



# Fertility, human capital accumulation, and the pension system<sup>☆</sup>

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## ABSTRACT

This paper provides a unified treatment of externalities associated with fertility and human capital accumulation within pay-as-you-go pension systems. It considers an overlapping generations model in which every generation consists of high earners and low earners with the proportion of types being determined endogenously. The number of children is deterministically chosen but the children's future ability is in part stochastic, in part determined by the family background, and in part through education. In addition to the customary externality source associated with a change in average fertility rate, this setup highlights another externality source. This is due to the effect of a parent's choice of number and educational attainment of his children on the proportion of high-ability individuals in the steady state. Our other results include: (i) Investments in education of high- and low-ability parents must be subsidized; (ii) direct child subsidies to one or both parent types can be negative; i.e., they can be taxes; (iii) net subsidies to children (direct child subsidies plus education subsidies) to at least one type of parents must be positive; (iv) parents who have a higher number of children should invest less in their education.

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## 1. Introduction

One of the most pressing problems facing the economies of the industrialized world is the fiscal solvency of their pay-as-you-go (PAYGO) social security systems.<sup>1</sup> An important contributing factor to this problem has been the recent drastic fertility declines in Western Europe and Japan. What truly determines fertility, and what accounts for the observed evolution in fertility behavior, are still open questions. What is clear, however, is that, faced with a PAYGO social security system, parents do not have the right incentives to choose a fertility rate that is optimal. In such systems, each person's fertility decision affects the economy's population growth rate and with it everybody's pension benefits. Specifically, an increase in the rate of population growth increases the number of future workers who will have to support a retired person. No individual, however, takes this

impact into account and that leads to a decentralized equilibrium outcome with too few children.<sup>2</sup>

The above problem is exacerbated by another externality associated with the "quality" of children, and their human capital accumulation, through the education decisions of parents. The rate of return of a pay-as-you-go system depends not just on the fertility rate, but also on productivity growth. The more productive the children, the higher will be their ability to produce and to pay taxes. This reinforces the public good nature of a family's child-rearing activities.<sup>3</sup>

Most of the literature has thus far treated the quality and quantity issues separately; or else have lumped the investments in quantity and quality together as if one decision determines both.<sup>4</sup> A basic shortcoming of this approach is that it cannot distinguish between child subsidies, which correct externalities emanating from fertility decisions, and education subsidies which correct for externalities due to

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<sup>1</sup> This has led to reforms in a number of countries. See Penner (2007) who surveys the recent reforms in Canada, Germany, Italy, Japan, Sweden, and the UK.

<sup>2</sup> In addition to this "intergenerational transfer" effect, the literature has also noted an offsetting force called "capital dilution" effect: A higher fertility rate, given the aggregate capital saved by the previous generation, implies a lower capital to labor ratio reducing per capita output; see Michel and Pestieau (1993) and Cigno (1993).

<sup>3</sup> To internalize the quantity and quality effects, some economists have advocated a policy of linking pension benefits (or contributions) to individuals' fertility choices. See, among others, Abio et al. (2004), Bental (1989), Cigno et al. (2003), Fenge and Meier (2005), Kolmar (1997), van Groezen et al. (2000, 2003).

<sup>4</sup> Cremer et al. (2003, 2008) are examples of this latter approach, while Cremer et al. (2006) is concerned only with quantity decisions. See also Gahvari (2009).

investing in education. This lack of distinction becomes more of a serious problem when the two types of externalities interact as they often do.

To be sure, there are a number of studies in the literature that distinguish between quantity and quality decisions and study them both in one unified framework. Peters (1995) is an early example of this. In his model, both fertility and education choices are made deterministically. The main shortcomings of his approach are the deterministic nature of both quantity and quality decisions, and the lack of any heterogeneity among parents. Cigno et al. (2003) also allow for both fertility and quality. Fertility is fully deterministic, but children's quality, which Cigno et al. define in terms of "lifetime tax contributions", is in part random and in part determined through actions of parents. The limitations of their study come from the static nature of their model, in looking at the decisions of the initial parent only, and their not allowing for heterogeneity among parents.

Cigno and Luporini (2003), while building on Cigno et al. (2003), allow for parents' heterogeneity in terms of their ability to influence their children's probability of success in life.<sup>5</sup> However, their model remains static in nature as they too do not go beyond the decisions of the initial parents. In Meier and Wrede (2008) both fertility and types are partly stochastic and partly determined by investments. The limitation of their model comes from their ignoring the impact of fertility and education investments on the distribution of types in the economy. But this induced change in the distribution of types constitutes an important component of fertility and education externalities.<sup>6</sup>

The current paper addresses the quantity and quality questions in an overlapping generations model with high- and low-ability individuals. The unique feature of our study is its endogenous determination of the distribution of types. Specifically, we allow for this distribution to be affected by both education and fertility decisions. This framework gives rise to three sources of externality. First, there is the customary externality associated with the change in average fertility—the intergenerational transfer effect. It arises from the fertility decisions of parents. This source of externality disappears if the pension system is a pre-funded one. The second source of externality emanates from decisions that change the distribution of types even if average fertility is kept constant. It arises from both education decisions and fertility decisions. Its unique feature is that it does not depend on the institution of social security and exists for pre-funded systems as well. The third source of externality is due to interaction between average fertility and the distribution of types. It too arises from both education decisions and fertility decisions. It is different from the second externality source in that it exists because of the PAYGO institution and disappears if one moves to a pre-funded system. It is also different from the first externality source because it will not exist if the distribution of types were immutable.

One distinguishing element between quantity and quality decisions is that of timing. One decides on the number of children quite early; the quality of children, i.e. their future earning capacity, is determined much later. We incorporate this timing sequence in our two-period overlapping generations model by assuming a sequential decision making process: At the end of the first-period, the young decide on starting a family and having children first and then on the extent of their children's education.

We assume that parents choose the number of their children deterministically. It is true that the actual number of children in a family does not necessarily coincide with the number that parents initially intended to have.<sup>7</sup> However, this choice is intrinsically more deterministic and less susceptible to random and other shocks than

determining the quality of one's children. As to the quality, it is unrealistic to expect that one can determine the future earning abilities of one's children in a deterministic fashion simply by investing in their education and training. We assume that quality is determined by three factors. One is random; the second is due to education; and the third is pre-determined by one's "genes" and family background. Nevertheless all children of a particular parent turn out to be either of high- or of low-ability.

Finally, we study the properties of an optimal pension system assuming that intergenerational transfer of resources occur only through the PAYGO scheme. This simplifies the analysis drastically by allowing us to ignore the issues relating to the choice between PAYGO and fully- or partially-funded pension systems. The determinants of this choice are multi-dimensional and, given our focus on endogenous fertility and education, any attempt to address this choice is bound to be inadequate.<sup>8</sup>

## 2. The model

### 2.1. Preliminaries

Consider, within an overlapping generations framework, the sequence of decisions a child has to face after he is born. First, upon reaching adulthood, he has to decide on starting a family and having children. Subsequently, as a parent, he has to decide on the extent of his children's education. Finally, the retirement period arrives. Such a rich model allows for children, adults, parents, and the retired (grandparents) to overlap, requiring a four-period overlapping generations model. However, analyzing a full-fledged four-period model quickly becomes cumbersome and too detailed for developing insights. We thus take a short cut and transform the four-period setup we have in mind into a simple two-period overlapping generations model. To do this we assume the decisions of having children and educating them occur sequentially just prior to the beginning of one's retirement. This saves us from having to distinguish between working as an adult and working as a parent.

Assume each generation consists of two types of people; they possess either a high or a low earning ability. Denote high- and low-ability types by subscripts  $h$  and  $l$  and let  $j = h, l$ . All children of a particular parent will turn out to be either of high- or of low-ability; no mix of high- and low-ability children is possible. There are three factors that determine if a child turns into a high- or a low-ability individual. One is due education; the second is a random element; and the third is pre-determined by one's "genes" and family background. The effect of education on ability is, *ceteris paribus*, most certainly positive. To introduce randomness into this process, we assume that investing in education does not necessarily transform a child into a high-ability type; instead, it only increases the probability of its occurrence. Thus, when a  $j$ -type parent invests  $e$  "units" in educating his child, the child will have a  $\pi_j = \pi_j(e)$  probability of turning out to be of high-ability. Naturally, the probability that the child will be of low-ability is  $1 - \pi_j$ . We assume that  $\pi_j(\cdot)$  is an increasing and strictly concave function with  $\pi_j(0) > 0$ .

The third factor, the child's family background, manifests itself through the functional form of  $\pi_j(e)$  and that is why the function is indexed by  $j$ . Specifically, one would expect that  $\pi_h(e) > \pi_l(e)$ . That is, for the same level of (formal) education, children of high-ability parents have a higher chance of becoming more able. This reflects the fact that high-ability parents tend to spend more time reading to their

<sup>5</sup> They also drop Cigno et al.'s (2003) assumption that fertility is fully deterministic.

<sup>6</sup> Sinn (2004) also considers a model that allows for both fertility and quality. In his setup fertility is fully random and quality fully deterministic. However, Sinn is interested more in examining the properties of a traditional PAYGO system rather than the properties of an optimal pension plan.

<sup>7</sup> Infertility, premature death, misplanning and multiple births are some of the reasons explaining this gap.

<sup>8</sup> One important question here is whether or not one should have a PAYGO system if the rate of return to capital exceeds the population growth rate. In a stripped down model such as ours, a PAYGO pension plan is undesirable unless the economy is characterized by dynamic inefficiency. Although Weil (2008) has recently argued that this possibility may arise even in advanced countries, we do not want to cope with this issue.

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