Health State Dependence and the Value of Means Tested Social Insurance

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Abstract

See MC's lecture notes on G&P (2002) for guidelines on writing the abstract and the introduction.

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1 Introduction

- HSD matters for a lot of things. See descriptions in:
  - Brown and Finkelstein (2009)
  - Edwards (2010)
  - Levy and Nir (2012)
  - Finkelstein, Luttmer, and Notowidigdo (2013)
  - Koijen, Van Nieuwerburgh, and Yogo (2016)
  - Gyrd-Hansen (2017)
  - Kools and Knoef (2019)
- While, although difficult, it would be possible to estimate HSD without a model, it is impossible to evaluate its consequences on all the things mentioned above without specifying a structural model.
- I build a structural model which takes HSD seriously into account to evaluate ...

2 Relationship to the literature and contributions

My paper connects to three branches of the literature. First, it relates to the literature on **structural life-cycle models with health risk.** Seminal contributions in this literature are Palumbo (1999), French (2005), and De Nardi, French, and Jones (2010). This literature is growing fast and includes, among others, Scholz and Seshadri (2011), Kopecky and Koreshkova (2014), Capatina (2015), De Nardi, French, and Jones (2016), De Nardi, Pashchenko, and Porapakkarm (2017), and recent contributions by Dal Bianco (2019), Hosseini, Kopecky, and Zhao (2020), Keane, Capatina, and Maruyama (2020), and Salvati (2020). Despite some notable exceptions, for example De Nardi, Pashchenko, and Porapakkarm (2017) and Hosseini, Kopecky, and Zhao (2020), most papers in this literature focus on the effects of health uncertainty on the elderly. I, instead, focus on the whole life-cycle, thus acknowledging the importance of health shocks even when young.[1] I contribute to this literature by studying the effect of health risk on the marginal utility of consumption and by analyzing the welfare effects of health-state dependence.

Second, my paper connects to the literature on **health state dependence.** This literature has yet to reach a consensus on either the magnitude or the direction of the effects of health on the marginal utility of consumption. Two approaches have emerged in this literature. On the one hand, there are papers which take a structural approach. Among these, Lillard and Weiss (1997) find positive health state dependence, meaning marginal utility increases with deteriorating health, while De Nardi, French, and Jones (2010) and Hong, Pijoan-Mas, and Ríos-Rull (2015) find evidence of negative health state dependence, so marginal utility decreases as health worsens. On the other hand, there are papers which take an empirical approach. Among these, Viscusi and Evans (1990) and Finkelstein, Luttmer, and Notowidigdo (2013) find evidence of negative health state dependence, while Evans and Viscusi (1991) find that there is no health state dependence at all. I contribute to this literature by taking a structural approach and I provide new estimates and identification results for health state dependence.

Third, my paper relates to the literature on **insurance against health shocks.** Two important papers in this literature are Braun, Kopecky, and Koreshkova (2016) and Blundell, Borella, Commault, and De Nardi (2020). Braun, Kopecky, and Koreshkova (2016) build a structural model of the whole life-cycle to study the role of means-tested social insurance programs - such as Medicaid and Supplemental Security Income - for medical expense, longevity, and poverty risk. Blundell, Borella, Commault, and De Nardi (2020), which is the paper I am closest to, uses a structural model for the elderly to show that the response of consumption to transitory health shocks depends on the effect the shock has on resources and on marginal utility, with the marginal utility channel being the strongest driver of the consumption response. I contribute to this literature by studying the whole life cycle, rather than only the elderly like Blundell, Borella, Commault, and De Nardi (2020), and considering health risk at all ages, rather than only for the elderly like Braun, Kopecky, and Koreshkova

[1] I should say more about this. I want to explain why I don't consider childhood and in utero and I would love to find some literature that shows that health shocks matter even for people between 25 and 65.

(2016). I also study the welfare effects of < insert what policies >

3 Health State Dependence in the literature

A large empirical literature has tried to estimate HSD using different methods and reaching different conclusions:

- Viscusi and Evans (1990)
- Evans and Viscusi (1991)
- Lillard and Weiss (1997)
- Edwards (2008)
- Finkelstein, Luttmer, and Notowidigdo (2013)
- Brown, Goda, and McGarry (2016)
- Gyrd-Hansen (2017)
- Kools and Knoef (2019)

The heterogeneity in the results stems from the difficulties in measuring HSD (which are ...) and the diverse methods employed by these papers.

There is recent literature that embeds HSD in a structural model and estimates it through the model:

- De Nardi, French, and Jones (2010)
- Hong, Pijoan-Mas, and Ríos-Rull (2015)
- Koijen, Van Nieuwerburgh, and Yogo (2016)
- Ameriks, Briggs, Caplin, Shapiro, and Tonetti (2020)
- Low and Pistaferri (2015) and De Donder and Leroux (2021) embed HSD in their structural models and do not estimate it, but they assume a value for it.

4 Model

In this section, I outline a partial equilibrium life cycle model in which health affects the marginal utility of consumption, survival, earnings, and medical expenditures. I will estimate my model to assess the magnitude and direction of health state dependence and I will use the estimated model to conduct policy experiments.

4.1 Environment

Households enter the model at age 25, retire exogenously at 65, and die with certainty by the time they are 90. Households are subject to health, earnings, and survival risk until retirement, after which earnings risk is resolved.

I assume that asset markets are incomplete. Households enter the model with zero assets and can only invest in a risk-free asset, which has a constant rate of return. There are no annuity markets to insure against mortality risk and I assume accidental bequests are lost to the economy.

4.2 Preferences and Health State Dependence

Each period, utility depends on health status and on consumption of non-durable and non-medical goods. The period flow utility of consumption is:

$$u(c_t, h_t) = \delta(h_t)\frac{c_t^{1-\gamma}}{1-\gamma}, \tag{4.1}$$

where c_t is consumption; h_t is health status; γ is the coefficient of relative risk aversion; and $\delta(h_t)$ measures health state dependence. Following Palumbo (1999) and De Nardi, French, and Jones (2010), I model health state dependence as:

$$\delta(h_t) = 1 + \delta h_t, \tag{4.2}$$

where δ is a parameter to be estimated. This formulation implies that, when δ is equal to 0, health status does not affect utility.

4.3 Health Status

Each period, health status can be either zero or positive. A value of zero signals perfect health, while a positive value denotes some degree of unhealthiness. In particular, health status can be at most 1 and, the closer it is to 1, the more unhealthy a household is.

When health is positive, I follow Hosseini, Kopecky, and Zhao (2021) and assume it evolves according to the following process:

$$\log(h_t) = \kappa_t + \pi_t^h + \varepsilon_t^h, \tag{4.3}$$

$$\pi_t^h = \rho\pi_{t-1}^h + \eta_t^h, \tag{4.4}$$

$$\varepsilon_t^h \sim \mathbb{N}(0, \sigma_{\varepsilon^h}^2), \tag{4.5}$$

$$\eta_t^h \sim \mathbb{N}(0, \sigma_{\eta^h}^2), \tag{4.6}$$

where κ_t is a deterministic component which depends on age; π_t is the persistent component of health; and ε_t is the transitory component of health. I assume that, when $h_t = 0$, $\pi_t = 0$ as well.

4.4 Working Age Earnings

Households face earnings risk during their working age. Labor earnings depend on health and other demographics and on a permanent and a transitory component. I follow a standard practice in the earnings dynamics literature - see, for example, Blundell, Pistaferri, and Preston (2008) and Blundell, Borella, Commault, and De Nardi (2020) - and assume that log-earnings evolve according to the following permanent-transitory process:

$$\log y_t(h) = \kappa_t(h) + \pi_t^y + \varepsilon_t^y, \tag{4.7}$$

$$\pi_t^y = \pi_{t-1}^y + \eta_t^y, \tag{4.8}$$

$$\varepsilon_t^y \sim \mathbb{N}(0, \sigma_{\varepsilon^y}^2), \tag{4.9}$$

$$\eta_t^y \sim \mathbb{N}(0, \sigma_{\eta^y}^2), \tag{4.10}$$

where $\kappa_t(h)$ denotes the deterministic component of earnings, which depends on age, health status, marital status, and birth cohort;[2] π_t^y is the permanent component of earnings; and ε_t^y is the transitory component of earnings.

4.5 Medical Expenditures and Death

In each period until death, households incur out-of-pocket medical expenditures and face survival probabilities.

I only consider medical expenditures that are not covered by health insurance and I do not model health insurance itself. Consistently with De Nardi, French, and Jones (2010) and Keane, Capatina, and Maruyama (2020), medical expenditures are exogenous and modeled as cost shocks. I model log-medical expenditures as follows:

$$\log m_t(h) = g(t, h) + \xi_t, \tag{4.11}$$

$$\xi_t \sim \mathbb{N}(0, \sigma_\xi^2), \tag{4.12}$$

where $g(t, h)$ denotes a deterministic function of age and health status and ξ_t denotes an i.i.d. shock. Medical expenditures are present even for households with perfect health to capture preventative care, such a routine physicals and examinations.

Survival probabilities in each period depend on age and health status.

4.6 Government

The government imposes taxes on income, provides Social Security benefits to retirees, and supplies a means-tested transfer.

Income taxes paid are a function of total income. I follow Bénabou (2002), Heathcote, Storesletten, and Violante (2017), and Borella, De Nardi, Pak, Russo, and Yang (2021), and adopt a log-linear tax function which allows for negative tax rates, and thus incorporates

[2]Because I do not model marital status and birth cohort explicitly, when solving the model, I use the average marital status by age and the average cohort effect I compute in my sample.

the Earned Income Tax Credit (EITC.) In particular, income taxes are given by:

$$T(y) = y - (1-\lambda)y^{1-\tau}, \tag{4.13}$$

where y denotes the level of total income; λ captures the average level of taxation in the economy; and τ denotes the degree of progressivity of the income tax system. [3]

I assume that the only source of income after retirement is government-provided Social Security benefits. In reality, Social Security benefits depend on workers' earnings histories. Modeling earnings histories requires adding a continuous state variable. To reduce computational costs, I follow De Nardi, Fella, and Paz-Pardo (2019) and assume that Social Security benefits are a function of the last realization of labor earnings.[4]

The government provides a means-tested transfer to guarantee a minimum level of consumption, $\underline{c}$. The transfer is computed as:

$$b_t = \max\{0, \underline{c} + m_t(h) - [a_t + y^n(ra_t + y_t(h), \tau)]\}, \qquad \text{if } t < T^{ret}, \tag{4.14}$$

$$b_t = \max\{0, \underline{c} + m_t(h) - [a_t + ss^n(ra_t + ss_t, \tau)]\}, \qquad \text{if } t \geq T^{ret}, \tag{4.15}$$

where b_t denotes the transfer; $y^n(\cdot)$ denotes net income during the working age; and $ss^n(\cdot)$ indicates net income during the retirement period.

4.7 Recursive Formulation

I compute four value functions for the following stages of life and realizations of health status.

4.7.1 The Value Function for Workers with Positive Health

The value function of a worker with positive health status depends on age t, assets a_t, the shock to medical expenditures ξ_t, the permanent component of earnings π_t^y, the transitory component of earnings ε_t^y, the persistent component of health π_t^h, and the transitory component of health ε_t^h:

[3]See Borella, De Nardi, Pak, Russo, and Yang (2021) for a detailed description of this tax function and the interpretation of its parameters.

[4]Insert more details on this function in model calibration section

$$V(X_t) = \max_{c_t, a_{t+1}} \left\{ \delta(h_t) \frac{c_t^{1-\gamma}}{1-\gamma} + \beta s_{h,t} \mathbb{E}_t[V(X_{t+1})] \right\}, \tag{4.16}$$

$$\text{sub. to } a_{t+1} = a_t + y^n(ra_t + y_t(h), \tau) - m_t(h) + b_t - c_t, \tag{4.17}$$

$$\log m_t(h) = g(t, h) + \xi_t, \quad \xi_t \sim N(0, \sigma_\xi^2), \tag{4.18}$$

$$\log(h_t) = \kappa_t + \pi_t^h + \varepsilon_t^h, \tag{4.19}$$

$$\pi_t^h = \rho \pi_{t-1}^h + \eta_t^h, \tag{4.20}$$

$$\log y_t(h) = \kappa_t(h) + \pi_t^y + \varepsilon_t^y, \tag{4.21}$$

$$\pi_t^y = \pi_{t-1}^y + \eta_t^y, \tag{4.22}$$

$$b_t = \max\{0, \underline{c} + m_t(h) - [a_t + y^n(ra_t + y_t, \tau)]\}, \tag{4.23}$$

$$a_t \geq 0, \tag{4.24}$$

$$\eta_t^h \sim N(0, \sigma_{\eta h}^2), \quad \varepsilon_t^h \sim N(0, \sigma_{\varepsilon h}^2), \tag{4.25}$$

$$\eta_t^y \sim N(0, \sigma_{\eta y}^2), \quad \varepsilon_t^y \sim N(0, \sigma_{\varepsilon y}^2), \tag{4.26}$$

where the vector of state variables is:

$$X_t = \{t, a_t, \xi_t, \pi_t^y, \varepsilon_t^y, \pi_t^h, \varepsilon_t^h\}, \tag{4.27}$$

4.7.2 The Value Function for Workers with Zero Health

The value function of a worker with health status equal to zero depends on age t, assets a_t, the shock to medical expenditures ξ_t, the permanent component of earnings π_t^y, and the transitory component of earnings ε_t^y:

$$V(X_t) = \max_{c_t, a_{t+1}} \left\{ \frac{c_t^{1-\gamma}}{1-\gamma} + \beta s_{h,t} \mathbb{E}_t[V(X_{t+1})] \right\}, \tag{4.28}$$

$$\text{sub. to } a_{t+1} = a_t + y^n(ra_t + y_t(h), \tau) - m_t(h) + b_t - c_t, \tag{4.29}$$

$$\log m_t(h) = g(t,h) + \xi_t, \quad \xi_t \sim N(0, \sigma_\xi^2), \tag{4.30}$$

$$\log y_t(h) = \kappa_t(h) + \pi_t^y + \varepsilon_t^y, \tag{4.31}$$

$$\pi_t^y = \pi_{t-1}^y + \eta_t^y, \tag{4.32}$$

$$b_t = \max\{0, \underline{c} + m_t(h) - [a_t + y^n(ra_t + y_t, \tau)]\}, \tag{4.33}$$

$$a_t \geq 0, \tag{4.34}$$

$$\eta_t^y \sim N(0, \sigma_{\eta y}^2), \quad \varepsilon_t^y \sim N(0, \sigma_{\varepsilon y}^2), \tag{4.35}$$

where the vector of state variables is:

$$X_t = \{t, a_t, \xi_t, \pi_t^y, \varepsilon_t^y\}, \tag{4.36}$$

4.7.3 The Value Function for Retirees with Positive Health

The value function of a worker with positive health status depends on age t, assets a_t, the shock to medical expenditures ξ_t, Social Security benefits ss_t, the persistent component of health π_t^h, and the transitory component of health ε_t^h:

$$V(X_t) = \max_{a_{t+1}} \left\{ \delta(h_t) \frac{c_t^{1-\gamma}}{1-\gamma} + \beta s_{h,t} \mathbb{E}_t[V(X_{t+1})] \right\}, \tag{4.37}$$

$$\text{sub. to } a_{t+1} = a_t + ss^n(ra_t + ss_t, \tau) - m_t(h) + b_t - c_t, \tag{4.38}$$

$$\log m_t(h) = g(t,h) + \xi_t, \quad \xi_t \sim N(0, \sigma_\xi^2), \tag{4.39}$$

$$\log(h_t) = \kappa_t + \pi_t^h + \varepsilon_t^h, \tag{4.40}$$

$$\pi_t^h = \pi_{t-1}^h + \eta_t^h, \tag{4.41}$$

$$ss_t = ss(y_{T^{ret}-1}), \tag{4.42}$$

$$b_t = \max\{0, \underline{c} + m_t(h) - [a_t + ss^n(ra_t + ss_t, \tau) - y_d]\}, \tag{4.43}$$

$$a_t \geq 0, \tag{4.44}$$

$$\eta_t^h \sim N(0, \sigma_{\eta h}^2), \quad \varepsilon_t^h \sim N(0, \sigma_{\varepsilon h}^2), \tag{4.45}$$

where vector of state variables is:

$$X_t = \{t, a_t, \xi_t, ss_t, \pi_t^h, \varepsilon_t^h\} \tag{4.46}$$

Households' Social Security benefits are a state variable because they depend on the last realization of labor earnings. The terminal value function is set to zero, as households do not derive utility from bequests.

4.7.4 The Value Function of Retirees with Zero Health

The value function of a worker with positive health status depends on age t, assets a_t, the shock to medical expenditures ξ_t, and Social Security benefits ss_t:

$$V(X_t) = \max_{a_{t+1}} \left\{ \frac{c_t^{1-\gamma}}{1-\gamma} + \beta s_{h,t} \mathbb{E}_t[V(X_{t+1})] \right\}, \tag{4.47}$$

$$\text{sub. to } a_{t+1} = a_t + ss^n(ra_t + ss_t, \tau) - m_t(h) + b_t - c_t, \tag{4.48}$$

$$\log m_t(h) = g(t,h) + \xi_t, \quad \xi_t \sim N(0, \sigma_\xi^2), \tag{4.49}$$

$$ss_t = ss(y_{T^{ret}-1}), \tag{4.50}$$

$$b_t = \max\{0, \underline{c} + m_t(h) - [a_t + ss^n(ra_t + ss_t, \tau) - y_d]\}, \tag{4.51}$$

$$a_t \geq 0, \tag{4.52}$$

$$\tag{4.53}$$

where vector of state variables is:

$$X_t = \{t, a_t, \xi_t, ss_t\} \tag{4.54}$$

5 Model Calibration

Insert killer takeaway sentence

The model period is one year. I set the coefficient of relative risk aversion γ to 2, a standard value in the literature. I follow De Nardi, Fella, and Paz-Pardo (2019) and fix the risk-free interest rate r at 4% and the discount factor β at 0.957.

I discretize the persistent and transitory component of health, the transitory component of income, and the i.i.d. shock to medical expenditures, using the Rouwenhorst method for stationary AR(1) processes, which is outlined in Rouwenhorst (1995).[5] Then, I discretize the permanent component of income using the version of the Rouwenhorst method for non-stationary processes outlined in Fella, Gallipoli, and Pan (2019). As argued in Kopecky and Suen (2010), the Rouwenhorst method allows for a lower number of grid points than the Tauchen method - see Tauchen (1986) - while, at the same time, providing better approxi-

[5]The transitory components of health and income and the i.i.d. shock to medical expenditures are treated as degenerate AR(1) processes, with an autoregression coefficient equal to 0 and can be discretized using the same methods as standard AR(1) processes.

mation accuracy. Thus, I use xxxx grid points for the persistent component of health, xxxx for the transitory component of health, xxxx for the permanent component of income, xxxx for the transitory component of income, and xxxx for the shock to medical expenditures.

I use the tax function estimated from the PSID by Borella, De Nardi, Pak, Russo, and Yang (2021). In particular, I use their estimated values of λ and τ for the representative decision unit in the economy (which pools together couples and singles) for the year xxxx. The values are xxxx and xxxx for λ and τ, respectively.

I follow Kaplan and Violante (2010) and De Nardi, Fella, and Paz-Pardo (2019) and compute Social Security benefits using a formula with fixed replacement rates, which mimics the US system. In particular, there is a 90% replacement rate for the part of the last realization of labor earnings, $y_{T^{ret}-1}$, below a first bend point; a replacement rate of 32% for the part of $y_{T^{ret}-1}$ between the first and a second bend point; and a 15 % replacement rate for the reminder part of $y_{T^{ret}-1}$. The bend points are set at 18% and 110% of average earnings in the last working period. Benefits are then slightly scaled up proportionately to ensure that the average worker in the economy, that is, the worker earning the average $y_{T^{ret}-1}$, has a 45% replacement rate.

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