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Human capital formation and macroeconomic performance in an ageing small open economy

Ben J. Heijdra [a,b,c,d,*], Ward E. Romp [d,e]

[a] Department of Economics and Econometrics, University of Groningen, P.O. Box 800, 9700 AV Groningen, The Netherlands
[b] Institute for Advanced Studies, Austria
[c] CESifo, Germany
[d] Netspar, The Netherlands
[e] Faculty of Economics and Business, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, The Netherlands

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ABSTRACT

We study the effects of stylized demographic and fiscal shocks on the macroeconomic performance of an industrialized small open economy. We construct an overlapping-generations model which incorporates a realistic description of the mortality process. Agents engage in educational activities at the start of life and thus create human capital to be used later on in life for production purposes. Simple and intuitive expressions are derived which demonstrate the key economic and demographic mechanisms that are operating in the model. The engine of growth during the demographic transition is an intergenerational externality in the production of human capital. In a calibrated version of our model, we find that the effects of increased longevity on human capital formation are small whereas the reduction in fertility has a rather strong effect.

1. Introduction

The western world is ageing rapidly. Since the postwar period, the ageing process can be attributed both to increased longevity and reduced fertility (Lee, 2003). For example, in the Netherlands, life expectancy at birth rose from 71.5 years in 1950 to 78.5 years in 2000, whilst the annual (crude) birth rate fell from 2.3% to 1.3% of the population. Because infant mortality stayed relatively constant during that period (at 0.8% of the population), the increase in longevity must be attributed to reduced adult mortality (Vaupel, 1997). A similar demographic pattern can be observed for most OECD countries.

The objective of this paper is to investigate the effects on the macroeconomic performance of a small open economy of demographic shocks of the type and magnitude mentioned above. It must be stressed from the outset that we restrict attention to the study of advanced industrial economies of small size having access to well-functioning markets including

* Corresponding author at: Department of Economics and Econometrics, University of Groningen, P.O. Box 800, 9700 AV Groningen, The Netherlands. Tel.: +31 50 363 7303; fax: +31 50 363 7337.
E-mail addresses: info@heijdra.org (B.J. Heijdra), w.e.romp@uva.nl (W.E. Romp).

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the world capital market. Our study is thus intended as a contribution to the field of open-economy macroeconomics.[1] We formulate a simple analytical growth model in which finitely lived agents accumulate both physical and human capital. Our analysis makes use of modeling insights from two main bodies of literature. First, in order to allow for demographic shocks, we employ the generalized Blanchard-Yaari overlapping-generations model reported in our earlier paper (Heijdra and Romp, 2008a). In this model disconnected generations are born at each instant and individual agents face a positive and age-dependent probability of death at each moment in time. By making the mortality rate age-dependent, the model can be used to investigate changes in adult mortality.[2]

The second building block of our analysis concerns the engine of growth during the demographic transition and possibly also in the long run. Following Lucas (1988), we assume that the purposeful accumulation of human capital forms the core mechanism leading to economic growth. More specifically, like Bils and Klenow (2000), Kalemli-Ozcan et al. (2000), de la Croix and Licandro (1999) and Boucekkine et al. (2002) we assume that individual agents accumulate human capital by engaging in full-time educational activities at the start of life. The start-up education period is chosen optimally by each individual and labor market entry is assumed to be irreversible. Depending on the parameter setting, the human capital production function (or *training function*) may include an intergenerational external effect of the 'shoulders of giants' variety, as first proposed in an overlapping generations context by Azariadis and Azariadis and Drazen (1990). With an operative externality, an individual's training function depends positively on the economy-wide stock of human capital per worker in that individual's birth period.

In our model, the strength of the intergenerational spillover is regulated by a single non-negative parameter, ϕ. Unfortunately, there is no consensus regarding the appropriate magnitude of this ϕ. For example, Kalemli-Ozcan et al. (2000) abstract from the intergenerational spillover altogether and thus set $\phi = 0$. In contrast, Bils and Klenow (2000) set $0 < \phi < 1$, and thus assume that the externality is operative but subject to diminishing returns. Finally, de la Croix and Licandro (1999), Boucekkine et al. (2002), Echevarría (2004) and Echevarría and Iza (2006) consider the knife-edge case with $\phi = 1$. In our theoretical model, we generalize the existing literature by allowing the spillover parameter to take on any value between zero and unity ($0 \leqslant \phi \leqslant 1$).

Our paper is structured as follows. In Section 2 we present the model and analytically demonstrate its main properties. A unique solution for the optimal schooling period is derived which depends on fiscal parameters and on the mortality process. For a given initial level of per capita human capital, the model implies a unique time path for all macroeconomic variables. Depending on the strength of the intergenerational external effect, the model either displays exogenous growth ($0 \leqslant \phi < 1$) and ultimate convergence to constant per capita variables, or endogenous growth ($\phi = 1$) and convergence to a constant growth rate.

Our model, and indeed the closely related one by Boucekkine et al. (2002), is analytically tractable because the interest rate is held constant, making the system block recursive. Boucekkine et al. achieve constancy of the interest rate by assuming that the felicity function is linear, i.e. that the intertemporal substitution elasticity is infinite. Apart from its empirical implausibility, this assumption has the unattractive implication that individual consumption profiles are indeterminate. In contrast, we attain tractability by assuming a small open economy facing a constant world interest rate. This allows us to postulate a concave felicity function, which gives rise to well-defined consumption profiles, both individually and in the aggregate. Our model thus fully determines unique transition paths for all macroeconomic variables of interest, including the current account of the balance of payments.

In Section 3 we investigate the effects of once-off demographic changes on the population growth rate, both at impact, during transition, and in the long run. We estimate the Gompertz–Makeham (G–M) mortality process, employing data for the Dutch cohorts born in the period 1920–2000, and use it to illustrate the rather complicated (cyclical) adjustment path resulting from once-off demographic changes. Especially for the cohort-specific mortality shock, convergence toward the new steady state is extremely slow. Indeed, due to the vintage nature of the population, more than a century passes until the new demographic steady state is reached.

In Section 4 we study the determinants of the optimal schooling decision in detail. An increase in the educational subsidy or the labor income tax leads to an increase in the length of the educational period. Similarly, a reduction in *adult* mortality also prompts agents to increase the schooling period. In the absence of retirement, such a shock lengthens the post-school period and increases the pecuniary benefits of schooling. In contrast, a reduction in *child* mortality has no effect on the optimal schooling period. Such a shock increases the probability of surviving the schooling period, but has no effect on the length of the working period. Finally, a baby bust also leaves the optimal schooling period unchanged because it has no effect on the individual's optimization problem. Unlike Boucekkine et al. (2002), who use a specific functional form for the mortality process, we reach our analytical conclusions using a general specification for the mortality process.

Section 5 deals with the exogenous growth model, which, on the basis of the empirical evidence, we consider to be the most relevant one. Indeed, using the recent empirical study by de la Fuente and Doménech (2006), we argue that a

[1] The recent growth and development literature takes a much longer-run perspective and attempts to model the '...long transition process, from thousands of years of Malthusian stagnation through the demographic transition to modern growth' (Galor and Weil, 2000, p. 806). Clearly, in this literature, both fertility and mortality rates are endogenous; see the recent survey by Galor (2005). In this paper, we follow the macroeconomic literature by assuming that the birth rate and the mortality process are exogenous.

[2] Other papers including an age-dependent mortality process include Boucekkine et al. (2002), Faruqee (2003) and d'Albis (2007). Boucekkine et al. (2002) is discussed throughout this paper. Faruqee (2003) analysis is flawed because he confuses the cumulative density function with the mortality rate. d'Albis (2007) characterizes the steady state in a closed economy setting. Both Faruqee (2003) and d'Albis (2007) only look at steady-state effects.