinants of fertility use indicators of the "total fertility rate" in their econometric models (Herzer, Strulik, and Vollmer 2012; Murtin 2013). Given that throughout the demographic transition in Western countries the overwhelming majority of births occurred within marriage, the effect of nuptiality is normally factored in by calculating indicators that measure fertility only among married women. Historically, the total fertility rate depended not only on how many children each married woman had but also on how many women married. To avoid possible distortions of fertility rates caused by nuptiality, we considered that it would be more suitable to use an indicator which measures only the fertility of married women. One very widely used indicator in historical studies is that known as the Princeton marital fertility index (I_g),[4] which we believe to be useful still, despite some published criticisms (Guinnane, Okun, and Trussell 1994; Brown and Guinnane 2007).

For the purposes of this study, we collected information on marital fertility and mortality in 25 developed countries over a very long period of time. We also obtained various kinds of socioeconomic information needed to apply the statistical models specified below. We have included the largest number of countries for which we were

[3] We were able to obtain information about the level of urban-ness for each country only from 1950 onwards (United Nations Population Division 2014) and so we included this variable only in the statistical models in Table 3 (covering the period from 1960 to 2010).

[4] I_g 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) (Coale and Watkins 1986: 153–162).

able to find historical data of proven reliability: Australia, Austria, Belgium, Canada, Czechoslovakia, Denmark, England and Wales, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, the Russian Federation, Spain, Sweden, Switzerland, and the United States. In the Appendix we provide a list of the large number of sources consulted.

All the statistical analyses in this study are based on aggregated data from specific countries. Some scholars (Guinnane and Brown 2002; Reher and Sanz Gimeno 2007; van Poppel et al. 2012) have expressed great scepticism as to the usefulness of aggregated data for understanding changes in reproductive behaviors in the past. Brown and Guinnane (2007) argued that the aggregated data referring to very large units of analysis masked considerable internal heterogeneity. They have recommended using information about individual cases obtained through family reconstruction techniques. Individual-level data might yield more nuanced results that help fit the theory better, but unfortunately they cannot cover such a broad geographical area or such a long time period. Although correlations that are based on aggregated data may be higher than correlations based on individual-level data, aggregated data enabled us to amass a data set for a considerable number of countries, far beyond what would be possible with microdata.

4. Results of our analysis

To analyze the role of the different socioeconomic variables in the historical decline in marital fertility, we carried out two kinds of statistical tests which are explained below. Our aim was to improve our understanding of the different determining factors affecting marital fertility in the long and the short run, and to provide more consistent results.

4.1 Country panel cointegrating regressions

When time series are used to measure the relationship between two trending variables one often gets spurious regression results (i.e., 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).[5] Tests of cointegration can be used to test

[5] Difference-stationarity means that the mean trend is stochastic (random process). Differencing the series *D* times yields a stationary stochastic process.

whether the relationship between two I(1) variables is true or spurious (Engelhardt, Kögel, and Prskawetz 2001: 11–12).

Recently a series of studies has been published which apply modern panel cointegration techniques to analyze the impact of different socioeconomic variables on fertility in the long term (Hondroyiannis and Papapetrou 2002, 2005; Narayan and Peng 2006; Hondroyiannis 2010; Ángeles 2010; Frini and Muller 2012; Herzer, Strulik, and Vollmer 2012; Hafner and Mayer-Foulkes 2013; Murtin 2013; Bakar, Haseeb, and Hartini 2014; Hartani, Bakar, and Haseeb 2015). Panel studies offer many advantages over time series and cross-sectional analyses. Having multiple years of data increases the sample size and may lead to more reliable estimates. Also, having multiple observations for each country enables researchers to include country-specific fixed effects, thereby controlling for a wide range of time-invariant country characteristics whose omission might otherwise bias the estimated relationship between the variables (Hondroyiannis and Papapetrou 2005: 145).

We apply this kind of technique on the database constructed for this study. Specifically, we utilize the Fully Modified Ordinary Least Squares (FMOLS) and the Dynamic Ordinary Least Squares (DOLS). These models indicate the long-term impact of the different determinants of fertility. The FMOLS is a nonparametric 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 country-by-country and panel bases.

To apply 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:

$$\cdot_{it} = \alpha_i + \beta_i x_{it} + \varepsilon_{it} \tag{1}$$

$$x_{it} = x_{i,t-1} + \varepsilon_{it} \tag{2}$$

Equation (1) expresses the cointegration relationship of the independent variables with respect to the dependent variable (we also assume that the dependent variable is difference-stationary). 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:

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

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.[6] 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 future values of the differenced I(1) regressors. The dynamic OLS estimator is obtained from the following equation:

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

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

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

where $z_{it} = [x_{it} - \bar{x}_i, \Delta x_{i,t-q}, \ldots, \Delta x_{i,t+q}]$ is 2(q+1)x1 vector of regressors.

The DOLS model is similar to equation (1) but introduces lags in the independent variables, which means that it generates a more efficient estimate.

The unit root tests, the central basis for proceeding to panel cointegration modeling, were performed to find the order of integration of the different variables. We obtained information for the dependent variable (marital fertility I_g) and the following independent variables: gross domestic product per capita expressed with inflation adjustment in 1990 International Geary-Khamis dollars (GDPpc), probability of dying before age 25 ($_{25}q_0$), and average years of total schooling for both sexes (Education) (see the Appendix for the sources from which this information was obtained).

We divided the sample into two large time periods which correspond to very different historical periods. In the first, from 1871 to 1949, the initial phases of the fertility transition took place. In the second, from 1950 to 2008, most of the baby boom and subsequent baby bust occurred.

Table 1 shows the results of the panel cointegration to explain the dependent variable I_g (marital fertility) using data from 20 countries.[7] One result shared by all the models calculated in both periods is that the relationships between the dependent variable (I_g) and $_{25}q_0$ and Education are always highly significant and display the

[6] 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.

[7] Of the 25 countries, five were not included in the model (Czechoslovakia, Greece, Hungary, Iceland, and the Russian Federation) because we lacked one variable or because the data covered only a small proportion of the period analyzed (1871–2008).

expected signs, that is, a decrease in mortality depresses marital fertility and an increase in education decreases fertility in the long term. The variable GDPpc appears to be statistically significant for both periods in only one of the four specifications that we carried out (FMOLS with constant). The results concerning mortality ($_{25}q_0$) and per capita income (GDPpc) are consistent with those obtained by Herzer, Strulik, and Vollmer (2012).

Table 1: Country panel cointegrating regressions (I_g dependent variable)

Period 1871–1949

	FMOLS[1]				DOLS[2]			
Variable	Constant		Constant and trends		Constant		Constant and trends	
GDPpc	–0.00001	***	0.000001		–0.000001		0.000002	
	2.14E-06		*2.16E-06*		*4.09E-06*		*4.23E-06*	
$_{25}q_0$	0.9492	***	0.5992	***	1.0056	***	0.6845	***
	0.02649		*0.05208*		*0.06266*		*0.09982*	
Education	–0.0336	***	–0.0103	**	–0.0381	***	–0.0390	***
	0.00201		0.00492		*0.00495*		0.00917	
Adjusted R^2	0.88		0.94		0.92		0.96	
Obs.	1,318 (unbalanced)		1,318 (unbalanced)		1,308 (unbalanced)		1,306 (unbalanced)	
Units	20		20		20		20	

Period 1950–2008

	FMOLS[1]				DOLS[2]			
Variable	Constant		Constant and trends		Constant		Constant and trends	
GDPpc	–0.000002	***	0.000001		–0.00000		–0.000001	
	5.47E-07		*9.75E-07*		*1.21E-06*		*2.09E-06*	
$_{25}q_0$	1.3045	***	1.5047	***	2.0397	***	1.9061	***
	0.09326		*0.13499*		*0.30345*		*0.36222*	
Education	–0.0147	***	–0.0254	**	–0.0177	***	–0.0298	***
	0.00177		0.00229		*0.00345*		0.00425	
Adjusted R^2	0.78		0.87		0.88		0.92	
Obs.	1148 (unbalanced)		1148 (unbalanced)		1137 (unbalanced)		1137 (unbalanced)	
Units	20		20		20		20	

Notes: p-value *** <0.01, ** <0.05; standard errors in italics

[1] FMOLS. Lag specification based on AIC information to compute long-run covariance and allowing for heterogeneous first-stage long-run coefficients

[2] DOLS. Automatic AIC information to select number of lags and leads

4.2 Country panel fixed and time effects generalized least squares

According to Tomka (2013: 157), examination of the dates of introduction of social security schemes in 16 European countries shows that accident and health insurance, pensions, and unemployment benefits (which mainly help mature or elderly people) were established before family allowances. In its origins, the welfare state was designed principally to protect the elderly (Lindert 2004: 183–186).

Lindert (1994, 2004) calculated the percentage of GDP spent on social transfers in various Organization for Economic Co-operation and Development countries from 1880 to 1930 and from 1960 to 1990. To compute this percentage, he takes into account the sum of transfers dedicated to welfare, unemployment, pensions, health, and housing subsidies. He does not include expenditure on education, which is one of the main budgetary areas that benefit only children and young people. Since education is left out, Lindert's estimates basically measure the effort that different countries have made to care for the adult and elderly population (this demographic segment is the main beneficiary of all the sections of the budget taken into consideration). We can use this information to test whether social protection and care for the elderly act as deterrents against fertility. We calculated the social transfers per capita (STpc) in each country by multiplying the proportions of the GDP dedicated to social transfers computed by Lindert (1994) by the GDPpc computed by Maddison (2009).[8]

In the previous model, we were unable to include the variable social transfers per capita (STpc) since Lindert (1994) provides data only for the periods 1880–1930 and 1960–1990. To be able to analyze the possible effect of this variable on the historical decline in fertility, we applied a regression with fixed and time effects generalized least squares.[9] The formal expression is as follows:

$$I_{g,i,t} = \beta_0 + \beta_1 * \text{GDPpc}_{i,t} + \beta_2 * \text{STpc}_{i,t} + \beta_3 * \text{Education}_{i,t} + \beta_4 * {}_{25}\text{q}_{0i,t} + \Upsilon_t + \alpha_i + \varepsilon_{i,t}, \quad (6)$$

where I_g is the index of marital fertility, GDPpc is the gross domestic product per capita for each country (inflation-adjusted expressed in 1990 International Geary-Khamis dollars), STpc is the social transfers per capita, ${}_{25}q_0$ is the probability of dying before the age of 25 (both sexes), Education is the average years of total schooling for both sexes, Υ_t is a vector of yearly dummies controlling for time effects, and α_i is a set of fixed effects accounting for the heterogeneity between countries. The Appendix lists the

[8] GDP per capita for each country is inflation-adjusted, expressed in 1990 International Geary-Khamis dollars.

[9] To see if time effects were needed when running a fixed effects model, we used a test to see if the dummies for all years were equal to 0 (testparm in Stata). We rejected the null hypothesis, so time effects were needed.

sources from which this information was obtained and also gives technical details about this statistical model.

The results of this analysis (Table 2) show us that the GDPpc had a negative effect on marital fertility throughout the period under study (1880–1990); that is, as we stated in our hypothesis, the increase in income per capita discouraged reproduction.[10] Mortality (measured by ${}_{25}q_0$), as might be expected, did have a statistically significant effect in the expected direction (positive) in the period analyzed (1880–1990). This also ratifies the results we obtained in the previous models in Table 1; that is, it confirms that the drop in mortality had a positive impact on the historical decline in marital fertility. Equally, as we might expect, we can once more observe that the increase in years of schooling had a negative (and statistically significant) effect on the evolution of marital fertility rates.

The variable representing social transfers per capita (STpc) also had a negative correlation,[11] which seems to indicate that the incipient welfare policies (mainly intended to cover the needs of the adult and elderly population) may also have had the effect of depressing marital fertility. In Model 6 on Table 2 we included the variable STpc with lags, so we may infer causality and rule out the possibility that higher fertility leads to more welfare spending on young people, as it raises the demand for such welfare. Transfers to the elderly shifted from a private, family-based institution to a public, tax-based institution. The expected number children thus declined as they became less relevant for old-age security. The welfare state displaced the family and took over the basic functions which are inherent to it by nature, supplanting its social role.

[10] The negative association of fertility with economic development is one of the most generally accepted empirical regularities in the social sciences (Bryant 2007; Lee 2003; Bongaarts and Watkins 1996).

[11] As we said before, for 1940 and 1950 we were unable to obtain information about social transfers in the different countries. This is why the number of data points drops in Models 4, 5, and 6 in Table 2 when we include the variable STpc.

Table 2: Country panel fixed and time effects generalized least squares (I_g dependent variable), developed countries (1880–1990)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Intercept	7.02E-01	***	5.77E-01	***	6.47E-01	***	6.57E-01	***	6.49E-01	***	6.59E-01	***
	1.49E-02		*1.69E-02*		*1.73E-02*		*2.17E-02*		*2.24E-02*		*2.17E-02*	
GDPpc	–2.87E-06	***	–6.72E-06	***	–6.38E-06	***	–3.70E-06	**			–4.16E-06	***
	8.56E-07		*9.05E-07*		*9.12E-07*		*1.55E-06*				*1.55E-06*	
$_{25}q_0$			4.54E-01	***	5.33E-01	***	4.24E-01	***	4.03E-01	***	4.44E-01	***
			2.96E-02		*2.96E-02*		*4.12E-02*		*4.27E-02*		*4.18E-02*	
Education					–2.22E-02	***	–1.65E-02	***	–1.59E-02	***	–1.78E-02	***
					1.72E-03		*2.47E-03*		*2.57E-03*		*2.50E-03*	
STpc							–9.31E-06	**	–1.24E-05	***		
							3.65E-06		*3.58E-06*			
$STpc_{t-1}$											–7.22E-06	**
											3.72E-06	
n countries	23		24		23		22		22		21	
N data points	2,241		2,209		2,150		1,315		1,315		1,300	
R^2	0.91		0.92		0.92		0.94		0.94		0.94	
Time period	1880–1990		1880–1990		1880–1990		1880–1930 and 1960–1990		1880–1930 and 1960–1990		1880–1930 and 1960–1990	

Notes: p-value *** <0.01, ** <0.05; standard errors in italics
Source: See Appendix

Figure 1 shows the actual marital fertility index (I_g) values and those predicted (by Model 6 in Table 2) for each country. It also shows the difference between the actual and the predicted values. We can see that, in general, the predicted values fit quite closely to the actual values. France is the only case where the fit is not close. As is well known, the historical decline in fertility in France started 100 years before that in the rest of Europe (Coale and Watkins 1986). It should therefore come as no surprise that the French actual values for the period 1880–1920 are well below those predicted by the statistical model. On the other hand, the French government's generous pioneering incentives designed to raise the birth rate in the last few decades almost certainly explain why in 1960–1990 the actual values are well above those predicted by the model.

Figure 1: Actual and predicted marital fertility values (I_g), developed countries (1880–1990)

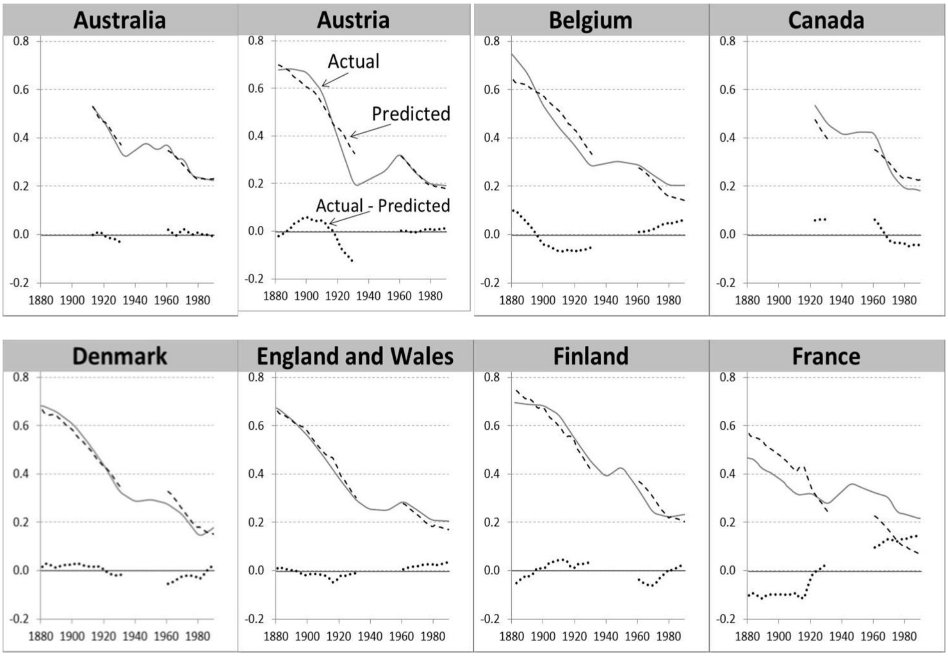
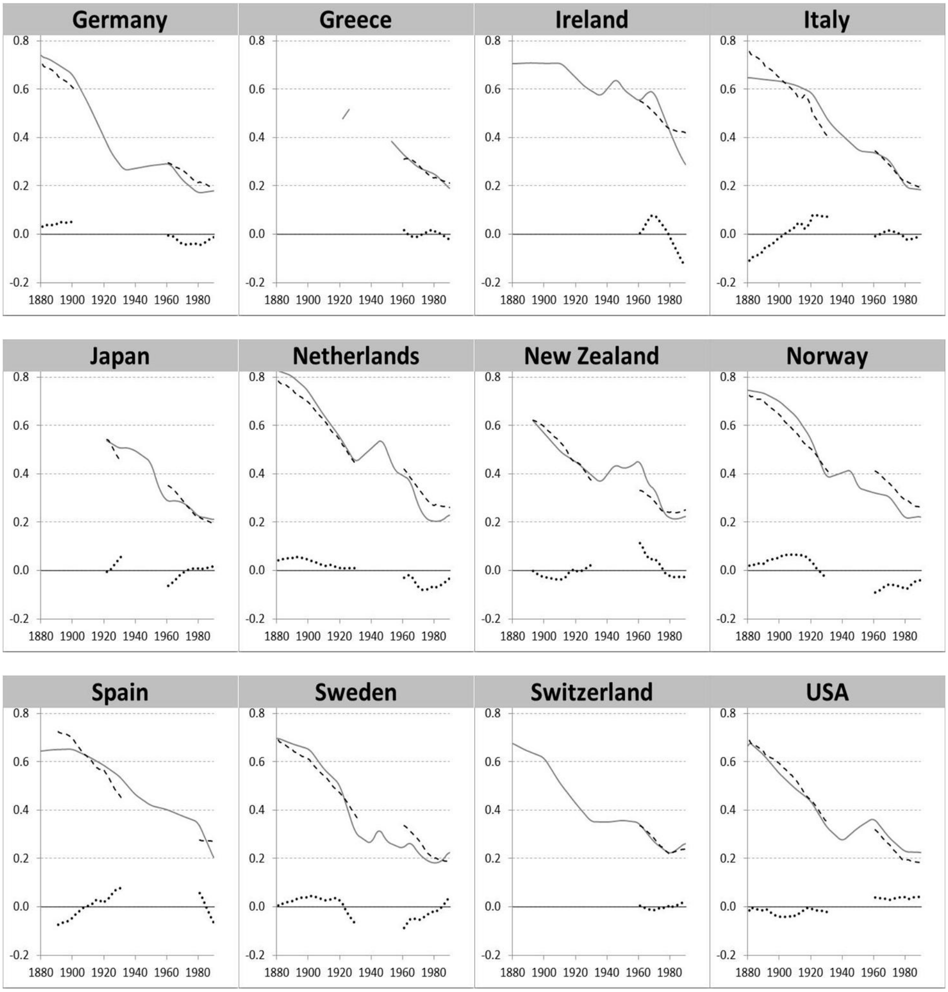


Figure 1: (Continued)



Note: Predicted marital fertility values (I_g) calculated using Model 6 in Table 2
Source: See Appendix

Once the decline in marital fertility had begun, the drop was not continuous. In many countries the downward trend was broken in the 1930s and 1940s, and there was an important recovery, a phenomenon which is colloquially known as the baby boom. Fertility rates went on rising until the late 1950s or early 1960s.[12]

After World War II Western economies began a period of healthy growth. Noticeable increases in GDP per capita gave parents greater economic autonomy from their children. This phase of economic prosperity was accompanied by a range of social spending policies. Social transfers relating to welfare, unemployment, pensions, health, and housing subsidies doubled between 1960 and 1980 (Lindert 2004: 12–13). Public spending on pensions shot up during this period: in 1980 pensions accounted for 8.4% of GDP in OECD countries (almost twice the figure for 1960). Governments' generosity in distributing public money can be seen in the way more people gained access to pensions and the retirement age came down, despite the increase in life expectancy (Tanzi and Schuknecht 2000: 39–42). As Gaullier (1982: 176) concludes, "[in] the period following World War II, old age became retirement."

According to our statistical models, the collapse in marital fertility from the 1960s onwards, known as the baby bust, would be a logical phenomenon.[13] The increase in income per capita enabled parents to find alternatives to the traditional strategy of having children in order to provide for future needs (disease, incapacity, unemployment, retirement) and they became economically independent from their children. The massive growth in public social transfers aimed at the mature and elderly population (pensions and health care) also made it less necessary to have a large family: once again, the welfare state took over responsibility for responding to most of the basic needs of the elderly population.

Where the panel cointegrating regressions was a dynamic model used to capture the long-term relationship between the variables, the country panel fixed and time effects generalized least squares model analyzes the contemporary effects and also takes account of the heterogeneity between different countries. Both models bring to light the same causal relationships which we established previously in our discussion of the hypotheses concerning marital fertility and the different socioeconomic variables.

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[12] A full analysis of the reasons for the baby boom and the baby bust lies beyond the scope of this article.

[13] The baby boom would also represent a logical response made by families to a period of prolonged political, economic, and military crisis (the Crash of 1929 and World War II) which slashed family income and undermined the incipient welfare policies that some countries had initiated a few decades previously. Faced with these extraordinary circumstances, families reverted to the traditional strategy as the safest way of preparing for life's challenges: having a large family. The phenomena of the baby boom and baby bust will form the subject of a much more detailed study in a future publication.

5. Measures to encourage fertility within the welfare state

Given the results obtained from the statistical models in Table 2, based on the information provided by Lindert (1994, 2004) on social transfers, we can say that the increased social spending per capita on older people has led to low fertility. We shall now address the question of whether directing more resources toward families increases fertility rates. Using data from the OECD from 1960 onwards (see the Appendix for details of sources), we were able to gather disaggregated information on different measures aimed at meeting the needs of the mature/elderly population on the one hand and children and young people on the other. Specifically, we calculated the social transfers per capita dedicated to health and pensions and to family and child allowances and benefits between 1960 and 2010. We were thus able to assess the effect that each of these had on marital fertility. We performed the following panel models where we could include different socioeconomic variables. Furthermore, we also consider it necessary to control for fixed and time effects:

$$I_{gi,t} = \beta_0 + \beta_1 * \text{lnGDPpc}_{i,t} + \beta_2 * \text{lnFamilypc}_{i,t} + \beta_3 * \text{lnHealthpenspc}_{i,t} + \beta_4 * \text{Education}_{i,t} + \beta_5 * {}_{25}\text{q}_{0i,t} + \beta_6 * \text{Urbpop}_{i,t} + \Upsilon_t + \alpha_i + \varepsilon_{i,t}, \quad (7)$$

where I_g is the intensity of marital fertility, GDPpc is the gross domestic product per capita for each country (inflation-adjusted expressed in 1990 International Geary-Khamis dollars), Healthpenspc is the social transfers per capita dedicated to health and pensions, Familypc is the social transfers per capita dedicated to family and child allowances and benefits, ${}_{25}q_0$ is the probability of surviving to age 25 (both sexes), Education is the average years of total schooling for both sexes, Urbpop is the percentage of urban population, Υ_t is a vector of yearly dummies controlling for time effects, and α_i is a set of fixed effect accounting for the heterogeneity between countries. The values of the variables GDPpc, Familypc, and Healthpenspc were transformed into logarithms, because inspection of the graphic representation of trends in these variables indicated to us that from 1960 onwards their growth was exponential. See the Appendix for the sources from which we obtained these data.

Table 3 shows that the signs of the estimators of the variables GDPpc and ${}_{25}q_0$ for the period 1960–2010 were as expected, and are fully consistent with those obtained in Tables 1 and 2. The variable Education in Model 3 has the expected sign, but this loses significance in Models 4 and 5. It is striking that the sign of the estimator for the variable Urbpop is positive (albeit with a very small value). This indicates that, at least for the period 1960–2010, the concentration of the population in cities may have had a bearing on the increase in levels of marital fertility. Although many studies testify to the well-established phenomenon that in modern European culture fertility rates are generally higher in rural areas than in cities (Jaffe 1944; Notestein 1945; Oppenheim 1997), we should not be surprised that there has recently been a change in sign here. It has been amply documented that the sign of many well-established associations may change over time, at both macro- and microlevels. It is therefore possible that the historical negative relationship between the percentage of urban population and marital fertility might have been changing in the last few decades.

Table 3 also shows that when social transfers designed to cover part of the costs of bringing up children (Familypc) increased, this had a positive effect on marital fertility. Conversely, increasing those benefits dedicated to the elderly population (Healthpenspc) had a negative effect. The relevant coefficients, Healthpenspc and Familypc, have negative and positive signs respectively, and are statistically significant, just as our hypothesis suggests, even when other variables such as GDPpc, Education, $_{25}q_0$, and Urbpop are used as controls and fixed and time effects are included. Model 8 in Table 3 includes the variables Healthpenspc and Familypc with lags. The signs and statistical significance of the estimators are the same as in Models 6 and 7, where no lags are applied.

These figures probably indicate that what really dissuades couples from having children is not so much the existence of a welfare state but its imbalance, which gives it a stronger bias toward caring for the elderly than toward helping young couples with the costs of childrearing.

Figure 2 shows the actual marital fertility index (I_g) values and those predicted (by Model 8 in Table 3) for each country. The fit of the predicted values to the actual values is very close. The only exceptions are Ireland and Spain, probably because in both countries the marital fertility rates dropped over a very short period of time.

Table 3: Country panel fixed and time effects generalized least squares (I_g dependent variable), developed countries (1960–2010)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Intercept	0.996 ***	0.867 ***	0.976 ***	0.952 ***	1.351 ***	1.334 ***	0.566 ***	1.413 ***
	0.070	*0.079*	*0.081*	*0.082*	*0.099*	*0.098*	*0.051*	*0.097*
ln GDPpc	–0.072 ***	–0.060 ***	–0.066 ***	–0.068 ***	–0.127 ***	–0.111 ***		–0.120 ***
	0.008	*0.008*	*0.009*	*0.009*	*0.011*	*0.012*		*0.012*
$_{25}q_0$		0.583 ***	0.346 **	0.323 *	0.684 **	0.463	0.918 ***	0.457
		0.172	*0.173*	*0.173*	*0.322*	*0.330*	*0.340*	*0.336*
Education			–0.006 ***	–0.006 ***	0.002	0.003 *	5.81E-05	3.53E-03 **
			0.002	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Urbpop				0.001 *	0.001 ***	0.001 ***	0.001 ***	0.001 ***
				3.41E-04	*3.38E-04*	*3.49E-04*	*3.64E-04*	*3.50E-04*
ln Familypc					0.008 ***	0.010 ***	0.007 **	
					0.003	*0.003*	*0.003*	
ln Healthpenspc						–0.025 ***	–0.061 ***	
						0.009	*0.008*	
ln $Familypc_{t-1}$								0.011 ***
								0.003
ln $Healthpenspc_{t-1}$								–0.027 ***
								0.009
n countries	24	24	23	23	21	21	21	21
N data points	1,104	1,104	1,055	1,055	937	937	937	916
R^2	0.81	0.81	0.82	0.82	0.84	0.84	0.83	0.84

Note: p-value *** <0.01, ** <0.05, * <0.1; standard errors in italics
Source: See Appendix

Figure 2: Actual and predicted marital fertility values (I_g), developed countries (1960–2010)

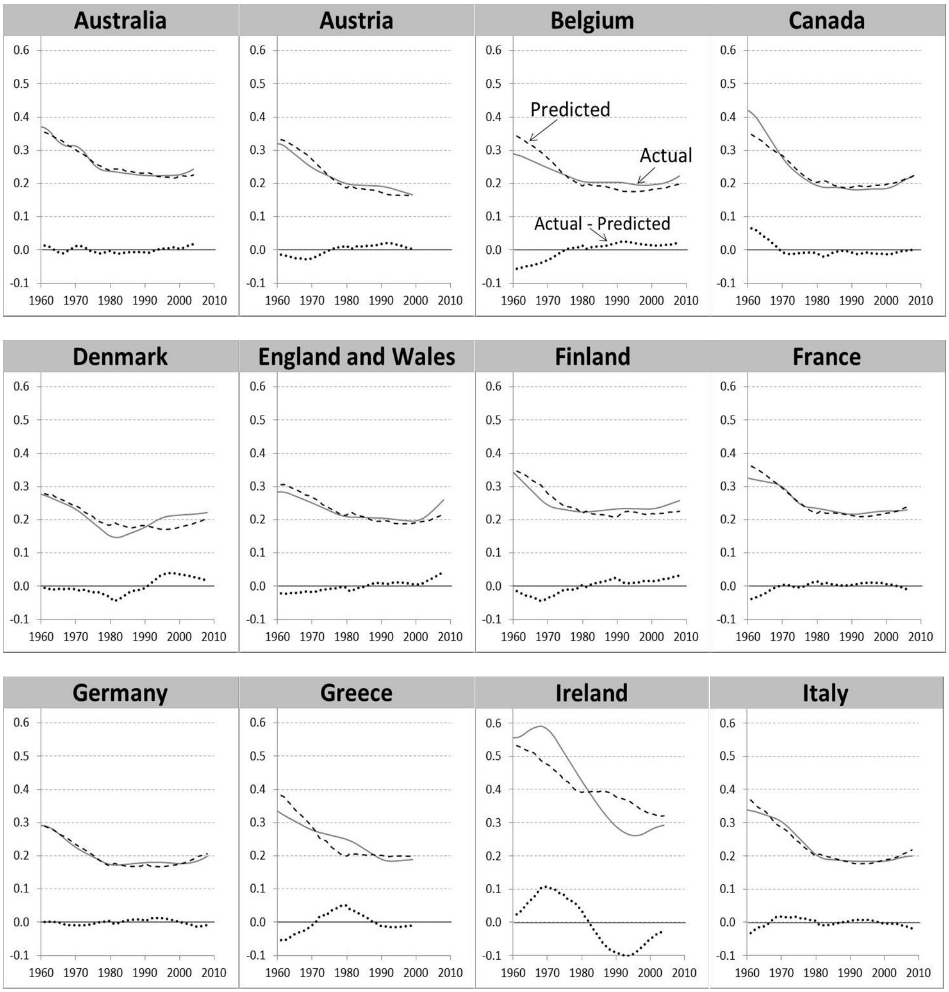
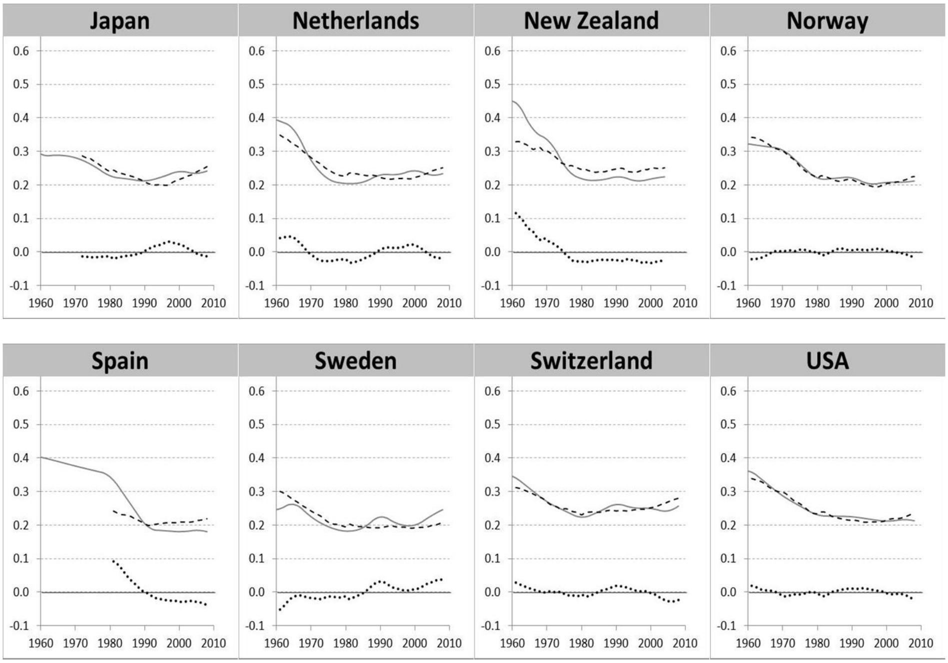


Figure 2: (Continued)



Notes: Predicted marital fertility values (I_g) calculated using Model 8 in Table 3
Source: See Appendix

6. Conclusions

In this research we show that, as demographic transition theory originally maintained, the decline in mortality and economic factors both played a leading role in the historical decline of fertility. In a similar vein, as we would expect, throughout the demographic transition the increase in educational level had a negative impact on marital fertility rates. We used two different statistical analysis techniques to examine the impact in both the long term and the short term, and obtained statistically robust results showing essentially the same, which we take as evidence of the solidity of our analysis.

In broad terms, we can conclude that welfare systems were originally designed in such a way as to devote much greater attention to the needs of the elderly population than to those of couples who want to have children. It is this imbalance in the system of public social transfers which has historically tended to deter people from having children. In fact we consider that, from the economic point of view, the present welfare system places a heavy burden on those who decide to have a family.

Obviously this general description of the rewards and punishments established by welfare states in the developed world needs to be qualified by many other considerations. There are major differences between countries concerning child benefits, policies on housing for young people, legal protection for the rights of working parents, family/work reconciliation policies, availability of public nurseries, and so on. Some of these differences probably account for the variations that we observe in the fertility rates from one country to another. As we have seen, the countries which are directing more resources toward families are those where the marital fertility index is highest.

As Gábor Regös (2014) says, one of the possible solutions to this problem is "the introduction of children pension: a system in which pension would also depend on the number of taxpayer children brought up by the pensioner." Paul Demeny (2015) outlines two radical policy proposals to raise fertility rates. The first one would give full voting rights to all citizens, including children under the current voting age. The voting rights of minors would be exercised by parental proxy. The second, which is more radical and more drastic, runs along the lines described by Regös (2014). The material status of the elderly would be conditioned by the number and productivity of their children. The children's contributions to the social security system, in Demeny's view, should be transferred directly – either completely or in a substantial proportion – to their parents.

We may conclude that a new kind of public social transfer model needs to be designed which will minimize the damaging consequences that our current welfare states have had with regard to birth rates, in that they spread the income generated by children across society once they start working, but fail to support the costs of their upbringing (which have to be met by parents alone). A fairer system should be implemented which would ensure that the benefits of children's labors would be enjoyed first and foremost by their parents.

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Appendix

Princeton marital fertility index (I_g)

The provincial and national values for the various Princeton indices were obtained from Coale and Watkins (1986). Data available from the following University of Princeton website: http://opr.princeton.edu/archive/pefp/. The author of the present paper calculated the indices for Table A-1.

Table A-1: Years for which the present author calculated the Princeton marital fertility index I_g (except where specified)

	National level
Australia	1911, 1921, 1933, 1947, 1954, 1966, 1971, 1976, 1981, 1986, 1991, 1996, 2001, 2006
Austria	1951, 1991, 2001
Belgium	1992, 1996, 2000, 2005, 2010
Canada	From 1852 to 1911 the data is from Quebec, Pouyez and Lavoie (1983); 1921, 1931, 1941, 1951, 1961, 1971, 1976, 1981, 1986, 1991, 1995, 2001, 2006, 2011
Czechoslovakia	1947, 1985, 1990, 1995, 2000, 2005, 2010
Denmark	1840 and 1847, Matthiessen (1985); 1950, 1981, 1940, 1990, 1995, 2000, 2005, 2010
England and Wales	From 1543 to 1850 using inverse projection techniques, Anderson et al. (2001); 1939, 1951, 1991, 1995, 2001, 2010
Finland	1991, 2001, 2011
France	From 1740 to 1911, Weir (1994); 1946, 1954, 1975, 1990, 1999, 2004, 2008
Germany	1946, 1950, 1991, 1996, 2001, 2006, 2010
Greece	1920, 1981, 1991, 2001
Hungary	1949, 1965, 1975, 1985, 1990, 2001, 2005, 2010
Iceland	1971, 1975, 1980, 1985, 1990, 1995, 2000, 2006, 2010
Ireland	1946, 1951, 1966, 1986, 1991, 1996, 2002, 2006
Italy	1981, 1991, 2001, 2006, 2010
Japan	1920, 1925, 1930, 1935, 1940, 1950, 1955, 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010
The Netherlands	1947, 1955, 1965, 1975, 1985, 1990, 1995, 2000, 2005, 2010
New Zealand	1891, 1911, 1921, 1936, 1945, 1951, 1956, 1961, 1966, 1971, 1976, 1981, 1986, 1991, 1996, 2001, 2006
Norway	1801, 1866, 1911, 1946, 1950, 1990, 1995, 2000, 2005, 2011
Portugal	1991, 2001, 2011
Russian Federation	1989, 2002, 2010
Spain	1860, 1877, 1950, 1991, 2001, 2006, 2011
Sweden	1750, 1800, 1850, 1870, 1890, 1910, 1920, 1940, 1945, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010
Switzerland	1980, 1985, 1990, 1995, 2000, 2005, 2010
United States	The I_g values for the years 1848, 1858, 1868 and 1878, Hacker (2003); 1880, 1890, 1900, 1910, 1920, 1930, 1940, 1950, 1960, 1970, 1980, 1990, 2000, 2006, 2010

Table A-2: Sources of information concerning the probability of death in the first 25 years of life ($_{25}q_0$)

	National level
Australia	From 1885 to 1905 (indigenous population excluded in 1885), Australian Bureau of Statistics (http://www.abs.gov.au/); from 1921 to 2007, Human Mortality Database (HMD) (www.mortality.org)
Austria	From 1870 to 1931, Human Life-Table Database (HLTD) (http://www.lifetable.de/cgi-bin/datamap.plx); from1947 to 2008, HMD
Belgium	From 1827 to 1832, estimated from the e_0 provided by Quetelet (1851), taking into account the Regional Model Life Tables “West” by Coale and Demeny (1983); from 1841 to 2007, HMD
Canada	From 1831 to 1911, Bourbeau, Légaré, and Émond (1997); from 1921 to 2007, HMD
Czechoslovakia	From 1875 to 1937, estimated from the e_0 provided by Srb (1962), taking into account the Regional Model Life Tables “East” by Coale and Demeny (1983); from 1920 to 1949, HLTD; from 1950 to 2008, HMD
Denmark	From 1665 to 1835 using inverse projection techniques, estimated from the e_0 provided by Johansen (2002) and Johansen and Oeppen (2001), taking into account the Regional Model Life Tables “West” by Coale and Demeny (1983); from 1782 to 1832, estimated from the e_0 provided by Andersen (1979), taking into account the Regional Model Life Tables “West” by Coale and Demeny (1983); from 1835 to 2008, HMD
England and Wales	From 1541 to 1870, using inverse projection techniques, estimated from the e_0 provided by Wrigley et al. (1997), taking into account the third English life table by Wrigley and Schofield (1981: 714); from 1841 to 2006 (England and Wales), HMD
Finland	From 1751 to 1875, Turpeinen and Kannisto (1997); from 1878 to 2008, HMD
France	1745, Vallin (1991); from 1752 to 1802, Blayo (1975); from 1806 to 1901, Bonneuil (1997); from 1902 to 2007, HMD
Germany	From 1810 to 1850, Imhof (1990); from 1871 to 1933, HLTD; 1950 (only West Germany), HLTD; from 1956 to 2008, HMD
Greece	From 1850 to 1922, estimated from the e_0 provided by Siampos (1989), taking into account the Regional Model Life Tables “South” by Coale and Demeny (1983); from 1928 to 2002, HLTD
Hungary	From 1900 to 1941, Hungarian Central Statistical Office (1992); from 1950 to 2006, HMD
Iceland	From 1838 to 2008, HMD
Ireland	1830 and 1848, estimated from the e_0 provided by Boyle and Ó Gráda (1986), taking into account the Regional Model Life Tables “West” by Coale and Demeny (1983); 1901 and 1911, estimated from the e_0 provided by Ó Gráda (1979), taking into account the Regional Model Life Tables “West” by Coale and Demeny (1983); from 1926 to 1946, HLTD; from 1950 to 2006, HMD
Italy	From 1650 to 1881 (only North Italy), using inverse projection techniques, estimated from the e_0 obtained in the annual inverse projection carried out by Galloway (1994), taking into account the Regional Model Life Tables “West” by Coale and Demeny (1983); from 1872 to 2006, HMD
Japan	From 1895 to 1935, HLTD; from 1947 to 2008, HMD
The Netherlands	From 1820 to 1846, estimated from the e_0 provided by Rothenbacher (2002), taking into account the Regional Model Life Tables “West” by Coale and Demeny (1983); from 1850 to 2008, HMD
New Zealand	From 1876 to 1941 (only the non-Maori population), estimated from the e_0 provided by Pool (1982, 1985, and 1993) and Pool and Cheung (2003, 2005), taking into account the Regional Model Life Tables “West” by Coale and Demeny (1983); 1936, Statistics New Zealand (http://www.stats.govt.nz/); from 1948 to 2008, HMD
Norway	From 1738 to 1843, estimated from the e_0 provided by Brunborg (1976), taking into account the Regional Model Life Tables “North” by Coale and Demeny (1983)); from 1846 to 2008, HMD
Portugal	From 1890 to 1920, Rodrigues Veiga, Guardado Moreira, and Fernandes (2004); 1930, Nazareth (1977); from 1940 to 2009, HMD
Russian Federation	1885 (Russia), estimated from the e_0 provided by Blum and Troitskaja (1996), taking into account the Regional Model Life Tables “East” by Coale and Demeny (1983); from 1896 to 1958 (Russia), HLTD; from 1959 to 2008 (Russia), HMD

Table A-2: Sources of information concerning the probability of death in the first 25 years of life ($_{25}q_0$)

Spain	From 1860 to 1890, estimated from the e_0 provided by Dopico (1987) and Livi Bacci (1968), taking into account the Regional Model Life Tables "South" by Coale and Demeny (1983); 1900, Dopico and Reher (1998); from 1908 to 2006, HMD
Sweden	From 1751 to 2007, HMD
Switzerland	From 1876 to 2008, HMD
United States	From 1795 to 1895 (only Caucasian population), Hacker (2010); from 1906 to 1930, HLTD; from 1933 to 2007, HMD

Sources of information used to obtain the variables for the statistical models (Tables 1, 2, and 3)

- Gross domestic product per capita (data for each country expressed in 1990 International Geary-Khamis dollars) (GDPpc): Maddison (2009)
- Social transfers per capita (STpc): social transfers per capita between 1880 and 1930 and 1960 and 1990 calculated by multiplying the percentages of GDP dedicated to social transfers calculated by Lindert (1994) by the GDP per capita (1990 International Geary-Khamis dollars) calculated by Maddison (2009)
- $_{25}q_0$: the probability of dying before the age of 25 (both sexes)
- Education: average years of total schooling for both sexes, from Barro and Lee (2015)
- Urbanization (Urbpop): percentage of urban population between 1950 and 2010 (United Nations Population Division, 2014)
- Social transfers in health and pensions per capita (Healthpenspc): social transfers per capita dedicated to health and pensions between 1960 and 2010

For the years from 1960 to 1980, data was obtained using information from the OECD (1985) and Varley (1986). The proportion of GDP dedicated to these social transfers was calculated by adding the values for health calculated by the OECD (1985: 75–97) to those for old age, disability, survivors calculated by Varley (1986: 23–43) and dividing this by the GDP published by the OECD (1985: 75–97).

For the years from 1990 to 2010, data was obtained using the OECD Social Expenditure Database (SOCX) (http://stats.oecd.org/Index.aspx?datasetcode=SOCX_AGG#, accessed May 2015). The proportion of GDP dedicated to these transfers was calculated by adding the variables Health and Old age.

To investigate the expenditure per capita, we multiplied the respective proportions by the per capita GDP (1990 International Geary–Khamis dollars) calculated by Maddison (2009).

- Family transfers per capita (Familypc): social transfers per capita dedicated to family and child allowances and benefits between 1960 and 2010

For the years from 1960 to 1980, data was obtained on the basis of information from the OECD (1985) and Varley (1986). The proportion of the GDP dedicated to these social transfers was calculated by dividing the values for Family assistance calculated by Varley (1986: 23–43) by the GDP published by the OECD (1985: 75–97).

For the years from 1990 to 2010, data was obtained from the OECD Social Expenditure Database (SOCX) (http://stats.oecd.org/Index.aspx?datasetcode=SOCX_AGG#, accessed May 2015). The proportion of the GDP dedicated to these transfers was calculated taking into account the variable Family.

To estimate per capita expenditure, we multiplied the respective proportions by the GDP per capita calculated by Maddison (2009).

Technical description of the statistical models in Table 1

Table A-3 shows the results of the unit root tests, including both the constant and the trend in an individualized way. The results point to an order of integration I(1) that is a constant.

Table A-3: Panel unit root test (20 cross-sectional units)

		Level and constant	Level, constant, and trend	First difference and constant
I_g	Im, Pesaran, Shin	0.98	0.99	0.00
	ADF–Fisher	0.98	0.99	0.00
	PP–Fisher	0.99	1	0.00
$_{25}q_0$	Im, Pesaran, Shin	0.47	0.97	0.00
	ADF–Fisher	0.25	0.90	0.00
	PP–Fisher	0.00	0.99	0.00
GDPpc	Im, Pesaran, Shin	1	1	0.00
	ADF–Fisher	1	1	0.00
	PP–Fisher	1	1	0.00
Education	Im, Pesaran, Shin	1	0.53	0.00
	ADF–Fisher	1	0.29	0.00
	PP–Fisher	1	0.99	0.00

The results shown in Table A-4 illustrate the cointegration relations in the panel and individually. In the case of panel cointegration, we find sufficient evidence to reject the null hypothesis that there is no cointegration, which means that we accept the alternative hypothesis of cointegration in the panel of countries. In the individual case, we find results which warrant special attention. To summarize the results that are stable across the different time lags, we need to mention that Sweden has no cointegration relationship; Germany, Portugal, Spain, and the United States have a cointegration relationship, while Denmark and England and Wales have two cointegrations. The other countries vary if we change the time lag. For this reason, we have adopted the following analytical strategy: First, we computed a cointegration regression for the whole panel (15 units); second, we analysed only the case of countries with a cointegration equation (four units); thirdly, we added those countries with one and two cointegrations (six units); and finally, we added Sweden, which is the only country with no cointegration.

Table A-4: Panel cointegration tests (20 countries)

Fisher (combined Johansen test)
Series: I_g, GDPpc, $_{25}q_0$, and Education

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	540.0	0.0000	447.70	0.0000
At most 1	163.1	0.0000	124.00	0.0000
At most 2	78.4	0.0003	76.29	0.0005
At most 3	48.5	0.1680	48.48	0.1680

Kao Residual Cointegration Test
Series: I_g, GDPpc, $_{25}q_0$, and Education

Null hypothesis: No cointegration

Automatic lag length selection based on SIC with a max lag of 11

Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-3,782,181	0.0001