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Journal of Economic Theory 132 (2007) 411–434
JOURNAL OF Economic Theory
www.elsevier.com/locate/jet

Demographic structure and capital accumulation

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Received 26 November 2002; final version received 3 October 2005
Available online 11 November 2005

Abstract

This paper develops an overlapping-generations (OLG) model to analyze the consequences of demographic structure changes induced by an exogenous shift in the birth rate. We first show that a finite growth rate of the population that maximizes long-run capital per capita exists. Then, we examine the theoretical properties of this growth rate by showing that: (i) it corresponds to the demographic structure such that the average ages of capital holders and workers are equal; (ii) it is associated to an efficient steady state; (iii) it increases with compulsory transfers from younger to older generations. Finally, we explain why standard OLG models do not exhibit such a growth rate.
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JEL classification: D91; E13; J10

Keywords: Continuous-time overlapping-generations models; Population aging

1. Introduction

Overlapping-generations (OLG) models are the neoclassical literature's common tool for analyzing the economic consequences of demographic structure changes. In this paper, we focus on the impact of exogenous shifts in the birth rate on long-run capital accumulation. This relationship is crucial for analyzing the consequences of population aging on most macro-variables,[1] such as growth, assets prices and unemployment. An increase in the population growth rate simultaneously induces a reduction in capital per worker and an increase in savings; the problem is to find out which one has the strongest effect. Standard OLG models with production in discrete or continuous time developed by Diamond [13] and Blanchard [4], respectively, can be used to show that a birth-rate increase reduces long-run capital per capita. The economic intuition given

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[1] See notably the paper by Abel [1] on demographic growth and stock prices.

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doi:10.1016/j.jet.2005.10.001

to this result relies on the absence of intergenerational altruism: the size of future generations does not directly influence the saving choices of current generations. The reduction in aggregate consumption that follows a birth rate increase is therefore insufficient for compensating the capital dilution effect. Following Weil [35], the birth rate measures the degree of disconnection between generations, and newborn individuals are interpreted as "unloved children" or immigrants.

Empirical studies, however, do not show that demographic structure changes have a significant impact of on capital accumulation or, more precisely, on its marginal productivity. In a recent paper, Poterba [30] analyzes the historical relationship between population structure and assets return, including the interest rate. Using time series from the United States, Canada and the United Kingdom for the last 70 years. Poterba finds no robust evidence of any impact of demographic variables on assets prices.

At a first glance, these empirical findings seem to invalidate the OLG models while validating the Ramsey framework. In this framework,[2] where the population is composed of one unique, altruistic family, the demographic variables have no impact at the balanced equilibrium. That is because the optimal response to a birth-rate increase is to reduce consumption in order to keep capital per capita constant. However, in this paper, we argue that Poterba's results can be reproduced in an OLG model. We build a continuous time OLG model of individuals with finite life-spans to show there exists a finite population growth rate, or equivalently an age structure of the population, that maximizes capital per capita. The existence of this capital maximizer implies that (i) the sign of the impact of demographic growth on capital per capita is ambiguous; (ii) the two different demographic structures could be associated to the same capital per capita; (iii) and the demographic structure changes have a little impact on capital per capita when these structures are at the neighborhood of the one that maximizes capital per capita. Hence, we conjecture that the demographic structures of developed countries have remained close to the structure which maximizes capital per capita. Of course an estimation is required to prove this statement, which is not within the scope of this paper. Instead, we focus on the theoretical characterization of the demographic growth rate that maximizes steady-state capital per capita.

Our argument hinges on the simple but crucial assumption of a population composed of non-altruistic individuals who accumulate assets following a life-cycle behavior. This is standard in neoclassical literature, but is barely implemented in general equilibrium models, because of the technical difficulties that arise in the aggregation procedure. Thus, the two-period lifetime model by Diamond [13] and the continuous time models by Blanchard [4] and Weil [35], which avoid these difficulties, are therefore extensively used in the literature. We show, however, that the assumptions that keep these models tractable, are responsible for the monotonic relationship they exhibit between population growth and capital per capita.

We argue that it is possible to develop an analytically tractable model that reproduces the stylized fact highlighted by Poterba [30]. We build a continuous time OLG model of individuals with finite life-spans based on the pioneering works of Tobin [33] and of Cass and Yaari [10].[3] We assume a general pattern of individual mortality, which includes such cases as the certain lifetime, the Blanchard's Poisson process and the Weil's infinitely-lived families. This formalization makes the comparative discussion straightforward. Aggregation is made following Lotka's [27] assumption of a stable population structure as well as assumptions of perfect financial and insurance markets.

[2] See [9,24].

[3] Further developments have been made recently by Burke [8], Malinvaud [28], Bommier and Lee [5] and Demichelis and Polemarchakis [12].

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