Appendix of “Health Investment over the Life-Cycle”

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This appendix provides the sensitivity analysis to the results in our paper “Health Investment over the Life-Cycle.” It also describes the details of the computational method for the benchmark model in the paper.

1 Sensitivity Analysis

In this section we conduct a sensitivity analysis to investigate how our quantitative findings from the benchmark model are affected if an alternative utility function is used and when we allow health to affect labor productivity rather than time.
1.1 Separability Between Consumption and Leisure

In the benchmark model, we used a non-separable utility function on consumption, leisure and health. In this section we test an alternative specification that allows for the separability over consumption and leisure. For consumption and health, we maintain a flexible CES function form. The period utility function is

$$U(c_j, l_j, h_j) = \left[ \lambda c_j^{\psi_c} + (1 - \lambda) h_j^{\psi_h} \right]^{\frac{1}{1 - \sigma}} + \chi \frac{l_j^{1-\theta}}{1 - \theta} + \zeta$$

(1)

A useful property of this specification is that it implies that the Frisch elasticity of labor supply is \(\frac{l_j}{1 - l_j - s_j} \theta\) at age \(j\). This objective varies over the life-cycle as a function of leisure relative to working time. While early empirical work finds that this elasticity is well below one, more recent estimates indicates that it centers around unity (Imrohoroglu and Kitao 2009). We choose \(\theta = 1.8\) to match an average value of one for the labor supply elasticity. We calibrate the weight of leisure \(\chi = 1.45\) to average fraction of working hours over working age. We also recalibrate the other remaining parameters to match targets as in Table 2 in the paper.\(^1\)

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\(^1\)The new parameter values are \(\beta = 0.9621, \sigma = 2.0, \psi = -4.7, \lambda = 0.25, \xi = 3.4, d_0 = -3.84, d_1 = 0.335, d_2 = 0.001, B = 0.72, \xi = 0.71, Q = 0.0144, \gamma = 2.3, w_0 = -5.809, w_1 = 0.285, w_2 = 0.008, w_3 = -0.25\).
Given all these recalibrated parameter values, Figure 1 shows the performance of the model. Although the performance is noticeably worse than in the benchmark in Section 5, we still capture the basic trends of each variable, with the exception of working hours. We also want to point out that now with separable leisure from consumption, the model generates a smooth consumption path around the retirement age.

We now conduct the decomposition experiment from Section 6. The benchmark model now refers to the model with the alternative preference in equation (1). “No C-Motive” is the model obtained by setting $\lambda = 1$ while keeping all other parameters at their values from the benchmark. “No C-Motive” refers to the model obtained by setting $Q = 0$ while keeping all other parameters at their benchmark values. “No S-Motive” refers to the model obtained by setting $\omega_3 = 0$ while keeping all other parameters at their benchmark values. “No I-Motive” and “No S-Motive” cases generate profiles similar to those from the benchmark model, whereas “No C-Motive” model yields much lower medical expenditures and health status. That said, C-Motive dominates the other two motives in driving up the medical expenditures over the entire life-cycle. Our earlier finding that deriving utility from health is crucial is robust to this alternative specification of preferences.
Figure 1: Life-cycle profiles: alternative preference vs. benchmark
Figure 2: Life-cycle profiles of the model with the alternative preference: decomposition
1.2 Time Endowment vs. Productivity

Grossman (1972) argues that the main difference between health capital and human capital is that human capital affects an individual’s productivity, whereas health capital determines the total amount of time that can be spent in market and non-market activities. Our benchmark model in Section 2 in the paper follows Grossman closely. Some literature, however, takes a different route and models health as a determinant of individual labor productivity (Feng 2008, Jung and Tran 2009). Will these two different modelling strategies generate significantly different life-cycle profiles? This section answers the question by running an experiment in which we replace the investment motive in the benchmark model in Section 2 with a specification of health-related labor productivity. Following Bloom and Canning (2005), we assume that an individual’s labor income at age \( j \) takes the form \( w_j e_j^{\eta h_j} n_j \), where the labor-efficiency unit \( e_j \) captures the effects of other forms of human capital (such as education) on an individual’s labor productivity. The term \( e_j^{\eta h_j} \) describes the effect of health on labor productivity at age \( j \).

As far as we know, there is no estimate of the parameter \( \eta \) from the life-cycle data. Bloom and Canning (2005) estimate \( \eta = 0.028 \) from an aggregate production function using a cross-country data set. We take their estimate and the age-efficiency profile \( \{e_j\} \) from the benchmark model and recalibrate all the other parameters to

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match the moment conditions as in Table 2 in the paper (except the two targets related to sick time).\textsuperscript{2} We call this the productivity model and report its comparison to the benchmark model in Figure 3.

If health affects labor productivity, better health transforms into higher wages and hence higher consumption. This gives an incentive to invest in health. Figure 3 shows that the productivity model provides profiles very similar to those in the benchmark model. Therefore, both modelling strategies do a fine job of replicating life-cycle profiles.

We again redo the decomposition exercise as in Section 6 in the paper. Strikingly, as shown in Figure 4, the “No C-Motive” model (set $\lambda = 1$, and keep all other parameter values the same as in the productivity model) generates almost negligible medical expenditure. On the other hand, the “No I-Motive” (set $\eta = 0$ and keep all other parameter values the same as in the productivity model) and “No S-Motive” model (set $\varpi_3 = 0$ and keep all other parameter values the same as in the productivity model) obtain life cycle profile of medical expenditures very similar to each other and also very similar to the one in the productivity model. This shows that health investment in the productivity model is mainly driven by the consumption motive,

\textsuperscript{2}The new parameters are $\beta = (0.9565)^5$, $\sigma = 2.0$, $\psi = -6.23$, $\lambda = 0.6$, $\rho = 0.342$, $\varpi = 3.6$, $d_0 = -4.35$, $d_1 = 0.23$, $d_2 = 0.009$, $B = 0.63$, $\xi = 0.8$, $\varpi_0 = -5.827$, $\varpi_1 = 0.264$, $\varpi_2 = 0.0081$, $\varpi_3 = -0.23$. 
Figure 3: Life-cycle profiles: productivity vs. sick time
Figure 4: Life-cycle profiles of productivity model: decomposition
i.e., the presence of health in the utility function. This again confirms the primary role of consumption motive plays in driving up the medical expenditures over the life-cycle.

2 Computing the Equilibrium

In this section, we describe the numerical algorithm to compute the recursive competitive equilibrium as defined in Section 2.5 in the paper.

Step 1: Make an initial guess of the accidental bequest \( T \), social security tax rate \( \tau_{ss} \) and social security benefit \( b \).

Step 2: Given the factor prices \( \{w, r\} \), and the initial guess of \( \{T, \tau_{ss}, b\} \), use backward induction method to solve an individual’s dynamic programming problem from age \( J \) to 1. Obtain the value functions \( V_j(a_j, h_j) \) and individual policy rules \( C_j(a_j, h_j), M_j(a_j, h_j), A_j(a_j, h_j), \) and \( N_j(a_j, h_j) \) for every age \( j \).

Step 3: Use the relevant decision rules to compute the age-dependent distribution \( \lambda_j(a_j, h_j) \) by forward induction for every age \( j \). (See no. 3 in Definition 1 in the paper)

Step 4: Compute the accidental bequest (see no. 6 in Definition 1 in the paper), social security tax rate (see no. 5 in Definition 1), and social security benefit based on the decision rules obtained from step 2 and the agent distribution obtained from
step 3. Compare them with the initial guess from step 1.

Step 5: If the difference between the current and previous round of \( \{T, \tau_{ss}, b\} \) is larger than the preset tolerance, use relaxation method to update the set of accidental bequest, social security tax rate and social security benefit and go back to step 1. Repeat step 1 to step 5 until the model converges.

References


