

the usual variables of capital and labor productivity and the rate of interest.⁹ Further, the static stock supply function of capital, in which the equilibrium capital-output ratio is related to the rate of interest, is negatively sloped; the higher the rate of interest (productivity of capital, for any given capital-output ratio) the lower is the capital-output ratio. This result is easily explained: the higher the rate of interest, the smaller is the fund which must be accumulated for each worker (relative to his wage) to pay his retirement benefits.

Essentially the same results carry over into a model in which population, the labor force, and factor productivity (via the level of technology) are all growing smoothly at constant rates. The capital-output ratio is rising through time, as is output and income per capita. Under certain assumptions about the aggregate production function, there exists a longrun equilibrium growth path for which the rate of interest (capital marginal productivity) is constant, as technological advance offsets the tendency toward diminishing returns to capital (implied by the rising capital-labor ratio).

If, in such a moving-equilibrium model, all saving is for retirement, and retirement income bears a constant relation to working income, it can again be shown that the equilibrium supply curve of capital (in a stock sense) is negatively related to the rate of interest. As in the static model, the longer is life expectancy at retirement, the larger will be the capital-output ratio and the share of national income consumed by retired persons.¹⁰ With a given life expectancy, as the retirement age falls and the retirement period lengthens, the equilibrium capital-output ratio rises, the rate of interest falls, and consumption per capita falls.¹¹

Let us turn our attention now from equilibrium-type models to our own economy. Under neoclassical assumptions of smooth full-employment adjustments in interest rate, prices, and capital-output ratios, an increase in the share of income and output saved would pose no problems. If pension plans increase the share of national income which is saved, then we should expect the economy to respond with lower interest rates, a higher capital-output ratio, and more output per capita during each time period. It does not follow that consumption per

⁹ For a more detailed discussion of such models, see my "Pensions, the National Income, and the National Wealth," in Juanita Kreps, ed., *Employment Income and Retirement Problems of the Aged*, Duke University Press, Durham, 1963.

¹⁰ For a demonstration of the growing population but constant productivity case, see Blackburn, op. cit. The more complicated cases in which both population and output per worker are rising but along a constant-interest-rate long-run equilibrium growth path are simply variants of neoclassical equilibrium growth models of the type treated by Solow, Brems, Phelps, and others. See, for example, R. M. Solow, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics*, November, 1956, vol. 70, pp. 537-562; Hans Brems, "Growth, Distribution, Productivities, and Thrift in Cobb-Douglas Models," *Southern Economic Journal*, January 1963, vol. 29, pp. 181-88. (See also my comment and his reply, *Southern Economic Journal*, October 1963, vol. 30, pp. 175-179); and Edmund S. Phelps, "The Golden Rule of Accumulation: A Fable for Growthmen," *American Economic Review*, September 1961, vol. 51, pp. 38-43. The proof that changes in the retirement age, life expectancy, or the fraction of working income desired as retirement income have the same effects on the interest rate and the capital-output ratio as in the static case is too lengthy to reproduce here. It is available from the author.

¹¹ Ando and Modigliani develop a model of aggregate saving based primarily on lifetime consumption (retirement saving) considerations. Their basic assumption is that all saving is for retirement, though they indicate ways in which this assumption can be relaxed without destroying the results. It is interesting that estimates of the stock of wealth implied by a wide range of empirically plausible values for working life, life expectancy, retirement income as a fraction of working income, the rate of interest, and age distributions of the population give values of the capital-output ratio far lower than the existing U.S. ratio. It would appear that nonretirement saving must be considered in the Ando-Modigliani model. See Albert Ando and Franco Modigliani, "The 'Life Cycle' Hypothesis of Saving; Aggregate Implications and Tests," *American Economic Review*, March 1963, vol. 53, pp. 55-84.