Research in Economics 65 (2011) 353–364

Contents lists available at SciVerse ScienceDirect

Research in Economics

journal homepage: www.elsevier.com/locate/rie

On the relationship between population change and sustainable development

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ARTICLE INFO

Article history:
Received 7 September 2010
Accepted 23 January 2011

Keywords:
Economic growth
Sustainability
Intertemporal welfare
Natural resources
Population change

ABSTRACT

This paper investigates the relationship between population growth and economic growth, through the study of fertility choices and their effects on natural resources. It aims at analyzing the interactions between endogenous fertility choices and the environment and their link to the sustainable matter. We analyze a growth model driven by natural resources and without production, where agents have jointly to determine consumption and fertility, taking into account the effects of their decisions on the dynamics of natural resources. We adopt the most optimistic view on natural capital (it generates endogenous growth) and the weakest notion of sustainable paths (all variables are positive): in such a framework we expect that sustainable paths exist. We instead show that this is not always true. In fact, even if renewal capacity of natural resources is unbounded, not always can a sustainable path be found: this depends on the difference between the stationary fertility rate and the mortality rate. If the stationary fertility is lower than the mortality rate, a sustainable path will not be found, and in such a case public intervention is necessary in order to address the economy along a sustainable path. This can simply be done through policies affecting public attention to environmental protection or the intensity of the dilution effect.

1. Introduction

The issue of the relationship between population and economic growth has really ancient roots in the economic literature: Adam Smith and Malthus were among the first to discuss the importance of controlling population growth in order to promote economic performance. After them, several theoretical and empirical studies investigated the relationship between population change and economic growth both from the economic and the demographic viewpoint, but a shared view has not arisen yet. In fact, as Bloom et al. (2003) summarize: *"...Though countries with rapidly growing populations tend to have more slowly growing economies..., this negative correlation typically disappears (or even reverses direction) once other factors... are taken into account"*. Three approaches have been proposed in order to study the issue: an optimistic, a pessimistic and a neutral view[1] (See Bloom et al., 2003). The most probably spread opinion is pessimistic (Solow, 1956; Becker and Barro, 1988; Barro and Becker, 1989) and considers population as a threat for growth. This can be due to two different reasons: if the economy shows fixed resources and no sources of technical progress, in the long-run the (food) production activity will not be able to satisfy the pressure of population growth, leading per-capita resources to fall below a minimal subsistence level (Malthus, 1798); if the economy instead shows rapid population growth, then a large share of

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[1] The optimistic view (Kuznets, 1960, 1967; Boserup, 1989; most recent analysis can be found in Jones, 2001; Tamura, 2002) considers population as an important input to produce knowledge: the higher the population, the higher the probability that a new Isaac Newton would be born. The neutral view (Bloom et al., 2003) instead has empirical foundation: there exists little cross-country evidence that population growth might either slow down or encourage economic growth.

1090-9443/$ – see front matter
doi:10.1016/j.rie.2011.01.007

investment will be devoted to satisfy the needs of the increasing population (*investment-diversion effect* — Kelley, 1988), rather than to increase per-capita capital endowments. The proponents of this view base their argument on the idea that an increase in the population size leads to a dilution of available resources.

The topic of sustainable growth, instead, is a recent and growing issue in the economic growth literature. The possibility that deterioration of environmental quality, in particular caused by pollution, could inhibit economic growth was first suggested in the report to the Club of Rome entitled *Limits to Growth* (Meadows et al., 1972). The first recognition of the issue at international level was the creation by the UN General Assembly in 1985 of the Commission for Sustainable Development, chaired by the Prime Minister of Norway, Mrs. Brundtland. The commission's report *Our Common Future* tried to emphasize that environmental protection is essential for economic development since the environment is an essential *'factor of production'* and source of important welfare services to people, even more in poor countries than in wealthy countries (World Commission on Environment and Development, 1987). There is wide agreement on the fact that sustainable development involves an integrated approach to economic, social and environmental processes; however, until now, the attention has been mainly focalized on the environmental and economic dimensions, addressing the social one (which can be mostly identified in the demographic dimension) only to a secondary role. In the current world, facing the uncertainties concerning the future of earth climate and environment, it is important to understand how finding a sustainable development path, where production, population and resources coexist without leading to an economic collapse. Such a situation in fact is not to be considered as unreal, as history can and should teach us. Typical examples are the collapse of the classical Maya civilization in the ninth century (Demarest, 2004), the dramatic decline of the Easter Island society (Flenley and Bahn, 2003) and the complete extinction of the Viking colonies of Greenland (Diamond, 2005). However, what sustainable development really means is not clear: several definitions have been proposed and each of them underlines different aspects of the matter; someone is too strong and someone else is too weak. The introduction of a clear notion of sustainability is still an open question and we propose an additional definition, which aims to introduce a minimal requirement for sustainability.

Population growth, as first Malthus (1798) noticed, is an important factor of environment depletion: consumption activities deteriorate environment and more people exert higher pressure on environmental stock. Therefore, since the interaction between natural resources and population can be really important, the aim of this paper is to build a bridge between this two different kinds of literatures. In fact, economic growth can be considered the main goal of current economies: however, its link with population dynamics and natural resources has often been underestimated.[2] Following Chichilnisky et al. (1995), we analyze the problem of sustainability studying an optimal growth model, where environment is represented by the stock of natural resources. We therefore assume that there exists a one-to-one correspondence between environment and natural resources. With respect to Chichilnisky et al. (1995), we rely on discounted utilitarianism as a welfare criterion and we introduce population change and its linkage with environment (natural resources). Our paper is strictly related to Nerlove (1991), who studies the mutual relationship between population dynamics and the evolution of natural resources. With respect to him, we adopt an optimal growth framework (and not an OLG model) since sustainability issues have to be dealt with by a long horizon approach; moreover, we explicitly model the population-environment relationship and we investigate under which conditions the economy is addressed along a sustainable path. We study the simplest model of endogenous growth, an AK type model, driven by natural resources, where economic agents jointly determine their consumption level and their fertility rate. Agents' decisions concerning consumption and fertility deplete the natural resources, which represent a source of utility. Therefore, they have to take into account the pressure their choices exert to the environment, when trying to identify a possible sustainable development path, along which natural resources, population and growth coexist.

In Section 2, we quickly review the issue of sustainability and its main implications for economic modeling. The attention is especially focused on the definition of sustainable development and on the choice of the welfare criterion to adopt in order to deal with such a matter. In Section 3, we introduce the model economy in its general formulation and derive the optimal paths for the control variables, consumption and fertility. Section 4 performs steady-state analysis, studying a balanced growth path along which the fertility rate is constant and identifying the presence of a possible sustainable path (defined as a path along which population, natural resources and consumption are positive, also asymptotically), and develops a comparative statics analysis, focalizing on policy implications. We show that even if renewal capacity of natural resources is unbounded, not always a sustainable path, where both population and natural resources coexist, can be found: this depends on the stationary fertility level. In particular, if it is lower than the mortality rate, the population will asymptotically disappear (implying that the economy will collapse) and the path followed by the economy is clearly not sustainable. We also show that with respect to other notions of sustainability (as Pezzey, 1997; Arrow et al., 2004), our definition has the advantage of discriminating among different paths, labeling some of them as sustainable and some others as not. In Section 5, we consider a special case of the model, that is an economy in which the stock of natural resources does not affect welfare, and we highlight the main differences. We show that also when utility depends only on consumption, the growth rate of population determines whether the path followed by the economy is sustainable or not, and the main results of the previous section still hold. Section 6, as usual, concludes.

[2] Since there is still not a shared view on the relationship between population and economics (population growth is an important factor of environment depletion and environmental assets have a fundamental role for economic development), the interaction between these three factors deserves particular attention.