

## Comments on the Referee's Report

The referee's report reflects a careful reading of our paper, makes constructive and useful suggestions, and invites a response to its perceptive criticisms of certain features of our model.

### *Assumptions about risk markets.*

The referee rightly raises concerns about our assumption of perfect annuity markets coupled with the complete absence of markets for the risks that we assume are insured by the government.

With respect to medical costs, we do not suppose that the medical shock occurs only at the retirement date—rather the shock that occurs at that time is the loss of private medical insurance. We grant, but do not model, that private medical insurance would be available to workers, perhaps provided by their employers, as is the common practice in the US. However, retirees typically lose such insurance and are notably uninsurable by other means, which explains the existence government medical insurance for retirees, even in the US which lacks universal government medical insurance..

The Blanchard-Yaari assumption of *perfect* annuities markets is, of course, counterfactual. Private markets for life annuities (reverse life-insurance) do exist, even in the indexed forms now that derivatives based on inflation indexed government securities are available, but no doubt these annuities carry abnormally high loading factors given the presence of adverse selection. The B-Y assumption is made in our model, as we suppose in all such models, for the purpose of model tractability. To the best of our knowledge, there is no good alternative. Our goal in choosing a stochastic retirement date, in addition to our desire to represent the uncertainty inherent in human capital, is to find a way, within the B-Y framework, of developing a phenomenon that is central issue to the social security debate, which is the uninsurable risk that arises from the uncertain duration of retirement. Given the assumption of perfect annuities markets, a certain retirement date would not create such uninsurable risk.

### *The assumption of age independent hazard*

It is, of course, unrealistic to assume that people face mortality and retirement hazards that are independent of their ages, but we do believe that a model based on such an assumption provides a good first approximation to the real world case of age-dependent risks, particularly for aggregate variables. More realistically, we could assume a Gompertz type of hazard functions for these risks, for example, but such functions are not tractable, and the models would need to be simulated. The tractability issue is less in the modeling of individual behavior than it is in the aggregation of variables, which is critical in the type of analysis we do. In any case, simulations of models based on more realistic assumptions would not be very enlightening if presented as a black-box, and simple models like ours, though based on an unrealistic assumption, provide the needed transparency.

The referee suggests that we adopt Gertler's assumption that mortality hazard does not begin until the household retires, but even this assumption does not allow us to carry out the needed aggregation. Gertler had to simulate his model, and while we have no objection to simulations, our goal was to develop a model that could provide analytic results.

### *Variable Retirement*

The referee is correct that the title of our paper is misleading and we will change "Variable Retirement" to "Uncertain Retirement". Conceivably, it would be possible to introduce variable retirement into our model by allowing households to have some choice (at a cost) about the retirement hazard rate. This would introduce moral hazard, and perhaps better motivate the absence of private insurance markets, but our feeling was that the model is quite complicated as it stands, and the benefit of introducing an additional complication was insufficient.

### *Specific Comments*

- 1) Yes—CARA was assumed for tractability. With CRRA, we could not model the social security and medicare systems as specifically as we do. The parameter gamma determines the curvature of the felicity function and determines both risk aversion and inter-temporal substitution. In the welfare analysis, gamma does determine the optimal values of the social insurance parameters. We will add something on that in section 7.
- 2) The main way in which the precautionary saving motive is reflected in the results is the fact that uncertain future medical costs have a greater impact on current (employee) saving than does the need for retirement consumption. We assume the referee finds our footnote 11 on this insufficient—we will try to expand.
- 3) The result in Prop 5 that wealth of workers and retirees is reduced by the same absolute amount undoubtedly reflects the CARA assumption and is not robust to other utility specifications.
- 4) Yes. Thank you—we will correct that.
- 5) The critical issue is the excess of worker saving over retiree. We should refer to this as the "lifecycle and precautionary motive for saving".
- 6) The variance of retirement medical expenses is captured in the  $\mu$  hat term (an increase in variance of medical expenses increases  $\mu$  hat which in turn increases the optimal social security benefit according to equation (50a). We will not this in prop. 8.