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The effects of demographic changes on the real interest rate in Japan

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ABSTRACT

What are the effects of demographic changes on the real interest rate in Japan? We present a dynamic general equilibrium model in which demographic changes are captured by exogenous changes in the ratio of workers to the total population. Our model predicts that a decline in this ratio in the process of population aging lowers the real interest rate; and the demographic impact on the real interest rate is amplified by a fall in land prices in the presence of collateral constraints. The model is simulated with the realized and forecasted changes in the working-age population ratio, the TFP growth, and government spending in Japan. Our results indicate that the TFP growth is the main source of variations in the real interest rate, but the demographic factor is also quantitatively important especially for its long-term movements.

1. Introduction

There have been significant changes in the demographic structure in developed countries. The upper panel of Fig. 1 shows the evolution of the ratio of the working-age population (persons with age 15–64) to the total population in Japan, where the data after 2010 is the projection of the United Nations. A striking feature that emerges from this figure is that the late 1980s is a turning point for the demographic history of Japan: because of the aging of the population, the working-age population ratio starts to decline in the late 1980s, and a declining trend in this ratio is expected to continue into the future. A similar shift in the demographic trend is observed in other developed countries as shown in the lower panels of Fig. 1, although the precise timing of the shift in many countries is later than that in Japan.

Such demographic changes are expected to have a widespread impact on the macroeconomy. Bakshi and Chen (1994) note that the investment behavior of the older age group is different from that of the younger age group, and present an empirical evidence that changes in the age distribution have a significant impact on stock and house prices. Similarly, Mankiw and Weil (1989) argue that the entry of the baby boom generation into its house-buying years caused a U.S. housing boom in the 1970s. Miles (1999) uses an overlapping generations (OLG) model to claim that the aging of the population is an important factor behind the evolutions of the saving rate. The aging of the population is sometimes listed as one of the potential causes of the slowdown in economic growth in Japan since the 1990s, together with a fall in the growth rate of total factor productivity (TFP) and problems in the financial sector.

Among the numerous macroeconomic variables that are expected to be influenced by demographic changes, this paper focuses on the real interest rate. More specifically, we are interested in the movements of the equilibrium real interest rate, or the natural rate of interest. This interest rate is not observable and needs to be estimated, but it provides an essential information when one evaluates the monetary condition and the state of macroeconomic environment: when the natural rate of interest falls below the actual real interest rate, the monetary condition becomes relatively tight and deflationary pressure emerges; such a pressure becomes especially strong if the zero lower bound prevents the policy interest rate from falling. In this paper, we use a model that does not include nominal frictions so that the equilibrium

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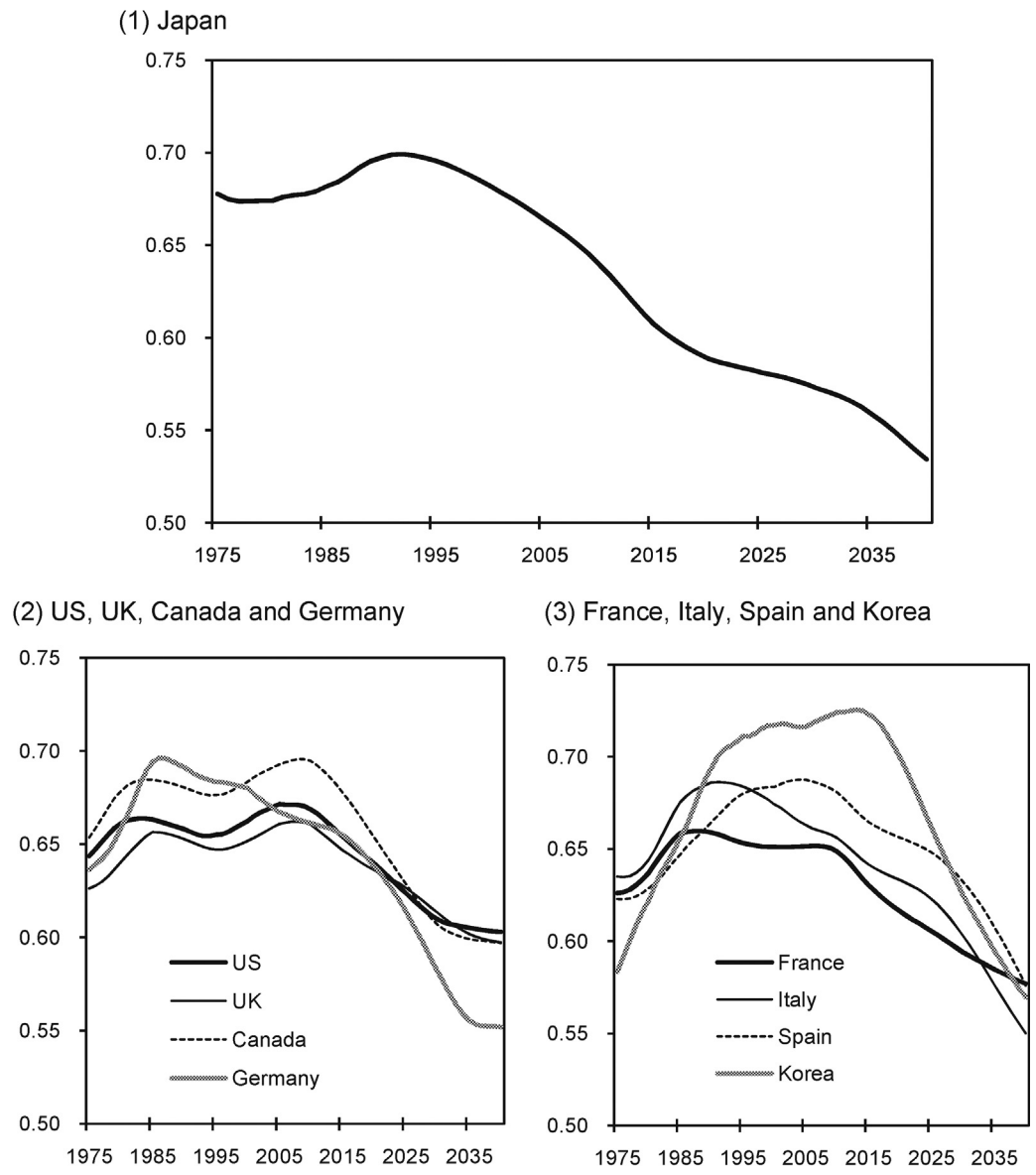

Fig. 1. Ratio of working-age population to total population. *Notes*: The data source is the United Nations. The data after 2010 is the forecast of the United Nations.

interest rate in our model can be interpreted as the natural rate of interest.[1]

The dynamic general equilibrium model in this paper includes the following three channels through which demographic changes – specifically, changes in the working-age population ratio – affect the real interest rate. The first channel works by increasing the supply of loanable funds by the household which is a lender in the model economy. Our model assumes that the wage income earned by workers is distributed within a household to support the consumption of non-workers. When the ratio of the working-age population to the total population is expected to decline in the process of population aging, the number of wage earners relative to the number of persons who consume is expected to decrease.[2] The household which follows a permanent income hypothesis then consumes less and saves more in order to smooth out the level of per-capita consumption into the future. The increase in the household savings results in an increase in the supply of funds in the loanable funds market, and generates downward pressure on the real interest rate.

The remaining two channels work by reducing the demand for loanable funds by the firm which is a borrower in the model economy. We consider a firm that conducts production using capital stock, labor, and land as inputs. In our model, a decline in the working-age population ratio works like a fall in TFP; this reduces the marginal products of capital and land, and the demand for capital and land by the firm decreases. Since the firm's expenditure on capital is financed partly by borrowing, a decrease in the demand for capital reduces the demand for loanable funds by the firm, placing downward pressure on the real interest rate. This is the second channel.

The third channel operates through a fall in land prices. Our model assumes that the land serves as a collateral in the firm's borrowing and that the amount of the firm's borrowing is constrained by the value of land. Because of the fall in the marginal product of

[1] Of course, the real interest rate in our model is a good approximation for the natural rate of interest only to the extent that the shocks and the structure of the model provide a good characterization of the actual economy.

[2] In contrast, a standard representative agent model assumes that all the household members work. Such a model allows for variations in the total population, but not the variations in the ratio of workers to the total population.