Contraception, Social Norms and Growth*

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Abstract

We introduce contraceptives and social norms in an overlapping-generations growth model of fertility and human capital. Parents can use costly modern contraceptives to control their family size and each household's fertility decision is influenced by the decisions made by others. Given the number of children born, parents decide how much education to provide and how much to save out of their income. We characterize the local dynamics of a stable steady-state equilibrium. Around this steady-state, family planning interventions, which reduce the price of modern contraceptives, decrease fertility and increase human and physical capital. The effects of family planning interventions are larger when reproductive externalities are stronger.

KEYWORDS: education, contraception, social norms, income
JEL CLASSIFICATION: J13, O11.

1 Introduction

In this paper we present an overlapping-generations model of fertility and human capital with costly fertility control and reproductive externalities, describing social norms (cf., Dasgupta, 2000). We characterize the economic dynamics of a local stable steady-state equilibrium in which fertility decreases with human and physical capital accumulation. In addition, we show that family planning interventions (or innovations in contraceptive methods), which reduce the price of modern contraceptives, decrease fertility and increase income levels. We also show that the effects of family planning interventions are stronger when reproductive externalities are larger.

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There is a long tradition in economics to investigate the link between the economic and the demographic processes (cf., Barro and Becker, 1989; Galor and Weil, 2000; de la Croix and Doepke, 2003; Baudin, de la Croix, and Gobbi, 2020). According to this literature, parents decrease their family size and invest more in each child when income rises, since the opportunity cost to raise a child increases with wages. This quantity-quality trade-off depends on the income elasticity of the quantity and quality of children, as explained in Doepke (2015). In general, when income and substitution effects cancel each other (e.g., log utility), then fertility is independent of income. Our model can generate a negative relationship between fertility and income even in the presence of a log utility. In our formulation, as income rises, modern contraceptive methods become relatively cheaper and therefore fertility decreases.

Although Becker (1960) already discussed in detail the importance of contraceptive methods in controlling family size, this is largely neglected in the macro growth literature.[1] An exception is Cavalcanti, Kocharkov, and Santos (2020), but their model can be only solved numerically and only quantitative exercises are provided. Here, the main results are derived analytically and therefore we are able to pin down the underlying mechanisms behind our aggregate results. Relative to Cavalcanti, Kocharkov, and Santos (2020), we also add social norms in fertility behaviour, which has pointed out as an important factor in the reduction of fertility during the demographic transition (cf., Fernández and Flogi, 2009; de Silva and Tenreyro, 2020).

2 Model

2.1 Demographics and endowments

Individuals live for three periods: childhood, young adulthood, and old adulthood. Children do not make any economic decisions, but they can acquire skills. Young adults have one unit of productive time and are endowed with skills that they acquire during their childhood. They make the relevant economic decisions, including investment decisions. Old adults do not work and simply consume their savings.

2.2 Production

The consumption good is produced with a technology that uses capital, K, and efficiency units of labor, L, as inputs, such that:[2]

$$Y = AK^{\alpha}L^{1-\alpha},\ \alpha \in (0,1),\ A > 0. \tag{1}$$

Capital depreciates fully after use. Let w be the wage rate and let R be the rental price of capital. Profit maximization implies that inputs are paid according to their marginal

[1] This is in contrast with the empirical micro literature, which shows strong effects of family planning interventions on fertility and children outcomes (cf., Schultz, 2008).

[2] We will abstract from the subscript t to denote the time period and use the convention that object $'$ stands for future variables.

productivity, such that:

$$
\begin{aligned}
w &= (1-\alpha)AK^{\alpha}L^{-\alpha}, && (2)\\
R &= \alpha AK^{\alpha-1}L^{1-\alpha}. && (3)
\end{aligned}
$$

2.3 Households

Fertility: Couples can have up to $N > 0$ children, and they can control their family size, n, by investing in contraceptive use, such that:

$$n = N - \theta q, \ \theta > 0, \tag{4}$$

where $q \geq 0$ is the investment in contraception and θ is related to the efficiency of contraception on birth control. Contraception is costly and the relative price of contraception is $\phi_q \geq 0$.

Human capital: Parents invest in the education of their children, $e \geq 0$, such that the human capital of their children is given by

$$h' = h(e) = e^{\zeta}, \ \zeta \in (0,1). \tag{5}$$

Investment in education is in terms of the consumption good. Children are also time consuming. Each child takes a fraction $\chi \in (0,1)$ of her parents' time endowment. We assume that parents are able to provide some hours in the labor market even when they have the maximum amount of children, i.e., $\chi N < 1$.

Preferences and optimal decisions: Consumption of couples during the young adulthood period is denoted by c_y, while c_o' denotes consumption of the couple in the next period, when old. Preferences of households are represented by:

$$U(c_y, c_o', n, h') = \log(c_y) + \beta \log(c_o') + \gamma \log(n) + \xi \log(h') + \psi \left(\frac{n - \bar{n}}{\bar{\bar{n}}} \right), \tag{6}$$

where β, γ, ξ and ψ are positive numbers. The variable $\bar{n}$ is the average fertility in society and describes social norms in reproduction behavior.

Let s denote savings during the young adulthood period. The problem of the couple is to choose c_y, c_o', q, s, and e to maximize (6) subject to (4), (5), and the following budget constraints:

$$
\begin{aligned}
c_y + s + \phi_q q + en &= wh(1 - \chi n), && (7)\\
c_o' &= R's. && (8)
\end{aligned}
$$

Equation (7) states that consumption plus savings and expenditures on contraception[3] and education equals income. Equation (8) implies that old couples consume their savings

[3] This is the relative price of modern contraceptives. This includes not only the monetary value of modern contraceptive methods but also any non-monetary barrier (e.g., access and availability) to use them.

from the young adulthood period. Whenever $q > 0$, then the equations which describe the solution of this problem after imposing the symmetric equilibrium condition that $n = \bar{n}$ are:[4]

$$c_y = \frac{1}{(1+\beta+\gamma+\psi)}\left(wh - \frac{\phi_q}{\theta}N\right), \tag{9}$$

$$s = \frac{\beta}{(1+\beta+\gamma+\psi)}\left(wh - \frac{\phi_q}{\theta}N\right), \text{ and } c_o' = R's, \tag{10}$$

$$e = \frac{\xi\zeta}{(\gamma+\psi-\xi\zeta)}\left(wh\chi - \frac{\phi_q}{\theta}\right), \tag{11}$$

$$q = \frac{N}{\theta} - \frac{(\gamma+\psi-\xi\zeta)}{\theta(1+\beta+\gamma+\psi)}\left(\frac{wh - \frac{\phi_q}{\theta}N}{wh\chi - \frac{\phi_q}{\theta}}\right), \tag{12}$$

$$n = \frac{(\gamma+\psi-\xi\zeta)}{(1+\beta+\gamma+\psi)}\left(\frac{wh - \frac{\phi_q}{\theta}N}{wh\chi - \frac{\phi_q}{\theta}}\right). \tag{13}$$

We make the following assumption:

Assumption 1: Let $N\chi < 1$ and $\frac{(\gamma+\psi-\xi\zeta)}{(1+\beta+\gamma+\psi)\chi} < N$.

The assumption that $N\chi < 1$ implies that even when fertility is at its maximum ($q = 0$), couples still supply a positive number of hours to the labor market. The second part of the assumption implies that when the price of modern contraceptive methods is zero ($\phi_q = 0$), then fertility is lower than the case in which there is no investment in modern contraceptive methods ($q = 0$). Observe that when ϕ_q goes to zero then fertility does not depend on labor income (wh). This is because when income rises the opportunity cost (time cost) of having more children rises (substitution effect), but since children are a normal good, then the income effect induces parents to have more children. With log-utility these two effects cancel each other out, and when $\phi_q = 0$ then fertility does not depend on income – see Equation (13). This is explained in (cf., Doepke, 2015; Jones, Schoonbroodt, and Tertilt, 2010). When ϕ_q is positive then there is a negative association between fertility and income, as reported in the data. In this case richer parents can increase the intensity of their use of contraceptive methods in order to control family size.

Notice that whenever the price of modern contraceptives falls then fertility decreases and this relationship is stronger for a higher ψ, which measures how social norms affect reproduction behavior.

Proposition 1. *Let Assumption 1 be satisfied, then for a given wage rate w and when $q > 0$, we have that $\frac{\partial n}{\partial \phi_q} > 0$ and $\frac{\partial\left(\frac{\partial n}{\partial \phi_q}\right)}{\partial \psi} > 0$.*

Proof. Take the partial derivatives of Equation (13) with respect to ϕ_q and then take the partial derivative of the derived equation with respect to ψ. *Q.E.D.*

[4] When $q = 0$, we have that $n = N$, $c_y = \frac{wh(1-\chi N)}{1+\beta+\xi\zeta}$, $s = \beta c_y$, $c_0' = R's$ and $e = \frac{\xi\zeta}{(1+\beta+\xi\zeta)}\frac{wh(1-\chi N)}{N}$.

One can argue that it is not necessary to explicitly add investment in contraceptives into a standard quantity-quality fertility model because parameter χ, which corresponds to the time cost of children, could capture that investment. Better access to contraceptives could be translated into a rise in parameter χ such that it would raise the quality of children (e) as well as reduce their quantity (n). In fact, the proportional changes in n and e due to a proportional variation in χ have opposite signs but equal magnitude. A fall in the price of contraceptives (ϕ_q) generates not only different quantitative but also qualitative effects. Indeed, a fall in ϕ_q also increases e and reduces n, but observe that parameter χ does not affect the consumption-saving decision, while the price of contraceptives does. In addition, family planning interventions which reduce the price of contraceptives have strong effects on the quantity and quality of children when income levels are low. Proposition 2 summarizes these findings.

Proposition 2. *Let Assumption 1 be satisfied and define $\epsilon_{z,\chi}$ and ϵ_{z,ϕ_q} as the elasticity of variable $z \in \{n, e\}$ with respect to χ and ϕ_q, respectively. Then whenever $q > 0$, we have that:*

(i) $\frac{\partial e}{\partial \chi} > 0$, $\frac{\partial n}{\partial \chi} < 0$ *and* $\frac{\partial s}{\partial \chi} = 0$. *Moreover,* $r_\chi = \frac{|\epsilon_{n,\chi}|}{\epsilon_{e,\chi}} = 1$.

(ii) $\frac{\partial e}{\partial \phi_q} < 0$, $\frac{\partial n}{\partial \phi_q} > 0$ *and* $\frac{\partial s}{\partial \phi_q} < 0$. *Moreover,* $r_{\phi_q} = \frac{\epsilon_{n,\phi_q}}{|\epsilon_{e,\phi_q}|} = \frac{wh(1-N\chi)}{wh - \frac{\phi_q}{\theta}N}$ *and* $\frac{\partial r_{\phi_q}}{\partial (wh)} < 0$.

Proof. For the partial derivative, simply use equations (10), (11), and (13) and take the corresponding partial derivatives with respect to χ and ϕ_q. For the elasticities, take the logarithm on both sides of equations (11) and (13) and differentiate either with respect to χ and ϕ_q. *Q.E.D.*

Let P denote the number of young adult households such that $P' = nP$. In equilibrium, demand equals supply in all markets. In the labor market this means that $L = P(1 - \chi n)h$, and in the capital market, $K' = Ps$. Let k denote physical capital per young household. In equilibrium with $q > 0$ it can be shown that $h' = Dk'^{\zeta}$ with $D = \left(\frac{\xi\zeta}{\beta}\right)^{\zeta} > 0$, and $w(k) = (1-\alpha)D^{-\alpha}Ak^{\alpha(1-\zeta)}(1-\chi n(k))^{-\alpha}$. When $q = 0$, we also have that $h' = Dk'^{\zeta}$, and $w(k) = (1-\alpha)D^{-\alpha}(1-\chi N)^{-\alpha}k^{\alpha(1-\zeta)}$. In addition,

$$n(k) = \min\left\{N, \frac{(\gamma+\psi-\xi\zeta)}{(1+\beta+\gamma+\psi)}\left(\frac{(1-\alpha)D^{-\alpha}Ak^{\alpha+\zeta(1-\alpha)}(1-\chi n(k))^{-\alpha} - \frac{\phi_q}{\theta}N}{(1-\alpha)D^{-\alpha}Ak^{\alpha+\zeta(1-\alpha)}(1-\chi n(k))^{-\alpha}\chi - \frac{\phi_q}{\theta}}\right)\right\}. \tag{14}$$

Then the following proposition summarizes the fertility choice.

Proposition 3. *Let Assumption 1 be satisfied. Then it can be shown that* $n(k) \in \left(\frac{(\gamma+\psi-\xi\zeta)}{(1+\beta+\gamma+\psi)\chi}, N\right]$ *and*

(i) there exists a $\underline{k} > 0$ *such that if* $k \le \underline{k}$, *then* $n(k) = N$; *and if* $k > \underline{k}$, *then* $n(k) < N$; *in addition,* $\frac{\partial \underline{k}}{\partial \phi_q} > 0$ *and* $\frac{\partial \underline{k}}{\partial \psi} > 0$;

(ii) for $k > \underline{k}$ *fertility is decreasing with capital accumulation, i.e.,* $n'(k) < 0$;

(iii) for $k > \underline{k}$ fertility decreases with family planning interventions which reduce the price of modern contraceptives, i.e., $\frac{\partial n(k)}{\partial \phi_q} > 0$; and the effects of family planning interventions on fertility is stronger for higher reproductive externality ψ, i.e., $\frac{\partial \left(\frac{\partial n(k)}{\partial \phi_q}\right)}{\partial \psi} > 0$.

Proof. Let $N\chi < 1$, then when $n(k) < N$ and using the Implicit Function Theorem (IFT) we can show that

$$n'(k) = -\frac{\left[\frac{(\gamma+\psi-\xi\zeta)}{(1+\beta+\gamma+\psi)}(\alpha+\zeta(1-\alpha))(1-\alpha)D^{-\alpha}Ak^{\alpha+\zeta(1-\alpha)-1}(1-\chi n(k))^{-\alpha}\frac{\phi_q}{\theta}(1-\chi N)\right]/X(n(k))^2}{1+\left[\frac{(\gamma-\xi\zeta)}{(1+\beta+\gamma)}\alpha(1-\alpha)D^{-\alpha}Ak^{\alpha+\zeta(1-\alpha)}(1-\chi n(k))^{-\alpha-1}\frac{\phi_q}{\theta}(1-\chi N)\right]/X(n(k))^2} < 0,$$

where $X(n(k)) = \left((1-\alpha)D^{-\alpha}Ak^{\alpha+\zeta(1-\alpha)}(1-\chi n(k))^{-\alpha}\chi - \frac{\phi_q}{\theta}\right)$. Moreover,

$$\frac{\partial n(k)}{\partial \phi_q} = \frac{\left[\frac{(\gamma+\psi-\xi\zeta)}{(1+\beta+\gamma+\psi)}(1-\alpha)D^{-\alpha}Ak^{\alpha+\zeta(1-\alpha)}(1-\chi n(k))^{-\alpha}\frac{1}{\theta}(1-\chi N)\right]/X(n(k))^2}{1+\left[\frac{(\gamma-\xi\zeta)}{(1+\beta+\gamma)}\alpha(1-\alpha)D^{-\alpha}Ak^{\alpha+\zeta(1-\alpha)}(1-\chi n(k))^{-\alpha-1}\frac{\phi_q}{\theta}(1-\chi N)\right]/X(n(k))^2} > 0.$$

and $\frac{\partial \left(\frac{\partial n(k)}{\partial \phi_q}\right)}{\partial \psi} > 0$. In addition, $\lim_{k\to\infty} n(k) = \frac{(\gamma+\psi-\xi\zeta)}{(1+\beta+\gamma+\psi)\chi}$. Notice that Equation (14) defines a critical value $\underline{k}(\phi,\psi) > 0$:

$$\underline{k} = \left(\frac{N\phi_q(1+\beta+\xi\zeta)(1-\chi N)^{\alpha}}{\theta(1-\alpha)D^{-\alpha}A((1+\beta+\gamma+\psi)N\chi-(\gamma+\psi-\xi\zeta))}\right)^{\frac{1}{\alpha+\zeta(1-\alpha)}}, \tag{15}$$

We have that $n(k) = N$ for any $k \leq \underline{k}$ and $n(k) < N$ for any $k > \underline{k}$. In order to see this, observe that without the upper bound in the fertility choice, $n(k)$ would go to infinity as k would be sufficiently small such that $n(k)\chi$ would tend to 1. Therefore, given the continuity of $n(k)$, we have that there exists a $\underline{k} > 0$ such that $n(\underline{k}) = N$. Using the IFT we can show that $\frac{\partial \underline{k}}{\partial \phi_q} > 0$. Similarly, the IFT and Assumption 1 imply that $\frac{\partial \underline{k}}{\partial \psi} > 0$. *Q.E.D.*

The condition that equilibrates the capital market implies that

$$k' = G(k) = \begin{cases} \frac{\beta(1-\alpha)D^{-\alpha}A(1-\chi N)^{-\alpha}k^{\alpha+\zeta(1-\alpha)}}{(1+\beta+\xi\zeta)N} & \text{for } k \leq \underline{k}, \\ \frac{\beta\left((1-\alpha)D^{-\alpha}Ak^{\alpha+\zeta(1-\alpha)}(1-\chi n(k))^{-\alpha}\chi-\frac{\phi_q}{\theta}\right)}{\gamma+\psi-\xi\zeta} & \text{for } k > \underline{k}. \end{cases} \tag{16}$$

We also have that

$$h' = Dk'^{\zeta}, \tag{17}$$

and human and physical capital are positively related.

Proposition 4. ***(Existence and uniqueness of equilibrium path)*** *For a given initial capital stock k_0, let h_0 be given by (17); then the dynamic system of difference equations (14)–(17) has a unique trajectory (solution).*

Proof. Given k_0 and the fact that h_0 is given by (17), we can use (14) to find $n(k_0)$, which is unique given that $n(k)$ is non-increasing and continuous in k. Then, we can use Equations (16) and (17) to find $k_1(k_0)$ and $h_1(k_0)$, respectively; and so on. *Q.E.D.*

Given the path for n, k, and h, we can find consumption and investment decisions (9)–(11), as well as investment in contraceptive methods. Asymptotically, the system may diverge to infinity, converge to a zero, or converge to a non-zero steady-state equilibrium. Observe that when $k < \underline{k}$, we have that $\frac{\partial G(k)}{\partial k} > 0$, $\frac{\partial^2 G(k)}{\partial k^2} < 0$, and $lim_{k \to 0} \frac{\partial G(k)}{\partial k} = \infty$. Therefore, the system does not converge to a zero steady-state. If $\underline{k}$ is sufficiently large,[5] then there will be a locally stable steady-state $k_N^* = G(k_N^*)$ in which $n(k) = N$. In this case, there is no investment in modern contraceptive methods ($q = 0$), and therefore family planning interventions do not have any effect on the long-run level of the capital stock, i.e, k_N^* is independent of ϕ_q. However, whenever $\underline{k} < k_N^*$, then it can be shown that there exists a locally stable steady-state equilibrium $k^* > \underline{k}$ such that fertility decreases with capital accumulation, and family planning interventions have long-run effects on capital accumulation and output. This is summarized in the following proposition.

Proposition 5. *Let Assumption 1 be satisfied and $\underline{k} < k_N^*$. Then there exists at least one locally stable steady-state equilibrium for capital per young household, $k^* = G(k^*)$, such that in the neighbourhood of k^*, fertility decreases with capital accumulation, and family planning interventions, which reduce the price of modern contraceptives, increase the steady-state level of capital, i.e., $\frac{\partial k^*}{\partial \phi_q} < 0$. In addition, the higher is the reproductive externality (higher ψ) the higher is the steady-state fertility and the lower is the steady-state level of capital, i.e., $\frac{\partial k^*}{\partial \psi} < 0$.*

Proof. If $\underline{k} < k_N^*$, then for any $k > \underline{k}$ it can be shown that $\frac{\partial G(k)}{\partial k} > 0$, and $\lim_{k \to \infty} \frac{\partial G(k)}{\partial k} = 0$. This implies that $k' = G(k)$ has to cross (at least once) the 45 degree line ($k' = k$) from above, and this defines $k^* = G(k^*)$ with $G'(k^*) \in (0, 1)$, which is locally stable. Fertility thus decreases with capital accumulation. Moreover, we can easily show that $\frac{\partial k^*}{\partial \phi_q} < 0$. Using the IFT we can show that $\frac{\partial n(k^*)}{\partial \psi} > 0$ and $\frac{\partial k^*}{\partial \psi} < 0$, completing the proof. *Q.E.D.*

Since human capital and physical capital are associated by Equation (17), then it is trivial to show the following result.

Corollary 1. *Let Assumption 1 be satisfied; then human capital increases with physical capital accumulation. If ϕ_q is sufficiently small (or ψ is sufficiently large) such that $\underline{k}(\phi_q, \psi) < k_N^*$, then $\frac{\partial h^*}{\partial \phi_q} < 0$ and $\frac{\partial h^*}{\partial \psi} < 0$.*

Proof. This follows directly from Equation (17) and Proposition 5. *Q.E.D.*

[5] For instance if the relative price of contraceptive methods is too high; see Equation (15).

3 Conclusion

In this paper we present a model that is able to replicate the negative relationship between fertility and income through the intensity in the use of modern contraceptive methods. The main mechanism is that, as income rises, then modern contraceptives become relatively cheaper and fertility decreases. We show the local dynamics of a stable steady-state equilibrium and characterize how family planning interventions affect fertility, human capital, physical capital and income levels around this equilibrium. Our results also show that the effects of family planning interventions on fertility are stronger when the reproductive externality is larger. Finally, changes in social norms relative to reproductive behavior can trigger a fall in fertility, which can be amplified with better access to modern contraceptives.

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