



Non-monotonicity of fertility in human capital accumulation and economic growth



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ABSTRACT

This paper investigates the relationship between per capita human capital investment and the fertility rate. In the first part of the article we analyze a theoretical model with endogenous birth rate in which we do not make any assumption on how fertility directly affects per capita human capital accumulation. The results obtained in this model are then compared with those of a more traditional setting where the birth rate is exogenous and in which the direct effect of this variable on per capita human capital investment is monotonically negative, a rather standard assumption within the available theoretical literature. By using non-parametric techniques, we document the presence of a strong non-monotonicity in the total effect that fertility plays on human capital accumulation, and hence on economic growth. The non-monotonic effect of fertility on human capital appears to hold empirically for OECD, as well as non-OECD countries.

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1. Introduction

The analysis of the impact of demographic change (population growth) on the growth rate of real per capita income represents an old, but still unsettled topic of research. Malthus (1798) was among the first to recognize that a higher population growth rate would ultimately in the very long-run have led to economic stagnation. According to his view, in a world in which economic resources are in fixed supply and technological progress is very slow or totally absent, the food-production activity would, sooner or later, have been overwhelmed by the pressures of a rapidly growing population. In this scenario, the available diet of each single individual in the population would have fallen below a given *subsistence level*, so leading to a fall of the productivity growth rate as well.¹ Unlike Malthus, proponents of the optimistic view² emphasize, instead, the positive effect that a larger population can exert on the rate of technological progress (an endogenous variable) and, thus, on economic growth: “. . . More people means more Isaac Newtons and therefore more ideas. More ideas, because of nonrivalry, mean more per capita income. Therefore, population growth, combined with the increasing returns to scale associated with ideas delivers sus-

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¹ More recent examples of the view that population growth is detrimental to economic development include the neoclassical growth theory with exogenous technological progress (Solow, 1956), some empirical applications of this theory (notably, Mankiw et al., 1992), and Barro and Becker (1988, 1989). The last two authors consider an environment in which fertility is endogenous. Under the assumption that children are normal goods and parents are altruistic (parents care about their children's well-being), they conclude that a faster population growth, by implying a dilution of the capital endowment of each individual in the population, harms long-run growth in real per capita incomes.

² See Kuznets (1960, 1967), Simon (1981), Boserup (1981), Kremer (1993), and Jones (2001), just to mention a few examples.

tained long-run growth" (Jones, 2003, p. 505).³ Besides the pessimistic and optimistic ones, there also exists another belief about the long-run effects of population growth on economic growth: the neutralist one. The advocates of this view claim that population growth has in general only little significant impact on economic growth and that such impact can be either positive, or negative, or else wholly inexistent (Srinivasan, 1988; Bloom et al., 2003, p. 17).

The pessimistic prediction of Malthus (1798) has fortunately never become reality. Nonetheless, it is now well known (Bloom et al., 2003, Fig. 1.1, p. 13; United Nations, 2004) that, unlike the industrialized world, the less (and especially the least) developed regions of the planet are rapidly and increasingly gaining shares of the world population. Since these regions are those that actually exhibit the highest fertility and the lowest literacy and economic growth rates, the following question becomes of paramount importance in such a context: what is the effect that a further increase in the fertility rate (thus, in the population growth rate) may have on human capital accumulation and, through this channel, on sustained long-run economic growth?

The main objective of the present paper is to tackle this issue from a theoretical as well as an empirical perspective. In order to achieve this objective we briefly present the main results of a simple benchmark model in which individuals can invest solely in human capital, the only input in the aggregate production function. We also assume that final output (aggregate GDP) can only be consumed, that the economy is closed (there is no international trade in goods and services and no international migration of people) and, finally, that there exists no governmental activity. Thus, in such an environment there is no room for physical capital investment. In this model the birth rate is exogenous, and moreover its direct effect on per-capita human capital investment (the so-called *dilution effect*) is taken as linear and monotonically negative. This is a rather standard assumption in the growth literature with human capital accumulation. The main prediction of the model is that the total impact of the population growth rate (the birth rate) on the rate of economic growth is, in general, monotonically negative as well.⁴

Then, we extend the benchmark model by allowing for an endogenous birth rate, and by making no ex-ante specific assumption on the way this rate might affect directly per capita human capital investment. This modeling strategy is compatible with a situation in which the total impact of population growth on economic growth is non-monotonic, i.e. a situation where the growth-effect of higher fertility is, as a whole, different (in sign and in magnitude) across different groups of countries characterized by different birth rates. Kelley (1988, p. 1686) was among the first to admit that the relationship between population and economic growth rates is indeed non-monotonic.⁵

In the last section of the paper we go to the data. By using semi-parametric and fully non-parametric methods, our empirical investigation finds strong evidence against the exogeneity of the birth rate, as well as against the monotonicity of the total impact that the birth rate has on the rate of per capita human capital investment and economic growth (these are the two building-blocks on which the simple benchmark model is founded).⁶

Kalaitzidakis et al. (2001), using non-parametric techniques, were among the first to search empirically for a nonlinear effect of human capital accumulation on economic growth. In their paper, the authors split human capital by gender (male vs. female human capital) and by category (primary vs. tertiary education). They argue that the nonlinearities come especially from the distinction of human capital by gender (as a result of the discrimination between males and females in the labor market), and suggest that overall human capital investment has a negative impact on economic growth (due to the fact that, particularly in countries with low levels of human capital, acquiring skills is generally considered as a rent-seeking economic activity). In our paper, contrary to Kalaitzidakis et al. (2001), we search for possible non-monotonic effects of demographic factors (the birth rate) on economic growth. Starting from the idea that a change in the birth rate affects agents' decision of how much to invest in per-capita human capital, and realizing that a higher birth rate leads to a faster depletion of available resources (so that investing in education becomes more costly), we claim that the relation between birth rate and per-capita human capital accumulation is non-monotonic. The presence of this non-monotonicity is, in turn,

³ In models with endogenous technological change population can affect economic growth in two distinct ways. In some papers (Romer, 1990; Aghion and Howitt, 1992; Grossman and Helpman, 1991) real per capita income growth depends positively on population size. This result (known as *strong scale effect*) is rejected on empirical grounds (Jones, 1995). In other papers, notably the semi-endogenous growth models (Kortum, 1997; Segerstrom, 1998), it is population growth (as opposed to population size) to sustain economic growth in the very long-run (*weak scale effect*). Another branch of endogenous growth theory has recently analyzed the impact of population growth on economic growth in environments in which there is also, along with technological progress, human capital accumulation. Such papers (Dalgaard and Kreiner, 2001; Strulik, 2005; Bucci, 2008) find that population growth is not necessary for long-run economic growth and that the effect of population growth on economic growth can be either non-positive (Dalgaard and Kreiner, 2001), or ambiguous (Strulik, 2005; Bucci, 2008). In all these papers, however, population (size and/or growth) is an exogenous variable.

⁴ At most, a rise of the growth rate of population may have no effect on economic growth. This occurs when agents are perfectly altruistic towards future generations, a very special case.

⁵ "[...] In some countries population growth may on balance contribute to economic development; in many others, it will deter development; and in still others, the net impact will be negligible" (Kelley, 1988, p. 1686).

⁶ The economic consequences of demographic change are at the heart of many empirical studies. While in some of them the focus is on the economy as a whole (for instance, Brander and Dowrick, 1994; Kelley, 1988; Kelley and Schmidt, 2003), in others country-based, household-level surveys are presented in order to shed light on the link between family size/fertility and human capital investment/children's performance at school (see, among others, Rosenzweig and Schultz, 1987 for Malaysia; Goux and Maurin, 2004 for France and Stafford, 1987 for the US). In comparison to Brander and Dowrick (1994), who analyze the impact of the birth rate on physical capital investment, we study the possible non-monotonic effects of the birth rate on human capital accumulation and economic growth. Contrary to Kelley (1988) and Kelley and Schmidt (2003), we use data covering a larger time-span (1960–2000) and non-parametric methods. Finally, unlike the household-level, country-based surveys (that in general predict a monotonically negative relationship between the two variables being analyzed), our main empirical motivation in the present paper is to search for possible non-monotonicities in the relation between birth rate and per-capita skill investment.

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