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ABSTRACT

We construct a simple exchange economy overlapping generations model in which there are along with a public social security various private insurance schemes to explore fertility and the effects of various variables on it. In the private system parents can invest in children and benefit from their support (care and income support) in the old age. An introduction of the public system will lower the incentive to have children, i.e. the fertility will be lower. This is an important negative externality of public pension system. We test some of the model's basic implications using long historical panel data from 11 countries for the period 1750-1995. In addition, two other data sets, the WDI (World Bank) and MZES (Manheim University) are used to reinforce the empirical results that are obtained with historical data. These analyses show that, opposite to common beliefs, there is a positive relationship between ageing and fertility if we control for the key determinants of fertility (size of the public sector, level of income, education and infant mortality). By contrast there is a strong negative relationship between the size of the public sector and fertility. The same is true in terms of income and education while the fertility effect of infant mortality is clearly positive.

JEL Classification: E21, E32

Keywords: fertility, pensions, overlapping generations

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1. Introduction

The demographic structures of many Western economies are experiencing substantial changes. Low fertility and longer expected lifetimes are behind this fundamental transformation. Both are presumed to have a large effect e.g. on fiscal policy. In fact, ageing and fertility decline are currently considered to be the main problems in Europe and many other industrialized economies. A report by the European Commission (see Oksanen 2003, p.11) goes even so far as stating that "the increase in public expenditure is mostly caused by declined fertility and increasing longevity…"

Both ageing and fertility decline are taken as "facts of life", which cannot be affected by any policies. In other words, they are apparently considered to be exogenous variables. Moreover, they are usually regarded as "problems", which to us sounds somewhat surprising. At least an increase in the life-span is usually thought to increase individual's lifetime utility and well-being.

The exogeneity assumption might be true more with ageing, but definitely not with fertility as we argue below. But how does fertility change? Obviously, any change requires changes in institutions and other relevant variables such as incentives to have children, but we simply cannot rule out all the possibilities for affecting fertility behavior even in the medium run. Both historical data and cross-country comparisons show that there are, and have been, huge differences in fertility behavior.

Fertility issues have received quite a lot of attention in the recent empirical and theoretical literature dealing with the long-term problems of many economies. Much of this literature approaches the study of fertility with overlapping generations framework, which at least for a long-term perspective is quite a natural model. Perhaps the key theoretical issue in these models is how to solve the level of donation given by children to their parents. If the middle-aged person's utility depends on his parents' utility, the optimum level of donation is quite straightforward to derive.[1] This approach is followed by e.g. Boldrin and Jones (2002) and Boldrin, De Nardi and Jones (2005). Ehrlich and Lui (1991, 1998), and Ehrlich and Kim (2005) assume in turn that there is a social compact between children and parents in such a way that the level of transfers received by the old from their offspring is proportional to the offspring's labor earnings.

[1] There are though game-theoretic issues involved here. Are children e.g. operating in a cooperative or non-cooperative fashion, when deciding about the level of donation? More on these issues see Boldrin and Jones (2002).

On the other hand, if the middle-aged person's utility does not depend on his parents' utility, the optimum level of donation is not so straightforward to derive. Cigno (1993) and Rosati (1996) follow this non-altruistic approach. Cigno does not execute complete formal analysis, but his discussion of the transfer problem between children and parents is informative and illuminating. Rosati assumes that there is uncertainty in the intra-family transfers, and lets the old's utility depend on the variance of that uncertainty.

Some of these papers have different emphasis from those of our paper. Here we briefly review their results on the effects of social security on fertility. Both Cigno and Rosati argue that the public pension system reduces incentives to have children. Rosati interestingly ties his result to the degree of risk aversion of consumers. The negative effect is obtained with a high degree of risk aversion. Ehrlich and Lui (1998) also contend that social security system diminishes fertility. The same conclusion is drawn by Ehrlich and Kim (2005). Boldrin, De Nardi, and Jones (2005) demonstrate the effect of old-age pensions in fertility in two types of calibrated models. In a model based on Boldrin and Jones (2002) they show that the effect is quite large, but in a model based on Barro and Becker (1989) it is actually very small.

To support our empirical work we construct a simple exchange economy two-period overlapping generations model with perfect foresight to study the interconnection between publicly and privately provided social security. Consumers live for three periods, but take part in economic activity only when they are middle-aged and old. We follow the non-altruistic approach, and basically consider all the donation levels, which improve the consumer's welfare. In this way we are also assuming, as Ehrlich and Lui (1991) for example, that there is a social compact between parents and children. Children are partly viewed as a vehicle for old age support. An important question is: to what extent will the publicly provided social security system replace children as such a mechanism?

In the empirical part we try to test the basic implications of the theoretical model. In particular, we focus on the relationship between fertility and the pension system. We try to control the other determinants/background variables of fertility, such as the income level, infant mortality and the life expectancy. Obviously, the growth of the pension system is just a part of the growth of the welfare state. Thus, the results of the empirical analysis cannot really discriminate between the effects of the pension system in the strict sense or the welfare state in general. One additional complication is the fact that at least some indicators of the welfare state also include expenditures on various child support systems which obviously affect fertility in a quite different way. Anyway, our evidence might help in designing policies, which will have less harmful effects on labour supply (retirement age) and fertility. If our thesis is correct, it would be dangerous for governments to try to solve the fiscal problems due to ageing with higher taxes and larger transfers, since fertility decline might still accelerate further, and make matters actually worse. Using the German data Cigno, Casolaro and Rosati (2002/2003) have tested empirically the effect of social security system on fertility. There is a negative effect, but they also point out that this effect jeopardizes the system's future by eroding the base of future contributions.

We proceed as follows. In section 2 we describe the behaviour of economic agents and characterize those combinations of endowments and some key parameters for which it is advantageous for the middle-aged to have children. In section 3 we explore the effects of the public social security system on incentives to have children. In section4 we delve deeper into the determinants of fertility by studying empirically the effects of a set of variables on the long-term trend of fertility. Finally, some conclusions are provided in section 5.

2. The Model and the Private Social Security

We consider a perfect foresight overlapping generations exchange economy, where consumers live for three periods, but they are economically active only in the middle and the last period of their lives: there are young, middle-aged and old people. Due to endogenous fertility population growth rate is endogenous. Consumers born in period $t-1$ are able to reproduce at t.[2] They choose the number of children (N_t^y). We note by n_t the number of children per the total number of middle-aged persons, i.e. $n_t N_t^m = N_t^y$. We assume that the mortality rate of the young agents is m_t^y. We also use the notation for the survival rate for youngsters: $\pi_t = 1 - m_t^y$. All the middle-aged will survive till the old age.

We compute the gross rate of population growth (N_t / N_{t-1}) as follows. The total number of people at t is

[2] Here we follow Boldrin and Jones (2002).

(1) $N_t = N_t^y + N_t^m + N_t^o$.

Given the assumptions above we have the following expressions: $N_t^y = n_t N_t^m$, $N_t^o = N_{t-1}^m$, and $N_t^m = n_{t-1}(1-m_t^y)N_{t-1}^m$. Using these expressions the gross population growth rate is

(2) $$\frac{N_t}{N_{t-1}} = \frac{\left[1+n_t+\dfrac{1}{n_{t-1}\pi_{t-1}}\right]N_t^m}{\left[1+n_{t-1}+\dfrac{1}{n_{t-2}\pi_{t-2}}\right]N_{t-1}^m}.$$

Rearranging we get

(3) $$\frac{N_t}{N_{t-1}} = \frac{[(1+n_t)n_{t-1}\pi_{t-1}+1]n_{t-2}\pi_{t-2}}{[(1+n_{t-1})n_{t-2}\pi_{t-2}+1]}.$$

In the steady state (or in the balanced growth path) $N_t / N_{t-1} = n\pi$

Consumers have positive endowments in both periods denoted by y_1 and y_2. The lifetime utility function is $u(c_1^t) + \beta\, u(c_2^t)$, where c_1^t refers to consumption in the middle age, and c_2^t to consumption in the old age. $u(c)$ is assumed to be a strictly concave increasing function, and fulfills the following Inada conditions: $\lim_{c\to 0} u'(c) = \infty$ and $\lim_{c\to\infty} u'(c) = 0$. $\beta = (1+\rho)^{-1}$, where ρ is the rate of time preference.

Without any social security arrangement (private and/or public) the consumers get the level of utility $\overline{U}$ $(=u(y_1) + \beta u(y_2))$. We first consider the private social security system, where the source for income in the old age is the children. The middle-aged pay the amount α_t for their parents, and when old, the current middle-aged get the amount $\pi_t n_t \alpha_{t+1}$ from their children.

The cost of rearing and educating one child is ν. In addition, there is a possibility to invest (denoted by s_t) in a private asset. This market is not, however, operative in equilibrium.

The decision problem of the middle-aged person is

(P1) $$\max_{\{c_1^t, c_2^t, n_t, s_t\}} u(c_1^t) + \beta u(c_2^t)$$

s.t.

(i) $c_1^t = y_1 - \nu n_t - \alpha_t - s_t$

(ii) $c_2^t = y_2 + n_t \pi_t \alpha_{t+1} + R_{t+1} s_t$.

In this general form the decision problem is quite interesting, since unlike e.g. Boldrin and Jones (2002), Boldrin, De Nardi and Jones (2005) and in fact also Ehrlich and Lui (1991) we do not assume that the utility of the middle-aged person depends on that of their parents. If that were the case, it would be quite straightforward to derive the optimal amount of the gift (α_t) that the middle-aged person wishes to donate to his parents.

We are not going to solve the general problem (P1), but leave that for future work. We just briefly conjecture, how that solution might look like. We follow the ideas from Azariadis and Galasso (2002) (see also Cigno 1993), where they characterize the social security system under majority voting. Abstracting from saving in (P1) it is easy to see that the sequence of donations, $\{\alpha_t\}_{t=1}^{\infty}$, must fulfill the condition

(4) $$u(y_1 - vn_t - \alpha_t) + \beta u(y_2 + n_t \pi_t \alpha_{t+1}) \geq \overline{U},$$

to be individually rational. The current middle-aged consumer decides α_t and n_t, and their children make a decision on α_{t+1}. We conjecture that a positive sequence will be supported by some form of trigger strategies, and most importantly as in Azariadis and Galasso (2002), we conjecture that there are a multitude of such sequences.

In what follows we assume as in Ehrlich and Lui (1991) that there is a social compact (or a family insurance arrangement) between the parents and their children. Indeed we assume that the level of donation is some constant, and characterize the optimal amount of children taking the level of donation as a parameter. Indeed, we only consider the stationary equilibria. Furthermore, we assume that the periodic utility function is logarithmic. Since children are a vehicle for saving, it will become clear below that given the arbitrary level of endowments it is not always optimal to have a positive level of children. Below we need to make assumptions which guarantee that our economy is Samuelsonian using the rather famous terminology propose by Gale (1973).

The decision problem now becomes

(P2) $$\max_{\{c_1^t, c_2^t, n_t, s_t\}} \ln c_1 + \beta \ln c_2$$

s.t.

(i) $c_1 = y_1 - vn - \alpha - s$

(ii) $c_2 = y_2 + n\pi\alpha + Rs$.

The budget constraints imply the following lifetime constraint

(5) $$c_1 + \frac{c_2}{R} = y_1 - \alpha + \frac{y_2 + n\pi\alpha - Rvn}{R}.$$

An obvious arbitrage condition is $\pi\alpha / v = R$ so that investment in children provides the same return as in an asset. We describe the decision situation in Figure 1. It makes clear the fact that it is not always advantageous to invest in children, since endowments provide the utility level $\overline{U}$. Consider e.g. high values for the cost of rearing children (v) and the low value for the survival probability (π) and the level of donation (α). Of course, the final allocation with e.g. positive investment in children must provide at least that level of utility.

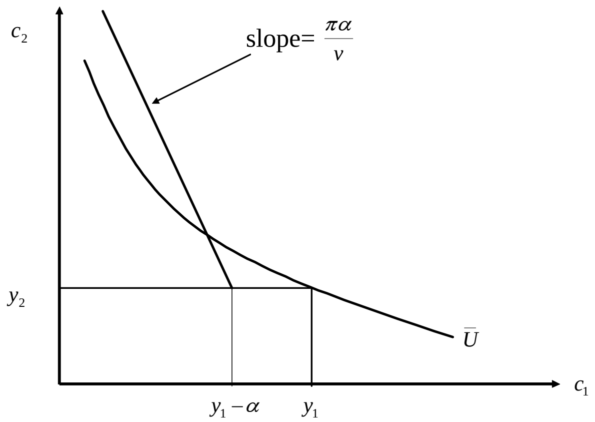


Fig. 1.

Next we just characterize the optimal determination of the number of children, and forget the saving decision, since in equilibrium there will be no saving. We get

(6) $$n = \frac{\beta(y_1 - \alpha)}{v(1+\beta)} - \frac{y_2}{\pi\alpha(1+\beta)},$$

which looks a lot like the regular saving function with the logarithmic preferences. For n to be nonnegative parameters must fulfill the condition

(7) $$\frac{\pi\alpha}{v} \geq \frac{y_2}{\beta(y_1 - \alpha)},$$

which is very close to the condition for the Samuelson case in models without endogenous population growth.

Next we return to the general case for a moment. We can express the utility as a function of the number of children and the level of donation as

(8) $V(n,\alpha) = u(y_1 - vn - \alpha) + \beta u(y_2 + n\pi\alpha)$.

The optimal choices of the number of children and the level of donation should improve the level of utility from that of endowment point. Thus we need to have

(9i) $V_\alpha(n,\alpha) = \beta u'(y_2)\left[-\frac{u'(y_1)}{\beta u'(y_2)} + \pi n\right] > 0$

(9ii) $V_n(n,\alpha) = v\beta u'(y_2)\left[-\frac{u'(y_1)}{\beta u'(y_2)} + \frac{\pi\alpha}{v}\right] > 0$.

Given the logarithmic utility we get two weak inequalities that the parameters must fulfill so that the final optimal allocation is better than the endowment point

(10i) $\frac{\pi\beta(y_1 - \alpha)}{v(1+\beta)} - \frac{y_2}{\alpha(1+\beta)} > \frac{y_2}{\beta y_1}$

(10ii) $\frac{\pi\alpha}{v} > \frac{y_2}{\beta y_1}$.

We rewrite these inequalities as

(11i) $y_2 < \frac{\pi\beta^2\alpha(y_1-\alpha)y_1}{v[(1+\beta)\alpha + \beta y_1]} \equiv h_1(y_1)$

(11ii) $y_2 < \frac{\pi\alpha\beta}{v} y_1 \equiv h_2(y_1)$.

$h_2(y_1)$ is a linear function of the first period endowment. We easily see that $h_1(0) = 0$ and $h_1(\alpha) = 0$. Differentiating $h_1(y_1)$ we get

(12) $h_1'(y_1) = \frac{\pi\beta^2\alpha^2(1+\beta)(2y_1 - \alpha) + \pi\beta^3\alpha y_1^{\ 2}}{v[(1+\beta)\alpha + \beta y_1]^2}$

One can see that there is one minimum for the function with a positive value for y_1, and that value is less than α. Furthermore, we see that $\lim_{y_1\to\infty} h_1'(y_1) = \frac{\pi\alpha\beta}{v}$, which equals the slope of the line $h_2(y_1)$. This means that the inequality (11ii) is the only relevant inequality. In Figure 2 we have drawn the areas of endowments, which fulfill both inequalities (11). We also see that the relevant area shrinks down, whenever the survival probability or the level of donation gets smaller. The same happens, if the cost of having children increases. An important point of this exercise is that there are combinations of endowments and parameters such that it is advantageous for the middle-aged to have children and donate some of their resources to their parents. E.g. if the economy is such that $y_2 = 0$, it is in the interest of the middle-aged have children and make donations for every $\alpha < y_1$. In what follows we assume that we are working in the relevant area.

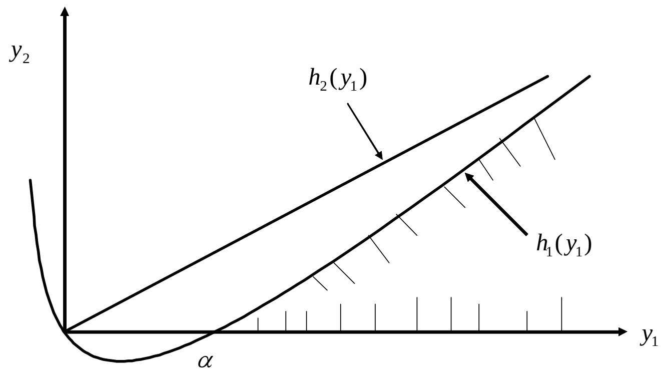


Fig. 2.

3. The Effects on Fertility of the Publicly Provided Social Security

From now on we assume that there is a pay-as-you-go social security system such that the benefit received in old age is financed by the lump-sum tax levied in the middle age. The system is thus balanced, and there is no need for government to float debt. τ_t is the tax on young, and b_t the benefit received by the old in that period. The budget constraint for the social security system is thus

(13) $$N_t^m \tau_t = N_t^o b_t .$$

Since $N_t^o = N_{t-1}^m$, and $N_t^m = n_{t-1}(1 - m_{t-1}^y) N_{t-1}^m$, it follows that per old benefit can be expressed as

(14) $$b_t = \frac{N_t^m}{N_t^o}\tau_t = \frac{N_t^m}{N_{t-1}^m}\tau_t = \frac{n_{t-1}(1-m_{t-1}^y)N_{t-1}^m}{N_{t-1}^m}\tau_t = n_{t-1}(1-m_{t-1}^y)\tau_t = n_{t-1}\pi_{t-1}\tau_t .$$

In the steady state we have that $b = n\pi\tau$.

With logarithmic utility function we have the following decision problem

(P3) $$\max_{\{c_1^t, c_2^t, n_t, s_t\}} \ln c_1 + \beta \ln c_2$$

s.t.

(i) $c_1 = y_1 - vn - \alpha - \tau - s$

(ii) $c_2 = y_2 + n\pi\alpha + b + Rs$.

The budget constraints imply the following lifetime constraint

(15) $$c_1 + \frac{c_2}{R} = y_1 - \alpha - \tau + \frac{y_2 + b + n\pi\alpha - Rvn}{R}.$$

It is important to note that we are assuming that the agents consider the future benefit parametrically, and do not see their own actions (voting in particular) as affecting the outcome of the political equilibrium. Indeed, we do not consider the determination of taxes and benefits in a political equilibrium.[3] Although when we analyze the equilibrium reactions of the agents, we need to take account the public sector's budget constraint.

The optimal number of children is now

(16) $$n = \frac{\beta(y_1 - \alpha - \tau)}{v(1+\beta)} - \frac{y_2 + b}{\pi\alpha(1+\beta)}.$$

Totally differentiating (16) and government's budget constraint we get

(17i) $$dn = -\frac{\beta}{v(1+\beta)} d\tau - \frac{1}{\pi\alpha(1+\beta)} db$$

(17ii) $$db = \pi\tau dn + \pi n d\tau.$$

We plug (17ii) into (17i) to obtain

(18) $$\left(1 + \frac{\pi\tau}{\pi\alpha(1+\beta)}\right) dn = -\left(\frac{\beta}{v(1+\beta)} + \frac{\pi n}{\pi\alpha(1+\beta)}\right) d\tau,$$

from where we get that $dn/d\tau < 0$.

4. The Empirical Effects of Some Key Variables on Fertility

After these theoretical considerations we turn to empirical testing. The main purpose of this analysis is to see whether the data do indeed support the notion that the growth of social security depresses fertility. For that purpose we estimate simple linear models in which social security is proxied with some alternative ways (using

[3] For such a model, but with a different emphasis from ours, see Azariadis and Galasso (2002).

indicators for the government size as main proxies) and in which the role of this variable is controlled by the most obvious determinants of fertility (income, education, infant mortality, structure of the economy and life expectancy).[4]

There might be some ambiguity with the variables determining fertility. Theory does not clearly predict how they affect fertility. Intuitively, we might expect that the longer life-expectancy makes children's support more valuable, and thus investment in children would give higher return. Therefore, ceteris paribus, there ought to be a positive relationship between life-expectancy and fertility. In the raw data, the relationship is just the opposite, but the reason is obvious. Life expectancy is highly correlated with income and all other indicators of economic development which in turn affect fertility. What we really need is the conditional effect of life-expectancy on fertility. That may be only obtained by a proper multivariate model.

In the empirical analyses, three data sets have been used: First of all we use historical data from 11 countries for the period 1860-2000. These data provide a lot variation in terms of all basic determinants of fertility (social security, education, life expectancy, infant mortality and income). In this respect the data are "better" than the more recent data where – at least in the developed countries – relatively little time-variation can be found in these variables. Obviously, the quality of the old data may be poor and sample sizes small (the historical data represent five -in some cases ten-year – intervals). The main data source is Mitchell (2005), although several national data sources are also utilized.[5]

In addition to these historical data we also use the World Development Indicators (WDI) data that cover the period 1960-2002. An update covers a bit longer period 1960-2003, but some key variables are not any more included in the data bank. These data sets include practically all countries in the world and the number of data points is at least 2300. Finally, we use the MZES (Manheimer Zentrum fur Europäische Sozialforschung) data on social security expenditures. The MZES data

[4] We have also scrutinized the role of child support on fertility using the detailed MZES data. Preliminary results with a very crude indicator, child support expenditures/GDP, suggest that child support does indeed have a positive impact on fertility in the cross-section of 21 countries. Although the result is quite robust for the whole panel some important individual country exceptions are found.

[5] The long time series of the fertility rate data have been constructed by dividing the number of births with the female age cohorts of 15-49. With the WDI and MZES data, the usual fertility measure is used.

cover the period 1949-1993 for 21 European countries.[6] Here we focus only pension expenditures, on the one hand, and total social security expenditures, on the other hand, both in relation to GDP. Both variables are related to fertility rates to facilitate comparison with relationships between fertility and cruder proxies of pensions and social security.

The results are reported below in the following fashion. The fertility data are illustrated in Figures 1 and 2. The relationship between fertility and its potential determinants are illustrated with subsequent scatter diagrams (Figures 3-5). The simple sample correlations between fertility other variables are reported in Table 1. Finally, estimation results with the alternative data sets are reported in Tables 2-5. All estimation results represent the panel data sets in which all coefficients are restricted to be equal.

The results can be summarized in the following way. In the estimated models all variables follow the predictions of the theory. Thus, income and education have a negative and infant mortality a positive effect on fertility. The role of life expectancy (or the share of old all people) is somewhat ambiguous. By contrast, the role of the government size (or social security) looks quite systematically negative: the bigger is government the lower is the fertility rate.

Obviously, we have potentially a severe measurement problem with the government size and the social security variables. Bigger government might just reflect more bureaucracy or more government interventions in the economy. It might also simply reflect wars or other problems. Perhaps proper measures would be some types of forecasts of government total outlays to (net of taxes) old-age people. Needless to say, such data are not available.

There are perhaps even more difficult measurement issues with the government intervention variables. Both pension expenditure/GDP, social security expenditure/GDP and child support expenditure/GDP suffer from the basic weakness that they are not genuinely exogenous. For instance the pension expenditure/GDP ratio may increase both because of an increase in the level of pension benefits, and because of an increase in the number of pensioners.[7] The two things are, however,

[6] The data base also include two countries (Slovakia and Czech republic) which are not include in our sample because they consist of 3 observations only (including those would not, however, make any difference).

[7] If the actual GDP is used as the scale variable some simultaneity problems might arise. Preferably, the trend of GDP ought to be used.

quite different from the point of view of individual maximization behavior, the former is relevant the latter is not. To overcome this problem, better indicators are needed.

5. Concluding remarks

Our paper has shown that fertility behavior can be considered analogously to investment in human capital and physical assets. Although the planning horizon of investors is quite long that does not make fertility behavior exogenous. Quite clearly it depends on the menu of investment alternatives and the respective returns. Government expenditures on social security constitute the key element, which affects the rate of return on investment in children. Not surprisingly, we present empirical evidence which is consistent with this conclusion. This result has powerful policy implications. Attempts to improve old-age support may lead to depressing fertility, which cannot really be offset by any child support programs. These negative fertility effects might be accompanied by negative labor supply effects due to higher tax rates which are needed to finance both systems. In this light one ought to reconsider the limits of the welfare state in securing all income risks.

Table 1 **Correlations with the fertility variable**

Variable	Historical data	WDI data	WDI update
Infant mortality	.816	.851	.831
Participation to education	-.659		
Literacy rate		-.817	-.817
University enrollment rate		-.671	
School enrollment rate		-.759	
Share of old people	-.845		
Life expectancy		-.853	-.853
Share of agriculture/GDP		.661	
Military expenditure/GDP		.281	
Government expenditures/GDP	-.635	-.271	
Gross tax rate		-.456	
Public consumption/GDP		-.167	-.153
GDP per capita	-.286	-.226	
GDP growth	-.035*	.055	-.111
Unemployment rate		-.018*	

All correlations are pair-wise and computed from the corresponding panel data sets. Starred values are NOT significant the 5 per cent level of significance.

Table 2 **Results with the historical data for 1860-2000.**

	1	2	3	4	5	6	7
log(gdp)	-.009	-.007	-.009	-.016	-.014	-.007	-.007
	(3.24)	(2.82	(3.24)	(6.23)	(7.12)	(2.93)	(2.75)
gov.size	-.035	-.024	-.030	-.070	-.031	-.025	-.048
	(1.72)	(1.90)	(1.55)	(4.54)	(1.94)	(1.18)	(2.43)
education	-.029	-.010	-.029			-.033	-.035
	(2.50)	(1.17)	(2.51)			(3.10)	(3.25)
IMR	.018	.012	.018			.023	-..019
	(3.48)	(3.31)	(3.48)			(5.36)	(4.36)
old	-.005	-.010	-.005	-.0.11	-.013	-.037	-.013
	(1.99)	(5.10)	(2.08)	(6.46)	(6.83)	(0.52)	(0.18)
old^2	.017	.032	.018	.045	.048		
	(1.87)	(3.77)	(1.90)	(6.34)	(6.03)		
war			-.005				
			(0.88)				
n	181	181	181	194	194	181	168
R2	0.825	0.792	0.844	0.834	0.788	0.873	0.842
SEE	0.023	0.013	0.013	0.014	0.014	0.13	0.012
Test	1.98	17.02	1.96	2.16	..	2.98	2.64
	(0.039)	(0.009)	(0.041)	(0.022)		(0.001)	(0.007)
model	FE	RE	FE	FE	RE	FE	FE

Corrected t-ratios are inside parentheses. All estimates are panel GLS estimates. In equation 7, Japan is excluded. FE indicates the fixed effects model and RE the random effects model. Tests refer to the corresponding fixed effects test (all cross-section effects are zero) and Hausman specification test for the orthogonality of cross-section error terms and the RHS variables. GDP denotes per capita GDP in fixed US dollars and IMR infant mortality rate. Government size (gov.size) is measured by government expenditures/GDP and "education" by participation to primary education. "Old" denotes the share of old (> 65 years if age) people out of total population and "War" is a dummy for war years.

Table 2 **continued: some stability analysis**

	6	6'	6''
log(gdp)	-.007	-.006	-.010
	(2.93)	(1.75)	(3.66)
gov.size	-.025	-.050	-.045
	(1.18)	(1.62)	(2.22)
education	-.033	-.049	-.048
	(3.10)	(3.25)	(3.94)
IMR	.023	.025	.019
	(5.36)	(3.50)	(3.83)
old	-.037	-.0316	.080
	(0.52)	(2.51)	(0.88)
n	181	104	148
R2	0.873	0.712	0.8126
SEE	0.013	0.015	0.014
Test	2.98	3.75	3.23
	(0.001)	(0.000)	(0.001)
model	FE	FE	FE

Equation 6 represents the full sample for 1850-2000, equation 6' 1850-1965 and 6'' 1850-1985.

Table 3 **Results with the WDI data for 1960-2002**

	1	2	3	4	5	6	7	8
log(gdp)	-.835	-.720	-.780	-1.191	-1.068	.202	.257	.176
	(103.08)	(77.20)	(68.49)	(26.79)	(30.25	(3.85)	(2.18)	(6.16)
gov.size	-.005	-.022	-.010	-.019	-.018	-.020	-.008	-.027
	(2.69)	(21.49)	(12.93)	(4.75)	(4.62)	(5.39)	(4.69)	(8.64)
Life expectancy						-.114	-.080	-.073
						(13.16)	(5.15)	(10.37)
Literacy rate						-.036	-.071	-.019
						(11.15)	(7.68)	(6.99)
IMR								.012
								(7.41)
military								-.152
								(9.19)
R2	0.801	0.844	0.801	0.871	0.381	0.793	0.962	0.984
SEE	1.290	1.455	1.290	0.692	0.703	0.917	0.392	0.642
Test	..			37.56	30.97	..	31.17	
				(0.000)	(0.000)		(0.000)	
N	2523	1534	1528	2523	2533	685	685	135
Estimator	GLS	GLS	GLS	GLS	GLS	GLS	OLS	GLS
Panel	No	No	No	FE	RE	No	FE	No
Gov.size	GQ	TAX	EXP	GQ	GQ	TAX	TAX	TAX

GQ denotes public consumption/GDP, EXP total government expenditure/GDP and TAX gross tax returns/GDP. Literacy denotes adult literacy rate, "Life expectancy" life expectancy at birth, IMR denotes the infant mortality rate and "Military" military expenditures/GDP. The number of countries is 150 and the number of data points 1525.

Table 4 **Results with the WDI update**

	GDP	GDP growth	government size	life expectancy	Literacy rate	infant mortality	R2/SEE	DW test
FE		-.322	-.035	-.012	-.044	.025	0.989	1.016
		(3.12)	(2.31)	(0.52)	(1.83)	(4.06)	0.242	17.68 (FE)
RE		.087	-.004	-.038	-.025	.020	0.862	1.814
		(0.17)	(0.30)	(2.19)	(3.22)	(4.22)	0.280	35.68 (H)
FE	-.373		-.006	-.124			0.914	1.462
	(4.34)		(1.23)	(13.59)			0.592	22.62 (FE)

Corrected t-values are inside parentheses. Results with the full set variables make use of 230 data points only. With the more parsimonious equation, the number of data points is 2239.

Table 5 **Relationship between fertility and social security**

	coefficient	R2/SEE	Estimator	Panel tests
Pension/GDP	-.114	0.389	OLS	
	(23.81)	0.454		
Pension/GDP	-.141	0.466	OLS,	26.15
	(23.58)	0.359	fixed effects	(0.000)
Pension/GDP	-.146	0.466	GLS,	1.22
	(23.25)	0.358	random effects	(0.271)
Sos.sec./GDP	-.051	0.383	OLS	
	(24.49)	0.467		
Sos.sec./GDP	-.067	0.680	OLS	37.96
	(28.01)	0.340	Fixed effects	(0.000)
Sos.sec./GDP	-.062	0.525	GLS	6.40
	(27.89)	0.341	Random effects	(0.011)

Corrected t-values are inside parentheses. Panel tests denote F test statistics for the fixed and random effects specifications, respectively (see Table 2 for details). Marginal probabilities are inside parentheses. The number of data points is 825.

Figure 1 **Median value of fertility in 11 countries for 1750-2000**

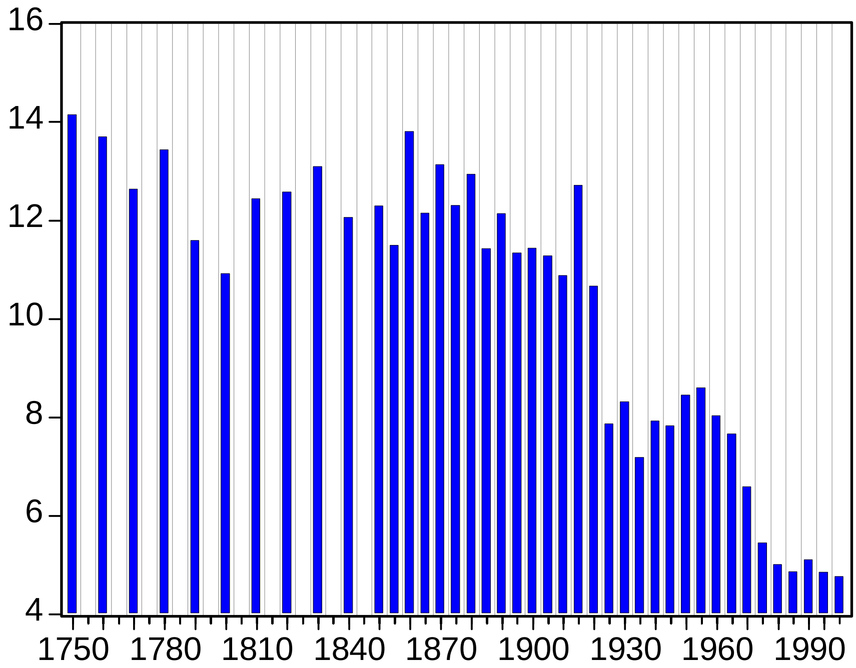
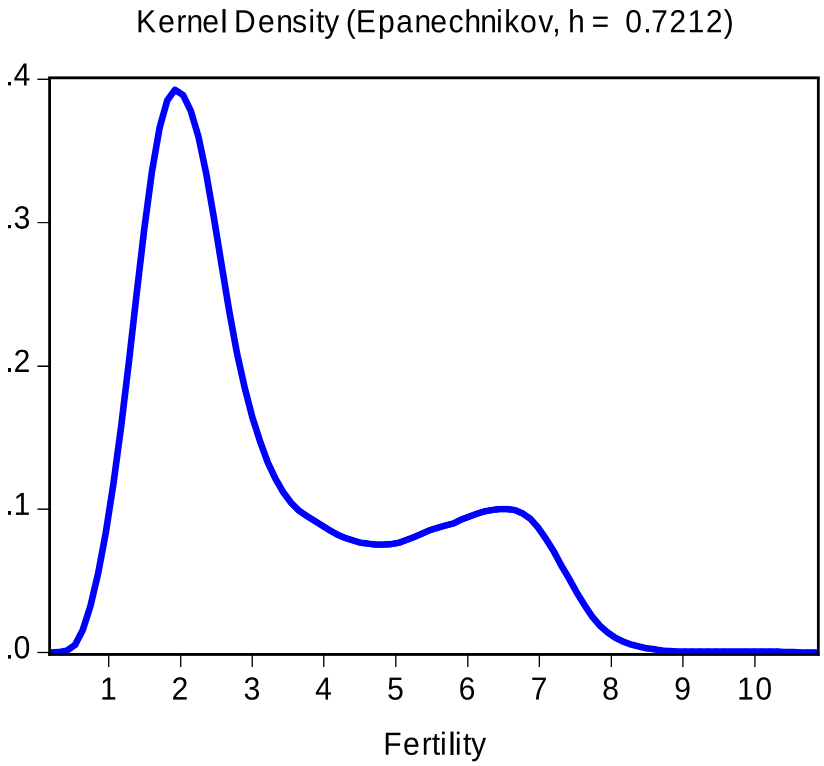
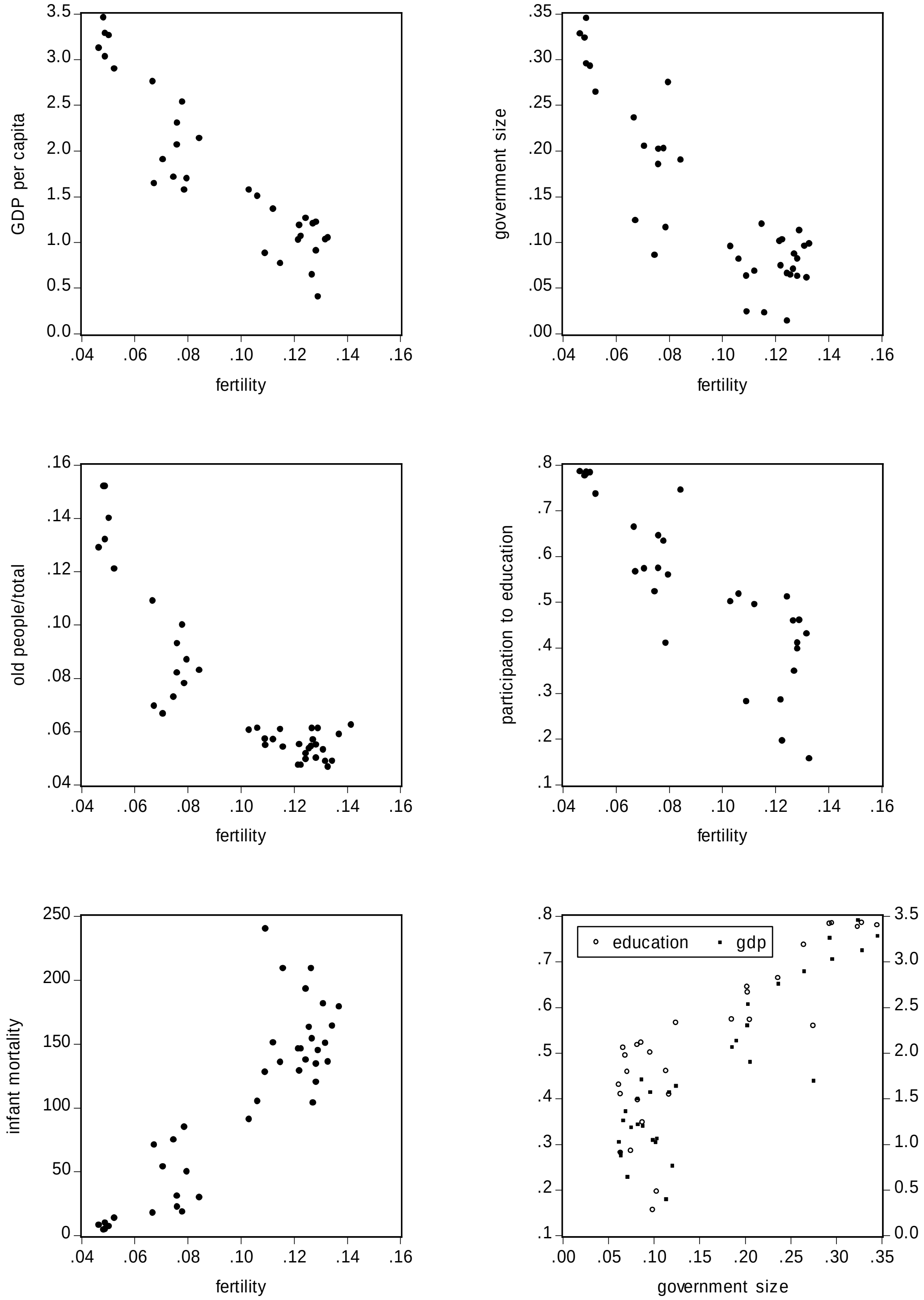


Figure 2 **Distribution of fertility rates in the WDI data**



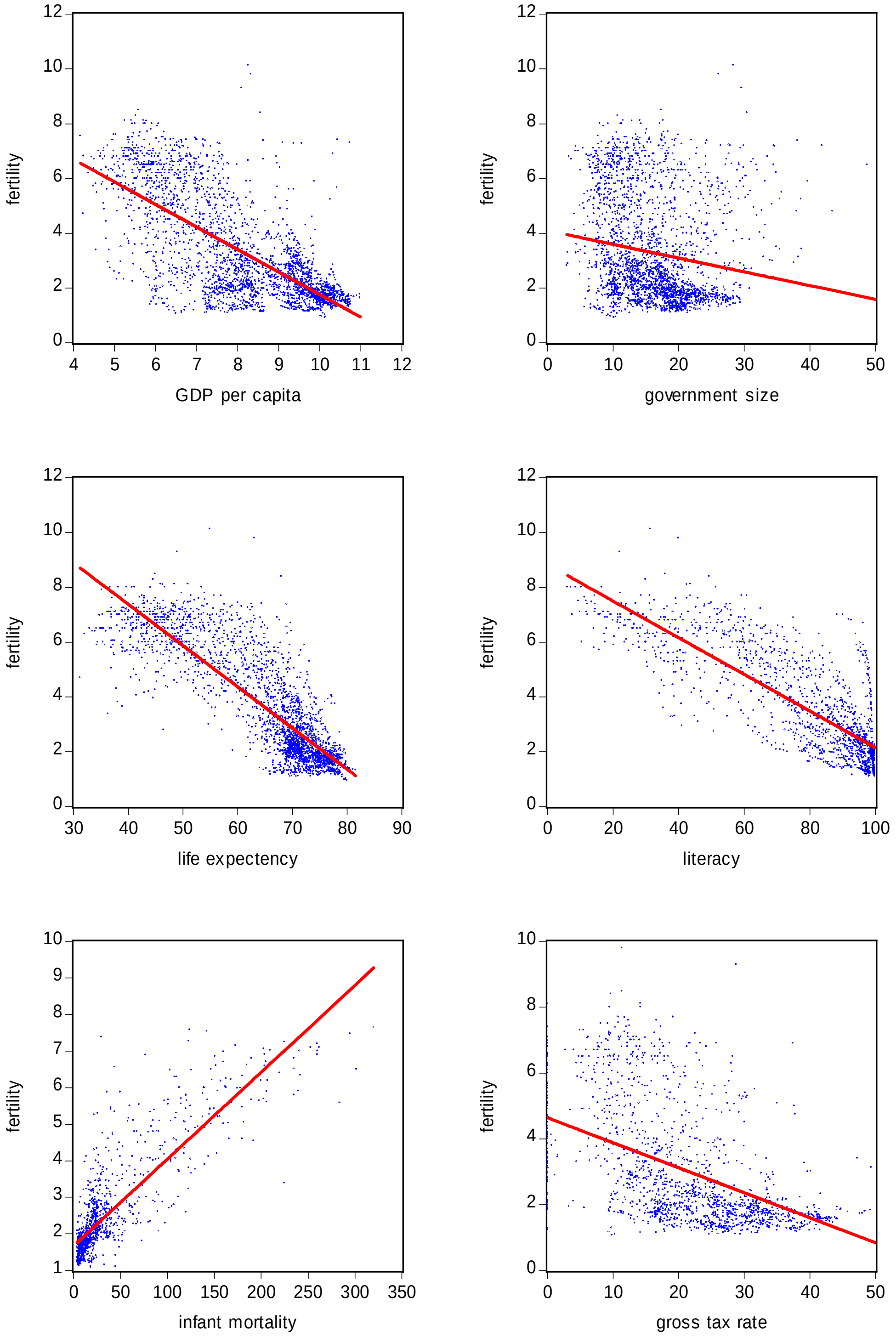
The distribution reflects differences in fertility rates both over countries and over time. Data source: the WDI databank (2523 observations)

Figure 3 **Scatter diagram between fertility and its determinants from the historical data**



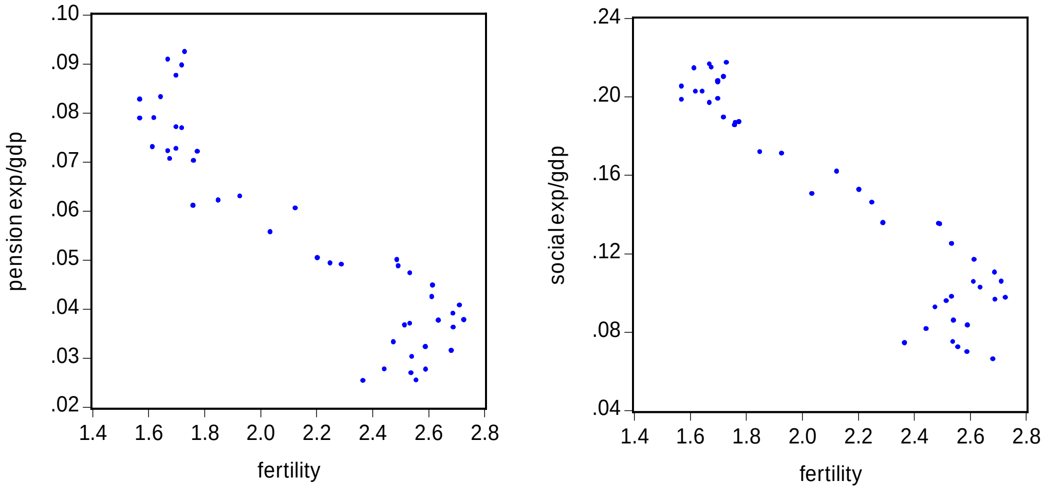
Numbers are median values of countries for 1860-2000. Note that in the last graph we compare government size with education, on the one hand, and GDP per capita, on the other hand.

Figure 4 **The relationship between fertility rate and its determinants**



Data source: The WDI database (Worldbank)

Figure 5 **Scatter diagram between fertility and pension/social expenditure from the MZES data**



Data source: the MZES data bank. The observations are median values over 21 countries for the period 1949-1992.

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Aboa Centre for Economics (ACE) was founded in 1998 by the departments of economics at the Turku School of Economics, Åbo Akademi University and University of Turku. The aim of the Centre is to coordinate research and education related to economics in the three universities.

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