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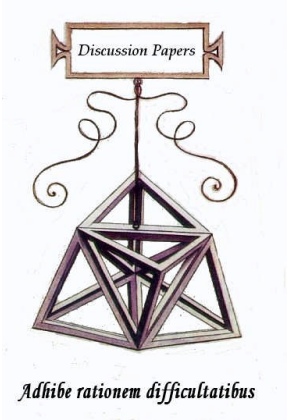

Luciano Fanti - Luca Spataro

Fertility and public debt

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Fertility and public debt

by Luciano Fanti[1] and Luca Spataro[2]

Abstract

Public debt and fertility are two issues of major concern in the current debate about economic policy, especially in countries with below replacement fertility and large debt. In this paper we show that public debt is in general harmful for fertility, in that debt issuing almost ever crowds out fertility. The relationship is reversed only if debt is sufficiently low and the share of capital (labor) in the economy is sufficiently low (high). Hence, our analysis would recommend that developed, capital intensive economies (such as OECD countries) aiming at a fertility recovery should reduce national debt, while developing, labor intensive economies, aiming at reducing fertility, should increase (reduce) national debt only if they are debt virtuous (vicious).

J.E.L. classification: **D91, E62, H63, J13.**
Keywords: overlapping generations, endogenous fertility, debt.

1. Introduction

Public debt and fertility are two issues of major concern in the current debate about economic policy. As regards the former issue, most OECD countries have experienced lasting budget deficits dating back to the mid-1970s and, as a consequence, rising debt to GDP ratios. In the EU's largest economy, Germany, public debt exploded in the years following the reunification; and in Asia's largest economy, Japan, the ratio of debt to GDP doubled during the 1990's. Remarkably, in Europe Italy, Greece and Belgium have the highest ratios of debt to GDP, namely larger than (or around) 100 per cent. As regards the second issue, the number of children per woman has fallen dramatically since the 1960's: however while in US such a number is around the replacement fertility rate, Japan and most European countries have a below-replacement fertility rate, in particular Italy.

Given the important size of public debt in many countries plagued by very low fertility rates (such as Italy), how and whether public debt affects fertility rates is an intriguing issue.

We note that while the literature has largely focused on the issue of the link between public debt and economic growth (e.g. Saint Paul, 1992; Josten, 2000; Bräuninger, 2005) little attention has been paid to the effect of the public debt on fertility[3]. This paper aims to fill this gap. The analysis is based on an OLG model (Samuelson, 1958; Diamond, 1965), extended in order to entail endogenous fertility motivated by a weak altruism of parents and in presence of constant public debt and lump-sum taxation, again strictly following Diamond (1965). We find that reducing debt policies, such as those advocated for such countries, may be either harmful or beneficial for a recovery of fertility, which is the other major policy target. In particular, the sign of the debt-

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[3] For example, Ono (2003) investigates the relationship between longevity and social security policy in a model with public debt, but fertility rates are exogenous. For another study on debt and social security, see Gertler (1997), but again with exogenous fertility.

reducing effect on fertility also depends, among other economic factors, on the size of the outstanding public debt: when such a debt is very high it is likely that its reduction favors a recovery of fertility. More precisely, we pick up the conditions under which debt-reducing policies may imply a fertility recovery: the latter occurs in the presence of i) high capital share in the economy (and any level of national debt); b) low capital share in the economy and a sufficiently high level of national debt. In all other cases debt reductions imply a decrease, rather than a recovery, of the fertility rates.

Interestingly, we show that the higher the cost of rearing children, the less likely is that a recovery of fertility is induced by debt reduction policy. This means that the debt tightening objectives being currently pursued by several developed countries can only go hand in hand with the recovery of fertility provided that the child bearing costs are sufficiently low or reduced accordingly.

We also provide a rule of thumb for forecasting the effect of debt management and rate of growth of population: if the latter is lower that the rate of interest, then its relationship with national debt is negative.

Our results have straightforward policy implications for those countries plagued by both very high public debt levels and very low fertility rates: 1) indicating the cases in which a trade-off between the targets of debt reduction and fertility recovery may occur (i.e. with high capital share and/or high public debt); 2) indicating the interventions useful for avoiding such a trade-off (i.e. by accompanying debt reductions with reductions of children's costs).

Therefore, given the different economic parameters and the different size of the outstanding public debt in various countries, the effect of debt-reducing policy is an empirical matter. The paper is organized as follows: after laying out the model, in section 3 we present the results and in section 4 we conclude the paper.

2. The model set up

We adopt a standard method for endogeneizing fertility in OLG models (e.g. Galor and Weil, 1996; Strulik 1999 and 2003) We assumed that life is divided into three periods (childhood, young adulthood, and old-age). In their childhood individuals do not make any decisions. Young adults are entailed with a well behaved utility function U defined over consumption in the second and third period of life (c_{1t}, c_{2t+1}) and on the number of children per adult (n_t), respectively. In words, in period t a representative agent born at time t-1, receives a salary w for her/his labour services (exogenously supplied) and decides how to split such an income over consumption in the same period, or in their adulthood or on children rearing (we assume that each child costs a fixed amount of resources, e)[4]. Since we assume for simplicity that every single young adult can have children, the population at the steady state will be stationary or increasing if n is equal or bigger than 1 (thus $n-1$ is the long run growth rate of the economy as well).

2.1. Firms

Each firm owns CRS production technology $F(K_t, L_t)$ which allows to transform physical capital K_t and labour L_t (=N_t) into a consumption good Y_t. Under hypothesis of perfect competitive markets, each firm hires capital and labour by remunerating them according to their marginal productivity. By defining k=K/L the capital intensity, homogeneity of degree one of F yields w_t =$f(k_t) - f'(k_t)k_t$ and $r_t = f'(k_t)$ (in the case of absence of depreciation) or $r_t = f'(k_t)-1$ (in the case of full depreciation), where low letters (apart from factor prices) indicate variables in per worker terms and f' indicates the derivative of f with respect to k_t.

[4] This assumption departs from Strulik ((1999) and (2003)) who assumes the rearing cost as a fixed fraction of w.

2.2. Government

Following Diamond (1965), we assume that the government at each date t issues an amount B_t of national debt and finances it by partly rolling it over and partly by levying lump sum taxes upon the young adults, according to the dynamic equation: $B_{t+1}=B_t(1+r_t) -\tau_{1t}N_{t-1}$ (where τ_{1t} is the lump sum tax). which, in per worker terms can be written as follows:

$b_{t+1}n_t=b_t(1+r_t) -\tau_{1t}$;

moreover, again by following Diamond (1965), we assume that government pursues the constancy of debt in per worker terms, so that

$\tau_{1t}=b(1+r_t-n_t)$.

2.3. Individuals

The young adults face the following maximization problem:

$$\max U(c_{1t}, c_{2t+1}, n_t) = h_1 \log c_{1t} + h_2 \log c_{2t+2} + h_3 \log n_t$$

where $c_{1t} = w_t - \tau_{1t} - en_t - s_t$ and $c_{2t+2} = s_t(1+r_{t+1})$.

Under our assumptions we get that:

$$s^* = b_2 e \frac{w - b(1+r)}{e\beta - bh_3} \qquad [2]$$

$$n^* = b_3 \frac{w - b(1+r)}{e\beta - bh_3} \qquad [3]$$

where $\beta = h_1 + h_2 + h_3$. Note that by eq. (3), in this simple standard OLG frame the population growth depends positively on the wage, in line with a classical view à la Malthus.

2.4. Steady state analysis

Given the market clearing equation $s_t N_{t-1} = K_{t+1} + B_{t+1}$ or, equivalently, $s_t = (k_{t+1} + b)n_t$ and assuming interior solutions for s, n, the long run per worker capital turns out to be:

$$k^* = e\frac{h_2}{h_3} - b\,. \qquad [4]$$

Firstly, it is worth noting that at the equilibrium there is a complete "crowding out" effect of the public debt upon the stock of capital, that is, a one to one correspondence between them (such an effect is in line with Diamond (1965)). Secondly, necessary and sufficient conditions for obtaining interior solutions (s>0 and n>0) and positive steady state of capital are i) $b \le e\frac{h_2}{h_3}$ and ii) $b < \frac{w}{1+r}$.

However, under full depreciation of capital and Cobb-Douglas technology of the kind $y = Ak^a$

(where A>0 is a constant index of technology), it can be easily shown that $\frac{w}{1+r}=\frac{(1-a)(eh_2-h_3b)}{ah_3}>b$ if $b<b_{\max}=\frac{(1-a)eh_2}{h_3}$, such that the satisfaction of condition ii) is also sufficient for condition i) to hold: in other words, public debt must be sufficiently low, especially when rearing costs and the degree of patience are low and preference for children is high and share of capital *a* is high. For the sake of simplicity in the paper we will assume that this condition is always satisfied.

Finally, by inspection of eq. [4] we can provide the following remark

Remark 1: The long run per worker capital is inversely linked with the factors increasing the population growth and, thus, depends positively on the rearing cost *e* and on the preferences for children b_3 and positively linked with the factor increasing accumulation, that is with the degree of patience b_2.

In other words, Remark 1 can be summarized as follows: i) the higher the preference for children the less saving will be accumulated for older age; ii) when, for given preferences for children, the cost of rearing them is lower, more children will be grown and less saving accumulated. Note that these results appear to be at all coherent with the empirical evidence.

3. The effects of debt variations on fertility

Let us start from some preliminary results which provide a first insight into the relationship between debt and fertility; moreover they also link the shape of such a relation to the difference between the rate of growth of population and the interest rate:

Lemma 1: If $n<1+r$, then $\frac{dn}{db}<0$; if $n>1+r$ then $\frac{dn}{db}\gtrless 0$. Moreover, when $n=1+r$, $\frac{dn}{db}<0$; finally, $\left.\frac{dn}{db}\right|_{b\max}<0$.

Proof: Preliminarily, let us write the total derivative of the equilibrium demand for children n as follows:

$$\frac{dn(w,r,b)}{db}=\frac{\partial n}{\partial b}+\frac{\partial n}{\partial w}\frac{\partial w}{\partial r}\frac{dr}{db}+\frac{\partial n}{\partial r}\frac{dr}{db}=\frac{\partial n}{\partial b}-\frac{\partial n}{\partial w}k\frac{dr}{db}+\frac{\partial n}{\partial r}\frac{dr}{db} \qquad [7]$$

where we have exploited the equilibrium relationship $\partial w/\partial r=-k$*, From individual's maximization problem, let us write as* $\Omega(n,b)=n-h_3\frac{w-\tau(b,\bar{n},r)}{e\beta}=0$ *the implicit function determining the economy's equilibrium value of n, where we have assumed that individuals do not take into account the effects of policy changes on the aggregate population growth rate (i.e.* $n=\bar{n}$*; however such an assumption is not crucial for our results); then, by using the implicit function theorem, we get the expression for* $\frac{\partial n}{\partial b}$ in [7]*:* $\frac{\partial n}{\partial b}=-\frac{\Omega_b}{\Omega_n}=\frac{\frac{h_3}{e\beta}(n-1-r)}{1-\frac{h_3}{e\beta}b}\gtrless 0\Leftrightarrow n\gtrless 1+r$[5]*, since the denominator is*

[5] One can show that this condition is equivalent to the following: $\frac{\partial n}{\partial b}>0\Leftrightarrow n>1+r\Leftrightarrow\frac{w}{1+r}>\frac{\beta e}{h_3}$.

positive under positive steady state capital. Moreover, we get that: $\frac{\partial n}{\partial w} = \frac{\frac{h_3}{e\beta}}{1-\frac{h_3}{e\beta}b} > 0$ *and*

$\frac{\partial n}{\partial r} = -\frac{\frac{h_3}{e\beta}b}{1-\frac{h_3}{e\beta}b} < 0$. *Collecting terms we get:*

$$\frac{dn}{db} = \frac{\frac{h_3}{e\beta}}{1-\frac{h_3}{e\beta}b}\left[(n-1-r)-(k+b)\frac{dr}{db}\right]. \qquad [7']$$

Finally, by eq. [4] and by the properties of the CD production function $f=Ak^a$*;*

$$\frac{dr}{db} = \frac{\partial r}{\partial k}\frac{\partial k}{\partial b} = -f'' = -a(a-1)A\left[\frac{eh_2}{h_3}-b\right]^{a-2} > 0. \qquad [8]$$

Hence, by eq. [7'] when n=1+r, dn/db<0. Furthermore, one gets that when b= $b_{\max} = \frac{(1-a)eh_2}{h_3}$,

$$\left.\frac{dn}{db}\right|_{b_{\max}} = -\frac{b_3^{\,2}A\left(\frac{ah_2e}{h_3}\right)^a}{e^2h_2a\beta} < 0. \qquad \square$$

In order to provide the economic intuition of the result, let us rewrite eq. [7'] as follows:

$$\frac{dn(w,r,b)}{db} = \underbrace{\frac{\partial n}{\partial b}}_{+/-} + \underbrace{\frac{\partial n}{\partial w}\frac{\partial w}{\partial r}\frac{dr}{db}}_{-} + \underbrace{\frac{\partial n}{\partial r}\frac{dr}{db}}_{-} \qquad [7'']$$

By looking at such an expression, we note that the ambiguity of the sign of the derivative *dn/db* stems from the direct (or partial) effect of public debt on fertility $\partial n/\partial b$ and precisely: if $n<1+r$ public debt is a net tax for the individual: since children are a normal good (given our logarithmic preferences), the negative income effect of the tax increase always causes a reduction of fertility rates. On the other hand, symmetrically, if $n>1+r$, then public debt behaves as a net subsidy and, as a consequence, given the above mentioned normality of children, fertility increases.

As regards the general equilibrium effects (that is the effects of public debt on prices) the signs are clear: fertility is always reduced by public debt increases through changes in prices.

To sum up, from Lemma 1 we may derive the following proposition:

Proposition 1: if $n<1+r$ debt issuing reduces fertility.

Things are dramatically different in presence of "overaccumulation" ($n>1+r$), which we will address in the remainder of the paper.

However, since up to now we have provided conditions based on variables that are endogenous to our model, we now turn to explore the role of the parameters underlying such conditions.

To start with, let us write the following lemma, which provides some conditions on debt and the capital share *a* ensuring that overaccumulation (underaccumulation) occurs.

Lemma 2: i) $n \underset{<}{\overset{>}{-}} 1+r$ iff $b \underset{>}{\overset{<}{-}} b' = e\dfrac{h_2(1-a)-a\beta}{h_3(1-a)}$; ii) when $a > a' = \dfrac{h_2}{\beta + h_2} < \dfrac{1}{2}$, it turns out that $b' < 0 < b$, such that $n < 1+r \;\; \forall b \in [0, b_{\max}), h_1, h_2, h_3 > 0$;

Proof: The proof is trivial by substituting for the equilibrium values into the equilibrium equations for n, w and r.

In the light of the result above, we can provide the following propositions:

Proposition 2a: if $a > a' = \dfrac{h_2}{\beta + h_2}$, debt issuing reduces fertility.

In the remainder of the paper we focus on the case $a < a'$, that is the situation in which the difference between the rate of growth of population and the interest rate is ambiguous, depending on the level of debt. If this is the case, recall that $n \underset{<}{\overset{>}{-}} 1+r$ iff $b \underset{>}{\overset{<}{-}} b' = e\dfrac{h_2(1-a)-a\beta}{h_3(1-a)} > 0$. Hence, we can study the function $\dfrac{dn}{db}$ with respect to the parameters of the model, focusing, in particular, on *a*. Let us write the function $\dfrac{dn}{db}$ as follows:

$$\frac{dn}{db} = E\left[\sigma + \phi b + \gamma b^2\right] \; where \; E = \frac{\left(\dfrac{eh_2 - bh_3}{b_3}\right)^a A h_3^{\,2}}{(e\beta - bh_3)^2 (eh_2 - bh_3)^2} > 0, \; \sigma = e^2 h_2 \left[\beta a^2 - (2\beta + h_2)a + h_2\right],$$

$$\phi = \left[a\beta - (a-1)(a-2)h_2\right] e h_3 < 0, \; \gamma = h_3^{\,2}(1-a) > 0.$$

Now, given that $\gamma > 0, \phi < 0$, and that $\left.\dfrac{dn}{db}\right|_{b_{\max}} < 0$, it turns out that in the $[0, b_{\max})$ interval the latter function can have either zero or one root if σ <0, or zero, one or two interior roots if σ >0. As for the case σ <0, since $\left.\dfrac{dn}{db}\right|_{b\max} < 0$, then it must be that *dn/db*<0 $\forall b \in [0, b_{\max})$ (because the latter function cannot change sign more than once). As for the case σ >0, since $\left.\dfrac{dn}{db}\right|_{b\max} < 0$, we have one and no more than one positive root (let us call it b^n).

Finally, we get that $\sigma \underset{<}{\overset{>}{-}} 0 \Leftrightarrow a \underset{>}{\overset{<}{-}} a'' = 1 + \dfrac{h_2}{2\beta} - \sqrt{1 + \left(\dfrac{h_2}{2\beta}\right)^2} \in (0,1)$, (Note that $a' - a'' > 0$).

Hence, we can provide the following Proposition:

Proposition 3: If $a'' < a < a'$, then increasing debt reduces fertility. If $a < a''$, debt increases raise fertility until a threshold level of debt, b^n, is reached, beyond which further increases reduce fertility.

Finally, we provide the value of b^n.

Lemma 4: *If* $(n - r - 1) > 0$, $\frac{dn}{db} \gtrless 0 \Leftrightarrow b \lessgtr b^n = e\frac{\Psi - \sqrt{(\Psi + 2\beta a)^2 - 4(1-a)^2 b_2^{\,2}}}{2b_3(1-a)}$; where $\Psi = b_2(1-a)(2-a) - a\beta$.

We can summarize our results through Figure 1. In the figure it emerges that, debt issuing almost ever reduces fertility. The only exception is represented by the case in which both debt and capital shares are low.

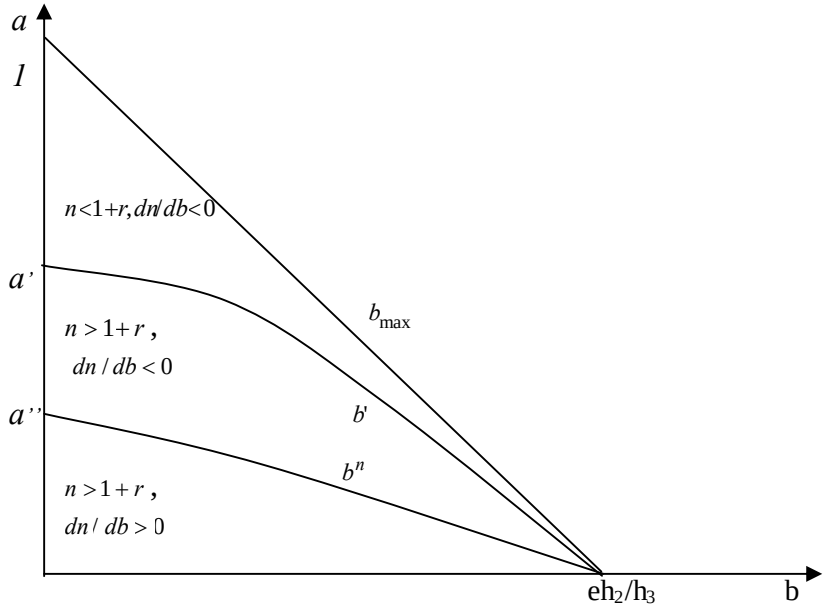

Figure 1: *The effects of debt variation on the fertility rate (dn/db) as a function of the technological parameter a and on the level of the outstanding debt b*.

Finally, the following interesting result, having straightforward policy implications, holds:

Corollary 1: The lower is the cost of rearing children (*e*) the more likely is a fertility stimulating effect of a debt reducing policy.

Proof : this straightforwardly follows by the derivative $db_n/de>0$. Since a'' is not dependent on the cost of children e, then the area at the bottom of the Figure 1 (below the b^n locus, that is the parameter space in which the vicious couple debt reduction fertility-reduction occurs), is enlarged.

This means that, if a government wishes to reduce its own debt and, at the same time, stimulate fertility rates, that is to end up outside the bottom region of Figure 1 (as it should be the case of countries largely indebted as well as less fertile such as Italy) it should also aim to a reduction of children's costs (for example, by enhancing the efficacy of publicly provided child services) in order to render more likely that their debt tightening policy (that is reducing the Area mentioned above of Figure 1) also brings upon a recovery of the fertility rates.

4. Conclusions

This paper extends the traditional OLG framework a là Diamond (1965) by allowing for endogenous fertility choices. Under this scenario we characterize the relationship between public debt and fertility, which are both important challenges for several advanced countries plagued both by large public debt and very low fertility rates, such as Italy. Therefore, for the latter countries, it seems to be crucial, on the one hand, a reduction of public debt (for instance, as regards Italy, in order to comply with the Maastricht rules) and, on the other hand, a recovery of fertility rates (for instance, for avoiding concerns on the viability of PAYG pension systems). The present analysis aims at unveiling the conditions whereby both objectives can be consistently pursued by national debt managing policies.

We point out that debt reductions can be either detrimental or beneficial for enhancing fertility, depending on economic factors such as technology, preferences and children costs and, interestingly, on the level of the outstanding public debt. In particular, we show that reducing debt is beneficial for fertility when the capital share of the economy and/or the outstanding level of debt are sufficiently high.

An interesting policy implication of our analysis is the following: the reduction of the cost of rearing children appears to be crucial for the current debt-tightening policies undertaken by several European countries to generate a recovery of population growth. In fact, these countries such as Italy are more likely moving in the right direction provided that they accompany the current reduction of the public debt stock with policies designed to keep low (or, better, reduce) the costs of rearing children, so as to secure a recovery of fertility rates in the long run.

Finally, we also provide a rule of thumb for detecting characterizing the relationship between national debt and rate of growth of population: if the latter is lower than the rate of interest, then this relationship is negative. Therefore, the presence of underaccumuluation is a sufficient condition for debt tightening policies to be beneficial for fertility.

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