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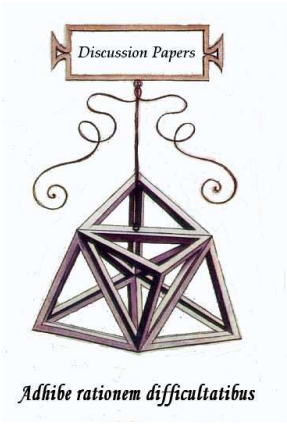

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Fertility and money in an OLG model

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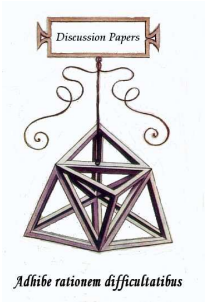

Luciano Fanti

Fertility and money in an OLG model

Abstract

We extend the two-period-lived-agent overlapping generations model with endogenous fertility and demand for money to understand whether and how the introduction of a money sector modifies what we have so far learned about fertility behaviours. It is shown that the existence of money may tend to exacerbate existing problems of either under-population or over-population.

Keywords Fertility; Money; Overlapping generations

JEL Classification J13; E41; O41

1. Introduction

In most industrialized countries, birth rates have been near or below the replacement level in recent decades, leading (jointly with a steadily increasing longevity) to population ageing, and thus triggering growing concerns about the impacts of ageing on economic growth, capital formation and social security systems.[1]

The present-day economic and political debate revolves around the understanding of the causes of this fertility drop, in order to face with the above mentioned concerns. Despite a large amount of economic literature on this topic, most works investigated fertility choices in a context of a real rather than monetary economy and in particular the relationship between fertility choices and asset portfolio choices has not been yet wholly analysed. As a consequence it is of importance to understand whether and how the introduction of a money sector modifies what we have so far learned about fertility behaviours.

As is known, in a broad sense money may be held for a threefold reason: (*i*) for transactions, (*ii*) as a store of value and (*iii*) for facing with cash-in-advance constraints. These different concepts lead to different methodologies of introduction of money in economic models and produce different macroeconomic effects, which are analysed, for instance, in the continuous time - infinite horizon frame by Wang and Yip (1992) and Zhang (2000) and in the discrete time - overlapping generations (OLG) frame by Crettez et al. (1999).

The present study considers money as a store of value. Thus, money is introduced into the economic model according to the money-in-the-utility function approach: money provides liquidity services to the holders in order for money to be held. Individuals will buy the services by holding real balances, and in this sense, money is a substitute of the other goods providing utility. Different from the previous cited papers which abstract from their fertility decisions, we assume that fertility choices are endogenous in the standard OLG model with endogenous fertility. This means that money is a substitute both of (current) consumption and number of children raised, both in the preferences and in the budget constraint of individuals.

While the literature has focused on this approach to show whether and how Tobin's portfolio effects[2] work (e.g., Abel 1987; Yakita 1989; van der Ploeg and Alogoskoufis 1994; Mino and Shibata 1995), we assume, for better focusing on the relationship between fertility and money, that monetary policy pursues the target of price stability, so that the return to money is constant.

We extend a two-period-lived-agent overlapping generations model with endogenous fertility and demand for money, concentrating on the effects that the portfolio choices of individuals have on the fertility choices. In fact, while endogenous fertility behaviours have been largely investigated in the standard OLG model with one asset (e.g. van Groezen et al., 2003; Fanti and Gori, 2007,

[1] Conversely, in many under-developed countries fertility rates remained steadily high, creating concerns as regards the economic development: for instance many African countries have live birth rates included between 4 and 5 per cent.

[2] That is, said in a nutshell, a fall in the return to money as the store of value induces portfolio shifts from money to non-money assets.

2012), less attention has been paid to the fertility choices when also a monetary asset is demanded by individuals. This paper aims to fill this gap.

The main result is that individual fertility depends crucially also on both the taste for money demand and the level of the interest rate, due to the presence of a portfolio choice between capital and money. As regards the relationship between fertility and the taste for money, it is shown that it can go in opposite directions. In particular, the larger the preference for children (the lower is the cost of children), and the lower the evaluation of the future consumption are, the more likely a high taste for money enhances the fertility rate. This means that in countries potentially prone to a high fertility rate (because of the presence of high "love" for children and low cost of children) and to take scarcely into account the future consumption, the presence of money demand tends to raise further the fertility rate, while, conversely, it tends to reduce it in countries with features (low "love" for children, high cost of children and low rate of time preference) favouring low fertility: in other words, the presence of money demand by individuals tends to rise (to reduce) fertility rates in countries with existing high (low) fertility rates. This means that money demand tends to exacerbate existing different (polar) fertility behaviours. The policy implication is that monetary policy should be taken into account for its effects on fertility, and, in particular, such effects may be of opposite sign in countries characterised by either under-population or over-population.

The key issue in this model with money-in the-utility-function and a monetary policy targeting price stability is that, while wage income is given, the transfer income (i.e. seignorage) depends positively only on the money demand (given the target of price stability). As a consequence, the presence of preference for money tends, on the one hand, to substitute number of children for money (negative substitution effect), but, on the other hand, to enhance parents' income (via rebated seignorage) which allows for a larger number of children raised (positive income effect). Thus, depending on whether the "love" for children is high (low) and the cost of children is low (high), when the taste for money is increasing the positive income effect tends to dominate (to be dominated by) the negative substitution effect.

As regards interest rates, it is shown that a high interest rate may increase (reduce) fertility rates in countries where taste for money is high (low) and taste for children is low (high). Then, given the historical fluctuations over time of the interest rates, our results highlight another channel, so far not explored in the demo-economic literature, through which fertility may be affected.

In conclusion, the original contribute of this paper to the literature about the economic theory of fertility lies into the introduction of the money sector into the (OLG) toy-model for analysing fertility decisions and show that monetary aspects may significantly influence fertility behaviours.

The remainder of this paper is structured as follows. Section 2 sets up the model. Section 3 studies the long-run outcomes. Section 4 examines the factors determining fertility when money exists. Section 5 concludes.

2 Model

We consider an overlapping generations model incorporating endogenous fertility and two assets (money and capital). The lifetime of a representative individual consists of two periods: a working period and a retirement period, both of fixed uniform duration. Each individual raises *n* children in his first period. At the end of this period children have matured and enter to the adulthood. Therefore, a working population grows at rate *(n-1)* both from generation to generation and from period to period. As regards the productive sector, we assume, for simplicity, that factor prices (wage and interest rate) are constant and exogenously given, in line with other articles dealing with the fertility issue in a real OLG economy (e.g. Nishimura and Zhang, 1995; Cigno, 1995; Cigno and Rosati, 1996; van Groezen et al., 2003; Fenge and Meier, 2005, Fanti and Gori, 2007, 2009, 2010).

2.1 Public sector

For our purpose, we simply assume that *i)* the public sector grows the money supply at the rate μ_t , such that a target of price stability is achieved (i.e. the inflation rate π=0) and *ii)* the seigniorage revenue is distributed as lump-sum transfers to workers. Let's define

$$m_t = \frac{M_t}{p_t N_t} \qquad (1)$$

where M_t denotes aggregate nominal money balances in the economy, N_t is the young population and p_t is the price level in period *t*.
Then the budget constraint of the public sector is given as $p_t \tau_t N_t = \mu_t M_{t-1}$, (2)
where τ_t is the per-young real lump-sum transfer in period *t*.
Re-writing Eq. (2) in per young terms, we obtain

$$\tau_t = \frac{\mu m_{t-1}}{n_t(1+\pi_t)} \qquad (3)$$

2.2 Individuals

An individual works, consumes, and saves in the first period of his life. Savings are held in the form of money and capital (real savings).We assume that his lifetime utility may be represented by the logarithmic utility function[3], defined over young-aged consumption ($c_{1,t}$), old-aged consumption ($c_{2,t+1}$), real money balances held at the end of the first period of life (m_t)[4] and the number of children raised (n_t),[5]

$$U_t = \ln c_{1,t} + \gamma \ln c_{2.t+1} + \psi \ln m_t + \phi \ln n_t \qquad (4)$$

[3] Although the logarithmic specification is generally used in the literature for simplicity, it seems to be empirically founded as well (see, for instance, Epstein and Zin (1989) who found values of relative risk aversion clustering around unity, consistent with such widely used utility function).
[4] As regards the introduction of money in the utility function, our formulation (4) strictly follows Yakita (2006), who used a two-period-lived-agent version of the utility function of Mino and Shibata (1995). Note that we assume that an individual does not hold real balances at the end of his second period, while Drazen (1981) considers the case in which money provides utility in both periods of life.
[5] The introduction of the number of children in the utility function is usual in the literature, dating back to Eckstein and Wolpin (1985). This formulation captures the fact that, according to the most part of researchers, people, mainly in developed economies, have children because they derive utility from having them (e.g. van Groezen et al., 2003).

where γ is the subjective discount factor, ψ and ϕ measures the taste for money and for children, respectively.
Assuming that the time endowment net of leisure is constant and normalized to unity, the first-period budget constraint of the individual is

$$c_{1,t} = w + \tau_t - qn_t - s_t - m_t \qquad (5)$$

where s_t is real savings, w is the wage rate, q is the fixed cost of rearing each child. Note that we have considered children as normal goods and that "a parent only wants to raise children with a certain level of well-being, that is, a child is only joyful for its parents if it is assured to receive a particular number of commodities and services like education, food, clothes, holidays etc. during its upbringing." (van Groezen et al., 2003, p. 239). The cost q represents such a 'quality-child', which is constant and equal for all children.

Therefore the second period, consumption is given as: $c_{2,t+1} = (1+r)s_t + \frac{m_t}{(1+\pi_{t+1})}$ (6)

where r is the interest rate, and π_{t+1} is his expectation concerning the inflation rate from period t to period $t+1$.
The individual chooses consumption in two periods, $c_{1,t}$ and $c_{t,t+1}$, and real balance holdings, m_t, so as to maximize his lifetime utility (Eq. 4) subject to the lifetime budget constraint,

$$c_{1,t} + \frac{c_{2,t+1}}{1+r} + \left[1 - \frac{m_t}{(1+r)(1+\pi_{t+1})}\right] = w + \tau_t - qn_t \qquad (7)$$

which is obtained from Eqs. (5) and (6).

2.4 Money market equilibrium

The dynamic equation in the money market is $(1+\mu_t)M_{t-1} = M_t$ (8)
which, after rearranging, may be expressed in per young terms as

$$m_t = \frac{(1+\mu_t)}{n_t(1+\pi_t)} m_{t-1} \qquad (9)$$

The equilibrium condition in the money market is given as

$$(1+\mu_t) = n_t(1+\pi_t) \qquad (10)$$

Rearranging Eq. (10), the equilibrium inflation rate is given as

$$\pi = \frac{1+\mu-n}{n} \qquad (11)$$

For our purpose, we simply assume that the target of the public sector is the achievement of price stability (i.e. the inflation rate $\pi=0$), and thus the growth rate of money supply is maintained at a value μ_t such that such a target is achieved . This amounts to say that the growth rate of money supply must be equal to the population growth rate, that is

$$\mu_t = n_t - 1 \qquad (12)$$

3. Long-run analysis

The steady-state optimal plans (as regards savings, money and fertility, respectively) are derived by the maximization of Eq. (4) under the constraint (Eq.(7)) and making use of Eqs. (3) and (11) (and recalling that $\pi=0$):

$$s = \frac{[q\psi(1+r)-\phi rw](\gamma r-\psi)}{\phi r[\psi - r(1+\gamma+\phi)]} \qquad (13)$$

$$m = \frac{\psi(1+r)[q\psi(1+r)-\phi rw]}{\phi r[\psi - r(1+\gamma+\phi)]} \qquad (14)$$

$$n = \frac{q\psi(1+r)-\phi rw}{q[\psi - r(1+\gamma+\phi)]} \qquad (15)$$

It is easy to see that savings are positive ($s>0$) if and only if one of the following three sets of conditions holds: *1)* $\psi<H$, $\psi>I$, $\psi>J$; or *2)* $\psi>H$, $\psi>I$, $\psi<J$; or *3)* $\psi<H$, $\psi<I$, $\psi<J$, where[6] $H = \frac{\phi rw}{q(1+r)}$, $I = \gamma r$, $J = r(1+\gamma+\phi)$.

As regards the real balance holdings, they are positive, i.e. $m>0$, if and only if one of the following two set of conditions holds: *1)* $\psi<H$, $\psi<J$; or *2)* $\psi>H$, $\psi>J$.

Also $n>0$ holds if and only if the same conditions valid for $m>0$ are satisfied.

Therefore, in order to ensure positive steady state values of all three variables (s, m, $n \geq 0$), the following set of conditions must be satisfied: $\psi<H$, $\psi<I$. From now on we assume (and check) that the latter conditions always hold.

Such conditions for the existence of a monetary economy with endogenous population deserve some comments. Firstly, the feasibility of the economic system in the presence of money demand requires that the taste for money is sufficiently moderate. Moreover it is more likely that the economic system is feasible when *i)* both the interest and wage rates are relatively high (e.g. the productive technology is sufficiently developed), *ii)* both the parsimony and the longevity are relatively high, and *iii)* the taste for children is relatively high if compared with the cost of children (e.g. fertility rates tends to be high). Therefore we can say that, different from the standard OLG model without money where the economic system is always feasible, the presence of money demand introduce some concerns for the existence of an economy. These concerns are rather important in that such an existence requires, on the one hand, some features (such as those mentioned at the points *i)* and *ii)*) which are typical of developed countries, and, on the other hand, a feature such as a potentially high fertility rate which is typical of under-developed countries.

Armed with the above considerations about the specific features of an OLG monetary economy with endogenous fertility, in the sequel we focus on the relationship between fertility and money.

4. Fertility and monetary parameters

It is easy to see (by eq. 15) that the introduction of money affects the fertility choices, as claimed in the following remark:

Remark 1. The presence of a portfolio choice between saving and money implies that fertility choices depends also on the taste for money demand and the level of the interest rate.

[6] Notice that $I<J$.

The relationships between fertility and monetary parameters are detailed below.

4.1 Effects of an increase in the taste for money.

Result 1. A large taste for money demand may increase (reduce) the fertility rate depending on whether the wage rate is sufficiently high (low) and/or interest rate, parsimony, longevity, cost of children are low (high) and the taste for children is high (low).

Proof: $\frac{\partial n}{\partial \psi} \gtreqless 0 \Leftrightarrow w \gtreqless \frac{q(1+r)(1+\gamma+\phi)}{\phi}$

4.2 Effects of an increase in the interest rate.

Result 2. Increasing interest rates may increase (reduce) the fertility rate depending on whether the wage rate is sufficiently low (high) and/or parsimony, longevity, cost of children, taste for money are high (low) and the taste for children is low (high).

Proof: $\frac{\partial n}{\partial r} \gtreqless 0 \Leftrightarrow w \lessgtr \frac{q(1+\gamma+\phi+\psi)}{\phi}$

Therefore, the exact determination of the effects of monetary parameters on fertility is an empirical matter. However some simple numerical examples may shed some light on the fertility reactions to monetary parameters changes under different stylised economies in terms of wages, children costs, rates of time preference, as shown in the next section.

4.3 A numerical illustration

Now we offer in Figs. 1 and 2 a numerical illustration of the theoretical results above enunciated. Only for illustrative purposes, we fix ϕ*=0.4, r=1* and display the fertility behaviour when monetary parameters change. In particular, for highlighting the twofold role on fertility played by the preferences for money in dependence of the configuration of the other economic parameters, we depict polar situations with respect to wage levels, percentage children costs and preferences for future consumptions which, although only for illustration and without having any pretensions to do a "calibrated" exercise, may be indicative of a more or less developed economy. Moreover we also illustrate how fertility varies for varying interest rates, for different levels of wages.

Fig.1 shows the potentially deleterious effect of increasing preference for money on fertility (ψ), which further increases (reduces) pre-existing high (low) fertility rates. For instance, assuming a wage level *w=8* and a cost of children *q=0.8* (implying that the cost of rearing each child is relatively low, around *10%* of the wage) and a rather low subjective discount factor - namely, γ*=0.1* – that is this parameter set may indicate, loosely speaking, a less developed economy, an increase in the taste for money parameter from *0* to *1* raises fertility rates from a rather high level of *5.4* children to an even higher level of *7.2* children for each couple. On the contrary, when wages are higher and children costs relatively high (for instance *w=16* and *q=3.2*, which implies that the percentage cost of each child is higher - around *20%* - and thus the rate of fertility is low) and the subjective discount factor

is relatively high – namely, γ=0.6 - that is the parameter set may denote, again loosely speaking, a developed economy, an increase in the taste for money parameter from zero to one reduces the fertility rate from the stationary population level to a very low below-replacement rate.

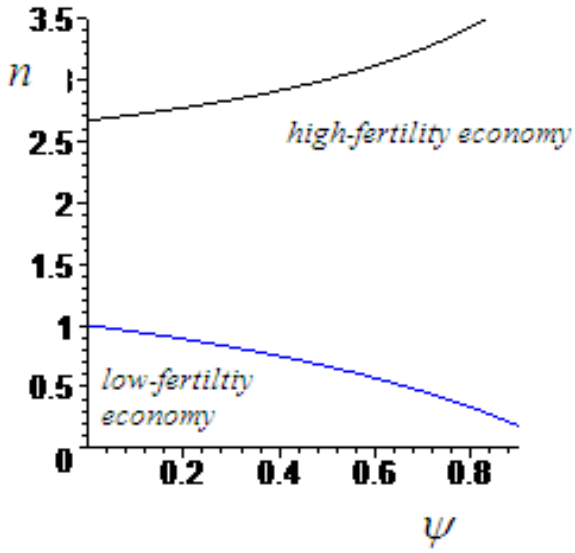

Fig. 1. *Fertility and taste for money relationship for two different parametric sets*. Legend: 1) high-fertility economy:ϕ=0.4, r=1, q=0.8, γ=0.1,w=8; 2) 1) low-fertility economy:ϕ=0.4, r=1, q=3.2, γ=0.6,w=16.

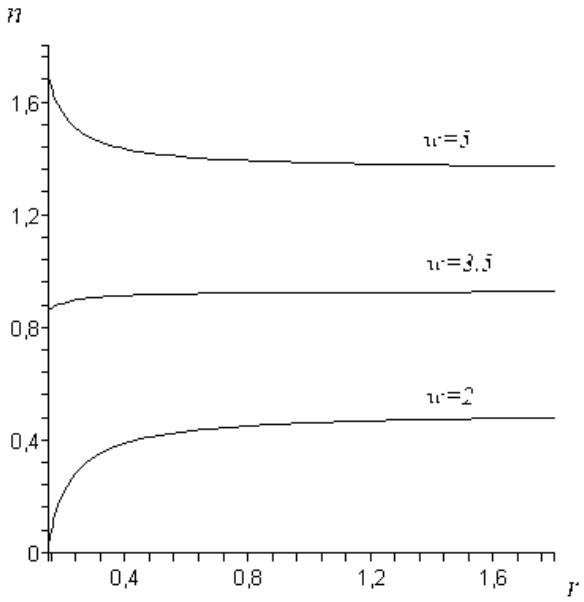

Fig. 2. *Fertility and interest rate relationship for different wage levels.*. Legend: ϕ=0.8, ψ=0.2, γ=q=1 ,w=(2, 3.5, 5).

Fig. 2 neatly shows the content of Result 2), that is persistently higher (lower) interest rates are potentially beneficial (harmful) for fertility rates in the following sense: for increasing interest rates, fertility tend to increase (to reduce) when its pre-existing level is low (high) (conversely for reducing interest rates). Therefore

enduring high interest rates tend to alleviate problems either of under or over-population, while, by contrast, enduring low interest rates tend to deteriorate both problems.

5. Conclusions

In this paper we extend a two-period-lived-agent overlapping generations model with endogenous fertility and demand for money, concentrating on the effects that the portfolio choices of individuals have on the fertility choices. It is shown that fertility choices depends also on the size of the taste for money demand and the level of the interest rate, and these relationships may be positive or negative, depending on other parameters, such as those determining fertility choices (i.e. the preference for children, the cost of children, the wage level and the rate of time preference).

This result delivers us an interesting and important lesson about the effects of monetary policy (pursuing a price stability target). When demand for money is present, policy makers should account for its effect also on fertility: we have shown that the higher the preference for money, the more likely there are potentially deleterious effect of the portfolio choices on fertility, because a larger taste for money further increases (reduces) pre-existing high (low) fertility rates. In other words the existence of portfolio choices tends to exacerbate pre-existing problems either of under-population or over-population.

Moreover we have picked up the effects of changes in interest rates: high (low) rates tends to reduce (to exacerbate) possible concerns about the population dynamics, by increasing (reducing) pre-existing low fertility rates and reducing (increasing) pre-existing high fertility rates.

Finally, we note that in this paper we used the simplest assumption that seignorage is rebated in a lump-sum way to the young people. However seignorage may be also used for financing child subsidisation policies as well as social security systems.[7] The investigation as regards whether and how these policies modify the relationship between fertility and money above presented is left for further research.

However, our model – which, at the best of our knowledge, is a first attempt to investigate the relationship between money and fertility in an OLG frame - is partial, and to give a fully satisfactory answer to whether and how the presence of money affects fertility, a general equilibrium approach should be used. Also this is a future directions of research.

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