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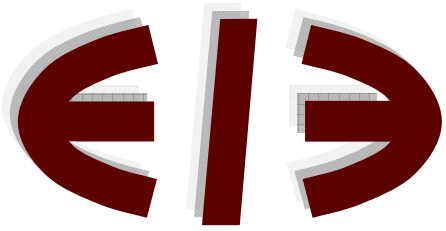

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Fertility Choice and Financial Development

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Abstract

We study the consequences of broader access to credit and to capital markets on household's decisions over the number of children. In a life-cycle model of choice with forward and backward caring between parents and children, we analyze the effects of relaxing adults' borrowing constrains and broadening the opportunities for financial investment, and show how the sign of these effects depends on the role of children as a normal or inferior good in parents' preferences. We estimate the quantitative implications of our theoretical model on data from 145 countries over the period 1980–2006. Empirical results indicate that improved access to credit reduces fertility in poor countries and increases fertility in high-income countries. The effect of the development of capital markets on the number of children is negative in low-income countries and positive in the rich. When the analysis includes public pensions the main results remain the same. We also estimate the effect of the real interest rate, which proves significant and negative.

JEL Codes: D1, J13, G1.
Keywords: Fertility, Financial Markets Development, Old-Age Security.

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1 Introduction

Fertility behavior and financial development have seen dramatic changes in recent decades, both showing distinctive patterns: as financial development spreads worldwide, enhancing the possibility of credit and intertemporal trade for households and firms, fertility shows a clear downward trend which is cause for concern, especially in developed countries that will be facing decreasing populations in the near future.

Do these two phenomena simply show a spurious temporal correlation or does one cause the other? Financial development may be among the driving forces that change fertility behavior. To raise children requires a significant transfer of parents' resources toward them which can be driven not only by caring, but also by the expectation that some resources will be returned during the parents' old age: this exchange is not synchronous and requires coordination of individual actions that can be best achieved through the means of specialized institutions. Since the basic function of financial markets is to facilitate intertemporal trade, making current consumption less dependent on current income, then better organized and diversified financial markets would make these transfers easier. Nevertheless, the development of financial markets reduces the demand for children for the purpose of receiving old age support. The impact of financial development on fertility is therefore undetermined and should be assessed empirically.

A glimpse at the figures involved can give an idea of the radical change that has taken place. At the world level, the fertility rate – the average number of children per woman over her lifetime – has dropped from 4.91 in 1960–1965 to 2.56 in 2005–2008, with large differences between country groups. While more developed regions have registered a decrease from 2.67 to 1.64, the rate in least developed countries has declined from 6.73 to 4.39.[1] Unlike fertility, financial development is a multifaceted phenomenon; many of its indicators also reveal a similarly striking trend. For example, the ratio of deposit money bank assets to GDP, a measure of liquidity available to the general public, has risen from 0.26 in 1960–65 to 0.6 in 2005–08; in the same period, more developed countries (MDCs) have recorded a considerable increase from 0.42 to 1.32, while less developed countries (LDCs) a more modest change from 0.14 to 0.38. By the same token, the ratio of private credit to GDP, has risen from 0.39 to 1.14 in high income countries and from 0.13 to 0.31 in LDCs. Similar patterns are followed by other financial variables, like stock market capitalization and life insurance premium volume, both compared to GDP, whose values measure the breadth of opportunities for financial investment.[2]

Despite the relevance of the causal relationship between financial development and fertility, theoretical and empirical analyses on the subject are still sparse. On the theoretical level, a life-cycle model integrating fertility choices and financial markets is lacking. Cigno and Rosati (1992) investigate the effects of households' access to capital markets on fertility. They put forward two models of life-cycle fertility, finding empirical support for a positive effect of financial development on fertility. Some evidence on this issue comes from the literature on microcredit programs: these studies show some controversial effects of increased financial availability on fertility. Nonetheless, these programs of financial empowerment are generally aimed at very poor people living in LDCs; accordingly, the external validity of these studies is

[1] The figures on fertility rates are accessible at `http://data.un.org/`.

[2] The figures on financial structure are accessible at `http://data.un.org/` and at Ross Levine's personal website.

questionable.

In this paper we attempt to provide a comprehensive account of the relations between households' choice of fertility and the availability of credit and opportunities for financial investment. In the theoretical section we introduce a four periods life-cycle model of fertility choice in which agents care for their children and for their parents too. In this setting young adults might choose to borrow some resources and, when older, to save and invest in the capital market. In this model, we also retrieve the distinction between two main types of imperfections of financial markets (Pollin, 1997; McKinnon, 1973): borrowing constraints – the difficulties encountered by individuals when trying to reach their optimal level of debt – and saving constraints, which pertain to the uneasiness encountered by individuals who wish to invest their savings in a private financial market. We show that in the context of fertility determination, this distinction has both theoretical relevance and a significant empirical counterpart.

In the empirical section, we estimate the quantitative implications of our theoretical model for 145 countries over the period 1980–2006, merging the data on fertility, social and economic indicators from World Development Indicators (2007) with those provided by Beck, Demirgüç-Kunt, and Levine (2000) who describe the level of financial development and structure at the country level with a variety of indicators. The econometric model used to test the implications of the theoretical model uses a fixed-effects panel estimator which takes into account heterogeneity between countries and time-invariant unobserved factors influencing fertility, also possibly correlated to our selected regressors.

Our key theoretical findings concern the multiple channels through which borrowing constraints and saving constraints affect fertility. These results are obtained by a decomposition of the equilibrium conditions accounting for the twofold nature of children as both consumption and investment goods. In particular, the effect of relaxing the borrowing constraint on fertility is determined by the balance between (1) an investment effect, whose positive sign is due to the reduction of future resources and to a corresponding greater investment in children, and (2) an income effect, whose sign can be either positive or negative. Hence, fertility will unambiguously increase only when children are normal goods in a household's preferences. Broader access to capital markets allows parents to rely less on children to fund their old age welfare. Nonetheless, larger savings imply lower debt in the early years of adulthood: in this case the household will command a smaller amount of resources for consumption and children. If children are inferior goods, the effect of greater saving will be ambiguous. An innovative feature of these results lies in their identification power. Any empirical finding of a positive effect on the number children due to a lift in borrowing constraints, other things being equal, would not reveal the nature of the underlying preferences toward children, while only a negative effect would. An analogous implication for identification regards any positive estimate of the effect of improved capital market access on fertility.

Our empirical results indicate that both borrowing constraints and investment opportunities do impact fertility and that the sign of these effects critically depends on a country's stage of economic growth. An increase in private credit of one standard deviation decreases fertility of 1.7%–5% in low-income countries, while high-income countries register an increase by 3.7%–5%. Analogously, a standard deviation increase in the ratio of deposit money bank assets and the sum of deposit money and central bank assets decreases the number of children by 1.8%–3.8% in low-income

countries, while in high-income countries the same change produces an increase of 3.2%–17.2%.

Financial investment opportunities are approximated by two variables: the ratio of the value of life insurance premiums to GDP, and the ratio of stock market capitalization to GDP. A one standard deviation increase in life insurance premiums increases fertility by 2.0%–3.1% in high-income countries, while in low income countries the effect of the same variation is negative and around 3.5% and 5.2%.

In the econometric analysis, we also check the role of the public pension system in determining fertility. This role arises because pensions are potential substitutes for voluntary savings. Using data on public pension expenditure from the ILO, we are able to show that private financial markets continue to play a significant role in explaining fertility changes. These results provide an additional perspective to the estimated differences among countries of the effect of financial markets on fertility. These differences also depend on the positive correlation, usually found in sectional data, between capital market development and social security. LDCs typically lack private *and* public saving institutions, while high-income countries have developed financial institutions in both sectors. Hence, the reaction of households to financial development crucially depends on the complementary presence of social security.

As far as we know, our econometric analysis provides the first test of the influence of the interest rate on fertility in a large sample of countries. We show that high real interest rates have a significant negative influence on fertility, a fact which can be easily reconciled with our theoretical approach. These results extend those obtained by Cigno and Rosati (1992, 1996) on data for Germany, Italy, the UK and USA. Various checks of robustness substantially confirm our theory that the structure of private financial markets does matter for fertility choices and help explaining the historical decreasing trend of fertility in LDCs and MDCs which has taken place after the demographic transition.

The remainder of the paper is organized as follows: Section 2 surveys the theoretical and empirical literature on the impact of financial variables on fertility; Section 3 describes the model determining intertemporal allocation of income and fertility determination; Section 4 describes the empirical implementation of the theoretical model, specification and identification issues, the data used for estimation and the relative results; Section 5 discusses policy implications and concludes.

2 Literature review

Economic models of fertility can be partitioned into two broad streams: those in which children are an intermediate good in the production of lifetime wealth, and those in which children are final consumption goods.

The models in the first stream date back to the pioneering contribution of Leibenstein (1957). In this work the hypothesis was advanced that children, rather than being net consumers of family resources, actually increase their families' lifetime wealth. Although infants are completely dependent upon their family for their personal consumption, as they grow up they become capable of working and transferring income back to their families. As long as the value of resources being returned by grown-up children exceeds the value of resources consumed as infants, fertility is a financially profitable trade from the standpoints of parents' and children. In this framework, fertility choices are driven by the behavior of parents, whose only objec-

tive is to maximize their lifetime wealth: instrumental to this financial program is the production of children.

When the demand for children depends only on purely financial return, the availability of alternative assets becomes crucial. When financial markets start providing assets which offer high returns, some families would drop fertility as an investment and turn to the market as the return on financial assets exceeds the return on children. This hypothesis of complete substitutability between children and financial assets may be found in the development economics literature (Willis, 1980; Schultz, 1974; Neher, 1971) and has invariably given raise to the statement that better access to financial markets and investment opportunities would invariably lead to a decrease in planned fertility. In a general equilibrium analysis context, Razin and Sadka (1995) have shown that financial deepening does not necessarily carry a drop in fertility. Introducing heterogeneity in preferences and technologies, as well as the basic equilibrium identity between aggregate saving and aggregate borrowing, financial trade opportunities allow some families to invest more in market assets and less in fertility, but at the same time other families must do the opposite, thus increasing fertility. The net balance between these competing forces may well result in higher overall fertility.

The models in the second stream of literature allow for children as durable consumption goods (Hotz, Klerman, and Willis, 1997; Willis, 1973; Becker and Lewis, 1973; Becker, 1960). It is generally assumed that parents are interested in children per se and may find it profitable to borrow against the future in order to finance their children's consumption and investment in human capital. In this case, financial deepening and credit consumption availability may induce an increase in fertility.

In their main contribution on this subject to date, Cigno and Rosati (1996) develop a model of joint determination of fertility and saving. In their framework, fertility behavior can be driven by two mutually exclusive reasons: altruism or selfishness. In the first case, altruism in the utility function runs either backwards, from parents to children, or forwards from children to parents. In the second case, the impossibility of intertemporal trade and the decreasing value of human capital across time make fertility the only available technology for saving for the old age: accordingly, children are instrumental goods in the production of their parents' future utility. In this case, when the return from market investment exceeds the return from fertility, the model predicts that intergenerational family links break up and fertility inevitably declines. Using cointegration analysis, the authors find evidence compatible with the selfish motivation for fertility, although the econometric specification is unable to identify exactly the underlying heterogeneity in the aggregate data, such that the possibility of *both* motivations for fertility cannot be rejected.

As stated above, there is scant evidence on the effects of financial availability on fertility. Cigno and Rosati (1992), employing cointegration analysis on Italian data, find evidence of a positive effect of capital market accessibility on fertility. The lagged ratio of currency held by the non-bank public to bank deposits is the variable selected to proxy for financial backwardness and the corresponding estimated elasticity on fertility lies between -0.662 and -0.711. Using calibrated data, Boldrin, De Nardi, and Jones (2005) find that better access to capital markets accounts for half of the observed drop in fertility in developed countries over the last 70 years; according to their estimates, a reduction in the rate of return on capital of about 20% would increase fertility by 30%. An alternative model by Scotese Lehr (1999) finds that financial intermediation can influence fertility in an indirect fashion. In an econ-

omy with two sectors – a traditional one with low capitalization and a modern one with high capitalization – an increase in the level of financial intermediation lowers the cost of capital, driving up wages in the modern sector. Households then find it optimal to reduce fertility as their members shift labor supply from the labor-intensive sector to the capital-intensive sector. Employing a reduced-form VAR model with panel data on 87 countries from 1965 to 1980, the author finds that some measures of the extent of financial intermediation Granger-cause a drop in fertility. Specifically, the estimated elasticity of fertility with regard to the ratio of money to GDP is -7.7% and the elasticity with regard to the ratio of private credit to GDP is -5.7%.

The link between financial empowerment of women and fertility is also a subject of investigation in the literature on evaluation of microcredit programs, although in this regard the empirical evidence is inconclusive. Since most of such programs target women, the additional financial resources provided tend to shift individual effort from childbearing to income-generating activities. At the same time, the wealth effect can increase the demand for children when these are normal goods. For example, some econometric studies of the Grameen Bank program in Bangladesh (Steele, Amin, and Naved, 2001; Schuler and Hashemi, 1994) observe an increased use of contraceptives resulting in lower fertility, while others (Pitt, Khandker, McKernan, and Latif, 1999; Schuler, Hashemi, and Riley, 1997) find that the impact of the same program on contraceptive use is in fact negligible.

3 Theory

The model represents the choices of a household over the life cycle as determined by the caring relations with its children, and by the trading relations with financial markets. In the following sections the terms household, adult, and agent will be used interchangeably, since we do not model explicitly the interactions between parents; basically, we assume a frictionless unitary setting for family decisions. We also assume parents derive satisfaction from living with their children; similarly, children have an altruistic attitude towards their parents (Ehrlich and Lui, 1991; Nishimura and Zhang, 1992). Given these links, adults spend resources to rear their children and to fund the consumption of their retired parents.

The time sequences of household expenditure and income over the life cycle imply the need to borrow resources in the first years of adulthood and the incentive to save and invest in the capital market later on. Capital markets can be perfect, meaning that households can borrow and save the optimal amounts consistent with their intertemporal budget constraint. Several forms of imperfections, nonetheless, may limit credit availability to households with significant consequences on their decisions. Similarly, opportunities for financial investment can be scarce in economies where property rights are not well enforced and informational asymmetries between lenders and borrowers are severe; in this case, investing in children is an alternative to poor financial market conditions.

We model consumer choice under rationing as a case of the more general theory by Tobin and Houthakker (1950-51). In what follows, for expository convenience, we first present the model with perfect financial markets, and then we turn to the distinct cases of borrowing constraints and limited access to capital markets. Though real economies often present both types of market imperfections, this expository strategy affords a better understanding of the consequences of each kind of market

failure on fertility choice.

3.1 Timing and budget constraints

A household lives for four periods: it is young in the first, young adult in the second, adult in the third, and old in the fourth. Children live with their parents who rear them and take any decisions on their behalf. A young adult works and takes care of her n_t children during the first period of adulthood; she still works when adult and takes care of her old parents; she retires when old. The choice problem starts in the second period of life and spans three periods. The life-cycle utility function of a household who is a young adult at t is:

$$U = U(c_t^1, n_t, c_{t+1}^2, c_{t+2}^3, c_{t+1}^3) \tag{1}$$

where c_t^1 is private consumption during early adulthood, c_{t+1}^2 is private consumption during late adulthood, c_{t+2}^3 is private consumption during old age, and c_{t+1}^3 is private consumption of the parents during their own old age. Each agent's utility is increasing in her private consumption, in the number of her children, and in the consumption of her parents. This function is assumed to be separable across time periods, such that:

$$U = v\left(c_t^1, n_t\right) + u\left(c_{t+1}^2, c_{t+1}^3\right) + g\left(c_{t+2}^3\right) \tag{2}$$

The functions $v(.)$, $u(.)$, $g(.)$ are assumed strictly concave and to satisfy Inada conditions. During each period, choices are constrained by intertemporal and intratemporal requirements.

- In the first period $(t-1)$ agents have no control variable, for their consumption level is entirely determined by their parents. During this period, agents complete their formal education. No choice problem is present.
- In the second period of their life (t) agents become adult and start working, get married, become parents, and use debt to finance their consumption and the cost of their children; they may face borrowing constraints. The budget constraint is:

  $$c_t^1 = (1 - \tau n_t) w_t^1 + D_t \tag{3}$$

  where τ is the cost of raising one child as a share of the labor income, w_t^1, and D_t is the amount of debt.
- In the third period $(t+1)$ parents keep working, pay back their debt, and save for their own old age. In addition, they support their parents by transferring money to them. At the beginning of the same period, their children leave parental house and start working. The budget constraint is:

  $$c_{t+1}^2 = w_{t+1}^2 - R_{t+1} D_t - q_{t+1} - s_{t+1} \tag{4}$$

  where w_{t+1}^2 is labor income, $R_{t+1} \equiv 1 + r_{t+1}$ and r_{t+1} is the interest rate, q_{t+1} is a money transfer towards parents, and s_{t+1} is the value of saving. During the same time period the agent's parents face the following budget constraint:

  $$c_{t+1}^3 = R_{t+1} s_t + n_{t-1} q_{t+1} \tag{5}$$

  where q_{t+1} is the amount of transfers received by the parents from each child.

- In the fourth period $(t+2)$ agents do not work because of their old age. They live on payments from previous financial investments and possibly from transfers from their children. The budget constraint is

$$c^3_{t+2} = R_{t+2}s_{t+1} + n_t q_{t+2} \tag{6}$$

where q_{t+2} is the amount of transfers received by parents from each child.

Substituting D_t, s_{t+1}, and q_{t+1} in the per-period budget constraints, we obtain the consolidated intertemporal budget constraint:

$$c^1_t + \frac{c^2_{t+1}}{R_{t+1}} + \frac{c^3_{t+2}}{R_{t+1}R_{t+2}} + \frac{c^3_{t+1}}{n_{t-1}R_{t+1}} = (1-\tau n_t)w^1_t + \frac{w^2_{t+1}}{R_{t+1}} + \frac{n_t q_{t+2}}{R_{t+1}R_{t+2}} + \frac{s_t}{n_{t-1}}. \tag{7}$$

3.2 Solving the model. Perfect capital markets

The young adult optimization program consists in maximizing the utility function (2) with respect to her life cycle consumption, the number of children, and parents' consumption, subject to the consolidated intertemporal budget constraint, as expressed by (7):

$$\begin{aligned} \max_{c^1_t, n_t, c^2_{t+1}, c^3_{t+1}, c^3_{t+2}} \quad & v\left(c^1_t, n_t\right) + u\left(c^2_{t+1}, c^3_{t+1}\right) + g\left(c^3_{t+2}\right) \\ \text{sub} \quad & (1-\tau n_t)w^1_t + \frac{w^2_{t+1}}{R_{t+1}} + \frac{n_t q_{t+2}}{R_{t+1}R_{t+2}} + \frac{s_t}{n_{t-1}} + \\ & - \left[c^1_t + \frac{c^2_{t+1}}{R_{t+1}} + \frac{c^3_{t+2}}{R_{t+1}R_{t+2}} + \frac{c^3_{t+1}}{n_{t-1}R_{t+1}} \right] = 0. \end{aligned}$$

Following the literature (e.g., Nishimura and Zhang (1992); Lagerlöf (1997)), we assume the household adopts Nash behavior and maximizes the utility function taking the future decisions of the children as given. Hence, the problem is parametric with respect to q_{t+2}, w^1_t, w^2_{t+1},R_{t+1}, R_{t+2}, n_{t-1}, and s_t. The first-order conditions for optimal decisions are obtained by setting to zero the partial derivatives of the Lagrange function L_u for the problem under study:

$$\frac{\partial L_u}{\partial c^1_t} = \frac{\partial v}{\partial c^1_t} - \lambda = 0 \tag{8}$$

$$\frac{\partial L_u}{\partial n_t} = -\tau w^1_t \lambda + \frac{\partial v}{\partial n_t} + \lambda \frac{q_{t+2}}{R_{t+1}R_{t+2}} = 0 \tag{9}$$

$$\frac{\partial L_u}{\partial c^2_{t+1}} = \frac{\partial u}{\partial c^2_{t+1}} - \frac{\lambda}{R_{t+1}} = 0 \tag{10}$$

$$\frac{\partial L_u}{\partial c^3_{t+1}} = \frac{\partial u}{\partial c^3_{t+1}} - \frac{\lambda}{R_{t+1}n_{t-1}} = 0 \tag{11}$$

$$\frac{\partial L_u}{\partial c^3_{t+2}} = \frac{\partial g}{c^3_{t+2}} - \frac{\lambda}{R_{t+1}R_{t+2}} = 0 \tag{12}$$

$$\begin{aligned} \frac{\partial L_u}{\partial \lambda} = & (1-\tau n_t)w^1_t + \frac{w^2_{t+1}}{R_{t+1}} + \frac{n_t q_{t+2}}{R_{t+1}R_{t+2}} + \frac{s_t}{n_{t-1}} + \\ & - \left[c^1_t + \frac{c^2_{t+1}}{R_{t+1}} + \frac{c^3_{t+2}}{R_{t+1}R_{t+2}} + \frac{c^3_{t+1}}{n_{t-1}R_{t+1}} \right] = 0, \end{aligned} \tag{13}$$

where λ is the Lagrange multiplier. The optimality conditions (8), (10) and (12) characterize the tradeoffs between the household's consumption in different ages. According to the f.o.c. (11) the adult chooses the gift to her parent by equating the marginal increase of utility she derives from greater parent's consumption to the the marginal utility cost, that is shared with her siblings. The optimal choice of the number of children, f.o.c. (9), is explained by the balance between the marginal cost of children in terms of utility and two marginal benefits: greater satisfaction from the babies and from the increase in future consumption due to their financial support. By the same token, in equilibrium the gross rate of return on children, which amounts to the ratio of the gift on the cost of a child net of the benefit in terms of current consumption, equals the rate of return of financial investment:

$$\frac{q_{t+2}}{\tau w_t^1 - \frac{\partial v/\partial n_t}{\lambda}} = R_{t+1}R_{t+2}. \tag{14}$$

The model accounts for some of the most important features of adults' life and highlights how they are affected by the financial markets. When these markets work perfectly, the plans of the parents can be fully achieved ensuring maximum satisfaction. In this respect, further insights on an adult's fertility choices come from the comparative statics of n_t with respect to some of the most important parameters. The change in the number of children due to a change in labor income is

$$dn_t = \frac{1}{\Delta}\left[\underbrace{\frac{\partial v}{\partial c_t^1}\tau\Delta_{22}dw_t^1}_{\text{Cost of children}} \underbrace{-(1-n_t\tau)\Delta_{62}dw_t^1 - \frac{\Delta_{62}}{R_{t+1}}dw_{t+1}^2}_{\text{Income effect}}\right] \tag{15}$$

where Δ and Δ_{ij} denote the determinant and the (i,j)-th cofactor of the bordered Hessian matrix of the problem, obtained deriving the first order conditions with regard to c_t^1, n_t, c_{t+1}^2, c_{t+1}^3, c_{t+2}^3, and λ. Among the second-order conditions for utility maximization we find that $\Delta < 0$ and $\Delta_{22} > 0$, which helps examine the sign of (15). Equation (15) displays two kinds of effects: an increase in the parent's income, w_t^1, has an unambiguous negative effect on fertility since it increases the cost of raising a child. Increasing w_t^1 or w_{t+1}^2 results in the usual income effect and in a change in the terms of investment in children. Indeed, we can decompose the last effect by deriving an expression for Δ_{62}:

$$\begin{aligned}\Delta_{62} = &-\frac{\partial^2 g}{\partial\left(c_{t+2}^3\right)^2}\left[\frac{\partial^2 u}{\partial\left(c_{t+1}^2\right)^2}\frac{\partial^2 u}{\partial\left(c_{t+1}^3\right)^2} - \left(\frac{\partial u}{\partial c_{t+1}^2 \partial c_{t+1}^3}\right)^2\right] \times \\ &\times\left[\left(\frac{\partial v}{\partial c_t^1 \partial n_t} - \tau w_t^1 \frac{\partial^2 v}{\partial\left(c_t^1\right)^2}\right) - \frac{q_{t+2}}{R_{t+1}R_{t+2}}\right]\end{aligned} \tag{16}$$

The strict concavity of the utility functions $u(\cdot)$ and $g(\cdot)$ implies that the sign of Δ_{62} depends on the sign of the expression in brackets on the second line of (16), which is made of the difference of two terms. The one in parentheses is either positive when children are normal goods in the maximization of $v\left(c_t^1, n_t\right)$ or negative when they are inferior goods. The fraction $\frac{q_{t+2}}{R_{t+1}R_{t+2}}$ refers to the negative effect on fertility of larger wealth because parents have more resources to fund their old-age consumption. Hence, we derive three possible effects of income on n_t, two negative,

and one positive or negative according to the role children have in young adults' preferences.

The comparative-statics effect of the gift q_{t+2} on n_t is given by:

$$\frac{dn_t}{dq_{t+2}} = -\frac{\Delta^{-1}}{R_{t+1}R_{t+2}}\left[\frac{\partial v}{\partial c_t^1}\Delta_{22} + n_t\Delta_{62}\right]. \tag{17}$$

Greater support from the children to the parents increases n_t since it modifies the trade-off between marginal benefit and marginal cost of fertility by increasing the return from investing in children, while the same change in q_{t+2} displays an income effect which is similar to those already discussed.

The change in the number of children due to a change in the interest rate, assuming that $R_t = R_{t+1} = R$, is given by

$$\frac{dn_t}{dR} = \frac{1}{\Delta R}\left\{\underbrace{\frac{\lambda}{R}\left[\frac{2q_{t+2}\Delta_{22}}{R} - \Delta_{32} - \frac{\Delta_{42}}{n_{t-1}} - \frac{2\Delta_{52}}{R}\right]}_{\text{Substitution effect}} + \underbrace{\Delta_{62}\left(D_t - \frac{s_{t+1}}{R}\right)}_{\text{Financial position}}\right\}.$$

An increase in R has several effects on n_t. As the financial alternative to investment in children yields a higher return, fertility becomes more costly – accordingly, the first term in the summation in brackets is negative. In addition, the household faces stronger incentives to shift expenditure from current items, c_t^1, n_t, to the future, c_{t+1}^2, c_{t+1}^3, c_{t+2}^3. These substitution effects are captured by the cofactors $\Delta_{32}, \Delta_{42}, \Delta_{52}$. The income effects of the interest rate depend on the net financial position of the household, which during its lifetime can borrow more than the amount it saves, or just the opposite. The resulting effect depends on the balance between the two income effects embedded in Δ_{62}.

3.3 The model with borrowing constraints

Now, suppose that households cannot borrow against the future the desired amount of resources, since they undergo rationing in financial markets. This additional constraint prevents expenditure on children and consumption of young adults from exceeding the total amount of resources available during the first period of adulthood. The budget constraint (3) becomes

$$c_t^1 = (1-\tau n_t)w_t^1 + \overline{D}_t \tag{18}$$

where $\overline{D}_t$ is the highest amount of resources that can be borrowed, exogenously given. Accordingly, the maximization program becomes

$$\begin{aligned}
\max_{c_t^1, n_t, c_{t+1}^2, c_{t+1}^3, c_{t+2}^3} \quad & v\left(c_t^1, n_t\right) + u\left(c_{t+1}^2, c_{t+1}^3\right) + g\left(c_{t+2}^3\right) \\
\text{sub} \quad (a) \quad & (1-\tau n_t)w_t^1 + \frac{w_{t+1}^2}{R_{t+1}} + \frac{n_t q_{t+2}}{R_{t+1}R_{t+2}} + \frac{s_t}{n_{t-1}} \\
& - \left[c_t^1 + \frac{c_{t+1}^2}{R_{t+1}} + \frac{c_{t+2}^3}{R_{t+1}R_{t+2}} + \frac{c_{t+1}^3}{n_{t-1}R_{t+1}}\right] = 0 \\
(b) \quad & c_t^1 = (1-\tau n_t)w_t^1 + \overline{D}_t.
\end{aligned}$$

Substituting the borrowing constraint (18) into the utility function, we are able to derive the corresponding Lagrangian function L_d:

$$\begin{aligned} L_d =& v\left((1-\tau n_t)w_t^1 + \overline{D}_t, n_t\right) + u\left(c_{t+1}^2, c_{t+1}^3\right) + g\left(c_{t+2}^3\right) + \\ &+ \lambda_d \left\{(1-\tau n_t)w_t^1 + \frac{w_{t+1}^2}{R_{t+1}} + \frac{n_t q_{t+2}}{R_{t+1}R_{t+2}} + \frac{s_t}{n_{t-1}} + \right. \\ &\left. - \left[\overline{D}_t + \frac{c_{t+1}^2}{R_{t+1}} + \frac{c_{t+2}^3}{R_{t+1}R_{t+2}} + \frac{c_{t+1}^3}{n_{t-1}R_{t+1}}\right]\right\}, \end{aligned} \tag{19}$$

where λ_d is the Lagrange multiplier. This maximization program lacks one variable when compared to the corresponding unconstrained program, because the household now is free to choose either n_t or c_t^1, but not both. The first order conditions for this problem resemble those found in the case without borrowing constraint, with two exceptions. Condition (8) has been dropped since c_t^1 is not a command variable when the borrowing constraint is binding. The partial derivative of (19) with regard to λ_d now reflects the borrowing constraint (18):

$$\begin{aligned} \frac{\partial L_d}{\partial \lambda_d} =& (1-\tau n_t)w_t^1 + \frac{w_{t+1}^2}{R_{t+1}} + \frac{n_t q_{t+2}}{R_{t+1}R_{t+2}} + \frac{s_t}{n_{t-1}} + \\ &- \left[\overline{D}_t + \frac{c_{t+1}^2}{R_{t+1}} + \frac{c_{t+2}^3}{R_{t+1}R_{t+2}} + \frac{c_{t+1}^3}{n_{t-1}R_{t+1}}\right] = 0 \end{aligned} \tag{20}$$

From differentiating the first order conditions, we obtain the comparative statics effects of the exogenous variables on n_t. First, consider a change in fertility driven by a change in wages:

$$\begin{aligned} dn_t =& \frac{1}{\Gamma}\left\{\left[(1-\tau n_t)\left(\tau w_t^1 \frac{\partial^2 v}{\partial\left(c_t^1\right)^2} - \frac{\partial v}{\partial c_t^1 \partial n_t}\right) + \tau \frac{\partial v}{\partial c_t^1}\right] \times \right. \\ &\left. \times \Gamma_{11} dw_t^1 - \frac{\Gamma_{51}}{R_{t+1}} dw_{t+1}^2\right\} \end{aligned} \tag{21}$$

where Γ and Γ_{ij} denote the determinant and the (i,j)-th cofactor of the bordered Hessian matrix of the problem obtained deriving the first order conditions with regard to n_t, c_{t+1}^2, c_{t+1}^3, c_{t+2}^3, and λ_d. In this case, $\Gamma > 0$ and $\Gamma_{11} < 0$ are required for the maximization problem to reach an optimal solution. The influence of w_t^1 on n_t can be interpreted in terms of income and cost of children effects as in the case of perfect markets. The cofactor Γ_{51} is given by:

$$\Gamma_{51} = -\frac{\partial^2 g}{\partial\left(c_{t+2}^3\right)^2}\left[\frac{\partial^2 u}{\partial\left(c_{t+1}^2\right)^2}\frac{\partial^2 u}{\partial\left(c_{t+1}^3\right)^2} - \left(\frac{\partial u}{\partial c_{t+1}^2 \partial c_{t+1}^3}\right)^2\right] > 0.$$

The interpretation of Γ_{51} can be grasped from the comparative-statics effect of the gift q_{t+2} on n_t:

$$\frac{dn_t}{dq_{t+2}} = -\frac{1}{\Gamma}\left[\frac{\lambda_d}{R_{t+1}R_{t+2}}\Gamma_{11} + \frac{n_t}{R_{t+1}R_{t+2}}\Gamma_{51}\right]. \tag{22}$$

This last equation can be given the same interpretation as equation (17), which holds in the case of perfect markets. If the gift from each child increases, then parents are able to obtain the desired old-age consumption by raising fewer children. By making use of these results, the income effects in eq. (21) can be interpreted in the same fashion as for the unconstrained case.

The problem of utility maximization is parametric with respect to the credit ceiling $\overline{D}$. Higher credit availability will impact on household fertility according to the following expression:

$$\frac{dn_t}{d\overline{D}_t} = \frac{1}{\Gamma}\left\{\underbrace{\left(\tau w_t^1 \frac{\partial^2 v}{\partial\left(c_t^1\right)^2} - \frac{\partial v}{\partial c_t^1 n_t}\right)}_{\substack{>0 \text{ if fertility is inferior good} \\ <0 \text{ if fertility is normal good}}} \times \Gamma_{11} + \Gamma_{51}\right\} \tag{23}$$

Equation (23) clearly shows two causal effects of credit availability on fertility. As the value of $\overline{D}$ grows – more credit is available to households – young parents command a greater amount of their future resources, and spend these resources on consumption and children. If children are normal goods in household's preferences then n_t will increase; otherwise, it will decrease. Furthermore, the same increase in $\overline{D}$ implies lower income available for consumption during retirement. Hence, the household will react by increasing investment in children, i.e., raising the number of children n_t. The sign of $dn_t/d\overline{D}_t$ is undetermined from a theoretical point of view if children are inferior goods. This hypothesis finds support in the empirical analysis of fertility after World War II showing a strong correlation between income growth and fertility decline (Jones, Schoonbroodt, and Tertilt, 2008).

3.4 The model with saving constraints

As mentioned above, the desire to smooth consumption over the life cycle provides a major incentive to save. Since children can also provide support to their retired parents, fertility becomes crucial in determining the optimal amount of saving. Accordingly, households interact with the financial markets not only as borrowers, but as lenders too. In this role of lenders, households may face a different type of market imperfection: a poorly organized financial market – possibly for technological or institutional reasons – can either provide few opportunities to invest and for effective risk diversification, or may impose severe costs upon those accessing them. This situation has been termed *saving constraint* in the literature (Pollin, 1997) and refers to the adverse role on savings played by a low level of financial deepening (McKinnon, 1973; Shaw, 1973). When access to financial investment as lenders is limited by saving constraints, investment in children becomes an attractive alternative.

Assume now that financial markets are so poorly developed that economic agents face significant access costs. In the following, we analyze the model of household choice by assuming that the optimal desired value of saving s_{t+1} is higher than the ceiling $\overline{s}_{t+1}$. Hence, adults face the following constraint:

$$c_{t+2}^3 = R_{t+2}\overline{s}_{t+1} + n_t q_{t+2}, \tag{24}$$

which shows that both financial investment and fertility contribute to ensure old age

consumption. Accordingly, the maximization program becomes:

$$\max_{c_t^1, n_t, c_{t+1}^2, c_{t+1}^3, c_{t+2}^3} \quad v\left(c_t^1, n_t\right) + u\left(c_{t+1}^2, c_{t+1}^3\right) + g\left(c_{t+2}^3\right)$$

$$\begin{aligned} \text{sub} \quad (a) \quad & (1-\tau n_t) w_t^1 + \frac{w_{t+1}^2}{R_{t+1}} + \frac{n_t q_{t+2}}{R_{t+1} R_{t+2}} + \frac{s_t}{n_{t-1}} \\ & - \left[c_t^1 + \frac{c_{t+1}^2}{R_{t+1}} + \frac{c_{t+2}^3}{R_{t+1} R_{t+2}} + \frac{c_{t+1}^3}{n_{t-1} R_{t+1}} \right] = 0 \\ (b) \quad & c_{t+2}^3 = R_{t+2} \overline{s}_t + n_t q_{t+2}, \end{aligned}$$

where we assume that household borrowing is not restricted. Plugging the saving constraint into the utility function and into the consolidated intertemporal budget constraint, we can write the new Lagrangian function L_s as

$$\begin{aligned} L_s = & v\left(c_t^1, n_t\right) + u\left(c_{t+1}^2, c_{t+1}^3\right) + g(R_{t+2} \overline{s}_{t+1} + n_t q_{t+2}) + \\ & + \lambda_s \left\{ (1-\tau n_t) w_t^1 + \frac{w_{t+1}^2 - \overline{s}_{t+1}}{R_{t+1}} + \frac{\overline{s}_t}{n_{t-1}} \right. \\ & \left. - \left[c_t^1 + \frac{c_{t+1}^2}{R_{t+1}} + \frac{c_{t+1}^3}{n_{t-1} R_{t+1}} \right] \right\}. \end{aligned} \tag{25}$$

The first order conditions for this problem resemble those found in the case without borrowing constraint, with two exceptions. Condition (10) has been dropped since c_{t+2}^3 is no longer a command variable as the saving constraint is binding. The partial derivative of (25) with regard to λ_s now reflects the saving constraint

$$\frac{\partial L_s}{\partial \lambda_s} = (1-\tau n_t) w_t^1 + \frac{w_{t+1}^2 - \overline{s}_{t+1}}{R_{t+1}} + \frac{\overline{s}_t}{n_{t-1}} - \left[c_t^1 + \frac{c_{t+1}^2}{R_{t+1}} + \frac{c_{t+1}^3}{n_{t-1} R_{t+1}} \right] = 0 \tag{26}$$

As in the previous subsection, we are interested in the change of n_t in response to exogenous changes in the model's parameters, especially that related to capital market accessibility. First, consider how fertility changes as labour income increases:

$$dn_t = \frac{1}{\Phi} \left\{ [\lambda_s \tau \Phi_{22} - (1-\tau n_t) \Phi_{52}] dw_t^1 - \frac{\Phi_{52}}{R_{t+1}} dw_{t+1}^2 \right\}$$

where Φ and Φ_{ij} denote the determinant and the (i,j)-th cofactor of the bordered Hessian matrix of the problem, obtained deriving the first order conditions with regard to c_t^1, n_t, c_{t+1}^2, c_{t+1}^3, and λ_s. Among the second order conditions for a maximum of the problem (25) we have $\Phi > 0$ and $\Phi_{22} < 0$. Since Φ_{52} equals

$$\Phi_{52} = - \left[\frac{\partial^2 u}{\partial \left(c_{t+1}^2\right)^2} \frac{\partial^2 u}{\partial \left(c_{t+1}^3\right)^2} - \left(\frac{\partial u}{\partial c_{t+1}^2 \partial c_{t+1}^3} \right)^2 \right] \left(\frac{\partial v}{\partial c_t^1 \partial n_t} - \tau w_t^1 \frac{\partial^2 v}{\partial \left(c_t^1\right)^2} \right),$$

the interpretation of the effects of labour income on fertility can follow along the lines of the preceding cases. The same arguments can be used to justify the effects of q_{t+2} and R on n_t. The case of constrained access to financial markets, by contrast, raises a novel question concerning the reaction of a household's fertility to greater investment opportunities, given by

$$\frac{dn_t}{d\overline{s}_{t+1}} = \frac{1}{\Phi} \left(\frac{\Phi_{52}}{R_{t+1}} - q_{t+2} R_{t+2} \frac{\partial^2 g}{\partial \left(c_{t+2}^3\right)^2} \Phi_{22} \right). \tag{27}$$

In this expression, the term

$$-q_{t+2}R_{t+2}\frac{\partial^2 g}{\partial\left(c_{t+2}^3\right)^2}\Phi_{22}<0$$

refers to the trade-off between the investment in children and that in financial activities. The sign of the term is negative because greater financial investment opportunities reduce the need to raise children for old age consumption. The other component of the effect of $\overline{s}_{t+1}$ on n_t has the opposite sign of the income effect of wages, determined by the sign of Φ_{52}. If parent appreciate children as normal good, then fertility will increase with w_t^1 (or with w_{t+1}^2), and will decrease with $\overline{s}_{t+1}$. Indeed, given the intertemporal budget constraint, when $\overline{s}_{t+1}$ increases young adults reduce their debt. As a result, their resources will be lower and fertility will drop. The case of children as inferior goods implies the opposite positive effect.

Our comparative statics results so far suggest that, when children are normal goods in the household's preferences, fertility unambiguously decreases with easier access to financial markets; by contrast, when children are inferior goods, the sign of the effect of financial markets accessibility on fertility remains theoretically indeterminate.

4 Empirical estimation

In this section the demand functions for fertility derived from the theoretical model are estimated empirically using data from a panel of countries, including both MDCs and LDCs, since the theoretical model is general enough to be applied to any type of population, regardless of its stage of economic development. The econometric exercise is carried out to find evidence for an economically significant impact of financial markets on fertility behavior and to check for alternative explanations.

We first introduce our empirical specification, then turn to data description, and finally show various estimates along with some robustness checks.

4.1 Model specification

Our theoretical model predicts that desired fertility should be responsive, among other things, both to borrowing constraints and to opportunities to access the capital markets. While borrowing constraints reflect the uneasiness of borrowing resources in the first section of the life cycle to finance transfers to children, saving constraints reflect the limited availability of instruments to allocate savings in the second section of the life cycle. When both these aspects play a distinct role in determining fertility, these two variables need to be accounted for separately. This is a peculiar feature of our approach, since the previous literature does not distinguish among different sources of imperfections in financial markets.

Our previous discussion established the following reduced-form equation for fertility, in which the number of children per woman is determined by a set of exogenous variables:

$$n_t = n\left(w_t^1, w_{t+1}^2, R_{t+1}, R_{t+2}, q_{t+2}, \tau, \overline{D}_t, \overline{s}_{t+1}\right) \tag{28}$$

In what follows, we assume that the parameters q_{t+2} and τ differ across countries, but stay constant across time for each country. Accordingly, we are in a position to

formulate an empirical counterpart of eq. (28) based on a panel specification of the following type:

$$\mathrm{TFR}_{i,t} = \beta_0 + \mathrm{X}'_{i,t-1}\beta_1 + \mathrm{BOR}'_{i,t-1}\beta_2 + \mathrm{FIN}'_{i,t-1}\beta_3 + u_i + \phi_t + \varepsilon_{i,t} \tag{29}$$

where TFR is the natural logarithm of the total fertility rate, BOR is a vector of variables used to approximate the easiness of access to borrowing, FIN is a vector of variables describing the development of investment opportunities in capital markets, X is a set of additional ancillary controls, u is a country-specific, time-unvarying, error term, ϕ is a time effect, and ε is an error term with $E[\varepsilon] = 0$. The subscript i is for countries, while t is for time periods.

The structure of time subscripts needs some explanations. Since the model developed in the theoretical section can be considered an approximation of long-run fertility behavior, the construction of the dataset was conducted according to two basic premises about fertility decisions: (a) they take time to develop their consequences and (b) involve expectations about the long run. The first of these premises implies that a dynamic specification for eq. (29) is needed, while the second implies some sort of smoothing to approximate the long-run values of the variables of interest in order to increase the signal-to-noise ratio. Consequently, each observation is obtained averaging the value of a given variable over a period of non-overlapping five years,[3] with all variables representing ratios being averaged by harmonic means.

4.2 Data description

Our fundamental dependent variable, the number of children per family, has its demographic counterpart in the total fertility rate. This rate amounts to the number of children born to an average woman over her reproductive years (15–49), obtained as the sum of the age-specific fertility ratios. Unlike the net reproduction rate, this measure is independent of a population's age structure. This variable is extracted from the World Bank's World Development Indicators (2007), a wide dataset of observations on demographic, economic and social aspects of life collected at the country level from 1960 to 2006.

The set of additional controls included in the variable X contains: the log of GDP per capita (GDP), the participation rate of women in the labor force (FLFP), the urbanization rate (URBAN) and the real interest rate (INTRATE). These controls, extracted from World Bank's World Development Indicators (2007), are indicated in the literature (e.g., Schultz (1997) and Ehrlich and Kim (2007)) as relevant covariates in the determination of fertility. While the majority of these variables have been collected since 1960, the participation of women in the labor force is a major exception, for its availability is limited to a time window running only from 1980 onward. A further variable, included in some specifications of our empirical model,[4] is the ratio of public pensions to GDP, extracted from the ILO's database. The description of each variable is reported in table 1, while basic statistics for the sample are reported in table 2. These figures are for the complete sample, while the various subsamples used for estimation are made up of observations for which the whole set of variables

[3] This temporal smoothing is used, among others, by Ehrlich and Kim (2007) in the study of fertility and by Beck, Demirgüç-Kunt, and Levine (2004) in the study of financial development.

[4] See subsection 4.6 for further details.

– dependent and independent – are non-missing. Accordingly, each estimation table reports the number of countries and the number of observations included in the calculation.

TABLE 1
DESCRIPTION OF VARIABLES

		Availability	
Variable	**Description**	**From**	**Until**
TFR	Log of total fertility rate: number of children born to an average woman over her reproductive years *	1960	2006
GDP	Log of per capita gross domestic product *	1960	2006
HIGHINC	Dummy for high income countries *	1960	2006
URBAN	Urbanization rate, as the ratio of population living in urban areas divided by total population *	1960	2006
FLFP	Female labor force participation *	1980	2006
INTRATE	Real interest rate *	1960	2006
DBACBA	Ratio of deposit money bank claims on domestic nonfinancial real sector to the sum of deposit money bank and Central Bank claims on domestic nonfinancial real sector **	1960	2006
INSLIFE	Life insurance premium volume as a share of GDP **	1960	2006
STMKCAP	Value of listed shares to GDP, deflated **	1975	2006
PRIVCRED	Private credit by deposit money banks to GDP, deflated **	1960	2006
PENSIONS	Public pensions expenses to GDP ***	1985	1999

Source: Variables denoted by * are from World Development Indicators (2007). Variables denoted by ** are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605. Variable denoted by *** is from the International Labor Office's Social Security Expenditure Database, available online at `https://www.ilo.org/dyn/sesame/ifpses.socialdbexp`.
Note: All variables averaged over non-overlapping five years.

With the exception of the real interest rate, the financial variables are extracted from the study published by Beck, Demirgüç-Kunt, and Levine (2000). Since borrowing constraints and access to financial markets are multidimensional phenomena, we consider these variables as reliable proxies for the financial difficulties actually experienced by families and we try alternative specifications to check for the robustness of our results.

For borrowing constraints we have two main indicators: DBACBA and PRIVCRED. The first variable is the ratio of deposit money bank claims on the domestic nonfinancial real sector to the sum of deposit money bank and Central Bank claims on the domestic nonfinancial real sector. The second variable is the value of private credit by deposit money banks to GDP. Countries with high values of DBACBA have a high proportion of credit allocated in the banking sector, while in countries with low values money is held by central banks: with high values, a larger fraction of liquidity can be used by families to borrow against the future. High values of PRIVCRED testify a flourishing market for credit in general and also for credit to households.

Financial opportunities variables are represented in our estimates by INSLIFE and STMKCAP: the first is the volume of life insurance premium to GDP, the second is the value of listed shares to GDP. Life insurance is a kind of long-term financial investment made by households who are worried about a sharp fall in their wellbeing during old age. Indeed, if one of the spouses

were to die, the other could incur severe income losses.[5] Furthermore, life insurance contracts often include the alternative – very similar to a private pension – of an annual payment starting on a certain date when the subscriber is still alive. The presence of a developed stock market in a country also signals the relative importance of investment opportunities which can be taken by households to shift their resources to later ages.

TABLE 2
SAMPLE STATISTICS

							Quartiles		
Variable	Countries	N	Mean	σ	Min	Max	25%	50%	75%
Demographics									
TFR	202	1,933	1.31	0.54	-0.13	2.16	0.84	1.40	1.82
Economy									
GDP	186	1,480	7.49	1.55	4.43	10.92	6.18	7.39	8.73
HIGHINC	229	2,197	0.27	0.44	0.00	1.00	0.00	0.00	1.00
URBAN	207	2,064	0.48	0.25	0.02	1.00	0.28	0.47	0.68
FLFP	186	1,100	0.39	0.09	0.06	0.54	0.35	0.41	0.46
Financial Structure									
INSLIFE	102	561	0.02	0.03	0.00	0.36	0.00	0.01	0.02
STMKCAP	114	489	0.40	0.53	0.00	5.28	0.07	0.20	0.51
PRIVCRED	161	1,147	0.38	0.35	0.00	2.31	0.13	0.25	0.52
DBACBA	176	1,329	0.79	0.21	0.03	1.27	0.68	0.86	0.96
INTRATE	170	898	0.05	0.09	-0.46	0.47	0.02	0.06	0.10
Public Welfare									
PENSIONS	95	151	0.09	0.10	0.00	0.38	0.01	0.05	0.16

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605.
NOTE – Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$.

To perform a first check of the relationship implied by the theoretical model, we regress the natural log of the TFR on the financial variables of interest, each separately using random effects and fixed effects estimators. We also distinguish in the sample between rich and developing countries according to the classification provided by the World Bank. The corresponding results are reported in table 3. Also, the third and sixth column of the table show the x-standardized beta coefficients, obtained by regressing the natural log of the TFR on the z-score of the financial variable under study: for a standard deviation increase in the x financial variable of interest, the total fertility rate is expected to change by $\beta\sigma_x$ percent points. The estimated values basically amount to univariate correlations between the fertility rate and the financial variable under study. Given the absence of controls, these figures represent a crude measure of linear association between TFR and finance-related variables.

[5]This situation is quite important in those countries where the share of females who do not have a job is high, also because women on average live longer than men.

These estimates display a number of facts. First, the figures for the whole sample show that the choice of the estimation technique – fixed or random effects – does not produce largely different results. Secondly, all financial variables impact negatively on fertility rate: from the inspection of the standardized beta, it becomes clear that the strongest predictor of a change in fertility rate is PRIVCRED: a one standard deviation increase in the private credit to GDP ratio reduces fertility by $\approx 18\%$. Thirdly, considerable differences emerge when the sample is split according to income group.

While PRIVCRED impacts on rich and poor countries in almost the same fashion, rich countries' fertility tends to be strongly associated with DBACBA, while the impact of this variable is significantly lower for low-income countries. A similar pattern is displayed by INSLIFE. An exception to this pattern is displayed by STMKCAP: here the negative impact on fertility looks greater in low-income countries.

From this first survey of the data, we receive the impression that the responsiveness of fertility to financial variables differs systematically among income groups. This feature is accounted for in the full model and modeled accordingly.

TABLE 3
BASIC REGRESSIONS
Dependent variable: log of total fertility rate

	Random Effects			Fixed effects				
	β	p-value	$\beta\sigma_x$	β	p-value	$\beta\sigma_x$	Countries	N
All countries								
DBACBA	-0.315	(0.000)	-0.068	-0.241	(0.014)	-0.052	173	1,139
INSLIFE	-2.277	(0.002)	-0.057	-2.054	(0.153)	-0.052	100	475
PRIVCRED	-0.562	(0.000)	-0.183	-0.516	(0.000)	-0.168	160	989
STMKCAP	-0.224	(0.000)	-0.100	-0.217	(0.000)	-0.097	113	376
Rich countries								
DBACBA	-1.494	(0.000)	-0.124	-1.538	(0.000)	-0.128	38	287
INSLIFE	-1.709	(0.015)	-0.051	-1.609	(0.222)	-0.048	36	233
PRIVCRED	-0.417	(0.000)	-0.154	-0.411	(0.000)	-0.151	39	288
STMKCAP	-0.078	(0.000)	-0.044	-0.074	(0.013)	-0.042	35	130
Poor countries								
DBACBA	-0.180	(0.001)	-0.040	-0.142	(0.125)	-0.032	135	852
INSLIFE	-6.092	(0.002)	-0.092	-7.092	(0.023)	-0.107	64	242
PRIVCRED	-0.771	(0.000)	-0.143	-0.755	(0.000)	-0.140	121	701
STMKCAP	-0.516	(0.000)	-0.141	-0.547	(0.000)	-0.150	78	246

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605.

NOTE – Dependent variable: log of total fertility rate. DBACBA = deposit money bank assets / (deposit money + central) bank assets, PRIVCRED = private credit by deposit money banks / gross domestic product, INSLIFE = life insurance premium volume / gross domestic product, STMKCAP = stock market capitalization / gross domestic product. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$. Standard errors at 95% in parentheses. Statistical significance asterisks: $*$ = 10%, $**$ = 5%, $***$ = 1%.

4.3 Estimation technique

From the empirical point of view, fertility choice is a very complex phenomenon, deeply intertwined with a large number of economic and social variables. Many of these variables are unobservable in the publicly available data collections while others are intrinsically nonmeasurable, like those related to deeply rooted mental habits, cultural influences, religious traditions, and the like. Given that these variables change only slowly, the elective method of estimation must allow for the exclusion of relevant variables while reducing to zero the omitted variable bias. In our context, this method is a fixed-effect panel estimator with robust standard errors.

Some variables, such as per capita GDP and female labor force participation, could also be influenced by fertility itself. This problem could in principle constitute a threat to a causal interpretation of regression results. To check for this source of bias, several tests of endogeneity of GDP and FLFP were performed, but the results cannot reject the exogeneity assumption.

The empirical model to be estimated is also prone to display spurious correlation: even in the absence of a precise causal link, it is likely that the countries with high levels of financial development also display low levels of fertility since both aspects could be side effects of economic development. We deal with this issue in several ways. First, the use of a five year average smooths out short-run movements in the variables that could induce serial correlation which is not present in the steady state.[6] Second, the dynamic formulation of the empirical models accounts only for links between actions taken at $t-1$ and outcomes happening at t: in this case, the simultaneous determination of fertility and financial variables is ruled out by construction.

Unobserved heterogeneity can be a serious issue when modeling fertility. Some countries, during a demographic transition, experience a sharp decrease in the number of children per woman, while fertility in countries which have already reached a steady-state nirvana changes only marginally from year to year. This feature drives us to adopt a heteroskedasticity-robust estimator for the standard errors of the model.

The exercise shown in table 3 reveals the presence of nonlinearities in our key financial variables with regard to their effect on fertility. We take this issue seriously and we systematically interact the financial variables with the dummy for high income (HIGHINC).

Results

The results of the estimated models are presented in table 4 and table 5. To model financial market imperfections, in the first model's specification we use DBACBA and PRIVCRED, while in the second we use INSLIFE and STMKCAP. Table 7 elaborates the results of preceding tables using z-scores instead

[6] The presence of a time trend in the dependent variable is in principle capable of distorting OLS estimates. However, we find no evidence of serial correlation in our model.

of levels for the independent variables. With this transformation, the estimated parameters reflect the percentage change in the fertility rate due to a one-standard deviation change in an independent variable. Since the magnitude and variance of the independent variables vary considerably across countries and time, this adjustment may prove useful in interpreting the estimates. Accordingly, our comments mostly focus on table 7.

The first four columns of table 4 and the first three of table 5 present estimated coefficients for the fixed effect model, while the remaining columns add the year-specific term ϕ_t, as mentioned in eq. (29). Columns 1 and 5 display the coefficients for the models stripped of all finance-related variables: this basic formulation of the model affords appreciation of the backbone variables used as controls. The intercepts are not displayed because they are not particularly informative.

The overall fit of the two alternative specifications – with and without time effects – is satisfactory, ranging from 48% to 63% of the total observed variability. Unsurprisingly, the models with time dummies display a higher R^2 when compared with the corresponding models without dummies, since most OECD countries displayed a common tendency to reduce fertility, probably captured by the time term. However, the inclusion of this variable does not dramatically change the value of the estimated parameters. Given these negligible discrepancies in the models estimated with and without a common temporal trend, table 7 elaborates on estimates obtained *without* temporal dummies.

The effect of interest rate on fertility is uniformly negative. A one standard deviation change in the interest rate produces a 1.5%–2.9% drop in the fertility rate, as shown in table 7. This evidence can be easily rationalized in the framework of our theoretical model. Whether children are an investment or a consumption good, a higher return of financial investment increases their relative price with regard to alternative options. In the first case, when children are an investment good and their return is exogenously given, higher interest rates decrease their relative return and drive down fertility rates. In the second case, when children are a durable consumption good, an increase in the interest rate reduces fertility to the benefit of other types of consumption goods.

Consistently with the literature on the determinants of fertility, we also found that higher levels of participation of women in the labor force and higher urbanization rates are associated with lower TFR. The effect of an increase in GDP is also associated with a reduction of fertility, even though the effect becomes very imprecisely estimated once temporal dummies and financial variables are added to the model.[7]

[7] More on the relationship between income and fertility can be found in Jones, Schoonbroodt, and Tertilt (2008) and in Jones and Tertilt (2006).

4.4 Borrowing constraints

The variables used to capture the presence of borrowing constraints are DBACBA and PRIVCRED. Since higher values of DBACBA correspond to a higher fraction of bank credit to total credit, this presumably translates in a larger credit availability and weaker borrowing constraints. We find that this variable displays an influence on the TFR and that influence is dependent upon income. Indeed, the use of a dummy to distinguish poor and rich countries seems useful since the effect of financial variables changes sign from one group of countries to the other. More specifically, in LDCs, the effect of a one standard deviation increase in the DBACBA ratio reduces fertility by 1.8%–3.8%. On the contrary, the same variable has a positive impact on the fertility in the high income countries, with a change of 3.2%–17.2%.

The other variable used for borrowing constraints is PRIVCRED: compared to DBACBA, its effect on fertility displays a similar pattern. In developing countries, a one standard deviation increase in the PRIVCRED ratio reduces fertility by 1.7%–5.1%, while in rich countries the effect is an increase which goes from a negligible 0.5% to a considerable 5%. The simultaneous inclusion of STMKCAP results in a loss of statistical significance which suggests a high level of collinearity between these two variables. The Wald test for joint statistical significance reported in table 5 shows that including PRIVCRED enhances overall estimation precision when STMKCAP is included.

These findings corroborate our main assumption that the availability of private credit systematically relates to fertility behavior. They also reveal some interesting features of this relation. The negative sign of credit availability parameters in LDCs can be ascribed to a negative income effect which characterizes children as an inferior good in poor countries, which seems to prevail over the positive one predicted by the theory due to the larger investment in children. Interpretation of the positive effect of the variables DBACBA and PRIVCRED on fertility which is distinctive of high income countries, relies on the role of children as a means to ensure their parents' old age consumption. Indeed, if households are allowed larger credit amounts later in the life cycle, they will also need some resources to pay back their debt. Hence, when the young adult borrows she will enjoy a higher welfare and reduce the number of children, but will also feel the need to have more children to achieve the planned consumption during retirement.

4.5 Investment opportunities

The variables we used to describe the degree of development of capital markets, INSLIFE and STMKCAP show in our estimates significant parameters both for high- and low-income countries. These estimates appear quite robust to the joint inclusion of credit constraint variables.

As in the case of borrowing constraints variables, the estimated parameters differ with regard to income groups. In the subsample of developing countries, one standard deviation increase in INSLIFE decreases fertility by

3.5%–5.2%, while in the subsample of rich countries the same increase gives raise to an increase of 2%–3.1% in the fertility rate.

Finally, the alternative specification of the regression model with the inclusion of the ratio of stock market capitalization to GDP shows that an increase of one standard deviation of STMKCAP results in a decrease of 7.4%–10.1% in the fertility rate for developing countries, while the same change in STMKCAP increases fertility by 1%–1.6% in high-income countries.

In low-income countries families may well encounter greater obstacles in investing their savings: there might be serious problems in the supply side of financial market services which prevent an efficient provision of intergenerational transfers towards the elderly. Hence, the expansion of capital markets induces a reduction in fertility. The same effect of better access to capital markets should be less important in high-income countries where opportunities for saving are already high. The positive sign of the parameters INSLIFE and STMKCAP in this group of countries confirms the finding that children are inferior goods also there. This effect of greater savings opportunities seems to prevail over that of considering children as an investment good.

4.6 The role of public pensions

Private capital markets are not the only device to save for old age and to obtain consumption smoothing across the life cycle. In many countries, governments provide elders with publicly-funded pensions financed through a pay-as-you-go system. This intergenerational transfer is made up by taxation on youths and a corresponding transfer to elders. As neither of these actions is voluntary, it is questionable whether they actually implement a social optimum. Nonetheless, public pension systems diminish the need to access private financial markets for old age support, resulting at least in a partial offset of freely-chosen savings. In other words, a public pension system, though not a market in the proper sense, provides a very similar kind of intertemporal trade.

The literature about the impact of public pensions on fertility almost invariably conjectures that the massive increase in the volume of state-provided pensions could be responsible for the marked decline in fertility which has been observed in developed countries since the 1970s and which is beginning to show in LDCs.

This explanation for the drop in fertility due to the increase in publicly-funded pensions constitutes an alternative framework in which (1) economic growth explains both the development of private financial markets *and* the development of public pension systems, but (2) the main driving force beyond the change in fertility is the expansion of the public pension system. If this explanation is true, then the inclusion of some measure of public pensions in eq. (29) would result in a strong coefficient for pensions and in a negligible coefficient for private financial markets. Hence, the observed correlation between financial opportunities and fertility would simply mask a genuine causal relation running from public pensions to fertility.

We tackle this potential threat to internal validity with a new regression model. To test for the significance of opportunity for employing private savings, on condition that the public sector provides pensions, we estimate the following model

$$\mathrm{TFR}_{i,t} = \gamma_0 + \mathrm{X}'_{i,t-1}\gamma_1 + \gamma_2 \mathrm{PEN}_{i,t-1} + \gamma_3 \mathrm{FIN}_{i,t-1} + \gamma_4 \left(\mathrm{FIN}_{i,t-1}\mathrm{PEN}_{i,t-1}\right) + u_i + \varepsilon_{i,t} \tag{30}$$

in which PEN is the ratio of public pensions to GDP, FIN is alternatively the ratio of life insurance to GDP or stock market capitalization, and X is the set of additional controls already included in the previous model. The results from the estimation of this model are displayed in table 8.

Now, pensions are also being interacted with the variables representing credit availability because these variables can be complements or substitutes in determining fertility. Consequently, the full effect of private finance or pensions on fertility is obtained using also the interaction parameter γ_4 times some statistics of the other variable. For example, the expected change in fertility in response to a unitary change in a private finance variable is

$$\frac{\partial E\left[\mathrm{TFR}_{i,t}\right]}{\partial \mathrm{FIN}_{i,t-1}} = \gamma_3 + \gamma_4 E\left[\mathrm{PEN}_{i,t-1}\right].$$

Since the estimated value of γ_3 is negative while that of γ_4 is positive, the sign of the full derivative will depend on the expected value of PEN. For this derivative to be positive we must have

$$E\left[\mathrm{PEN}_{i,t-1}\right] \geq -\gamma_3/\gamma_4$$

and similar conditions hold for the other derivatives. The systematic inspection of these thresholds for positivity of derivatives is displayed in table 9.

The econometric technique used for estimating the model is the panel between-effects estimator. Although an estimator allowing for unobserved heterogeneity would be preferable to obtain a comparison closer to the previously estimated regression models, the limited availability of the pensions' time series severely restricts our choice of estimators.

The figures reported in table 8 show the overall significance in the estimated models of the financial variables INSLIFE and STMKCAP with PENSIONS. Hence, there is evidence that INSLIFE and STMKCAP keep playing a substantial role in explaining the change in the TFR, even when the regression model includes public pensions. Complete analysis of the effects requires a close look at the effect of interactions, as reported in table 9.

Such estimates afford a new view on the effect of life insurance on fertility once the role of public pensions is taken into account. We find that the effect of life insurance premiums is positive when the ratio of public pensions to GDP is higher than 11.5%. Since the mean value of PENSIONS is 4.1% for low-income countries, while it is 19.7% for high-income countries, the effect of life insurance is negative for many low-income countries and positive for many high-income countries.

The effect of stock market capitalization is also positive as the ratio of public pensions to GDP exceeds 3.8%. Given that the distribution of PENSIONS in low-income countries is dispersed around a mean of 4.1% with a standard deviation of 5.9%, for most poor countries the impact of STMKCAP may well be negative. A positive effect of STMKCAP can be found for several high-income countries which are characterized by higher PENSIONS ratios.

Conversely, also the effect of public pensions depends on access to financial markets. The effect of PENSIONS becomes positive as the life insurance ratio exceeds 3.5% which can be observed mainly in high-income countries. Moreover, public pensions impact positively on fertility when stock market capitalization exceeds 81.7%: these figures are likely to be observed mostly in the right-hand tail of high-income countries distribution.

Given the high correlation between the variables PENSIONS and GDP ($r = 0.64$), the whole set of econometric results looks consistent with those obtained in the models of the previous subsections where a dummy was used to distinguish between poor and rich countries. Indeed, extension of the model to PENSIONS highlights to what extent the differences between MDCs and LDCs are amplified by the system of social security. In other words, in rich countries there are more opportunities for investing savings in private markets and a substantial presence of government social security. Hence households rely less on children to ensure their old-age welfare. By contrast, in many LDCs neither the state nor the market can help families take care of retired parents. In such environments the improvement in saving opportunities has significant negative effects on fertility.

5 Final remarks

The objective of this paper was twofold: to explore the role of financial markets imperfections in determining fertility and to find evidence using international data. The first goal was pursued by putting forward an eclectic model of the family in which parents care for their children and children provide support for their parents in old age. Putting together altruistic and selfish motivations for fertility behavior, we managed to reconcile two major approaches to fertility choice. In this framework there naturally emerges a crucial role for the interactions of households with financial markets. Households are net borrowers during the first years of parenthood, while they become savers later on as children leave home and retirement draws closer. Financial development affects adult behavior in both periods and in different ways. Since children are one of a family's main concerns and resources, fertility choice is one important component of this influence and our model shows how its sign cannot be determined a priori.

The second objective of the paper, that of gathering relevant empirical evidence, was pursued with econometric analysis of a panel of data from a large group of countries. From the estimation results it transpires that allowing households greater credit to brings about a reduction in fertility in poor coun-

tries, while it causes an increase in fertility in high-income countries. Effects on fertility of the same signs derive from estimates of proxy parameters of access to capital markets.

Our results appear useful to interpret the differential trends in fertility between less developed and more developed countries occurring in recent decades. In the first group, fertility dropped sharply from high values to others which are still remarkable. According to our estimates, the development of financial markets played a significant role in driving this phenomenon. Children emerge as inferior goods in the preferences of parents in the whole set of countries considered in the econometric analysis. Families channel higher credit flows towards improving their own welfare which drives a reduction in family size, since children are perceived as inferior goods. Such families may also have benefited from the development of capital markets which provided new ways to secure consumption in old age which offset fertility. Both sides of financial market development seem part of the same phenomenon of households' welfare improvement and fertility reduction.

The demographic transition of high-income countries was already complete after World War II when fertility dropped from an already low level. This reduction was fundamentally caused by growing income and human capital and wider participation of females in the labor force. In the last few decades household indebtness is known (Harvey, 2004) to have sharply increased in these countries while financial markets further developed with a burst of innovation. According to our estimates, the development of financial markets in high-income countries has positively influenced the fertility rate. Indeed, household behavior has led to a significant shift of resources in the life cycle from the later stages of adulthood to the earlier ones. Greater debt brought about an incentive to invest in children to compensate the negative effects on old-age consumption. Broader access to financial investment had an important income effect (negative) on fertility choice of young adults. Finally, with the transition of LDCs towards higher levels of economic development, it is reasonable to expect that the years to come will show further signs of decline in fertility rates.

TABLE 4
LINEAR MODEL 1
Dependent variable: log of total fertility rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP	−0.115***	−0.127***	−0.112	−0.087	−0.031	−0.048	0.008	0.019
	(0.042)	(0.040)	(0.068)	(0.063)	(0.041)	(0.037)	(0.057)	(0.050)
FLFP	−1.396***	−1.209***	−0.845*	−0.556	−0.367	−0.387	0.014	0.183
	(0.443)	(0.401)	(0.454)	(0.428)	(0.341)	(0.329)	(0.453)	(0.412)
URBAN	−1.713***	−1.756***	−1.507***	−1.595***	−0.647***	−0.652***	−0.937***	−0.968***
	(0.191)	(0.193)	(0.337)	(0.320)	(0.236)	(0.213)	(0.353)	(0.318)
INTRATE	−0.147**	−0.148**	−0.328***	−0.247***	−0.036	−0.026	−0.208**	−0.101
	(0.065)	(0.070)	(0.100)	(0.087)	(0.061)	(0.061)	(0.091)	(0.077)
Borrowing Constraints								
DBACBA		−0.082		−0.267**		−0.095**		−0.282***
		(0.051)		(0.108)		(0.045)		(0.098)
DBACBA * HIGH		0.863***		0.698***		1.321***		1.032***
		(0.150)		(0.167)		(0.200)		(0.181)
Investment Opportunities								
INSLIFE			−1.981***	−1.443**			−0.634	−0.113
			(0.655)	(0.559)			(0.925)	(0.723)
INSLIFE * HIGH			3.101***	2.195***			2.074*	1.236
			(0.839)	(0.743)			(1.065)	(0.898)
Year effects	No	No	No	No	Yes	Yes	Yes	Yes
Statistics								
Observations	623	598	311	300	623	598	311	300
Countries	159	157	92	90	159	157	92	90
% of high income countries	0.258	0.247	0.460	0.440	0.258	0.247	0.460	0.440
R^2 Within	0.479	0.517	0.455	0.512	0.589	0.628	0.522	0.597
Correlation E(u_i,$X\beta$)	−0.435	−0.261	−0.456	−0.508	0.427	−0.741	−0.083	−0.848
Wald Significance Tests								
Liquidity Constraints Vars		0.000		0.000		0.000		0.000
Investment Opportunities Vars			0.002	0.014			0.072	0.219
Investment Opp. and Liquid. Vars				0.000				0.000

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from the World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605.

NOTES – Dependent variable: log of total fertility rate. Independent variables: GDP = log of per capita gross domestic product, FLFP = female labor force participation rate, URBAN = urbanization rate, INTRATE = real interest rate, DBACBA = deposit money bank assets / (deposit money + central) bank assets, PRIVCRED = private credit by deposit money banks / gross domestic product, INSLIFE = life insurance premium volume / gross domestic product, STMKCAP = stock market capitalization / gross domestic product, HIGH = dummy for high income countries. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$. Standard errors at 95% in parentheses. Statistical significance asterisks: $*=10\%$, $**=5\%$, $***=1\%$.

TABLE 5
LINEAR MODEL 2
Dependent variable: log of total fertility rate

	(1)	(2)	(3)	(4)	(5)	(6)
GDP	−0.162***	−0.107	−0.148**	−0.039	0.055	0.015
	(0.062)	(0.066)	(0.070)	(0.055)	(0.060)	(0.074)
FLFP	−1.439***	−0.298	−0.413	−0.664**	0.413	0.205
	(0.401)	(0.500)	(0.496)	(0.318)	(0.423)	(0.419)
URBAN	−1.544***	−1.476***	−1.427***	−0.605***	−0.619**	−0.655**
	(0.213)	(0.313)	(0.307)	(0.201)	(0.262)	(0.252)
INTRATE	−0.169**	−0.153	−0.159	−0.035	−0.113	−0.113
	(0.084)	(0.103)	(0.105)	(0.070)	(0.072)	(0.077)
Borrowing Constraints						
PRIVCRED	−0.136**		0.041	−0.106*		0.003
	(0.069)		(0.065)	(0.056)		(0.058)
PRIVCRED * HIGH	0.270***		0.029	0.303***		0.076
	(0.081)		(0.075)	(0.076)		(0.072)
Investment Opportunities						
STMKCAP		−0.202**	−0.208**		−0.125**	−0.121**
		(0.079)	(0.085)		(0.056)	(0.054)
STMKCAP * HIGH		0.224***	0.226***		0.182***	0.169***
		(0.079)	(0.083)		(0.059)	(0.056)
Year effects	No	No	No	Yes	Yes	Yes
Statistics						
Observations	557	301	287	557	301	287
Countries	145	102	96	145	102	96
% of high income countries	0.247	0.460	0.440	0.247	0.460	0.440
R^2 Within	0.513	0.517	0.541	0.619	0.625	0.634
Correlation E(u_i,$X\beta$)	−0.420	−0.484	−0.510	0.362	−0.264	−0.137
Wald Significance Tests						
Liquidity Constraints Vars	0.003		0.202	0.000		0.162
Investment Opportunities Vars		0.019	0.026		0.010	0.013
Investment Opp. and Liquid. Vars			0.011			0.003

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from the World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605.

NOTES – Dependent variable: log of total fertility rate. Independent variables: GDP = log of per capita gross domestic product, FLFP = female labor force participation rate, URBAN = urbanization rate, INTRATE = real interest rate, DBACBA = deposit money bank assets / (deposit money + central) bank assets, PRIVCRED = private credit by deposit money banks / gross domestic product, INSLIFE = life insurance premium volume / gross domestic product, STMKCAP = stock market capitalization / gross domestic product, HIGH = dummy for high income countries. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$. Standard errors at 95% in parentheses. Statistical significance asterisks: $*$ = 10%, $**$ = 5%, $***$ = 1%.

TABLE 6

ALTERNATIVE SPECIFICATION

Dependent variable: log of total fertility rate

	(1)	(2)	(3)	(4)	(5)	(6)
GDP	−0.159**	−0.143**	−0.155**	−0.041	−0.015	−0.022
	(0.061)	(0.067)	(0.064)	(0.055)	(0.064)	(0.078)
FLFP	−1.450***	−0.713	−0.618	−0.725**	−0.028	−0.033
	(0.408)	(0.474)	(0.507)	(0.319)	(0.417)	(0.415)
URBAN	−1.566***	−1.307***	−1.510***	−0.538**	−0.616**	−0.843***
	(0.215)	(0.278)	(0.272)	(0.207)	(0.271)	(0.259)
INTRATE	−0.168**	−0.248***	−0.221***	−0.021	−0.186**	−0.133*
	(0.084)	(0.090)	(0.080)	(0.069)	(0.084)	(0.072)
Borrowing Constraints						
DBACBA	−0.007		−0.116	−0.022		−0.122
	(0.060)		(0.086)	(0.049)		(0.079)
DBACBA * HIGH	0.637***		0.400*	0.998***		0.525**
	(0.160)		(0.218)	(0.182)		(0.206)
PRIVCRED	−0.128*		−0.002	−0.088		−0.031
	(0.071)		(0.075)	(0.053)		(0.063)
PRIVCRED * HIGH	0.244***		0.068	0.257***		0.097
	(0.087)		(0.079)	(0.077)		(0.074)
Investment Opportunities						
INSLIFE		0.630	0.640		1.347	1.436
		(1.047)	(1.145)		(0.880)	(0.993)
INSLIFE * HIGH		0.043	0.100		−0.455	−0.500
		(1.167)	(1.256)		(0.998)	(1.109)
STMKCAP		−0.162*	−0.129		−0.125*	−0.079
		(0.087)	(0.081)		(0.070)	(0.063)
STMKCAP * HIGH		0.188**	0.164*		0.174**	0.139**
		(0.086)	(0.083)		(0.071)	(0.066)
Year effects	No	No	No	Yes	Yes	Yes
Statistics						
Observations	541	251	236	541	251	236
Countries	144	84	78	144	84	78
% of high income countries	0.247	0.460	0.440	0.247	0.460	0.440
R^2 Within	0.527	0.539	0.601	0.647	0.620	0.679
Correlation E(u_i,$X\beta$)	−0.213	−0.467	−0.457	−0.742	0.006	−0.687
Wald Significance Tests						
Liquidity Constraints Vars	0.000		0.076	0.000		0.023
Investment Opportunities Vars		0.033	0.085		0.022	0.027
Investment Opp. and Liquid. Vars			0.000			0.000

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from the World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605.

NOTES – Dependent variable: log of total fertility rate. Independent variables: GDP = log of per capita gross domestic product, FLFP = female labor force participation rate, URBAN = urbanization rate, INTRATE = real interest rate, DBACBA = deposit money bank assets / (deposit money + central) bank assets, PRIVCRED = private credit by deposit money banks / gross domestic product, INSLIFE = life insurance premium volume / gross domestic product, STMKCAP = stock market capitalization / gross domestic product, HIGH = dummy for high income countries. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$. Standard errors at 95% in parentheses. Statistical significance asterisks: $*$ = 10%, $**$ = 5%, $***$ = 1%.

TABLE 7
PARTIALLY STANDARDIZED VARIABLES
Dependent variable: log of total fertility rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Borrowing Constraints								
DBACBA	−0.018				−0.038**	−0.031**		
	(0.011)				(0.015)	(0.014)		
DBACBA * HIGH	0.190***				0.098***	0.063*		
	(0.033)				(0.023)	(0.034)		
PRIVCRED		−0.051**					−0.034	0.017
		(0.026)					(0.033)	(0.027)
PRIVCRED * HIGH		0.101***					0.071*	0.012
		(0.030)					(0.037)	(0.032)
Investment Opportunities								
INSLIFE			−0.052***		−0.038**		−0.035*	
			(0.017)		(0.015)		(0.021)	
INSLIFE * HIGH			0.081***		0.058***		0.066***	
			(0.022)		(0.020)		(0.025)	
STMKCAP				−0.097**		−0.074**		−0.101**
				(0.038)		(0.030)		(0.041)
STMKCAP * HIGH				0.107***		0.090***		0.110***
				(0.038)		(0.032)		(0.041)
INTEREST	−0.015**	−0.017**	−0.025***	−0.013	−0.019***	−0.010	−0.026***	−0.013
	(0.007)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)	(0.009)

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from the World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605.

NOTES – Dependent variable: log of total fertility rate. Independent variables: GDP = log of per capita gross domestic product, FLFP = female labor force participation rate, URBAN = urbanization rate, INTRATE = real interest rate, DBACBA = deposit money bank assets / (deposit money + central) bank assets, PRIVCRED = private credit by deposit money banks / gross domestic product, INSLIFE = life insurance premium volume / gross domestic product, STMKCAP = stock market capitalization / gross domestic product, HIGH = dummy for high income countries. All displayed dependent variables are centered around zero and divided by one standard deviation. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$. Standard errors at 95% in parentheses. Statistical significance asterisks: $*=10\%$, $**=5\%$, $***=1\%$

TABLE 8

THE ROLE OF PUBLIC PENSIONS

Dependent variable: log of total fertility rate

GDP	−0.210***		−0.166***		−0.118**	
	(0.051)		(0.057)		(0.053)	
FLFP	−0.675		−0.941		−1.706**	
	(0.659)		(0.626)		(0.741)	
URBAN	0.029		0.463*		0.174	
	(0.292)		(0.253)		(0.274)	
INTRATE	1.560***		0.962		0.951	
	(0.439)		(0.694)		(0.742)	
Social Security						
PENSIONS	−0.913	[−0.176]	−2.919***	[−0.757]	−1.857**	[−0.517]
	(0.672)		(0.790)		(0.804)	
Investment Opportunities						
INSLIFE			−9.549***	[−0.510]		
			(3.495)			
INSLIFE * PENSIONS			83.210***	[0.940]		
			(20.576)			
STMKCAP					−0.085	[−0.077]
					(0.192)	
STMKCAP * PENSIONS					2.273*	[0.447]
					(1.205)	
Statistics						
Observations	124		90		89	
Countries	79		56		58	
% of high income countries	0.247		0.460		0.440	
R^2 Between	0.632		0.662		0.523	
Wald Significance Tests						
Liquidity Constraints Vars			0.009		0.658	
Social Security Vars	0.179		0.001		0.025	
Social Security and Liquid. Vars			0.009		0.658	

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from the World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605. Public pensions data are from the International Labor Office's Social Security Expenditure Database, available online at `https://www.ilo.org/dyn/sesame/ifpses.socialdbexp`.

NOTES – Dependent variable: log of total fertility rate. Independent variables: GDP = log of per capita gross domestic product, FLFP = female labor force participation rate, URBAN = urbanization rate, INTRATE = real interest rate, DBACBA = deposit money bank assets / (deposit money + central) bank assets, PRIVCRED = private credit by deposit money banks / gross domestic product, INSLIFE = life insurance premium volume / gross domestic product, STMKCAP = stock market capitalization / gross domestic product, HIGH = dummy for high income countries, PENSIONS = public pensions payments / gross domestic product. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$. Standard errors at 95% in parentheses. Statistical significance asterisks: $*=10\%$, $**=5\%$, $***=1\%$. The values in brackets are obtained using z-score standardization for independent and dependent variables.

TABLE 9

THE ROLE OF PUBLIC PENSIONS, CONTINUED

Dependent variable: log of total fertility rate

A. Summary statistics for the sample including public pensions

	Statistics				
High-income countries	**Mean**	**Median**	**Min**	**Max**	σ
Public pensions	0.195	0.197	0.017	0.385	0.094
Life insurance	0.033	0.027	0.001	0.092	0.024
Stock market capitalization	0.501	0.417	0.118	1.702	0.368
Low-income countries					
Public pensions	0.053	0.017	0.000	0.217	0.066
Life insurance	0.007	0.005	0.000	0.032	0.007
Stock market capitalization	0.220	0.149	0.002	1.443	0.269

B. Thresholds for positive derivatives

Variable	**Condition**		
Public pensions	Life insurance	$\geq$	0.035
Public pensions	Stock market capitalization	$\geq$	0.817
Life insurance	Public pensions	$\geq$	0.115
Stock market capitalization	Public pensions	$\geq$	0.038

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from the World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605. Public pensions data are from the International Labor Office's Social Security Expenditure Database, available online at `https://www.ilo.org/dyn/sesame/ifpses.socialdbexp`.

LEGEND – Dependent variable: standardized log of total fertility rate. Independent variables: DBACBA = deposit money bank assets / (deposit money + central) bank assets, PRIVCRED = private credit by deposit money banks / gross domestic product, INSLIFE = life insurance premium volume / gross domestic product, STMKCAP = stock market capitalization / gross domestic product. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$.

TABLE 10
ROBUSTNESS CHECK:
COMPLETE SAMPLE 1960–2006
Dependent variable: log of total fertility rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP	−0.179***	−0.191***	−0.152***	−0.153**	−0.037	−0.053	−0.029	−0.027
	(0.036)	(0.040)	(0.057)	(0.060)	(0.039)	(0.034)	(0.067)	(0.058)
URBAN	−1.687***	−1.722***	−1.753***	−1.764***	−0.577***	−0.590***	−1.140***	−1.189***
	(0.169)	(0.165)	(0.342)	(0.332)	(0.210)	(0.196)	(0.372)	(0.352)
INTRATE	−0.257***	−0.245***	−0.529***	−0.405***	−0.062	−0.035	−0.342***	−0.189*
	(0.069)	(0.075)	(0.157)	(0.134)	(0.062)	(0.064)	(0.123)	(0.106)
Borrowing Constraints								
DBACBA		−0.084		−0.243**		−0.159**		−0.316***
		(0.074)		(0.104)		(0.062)		(0.108)
DBACBA * HIGH		0.536***		0.624***		1.179***		0.990***
		(0.160)		(0.189)		(0.227)		(0.259)
Investment Opportunities								
INSLIFE			−2.104***	−1.761***			−1.371*	−1.023
			(0.537)	(0.482)			(0.780)	(0.628)
INSLIFE * HIGH			3.249***	2.655***			2.884***	2.234***
			(0.777)	(0.739)			(0.945)	(0.837)
Year effects	No	No	No	No	Yes	Yes	Yes	Yes
Statistics								
Observations	744	713	356	343	744	713	356	343
Countries	166	162	92	90	166	162	92	90
% of high income countries	0.258	0.247	0.460	0.440	0.258	0.247	0.460	0.440
R^2 Within	0.473	0.509	0.501	0.539	0.601	0.638	0.558	0.608
Correlation E(u_i,$X\beta$)	−0.587	−0.417	−0.597	−0.502	0.424	−0.706	−0.138	−0.778
Wald Significance Tests								
Liquidity Constraints Vars		0.005		0.005		0.000		0.000
Investment Opportunities Vars			0.000	0.001			0.011	0.032
Investment Opp. and Liquid. Vars				0.000				0.000

SOURCE – Total fertility rates are from United Nations data. Partitioning between poor and rich countries is from the World Bank. All remaining data are from Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), *A New Database on Financial Development and Structure*, World Bank Economic Review 14, 597-605.

NOTES – Dependent variable: log of total fertility rate. Independent variables: GDP = log of per capita gross domestic product, FLFP = female labor force participation rate, URBAN = urbanization rate, INTRATE = real interest rate, DBACBA = deposit money bank assets / (deposit money + central) bank assets, PRIVCRED = private credit by deposit money banks / gross domestic product, INSLIFE = life insurance premium volume / gross domestic product, STMKCAP = stock market capitalization / gross domestic product, HIGH = dummy for high income countries. Each observation used in the estimation is obtained averaging the value of any variable over a period of non-overlapping five years, with all variables representing ratios being averaged by harmonic means. All independent variables are taken at $t-1$. Standard errors at 95% in parentheses. Statistical significance asterisks: $*=10\%$, $**=5\%$, $***=1\%$.

A Appendix: Data description

The samples used for estimation of the regression models are basically two: the first sample includes those countries which have observations for the variable DBACBA and for the control variables. This sample is used to estimate the column 2 and 6 of table 4. These countries are Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea Bissau, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kenya, Kuwait, Kyrgyz Republic, Laos, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macao, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Russian Federation, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sierra Leone, Singapore, Slovak Republic, Slovenia, Solomon Islands, South Africa, South Korea, Spain, Sri Lanka, St. Lucia, St. Vincent and the Grenadines, Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Vanuatu, Venezuela, Vietnam, Yemen, Zaire, Zambia, Zimbabwe.

A second, more restricted, sample was used to estimate the regression model with the simultaneous inclusion of the variables DBACBA and INSLIFE: for this last variable, less countries provide valid observations. These countries are Algeria, Angola, Argentina, Australia, Austria, Bahrain, Bangladesh, Belgium, Botswana, Brazil, Bulgaria, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Finland, France, Germany, Greece, Guatemala, Honduras, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kenya, Kuwait, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Macao, Malaysia, Malta, Mauritius, Mexico, Morocco, Namibia, Netherlands, New Zealand, Nigeria, Norway, Oman, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Russian Federation, Singapore, Slovak Republic, Slovenia, South Africa, South Korea, Spain, Sri Lanka, Sweden, Switzerland, Syrian Arab Republic, Thailand, Trinidad and Tobago, Tunisia, Ukraine, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Zimbabwe.

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