

The Effects of Collecting Income Taxes on Social Security Benefits

John Bailey Jones Yue Li*

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Abstract

Since 1983, Social Security benefits have been subject to income taxation, a provision that can significantly increase the marginal income tax rate for older individuals. To assess the impact of this tax, we construct and calibrate a detailed life-cycle model of labor supply, saving and Social Security claiming. We find that in a long-run stationary environment, replacing the taxation of Social Security benefits with a revenue-equivalent increase in the payroll tax would significantly increase labor supply, consumption and welfare. From an ex-ante perspective an even more desirable reform would be to make the portion of benefits subject to income taxes completely independent of other income.

JEL: E21, H24, H55, I38

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*John Bailey Jones: Federal Reserve Bank of Richmond and University at Albany, SUNY, jbjones@albany.edu. Yue Li: University at Albany, SUNY, yli49@albany.edu. We would like to thank the seminar participants at University at Albany, University of Connecticut, McGill University, Purdue University, and Union College for helpful comments. This work used the Extreme Science and Engineering Discovery Environment (XSEDE), which is supported by National Science Foundation grant number ACI-1053575. The opinions and conclusions are solely those of the authors, and do not reflect the views of the NSF, the Federal Reserve Bank of Richmond, or the Federal Reserve System.

1 Introduction

The sustainability of the Social Security system has been a pressing concern for several decades. Even after a number of reforms, the system’s trust fund is expected to be depleted in 2035 (Social Security Administration, 2016a). Many observers also fear that Social Security unduly discourages labor supply and private saving. The extensive literature on potential Social Security reforms thus continues to grow. There are nonetheless provisions of Social Security that remain relatively unexamined. In this paper we focus on one such provision, the income taxation of Social Security benefits.

According to the Congressional Budget Office (CBO, 2015), in 2014 about half of Social Security recipients owed income taxes on their Social Security benefits. An important feature of these taxes is that the amount of Social Security benefits subject to taxation is an increasing function of the beneficiaries’ “combined” income, which includes earnings.¹ At certain income levels, each additional dollar of earnings, in addition to being taxable itself, adds 50-85 cents of Social Security benefits to taxable income, increasing the effective marginal income tax rate on these earnings by 50% to 85%. The effects of this provision are thus potentially quite large.

The income taxation of Social Security benefits is a mechanism distinct from the Social Security Earnings Test, where earnings above a certain threshold result in a reduction in current Social Security benefits and an increase in future benefits. The effects of the Earnings Test, and in particular its partial elimination through the Senior Citizens Freedom to Work Act of 2000, have been studied extensively: see the review in Engelhardt and Kumar (2014). In contrast, only a few studies have analyzed the effects of taxing Social Security benefits, and none of them have developed models that formalize the dynamic aspects of the taxes. To fill this gap in the literature, we develop a heterogeneous-agent, life-cycle model, and use it to assess the effects of taxing Social Security benefits on

¹Combined income is the total of adjusted gross income, interest on tax-exempt bonds, and 50% of Social Security benefits and Tier I Railroad Retirement Benefits.

asset accumulation, employment at old ages, Social Security claiming, and welfare.

Using a dynamic model allows individuals to respond to benefit taxation along multiple dimensions. For example, if a beneficiary's unearned income is sufficiently high, she will pay the maximum possible taxes on her Social Security benefits even if she does not work at all. In a static framework, this results in a pure income effect that encourages work (Page and Conway, 2015). In a dynamic framework, people can also adjust their asset accumulation and the age at which they first claim Social Security benefits. Such responses may attenuate the income effect. Using a dynamic framework allows for the intertemporal substitution of labor as well. Individuals may respond to higher tax rates in retirement by shifting their labor supply to earlier ages, or they may view the taxation of retirement benefits, which depend on their lifetime earnings, as a reduction in their total labor compensation at every age.

Because the revenues raised by taxing Social Security benefits are dedicated to the Social Security and Medicare trust funds, the most likely alternative to this tax is the payroll tax, the principal revenue source for the two trust funds. In all of our experiments, changes in the income taxation of Social Security benefits will be accompanied by surplus-balancing changes in the Social Security payroll tax rate. The two tax mechanisms differ in three important ways. First, the burden of payroll taxes falls heavily on young and middle-aged people, who arguably have a smaller labor supply elasticity than the elderly people who receive Social Security benefits (French and Jones 2012, Karabarbounis 2016). Second, payroll taxes impose fewer distortions on asset accumulation and Social Security claiming decisions. Third, income taxes are progressive. In contrast, the payroll tax for Social Security is regressive, as earnings above an upper bound are not taxed at all, and earnings below are taxed at a flat rate.

We conduct these experiments using an extension of the Bewley-Aiyagari-Huggett framework that includes a detailed model of Social Security and the income taxation of benefits. In the model, individuals face uncertain wages, health, health spending, and

survival. They choose how much to work and save, and when to claim Social Security benefits. Consistent with the empirical evidence (Aaronson and French, 2004), as older workers transit into part-time jobs their wages fall. The government collects income, payroll and consumption taxes, and provides Social Security, Medicare and means-tested social insurance. The timing of Social Security claims affects the amount of benefits, the treatment of the Earnings Test, and the level of income taxes. We calibrate the model to match the 2006 US economy and use it to examine the effect of replacing the income taxes on Social Security benefits with payroll taxes.

In the structural analysis of Social Security reforms, little attention has been paid to the taxation of Social Security benefits (e.g., Feldstein and Liebman 2002). Our analytical framework is similar to that of Imrohoroğlu and Kitao (2012), expanded to include benefit taxation and labor supply decisions after age 70. The paper also adds to the large body of work on life-cycle labor supply decisions (see, e.g., the review in Blundell et al. 2016). Our contribution to this literature is to carefully model the tax incentives of elderly workers and discuss their implications for labor supply.

Although there are, to our knowledge, no existing structural analyses of the Social Security benefits tax, there are a few non-structural empirical studies.² Here two papers are of note. Burman et al. (2014) exploit the fact that Social Security benefits are taxable only when combined income exceeds a statutory threshold. Finding that the income of older workers is not bunched around this threshold, they argue that the benefit tax has little impact, perhaps because of its complicated structure. But if workers cannot modulate their labor very precisely, because of fixed costs in labor supply, pronounced bunching may not appear (Chetty 2012; Engelhardt and Kumar 2014). Perhaps more important, analyses of bunching cannot identify responses along the extensive margin. Our model, which includes fixed cost of work and reentry the labor market, allows us

²While Kopecky and Koreshkova (2014) and Braun et al. (2016) explicitly model benefit taxation, in their framework the retirement age is fixed and Social Security beneficiaries are unable to work.

to examine participation decisions. Page and Conway (2015) find that the introduction of benefit taxation in 1983 increased the labor force participation of the highest income people, for whom the tax generated (in a static framework) an income loss but no change in marginal tax rates. Our framework allows us to consider effects across the entire income distribution and life cycle. Perhaps more important, Page and Conway's approach exploits a one-time change in the taxation rules introduced in 1983. Our model, which is identified by life-cycle variation, can be applied to the current taxation regime, which has been stable in nominal terms since 1993.

In addition to allowing us to consider a broad range of labor supply decisions, our structural model allows us to perform counterfactual policy analyses. We have four principal findings. The first finding is that replacing the taxation of Social Security benefits with a revenue-equivalent increase in the payroll tax would significantly increase labor supply, consumption and welfare. The work disincentives of the benefit tax are most potent at older ages, when labor supply is very elastic. Replacing it with the payroll tax, which affects all ages evenly, is beneficial. The second finding is that benefit taxation affects the aggregate labor supply primarily through the extensive margin. To reproduce the observed distribution of hours, and following a number of earlier studies, our model includes a fixed cost of work. The fixed cost leads most individuals to work either full time or not at all. In practice, most Social Security beneficiaries do not need to know the exact benefit taxation formula: when deciding whether to work, they need only to know that working will lead to significantly higher income taxes. Our third finding is that the effects of eliminating benefit taxation are larger than the effects of eliminating the remainder of the Earnings Test. This finding is in part driven by our assumption that workers understand that benefits withheld through the Earnings Test are credited to future benefits, but it is also in part driven by interactions between the income taxation of benefits and the Earnings Test. Because the effects of benefit taxation are bounded by the total amount of benefits, the reduction of benefits through the Earnings Test at-

tenuates the (immediate) effect of the benefits tax. Removing the Earnings Test exposes more benefits to taxation.

Our final finding is that from an ex-ante perspective the most desirable reform would be to continue taxing Social Security benefits but make the portion of benefits taxable independent of other income such as earnings and asset income. Like most tax provisions, the taxation of benefits generates both income and substitution effects. The largest substitution effect comes from the way in which higher earnings can lead to higher benefit taxes. Making the taxation of Social Security benefits unconditional severs this link, encouraging work. This reform has the additional benefit of increasing benefit-based income tax revenues, which in turn allows the government to lower the payroll tax rate. Replacing the regressive payroll taxes with progressive income taxes increases aggregate welfare. One drawback of this reform is that its effects vary greatly by age. While the young benefit, the increase in benefit-related income taxes harms older individuals.

The remainder of the paper is organized as follows: Section 2 details the current rules for taxing Social Security benefits; Section 3 presents the model; Section 4 describes the calibration and the benchmark economy; Section 5 conducts counterfactual experiments; Section 6 discusses an extension of the model within which individuals have limited information about benefit taxation; and Section 7 concludes.

2 Institutional Background

Aiming to increase Social Security revenues and to make the treatment of Social Security benefits more like that of private pensions, the 1983 Social Security Amendment introduced income taxes on Social Security benefits.³ Under the amendment, if a taxpayer's combined income – the sum of adjusted gross income (AGI), interest on tax-exempt bonds, and 50% of Social Security benefits – exceeded a threshold (\$25,000 for an individual),

³A more detailed history of the legislation can be found in Meyerson (2014).

the amount of benefits subject to income taxation were the lesser of 50% of the benefits or 50% of the combined income in excess of the threshold. Ten years later, the Omnibus Budget Reconciliation Act of 1993 introduced a second, higher threshold (\$34,000 for an individual). For taxpayers with income in excess of the second threshold, the amount of benefits subject to income taxation were increased to the sum of: 50% of the difference between the second and first thresholds; and 85% of any combined income in excess of the second threshold, up to 85% of total benefits. Because neither threshold has been indexed for inflation, the number of beneficiaries affected by these provisions is rising over time.

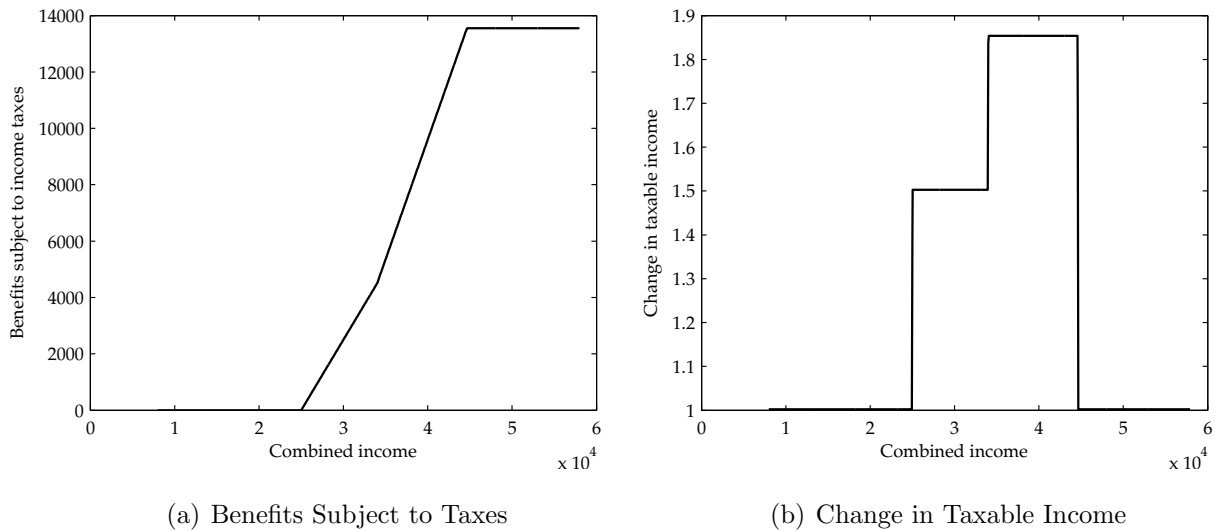


Figure 1: Taxation of Social Security Benefits

Note: Calculations for a person receiving an annual Social Security benefit of \$15,942.

Figure 1 illustrates the benefit taxation rules for an individual who receives an annual Social Security benefit of \$15,942.⁴ Figure 1(a) plots taxable Social Security benefits against combined income, holding total Social Security benefits fixed but allowing other sources of income (such as earnings) to vary. Once combined income reaches the initial threshold of \$25,000, each additional dollar of income adds 50 cents of Social Security benefits to taxable income. Once the second threshold of \$34,000 is reached, each additional

⁴This is the annual benefit for an average retired worker (2015 Social Security statistical supplement).

dollar of income adds 85 cents of Social Security benefits to taxable income until 85% of Social Security benefits are taxed; in the current example the taxable limit of \$13,551 ($= \$15,942 \times 0.85$) is reached at a combined income of \$44,648.⁵ Figure 1(b) shows the increase in taxable income associated with a \$1 increase in earnings. Between the first and second thresholds, each additional dollar of earnings adds 1.5 dollars to taxable income; after the second threshold, the ratio increases to 1.85, until the maximum is reached.

In a static model, this way of taxing Social Security benefits has no effect on people with combined income below the first threshold, a pure income effect for people with income above the maximum, and a combination of income and substitution effects on people with income between these two boundary points. The range of tax distortions is increasing in the Social Security benefit, and thus depends on the beneficiary's claiming decisions and lifetime earnings.

3 Model

3.1 Demographics

The population consists of overlapping generations. Let $j \in \{1, 2, \dots, J\}$ denote age, where J represents the maximum life span. Let $s_j(h_j)$ denote the survival rate between periods, which depends on each individual's age and idiosyncratic health status, $h_j \in \{\text{good}, \text{bad}\}$. The population grows at the constant rate χ .

3.2 Preferences

Each period, surviving individuals receive utility from consumption (c) and leisure (l) according to the function $u(c, l)$. Leisure in turn depends on hours of work, n_j , health,

⁵As $[\$44,648 - \$34,000] \times 0.85 + [\$34,000 - \$25,000] \times 0.5 = \$13,551$.

and labor market participation in the previous period (n_{j-1}):

$$l_j = 1 - \phi_h I_{\{h_j=\text{bad}\}} - \phi_n I_{\{n_j>0\}} - \phi_{re} I_{\{n_{j-1}=0 \text{ and } n_j>0\}} - n_j, \quad (1)$$

where $I_{\mathcal{A}}$ is the 0-1 indicator function that takes the value of 1 when event \mathcal{A} occurs. The term $\phi_h I_{\{h=\text{bad}\}}$ reflects the time cost of bad health, aiming to reproduce the empirical observation that unhealthy people work less. The term $\phi_n I_{\{n>0\}}$ captures the fixed time costs of work, aiming to reproduce the observation that most people work full time or not at all (see, e.g., Cogan 1981 and French and Jones 2012). The term $\phi_{re} I_{\{n_{j-1}=0 \text{ and } n_j>0\}}$ captures the time cost of reentering the labor market, aiming to reproduce the observation that most people do not repeatedly enter and exit the labor market in response to transitory changes in wages. Similar specifications for leisure have been used in, among other studies, French (2005) and French and Jones (2011).

When they die, individuals receive warm-glow utility from bequests according to the function $v(a)$, where a denotes the amount of assets bequeathed. Future utility is discounted using the factor β .

3.3 Earnings

Individuals who work at age j receive the wage w_j ,

$$w_j = w \varepsilon_j \eta_j \left(\frac{n_j}{\bar{n}} \right)^\zeta. \quad (2)$$

where w is the unit wage, ε_j is an age-specific life-cycle productivity level, and η_j is an idiosyncratic productivity shock following a Markov process with transitions $\Pi^\eta(\eta_j, \eta_{j+1})$. The final term, $[n_j/\bar{n}]^\zeta$, imposes a penalty for working less than the full-time work load of \bar{n} . Aaronson and French (2004) show that part-time workers earn lower wages; potential explanations include fixed costs on the employer's side and the loss of human capital as

older workers transit from career to bridge jobs (Ruhm 1990, Giandrea et al. 2009). Following Aaronson and French (2004), we set ζ to 0.415, implying that half-time workers are paid 25% less than full-time workers. Imposing the part-time earnings adjustment leads total earnings, $W_j = w_j n_j$, to have increasing returns to scale in hours of work. This feature combines with the fixed time cost of work to encourage full-time work.

3.4 Medical Expenditure and Health Insurance

Each individual's health status (h_j) changes stochastically over the life cycle, following a Markov process with the age-dependent transitions $\Pi_j^h(h_j, h_{j+1})$. Health status affects individuals through three channels: the survival probability, the participation cost of working, and medical expenditures. Total medical expenditures, denoted by $m_j = m_j(h_j, \epsilon_j)$, depend on age, health, and the idiosyncratic white noise shock ϵ_j , which follows the stationary distribution $\Pi(\epsilon)$. Health insurance coverage is universal: Medicare covers all individuals 65 and older ($j \geq J^M$), and private health insurance covers the rest of the population.⁶ The medical expenses paid by the individuals themselves can be split into two parts: insurance premiums, p_j , which are paid at the beginning of each period before the medical spending shocks for that period are revealed; and co-payments, $Q_j(m_j(h_j, \epsilon_j))$, which are paid at the end of each period after the shocks are revealed. Premiums and co-payments follow

$$p_j = \begin{cases} p^{\text{priv}} & \text{if } j < J^M \\ p^{\text{mcr}} & \text{otherwise,} \end{cases}$$

$$Q_j(m_j(h_j, \epsilon_j)) = \begin{cases} \kappa^{\text{priv}} m_j(h_j, \epsilon_j) & \text{if } j < J^M \\ \kappa^{\text{mcr}} m_j(h_j, \epsilon_j) & \text{otherwise,} \end{cases}$$

⁶The model abstracts from heterogeneity in private insurance access. Dynamic models with different insurance eligibility and insurance take-up include Jeske and Kitao (2009) and Pashchenko and Porapakarm (2013).

where the superscripts “priv” and “mcr” denote, respectively, private insurance and Medicare, and $\kappa^i, i \in \{\text{priv}, \text{mcr}\}$ is the coinsurance rate.

3.5 Government

The government collects taxes and provides social insurance. The difference between the government’s revenues and its transfer spending is absorbed by direct spending (G). The government also appropriates all bequests, which it then distributes equally among all living individuals, each of whom receives the transfer B .

Social Security. Let J^E denote the Early Retirement Age (ERA), J^N denote the Normal Retirement age (NRA), and J^L denote the Late Retirement Age (LRA). Individuals can choose any age from the ERA of 62 to the LRA of 70 to claim their Social Security benefits. Social Security recipients receive benefits according to $A_k ss(e_j)$. The variable e_j is an index of the individual’s earnings over her 35 highest earnings years. The piecewise linear function $ss(\cdot)$ determines the benefits received if Social Security is first claimed at the normal retirement age J^N . The final term, A_k , is an adjustment factor based on the benefit claiming age k , reflecting early retirement penalties and delayed retirement credits, with $A_{J^N} \equiv 1$.

Until benefits are claimed, e_j is updated any time that current earnings qualify as one of the 35 highest annual totals. Once Social Security benefits have been claimed, e_j is updated to only reflect the benefits that are withheld due to the Earnings Test.⁷ Beneficiaries who are below the NRA and have labor income in excess of the earning limit y_j^{et} have their benefits withheld at a rate of τ_j^{et} : for each additional dollar earned, Social Security benefits are reduced by τ_j^{et} , until all benefits are withheld. Let T_j^{et} denote benefits lost through the Earnings Test, and let ss_j^* denote the remaining benefits. We

⁷In actual practice, e_j continues to be updated for high current earnings even after benefit claiming. This is a relatively rare event, however, and in the interest of simplicity we rule it out.

have

$$T_j^{\text{et}}(ss_j, W_j) = \min \{ ss_j, \tau_j^{\text{et}} \max\{0, W_j - y_j^{\text{et}}\} \}, \quad (3)$$

$$ss_j^*(ss_j, W_j) = ss_j - T_j^{\text{et}}(ss_j, W_j). \quad (4)$$

Any such reductions in current benefits, however, are offset by permanent increases in future benefits, implemented in our framework through increases in e_{j+1} .⁸ The net incentive generated by the Earnings Test depends on whether the increases in future benefits are actuarially fair; because the current crediting formula is considered actuarially fair for the average person, for most workers the net tax rate associated with the Earnings Test is small.

Taxes. The government collects income taxes, consumption taxes, payroll taxes, and Medicare premiums. Payroll taxes consist of two parts: a Medicare tax imposed on all earned income at the flat rate τ^{mcr} , and a Social Security tax imposed on earned income up to the taxable threshold y^{ss} at the flat rate τ^{ss} . Consumption taxes are imposed on all consumption goods at the flat rate τ^c . Income taxes are progressive and are based on taxable income y_j according to the tax function $T(y_j)$. Taxable income itself is the sum of asset income (ra_j), earnings (W_j) and the taxable portion of Social Security benefits, $SS(ss_j^*, ra_j, W_j)$.

Means-Tested Social Insurance. Means-tested social insurance can be thought of as a combination of TANF, SNAP, SSI, uncompensated medical care and Medicaid. Following the practice established by Hubbard et al. (1995), we assume that this program provides a consumption floor of \underline{c}_j . At the beginning of each period means-tested transfers are given by

$$tr_j = \max\{0, (1 + \tau^c)\underline{c}_j - y_j^d\}, \quad (5)$$

⁸This is a simplification, as in actual practice benefits are adjusted only after a person reaches the NRA.

where y_j^d denotes total financial resources – the sum of assets, after-tax income and distributed bequests, less insurance premiums – prior to receiving means-tested transfers:

$$y_j^d = (1 + r)a_j + W_j + ss_j^*(ss_j, W_j) - T(ra_j + W_j + SS(ss_j^*, ra_j, W_j)) - \tau^{\text{mcr}}W_j - \tau^{\text{ss}} \min\{W_j, y_j^{\text{ss}}\} + B - p_j. \quad (6)$$

3.6 The Individual's Problem

Individuals can be characterized by their age j and the six-element state vector $\mathbf{x}_j = \{a_j, \eta_j, h_j, e_j, b_{j-1}, n_{j-1}\}$, where a_j records assets carried over from period $j - 1$, η_j is the idiosyncratic productivity shock, h_j is the health status, e_j is the earnings index, b_{j-1} is an indicator function for receiving Social Security in the previous period, and n_{j-1} records labor force participation in the previous period.

At the beginning of each period, individuals choose labor hours and whether to file a Social Security claim (if they are age-eligible and have not already claimed). Claiming allows them to receive Social Security benefits from the current period forward, and is not reversible. At this point, individuals' financial resources consist of their labor income, assets and asset income, Social Security benefits, and lump-sum bequest transfers, net of taxes and health insurance premiums. If this amount is below the consumption floor, government transfers via means-tested insurance bridge the gap. Individuals then choose how much to consume out of their (post-transfer) financial resources. They can save, but borrowing constraints prevent them from consuming more than their current resources.

At the end of each period, medical expenditure shocks are realized. If out-of-pocket medical expenditures exceed available (post-consumption) resources, assets in the next period, a_{j+1} , are negative. The survival shock is realized. Individuals who die receive warm-glow utility from bequests, while surviving individuals realize their new productivity shocks (η_{j+1}) and health shocks (h_{j+1}), and enter the next period with state vector $\mathbf{x}_{j+1} =$

$\{a_{j+1}, \eta_{j+1}, h_{j+1}, e_{j+1}, b_j, n_j\}$.

In recursive form, the individual's problem is

$$V_j(\mathbf{x}_j) = \max_{c_j, n_j, b_j} \{u(c_j, l_j) + \beta E_j[s_j(h_j)V_{j+1}(\mathbf{x}_{j+1}) + (1 - s_j(h_j))v(a_{j+1})]\}$$

subject to equations (1)-(6) and:

$$(1 + \tau^c)c_j \leq y_j^d + tr_j, \tag{7}$$

$$a_{j+1} = y_j^d + tr_j - (1 + \tau^c)c_j - Q_j(m_j(h_j, \epsilon_j)), \tag{8}$$

$$e_{j+1} = f_j(e_j, W_j, b_{j-1}, b_j). \tag{9}$$

Equation (7) prohibits borrowing to fund current goods consumption. Equation (8) describes the law of motion for assets. Note that individuals are allowed to take on medical expense debt. Last, equation (9) describes the law of motion of the earnings index e_j , which depends on age, the index's current value, current earnings, and Social Security reciprocity status.

3.7 Stationary Equilibrium

Our approach will be to take wages and the interest rate from the data, and to find the private insurance premium and government policies that produce budget balance for a stationary distribution of individuals. Our equilibrium concept is identical to the one used in Kitao (2014).

Definition 1. *A stationary equilibrium is a collection of government policies, a lump-sum transfer, a private health insurance premium, policy functions, and a distribution $\mu(\tilde{\mathbf{x}})$, $\tilde{\mathbf{x}} = [\mathbf{x}_j', \epsilon_j, j]'$, of individuals, such that the following conditions hold.*

1. *Given government policies, the lump-sum transfer, the private health insurance pre-*

mium, and the policy functions are the solutions to the individual problem described in subsection 3.6.

2. The government budget is balanced:

$$\begin{aligned} & \int \left[\tau^c c + T(ra + W + SS(ss^*, ra, W)) + \tau^{mcr}W + \tau^{ss} \min\{W, y^{ss}\} \right. \\ & \quad \left. + T_j^{et}(ss, W) + p^{mcr}I_{j \geq JM} \right] \mu(\tilde{\mathbf{x}}) d\tilde{\mathbf{x}} \\ & = G + \int [ss + tr + (m - Q)I_{j \geq JM}] \mu(\tilde{\mathbf{x}}) d\tilde{\mathbf{x}}; \end{aligned}$$

3. Health insurers earn zero profits:

$$p^{priv} \int I_{j < JM} \mu(\tilde{\mathbf{x}}) d\tilde{\mathbf{x}} = \int (m - Q)I_{j < JM} \mu(\tilde{\mathbf{x}}) d\tilde{\mathbf{x}};$$

4. Total lump-sum transfers equal the assets of deceased individuals:

$$(1 + r) \int (1 - s(\tilde{\mathbf{x}}))a'(\tilde{\mathbf{x}}) \mu(\tilde{\mathbf{x}}) d\tilde{\mathbf{x}} = (1 + \chi)B;$$

5. The distribution of individuals is stationary.

4 Calibration and Benchmark Economy

4.1 Data

Our principal data source is the Medical Expenditure Panel Survey (MEPS). The MEPS is a rotating panel, with each individual interviewed multiple times over a two-year period. We use panels 10 and 11, which were collected around 2006, just prior to the Great Recession, for data on employment, health insurance, health status, and medical expenditures. Because our model does not account for child-rearing, we consider employment

data only for men.⁹ For all other uses, we include both genders.

To estimate median asset holdings by age, we use the 2004 Survey of Consumer Finances (SCF).¹⁰ Because the benchmark model is calibrated to match the 2006 US economy, all values are denominated in 2006 dollars, unless otherwise stated.

4.2 Demographics and Health

Each generation enters the economy at age 20 and lives up to 100. The growth rate of new entrants (χ) is set to 1.1%, the long-run average population growth rate in the US. The health measure is derived from the MEPS’s question about perceived health status, which is answered on a scale of one (excellent) to five (poor). Following Imrohoroglu and Kitao (2012), bad health is defined as having an average score (over a year span) that is greater than three, and good health is defined as the complement. Table 1 shows the transition probabilities for health status. Survival rates by health status are set to match those in Imrohoroglu and Kitao (2012) and are displayed in Figure 2(a).

Table 1: Annual Transition Matrices for Health Status by Age Group

Age	Health	Good	Bad	Age	Health	Good	Bad
20-29	good	0.97	0.03	50-59	good	0.91	0.09
	bad	0.61	0.39		bad	0.30	0.70
30-39	good	0.96	0.04	60-69	good	0.92	0.08
	bad	0.48	0.52		bad	0.28	0.72
40-49	good	0.94	0.06	70+	good	0.86	0.14
	bad	0.39	0.61		bad	0.29	0.71

Source: MEPS Panels 10 and 11.

We allow the medical spending shock ϵ to take on three values. As in Kitao (2014), we capture the long tail in the distribution of medical expenses by using: a small shock with a 60% probability, a medium shock with a 35% probability, and a large shock with

⁹An individual is coded as participating in the labor force if he was employed at the point of any interview date in the year of 2006.

¹⁰Assets for married couples are split evenly.

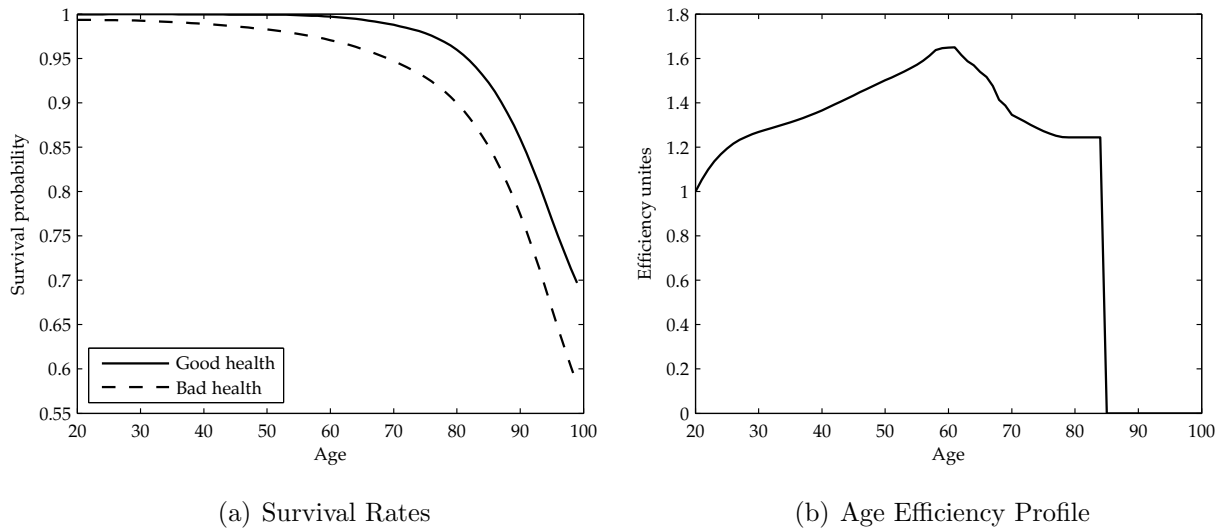


Figure 2: Survival Rates and Age Efficiency Profile

a 5% probability. Table 2 reports the distribution of medical expenses by age and health status. The coinsurance rate for Medicare, κ^{mcr} , is set to 38% percent to target the ratio of average Medicare payments to average medical expenses found among people aged 65 and above in the MEPS. The Medicare premium is set to \$1,700, which is the sum of Part B and Part D premiums in 2006 (Centers for Medicare & Medicaid Services). The coinsurance rate for private insurance, κ^{priv} , is set to 27% to match the MEPS payment data for those who are covered by private insurance and are under the age of 65. The private health insurance premium p^{priv} is set to solve the insurance firm’s zero profit condition and takes an annual value of \$2,217 in the benchmark economy.

4.3 Endowments and Preferences

The life-cycle productivity profile is based on the profile for healthy workers with “tied” wages found in French (2005).¹¹ We normalize the age-20 productivity level to 1. As

¹¹The wage profiles are the combination of a base profile and an adjustment for selection bias. Because the wage bias series in French (2005) stops at age 58, we spline the original estimate to create the wage bias series for ages 59-75 as in French and Jones (2011). We assume wages are constant from age 75 forward to age 84. We are grateful to Eric French for sharing these data.

Table 2: Annual Medical Expenditures by Age Group and Health Status

Age	Health	0-60%	61-95%	96-100%	Age	Health	0-60%	61-95%	96-100%
20-29	good	128	2,165	14,172	50-59	good	677	4,948	28,936
	bad	426	5,917	24,472		bad	2,492	16,442	76,699
30-39	good	210	2,796	18,486	60-69	good	1,226	6,615	32,962
	bad	806	7,361	38,643		bad	3,180	18,070	81,104
40-49	good	292	2,819	15,979	70+	good	1,948	9,512	43,941
	bad	1,222	11,491	62,916		bad	4,254	21,033	70,241

Source: MEPS Panels 10 and 11.

shown in Figure 2(b), we assume that the age-productivity profile goes to zero at age 85. We model the log of the idiosyncratic productivity shock η using a five-state Markov chain, which we set to approximate a first-order auto-regressive process with a persistence parameter of 0.97 and an innovation variance of 0.018, as in Heathcote et al. (2010).

A number of preference parameters are calibrated by fitting the model to a set of empirical targets. Table 3 lists the parameters and associated targets, and shows the model's fit.

The flow utility function is specialized as:

$$u(c, l) = \frac{1}{1 - \sigma} (c^\gamma l^{1-\gamma})^{1-\sigma},$$

where l denotes leisure and is defined in equation (1). γ determines the weight on consumption relative to leisure and is calibrated so that an average worker spends 33% of her disposable time on her job.¹² The parameter ϕ_n determines the fixed cost of working and is calibrated to match the average employment rate of people aged 62-69, the group deciding when to claim Social Security benefits. The parameter ϕ_h determines the time cost of being in bad health and is set to match the difference in employment between good-health and bad-health individuals in the 62-69 age group. The parameter ϕ_{re} deter-

¹²If an individual has 16 waking hours each day, a workload of 2,000 hours absorbs 34.25% of her annual time endowment.

mines the cost of reentering the labor market and is calibrated to match the reentry rate of individuals aged 62-69. We set σ to 7.5, the (approximate) value estimated by French (2005) and French and Jones (2011), who use utility functions and wage processes very similar to ours. Setting σ to 7.5 implies a coefficient of relative risk aversion $(1 - \gamma(1 - \sigma))$ of 2.77, which is in line with the results in French (2005), French and Jones (2011) and De Nardi et al. (2010).

Deceased individuals derive utility from bequests according to

$$v(a) = \psi_1 \frac{(\psi_2 + \max\{a, 0\})^{\gamma(1-\sigma)}}{1 - \sigma}, \quad (10)$$

where ψ_2 is set to \$500,000, as in De Nardi (2004) and French (2005). ψ_1 is calibrated to match the median assets of individuals aged 70-79, a relatively older age group. The maximum operator is added to ensure that any debt due to medical expenditure shocks is waived upon death.

The discount factor β is set to match the median assets of individuals aged 40-49, an age group accumulating wealth for retirement. The pre-tax interest rate is set to 0.05 per year, the value suggested in Cooley (1995). The unit wage rate w is set to generate average earnings of \$38,650, the earnings level for 2006 used by the Social Security Administration in its indexing calculations (Social Security Administration, 2015).

4.4 Government

We calibrate government policy parameters to those in effect in 2006.

Social Security. Social Security benefits are given by $A_k ss(e_j)$, where e_j is an index of the individual's earnings over her working life and $ss(\cdot)$ is a piecewise linear function determining the Primary Insurance Amount (PIA), the benefit received when Social Security is first claimed at the normal retirement age (NRA) J^N . A_k is an adjustment factor based on the benefit claiming age k , reflecting early retirement penalties and delayed re-

Table 3: Calibrated Parameters

Parameter	Value	Targets	Model	Data
β	0.985	Median assets for individuals aged 40-49 (\$000's)	91.881	91.541
γ	0.273	Average work hours for workers	0.333	0.335
ϕ_n	0.068	Participation rate for individuals aged 62-69	0.509	0.485
ϕ_h	0.133	Participation for good-health aged 62-69 / participation for bad-health aged 62-69	2.275	2.269
ϕ_{re}	0.066	Reentry rate for individuals aged 62-69	0.053	0.054
ψ_1 (000's)	28.659	Median assets for individuals aged 70-79 (\$000's)	142.428	141.983
w (000's)	74.079	Average earnings for workers (\$000's)	38.651	38.477

Note: Participation targets based on data from the MEPS. Asset targets based on data from the SCF. See Section 4.1 for more detail. Targets for hours and earnings are described in Section 4.3

tirement credits, with $A_{jN} \equiv 1$. The NRA and the adjustment factors are set to match the rules for the 1940 birth cohort, which reaches its NRA in 2006.

Under the 2006 rules, the PIA formula is

$$ss(e_j) = \begin{cases} 0.9e_j & \text{if } e_j \leq 7872 \\ 7084.8 + 0.32(e_j - 7872) & \text{if } 7872 < e_j \leq 47460 \\ 19753.0 + 0.15(e_j - 47460) & \text{if } 47460 < e_j \leq 94200 \\ 26764.0 & \text{otherwise.} \end{cases} \quad (11)$$

Rather than track the individual's claiming age – and add a variable to the state vector \mathbf{x}_j – when an individual first claims Social Security we replace e_{j+1} with \tilde{e}_{j+1} , where $ss(\tilde{e}_{j+1}) = A_k ss(e_{j+1})$, and use (\tilde{e}_{j+1}) and $\tilde{A}_k = 1$ in all ensuing calculations.¹³

An additional complication is that individuals who claim Social Security benefits before the NRA may have their benefits reduced through the Earnings Test: for those aged 64 and below, the tax rate τ_j^{et} is 0.5 and the earning threshold y_j^{et} is \$12,480; for those aged 65, the tax rate is 0.33 and the earnings threshold is \$33,240. These mechanisms

¹³By way of example, suppose a person aged 62 has an earnings index e_{62} of \$10,000 per year. Under the 2006 rules shown in equation (11), her PIA is $ss(e_{62}) = \$7,765.8$. If she made an early claim at age 62, her monthly benefit would be reduced by 22.5%, to \$6,018.5. Instead of tracking the monthly benefit, we reduce the earnings index to $\tilde{e}_{63} = \$6,687.2$, as $ss(\tilde{e}_{63}) = \$6,018.5$.

are captured in $T_j^{\text{et}}(ss_j, W_j)$, as defined in equation (3). Moreover, benefits clawed back through the Earnings Test are credited to future benefits, using the adjustment factors just described, with the credit to e_{j+1} proportional to T_j^{et} .¹⁴

The index e_j equals the beneficiary's average earnings over her 35 highest earnings years prior to claiming. Because keeping track of 35 years of earnings is infeasible, we use an approximation similar to that used by Imrohoroğlu and Kitao (2012). For those who have not claimed Social Security benefits or reached the ERA, e_j is updated each period using its previous value and current earnings. Once an individual reaches the ERA, but before she claims Social Security benefits, e_j is updated whenever her current earnings exceed the existing index. Once Social Security benefits have been claimed, e_j is updated to only reflect the benefits that are withheld due to the Earnings Test. The resulting formula is

$$e_{j+1} = \begin{cases} [(j-1)e_j + W_j]/j & \text{if } j < J^E \\ \max\{e_j, [(j-1)e_j + W_j]/j\} & \text{if } j \geq J^E, b_{j-1} = 0, b_j = 0 \\ ss^{-1}\left(A_j ss(e_j) + T_j^{\text{et}}(A_j ss(e_j), W_j)\left(\frac{A_{j+1}}{A_j} - 1\right)\right) & \text{if } J^N > j \geq J^E, b_{j-1} = 0, b_j = 1 \\ ss^{-1}\left(ss(e_j) + T_j^{\text{et}}(ss(e_j), W_j)\left(\frac{A_{j+1}}{A_j} - 1\right)\right) & \text{if } J^N > j \geq J^E, b_{j-1} = 1, b_j = 1 \\ ss^{-1}(A_j \times ss(e_j)) & \text{if } j \geq J^N, b_{j-1} = 0, b_j = 1 \\ e_j & \text{otherwise} \end{cases}$$

where $ss^{-1}(\cdot)$, converting benefits into values of the earnings index, is the inverse of the function in equation (11).

Taxes. The Social Security payroll tax rate τ^{ss} is 12.4 percent, and the taxable earnings limit y^{ss} is \$94,200. The Medicare payroll tax rate τ^{mcr} is 2.9 percent. The consumption tax rate τ^c is set to 6.0 percent, as summarized in Mendoza et al. (1994).

As described in Section 2, the portion of Social Security benefits subject to income

¹⁴In particular, each dollar withheld through the Earnings Test at age j increases future benefits by $(\frac{A_{j+1}}{A_j} - 1)$ dollars, i.e., at the same rate as benefits grow when claiming is delayed from age j to age $j+1$.

taxes depends on the net benefits themselves, $ss_j^*(ss_j, W_j)$, and “combined income”, $Y_j^{\text{CI}} = ra_j + W_j + 0.5ss_j^*$. The exact formula is

$$SS(ss_j^*, ra_j, W_j) = \begin{cases} 0 & \text{if } Y_j^{\text{CI}} < 25000 \\ \min\{0.5ss_j^*, 0.5(Y_j^{\text{CI}} - 25000)\} & \text{if } 25000 \leq Y_j^{\text{CI}} < 34000 \\ \min\{0.85ss_j^*, 4500 + 0.85(Y_j^{\text{CI}} - 34000)\} & \text{otherwise.} \end{cases}$$

Total taxable income y_j is in turn the sum of earnings, asset income and taxable Social Security benefits:

$$y_j = ra_j + W_j + SS(ss_j^*, ra_j, W_j).$$

We model income taxes using the functional form estimated by Gouveia and Strauss (1994):

$$T(y_j) = \lambda_0[y_j - (y_j^{-\lambda_1} + \lambda_2)^{-1/\lambda_1}].$$

The parameter λ_0 determines the level of the average tax rate, while λ_1 controls the progressivity of the tax code. These two parameters are set, respectively, to 0.258 and 0.768, as in Gouveia and Strauss (1994). λ_2 is a scaling parameter and is calibrated so that in a balanced budget equilibrium direct government spending (G) equals about 23 percent of total earned income.¹⁵

Means-Tested Insurance. In the model means-tested social insurance provides a consumption floor (c_j) of \$3,000 for individuals under age 65, and of \$6,377 for individuals aged 65 and above. The first consumption floor of \$3,000 is close to the values used by Kitao (2014) (\$3,760 in 2006 dollars) and De Nardi et al. (2010) (\$3,280). The second consumption floor of \$6,377 is set to be 16.5% of average earnings as in Kopecky and Koreshkova (2014), reflecting that the government provides more means-test transfers via Medicaid and SSI to the elderly population.

¹⁵Direct spending is about 15% of GDP (The World Bank, 2016), and labor income comprises about two-thirds of GDP.

4.5 Benchmark Economy

Employment. As shown in Figure 3, the model fits well both the aggregate life-cycle employment profile and the disaggregated profiles for good and bad health. In particular, the model captures the sharp drop in employment after the ERA of 62. As discussed below, part of the drop is explained by the income tax treatment of Social Security benefits. In line with the data, the model also produces a substantial number of older people who continue to work after age 70.

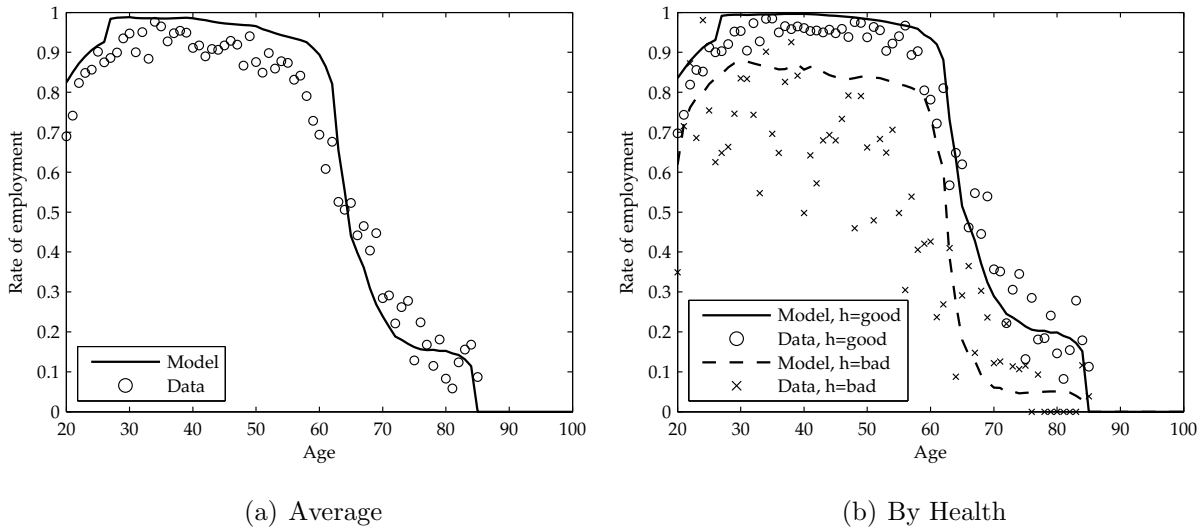


Figure 3: Rate of Employment by Age

Source: Employment data for male respondents in MEPS panels 10 and 11.

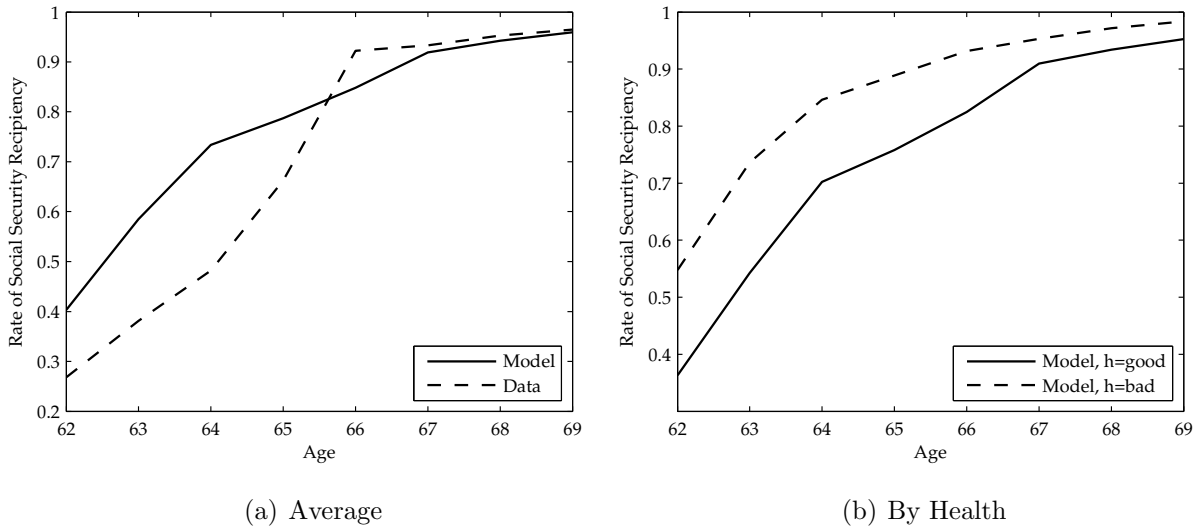


Figure 4: Rate of Social Security Reciprocity by Age

Notes: The claiming rate for the data is computed as the age-by-age ratio of male retired worker beneficiaries from the 2007 Statistical Supplement (Social Security Administration 2008, Table 5.A1.1) to the intercensal population estimates for men in 2006 (United States Census Bureau, 2016).

Social Security Claims. Figure 4(a) compares the model-generated claiming profile to the observed claiming profile. Although the model does not target these data, it matches the general pattern of Social Security claims. In particular, the model correctly predicts that most individuals do not claim benefits at the ERA of 62, even though early filing maximizes expected discounted benefits (at an assumed after-tax interest rate of 4.25%). Within our model, there are at least two reasons why individuals defer claiming their benefits. First, risk-averse individuals will defer claiming in order to have higher benefits should they live to unexpectedly old ages (Imrohoroglu and Kitao, 2012). Second, claiming decisions are distorted by the combination of the Earnings Test and the income tax on Social Security benefits.

Assets and Earnings. As shown in Figure 5(a), consistent with the data, individuals in the model do not reduce asset holdings after retirement. This reflects the bequest motive, precautionary saving for health spending, and mortality bias – people with bad health are more likely to both have small assets and die young. Average assets drop

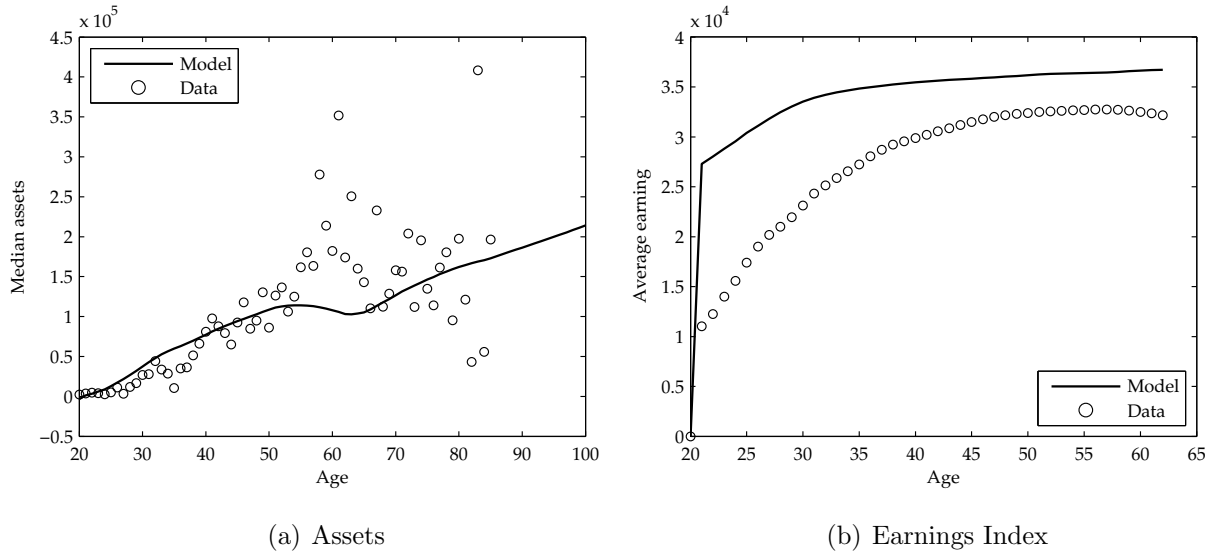


Figure 5: Median Assets and Mean Earnings Index by Age

Notes: Observed asset values are from the 2004 SCF, while the earnings index is constructed from the 2006 Social Security Earnings Public Use File.

slightly before 65, when some individuals retire early, live on their assets, and wait to claim their Social Security benefits.

Figure 5(b) compares the life-cycle profile of the earnings index (e_j) generated by the model to the earnings index implied by the data.¹⁶ To construct the latter, we take earnings histories from the 2006 Social Security Earnings Public Use File and calculate earnings in the same way as in our model.¹⁷ Figure 5(b) shows that the model over-predicts the growth of the earnings index before age 40 but matches reasonably well the flat pattern after age 40. The discrepancy between model and data is likely due to the fact that in the data the upper bound on taxable earnings has increased over time: the real value of the upper bound in the 1960s is about 40-50% of that in 2006 (Whitman and Shoffner, 2011). Therefore, before age 40 the indexed earnings in the data are substantially lower than total earnings and lower than the indexed earnings implied by the model.

¹⁶Figure 5(b) displays the earnings index only up to age 62, because from age 63 forward the model adjusts the index to reflect the timing of Social Security claims.

¹⁷The sample is restricted to males born in 1944 and have earned at least 40 credits (work for 10 years) by the age of 62. All wages are converted to 2006 constant dollars using the Consumer Price Index. To maintain comparability with the model, we do not adjust for real wage growth.

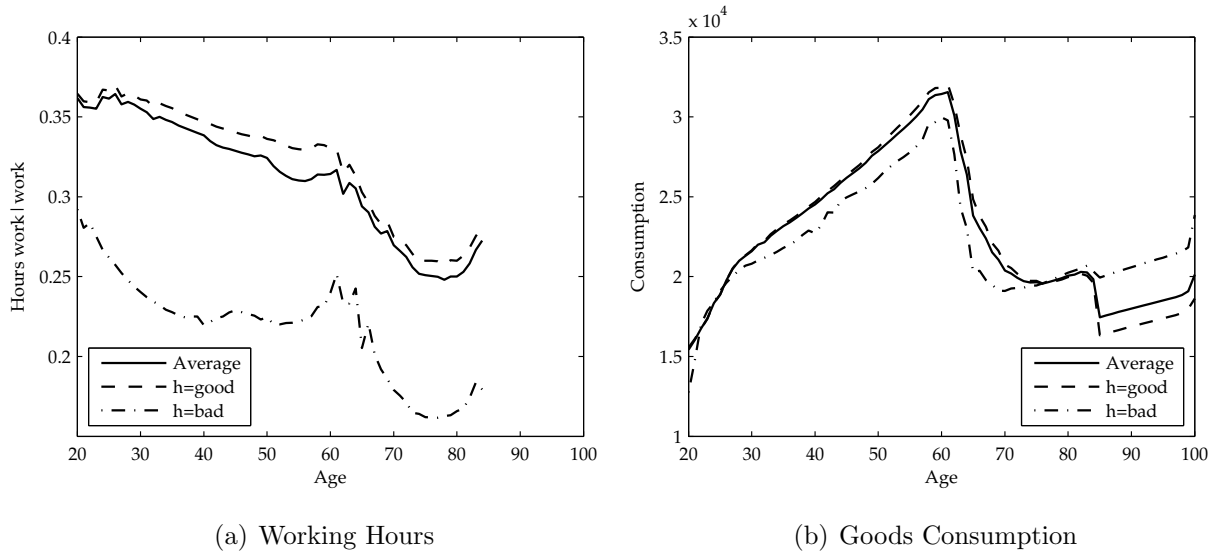


Figure 6: Average Working Hours and Goods Consumption by Age

Hours and Consumption. As shown in Figure 6(a), the model predicts that the life-cycle profile of working hours declines over almost all of the life cycle. At younger ages, borrowing-constrained younger workers work extended hours to build up their wealth (Low, 2005). As wealth accumulates, hours begin to fall. Hours decline sharply after age 60, as many workers transit to part-time jobs. The switch to part-time work reflects the decline in the age-efficiency profile, the increase in asset wealth, and the disincentives generated by the Earnings Test and benefit taxation. Bad-health individuals work fewer hours at every age, consistent with their reduced time endowment (captured by ϕ_h). The hours profiles documented in French (2005, Figures 2 and 3) show similar patterns.

Figure 6(b) displays life-cycle consumption profiles. The shape of the consumption profiles resembles the shape of the efficiency profile, for two reasons. First, because low-earning younger workers cannot borrow against higher future earnings, their consumption tracks their income, and thus rises with age (Gourinchas and Parker, 2002). Second, with $\nu > 1$ consumption and leisure are substitutes (Low, 2005). As workers retire, they substitute leisure for consumption, leading to sharp drops in consumption around ages 60

and 85.

Income Taxes on Social Security Benefits. In the model, about 31% of Social Security recipients pay income taxes on Social Security benefits, about three-quarters of the 2005 value of 39% (CBO, 2015). Among those who pay positive income taxes on their Social Security benefits, average taxable benefits are \$5,828 and average taxes are \$1,101. In the model, income taxes on Social Security benefits equal about 2.3% of total Social Security benefits. This is less than half of the value for 2006, 5.7%.¹⁸ One likely reason why the model generates a smaller ratio is that it abstracts from household structure, treating everyone as single. While the taxation of benefits for married couples depends on their joint income, the benefit taxation thresholds for couples are only about 30% higher than those for singles.¹⁹ Another potential reason is that the model assumes that individuals are fully aware that their Social Security benefits may be taxed when they make their claiming decisions. If individuals do not learn about the tax before they claim, they will likely claim earlier and pay more taxes than the model predicts. To understand the impact of the information channel, in Section 6 we examine a case where individuals do not know about the income taxation of Social Security benefits until one year after they claim benefits.

5 Policy Experiments

We assess the impact of benefit taxation through six policy experiments. These are, in order:

¹⁸Income taxes on Social Security benefits are divided between the Social Security and Medicare Trust Funds. (There are also income taxes on Disability Insurance benefits that are directed to the Disability Insurance Trust Fund, which we ignore in our model.) In 2006, \$15.6 billion of such taxes were directed to the Social Security fund (Social Security Administration 2007, Table IV.A1) and \$10.3 billion to the Medicare fund (Centers for Medicare and Medicaid Services 2007, Table II.B1). Total Social Security benefits were \$454.5 (Social Security Administration 2007, Table IV.A1) for a ratio of $(15.6+10.3)/454.5 = 5.7\%$.

¹⁹The two thresholds for married couples are \$32,000 and \$44,000, which are, respectively, 28% and 29% greater than those of singles.

1. Eliminating the income taxation of Social Security benefits
2. Eliminating the Social Security Earnings Test
3. Eliminating both benefit taxation and the Earnings Test
4. Making 85% of Social Security benefits subject to income taxation at any income level
5. Eliminating the second taxation threshold (\$34,000) and conversion rate (85%) introduced by the 1993 legislation
6. Adjusting the two taxation thresholds to reflect inflation between 1993 and 2006.

In all experiments, the Social Security payroll tax (τ^{ss}) is adjusted to preserve the balance of the combined Social Security and Medicare budgets:

$$\begin{aligned}
& \int \left[T(ra + W + SS(ss^*, ra, W)) - T(ra + W) + \tau^{mcr} W + \tau^{ss} \min\{W, y^{ss}\} \right. \\
& \quad \left. + T_j^{et}(ss, W) + p^{mcr} I_{j \geq JM} \right] \mu(\tilde{\mathbf{x}}) d\tilde{\mathbf{x}} \\
& = G_{OAIHI} + \int [ss + (m - Q)I_{j \geq JM}] \mu(\tilde{\mathbf{x}}) d\tilde{\mathbf{x}};
\end{aligned}$$

where G_{OAIHI} denotes the surplus of the Social Security and Medicare systems in the benchmark economy and is fixed across different experiments.

5.1 No Income Taxes on Social Security Benefits

The first policy reform we consider is the complete elimination of Social Security benefit taxation. The effects of this reform can be seen by comparing column (0) of Table 4, which shows results for the baseline model, to column (1). Eliminating benefit taxation raises the aggregate employment rate by 1.2 percentage points, from 79.0% to 80.2%. The solid line in Figure 7(a) shows how employment changes over the life cycle. The largest effects are after age 65, reflecting that workers near retirement are sensitive to changes in the after-tax wage (French and Jones 2012, Karabarbounis 2016).

Table 4: Comparisons across Stationary Economies

	Benchmark (0)	SSB not taxable (1)	No earn- ings test (2)	Neither (3)	SSB always taxable (4)	Single threshold (5)	Thresholds indexed (6)
Panel A: Aggregate Statistics							
Participation	78.96%	80.18%	79.12%	80.60%	79.20%	79.31%	79.89%
Hours work	33.51%	33.31%	33.48%	33.26%	33.63%	33.46%	33.27%
Efficiency units		+0.95%	+0.10%	+1.23%	+0.85%	+0.37%	+0.23%
Mean assets (\$000's)	100.5	101.9	100.7	103.4	102.9	101.2	101.2
Mean cons. (\$000's)	23.4	23.6	23.4	23.8	23.6	23.5	23.5
Panel B: Government Budget (Dollars per capita)							
OASDI+HI							
Revenue	5,172	5,183	5,058	5,003	5,187	5,198	5,164
Expenditure	4,227	4,238	41,14	4,058	4,242	4,253	4,219
Balance	945	945	945	945	945	945	945
General Budget							
Revenue	6,195	6,261	6,203	6,289	6,281	6,223	6,207
Expenditure	7,140	7,133	7,143	7,129	7,148	7,138	7,135
Balance	-945	-872	-940	-839	-867	-915	-929
Panel C: General Equilibrium Variables							
OASDI tax	12.40%	12.42%	12.36%	12.26%	11.46%	12.34%	12.45%
Bequests	2,195	2,258	2,194	2,273	2,154	2,215	2,216
Panel D: Welfare							
CEV		0.32%	0.04%	0.60%	0.74%	0.19%	0.06%

In contrast to employment, average hours of work for workers falls when benefit taxes are eliminated. Figure 7(b) reveals that around age 65, hours of work fall, as new workers work fewer hours than existing ones. Hours also fall around age 30, perhaps because people substitute increased earnings at older ages for earnings at younger ages. Average hours of work do rise after age 70, but because workers at these older ages work fewer hours than workers at younger ages, increases in employment at these ages still pull down average hours.

To measure the overall change in labor supply, we track labor efficiency units. This measure incorporates not only participation and hours of work, but also skill heterogeneity and the efficiency loss associated with part-time work. Eliminating benefit taxation causes efficiency units to increase by 0.95%. Total labor supply thus moves in the same direction as participation and with a similar magnitude. The taxation of Social Security benefits alters the aggregate labor supply primarily through the extensive margin.

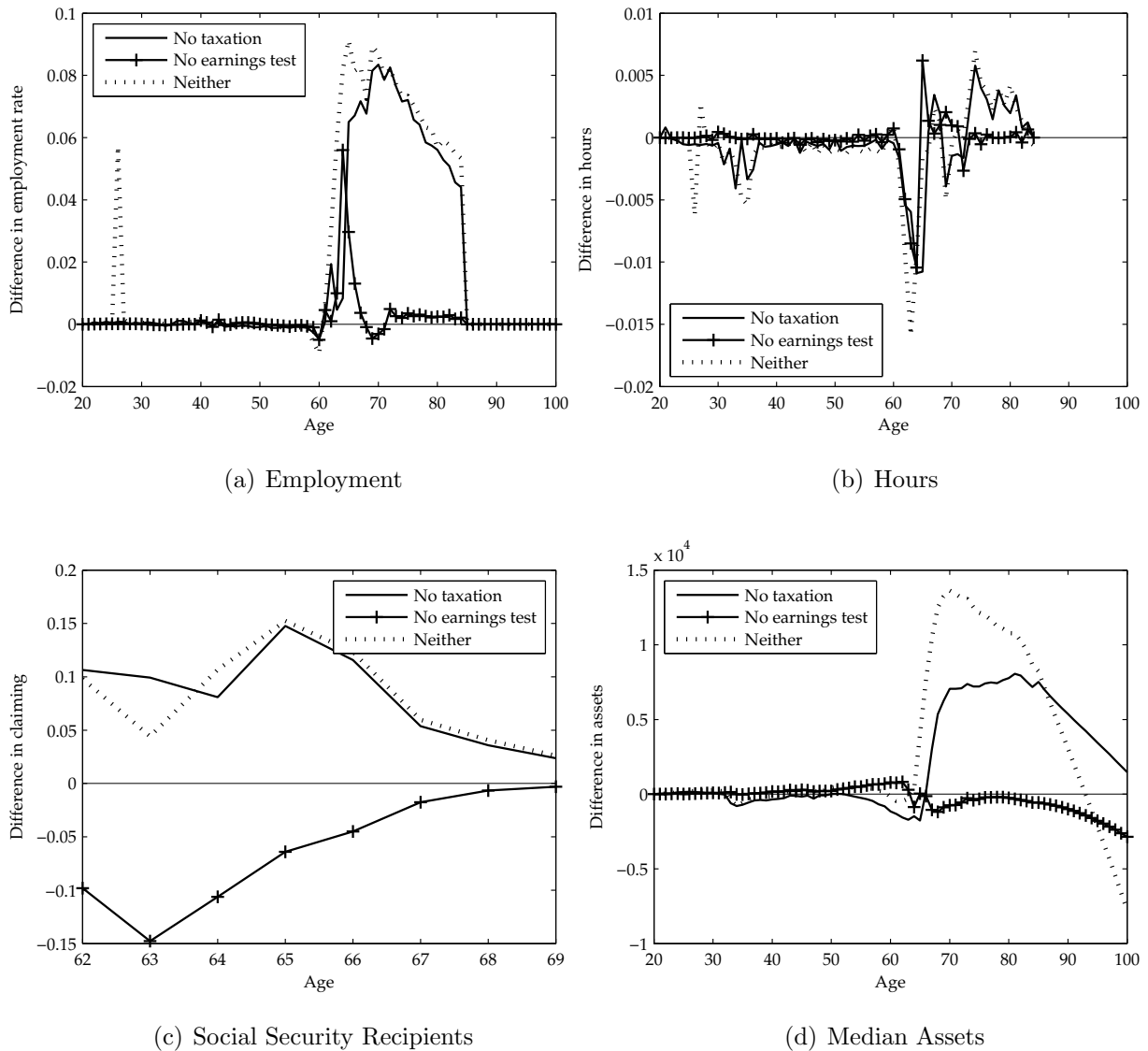


Figure 7: Life-cycle Effects of Policy Reforms: Experiments (1)-(3)

Table 4 also shows that removing the income tax on Social Security benefits increases consumption, and assets, especially for the elderly population (see Figure 7(d)).

To balance the combined Social Security and Medicare budget, the payroll tax rate rises slightly from 12.40% to 12.42%. Total spending on Social Security increases, even though eliminating benefit taxation leads individuals to claim Social Security benefits at earlier ages (Figure 7(c)), and in the cross-sectional aggregate earlier claiming reduces

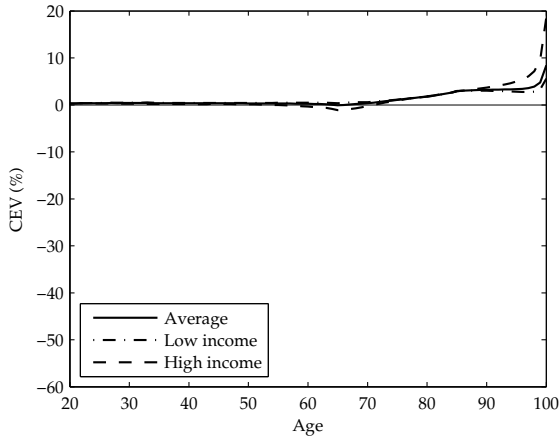
total Social Security spending.²⁰ This is explained by increased use of the Earning Test, which withholds some early claimers' current benefits but credits their future benefits, causing an increase in cross-sectional aggregate spending. This reform to Social Security has spillover effects on other government programs: the increase in the aggregate labor supply increases general government revenues by 1.1%, and the increase in assets reduces government spending on means-tested transfers, leading general government spending to fall by 0.1%.²¹

Finally, to measure the welfare implications of the reform, we calculate the ex-ante consumption equivalent variation (CEV), the proportional increase in lifetime consumption needed to make a newborn individual in the benchmark economy as well off as a newborn in the counterfactual economy.²² We also calculate the CEV separately for different ages, and for two permanent income levels: high-income individuals who have an earnings index e_j above the median level of their age group, and low-income individuals who have an earnings index below the median. While individuals aged 60 and below are sorted according to their current earnings index e_j , individuals older than 60 are sorted according to their age-60 earnings index e_{60} , to remove the effects of retirement and claiming choices on the earnings index.

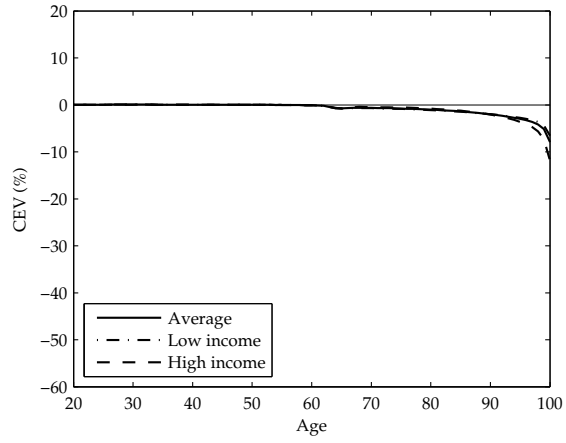
²⁰From the perspective of the individual, who discounts future benefits at her after-tax interest rate, early claiming maximizes the present discounted value of benefits. In a cross-sectional aggregate, however, payments made to older individuals are given the same weight as payments made to younger individuals (with modest adjustments for population growth). In this case, earlier claiming reduces the sum.

²¹Direct government spending is held fixed throughout the experiments.

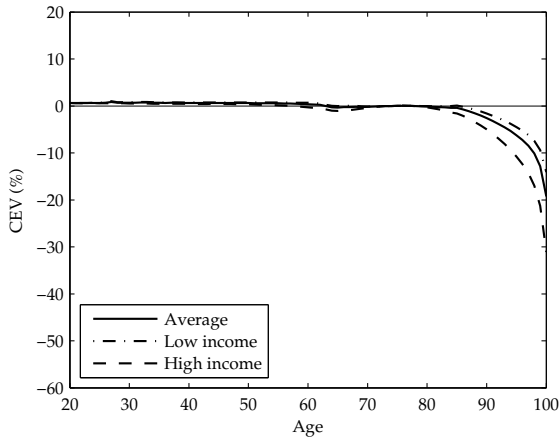
²²We calculate this as $\left(\frac{\text{lifetime utility}_{\text{reform}} - \text{utility from bequests}_{\text{benchmark}}}{\text{lifetime utility}_{\text{benchmark}} - \text{utility from bequests}_{\text{benchmark}}} \right)^{1/[\gamma(1-\sigma)]} - 1$, with all utility measured ex-ante.



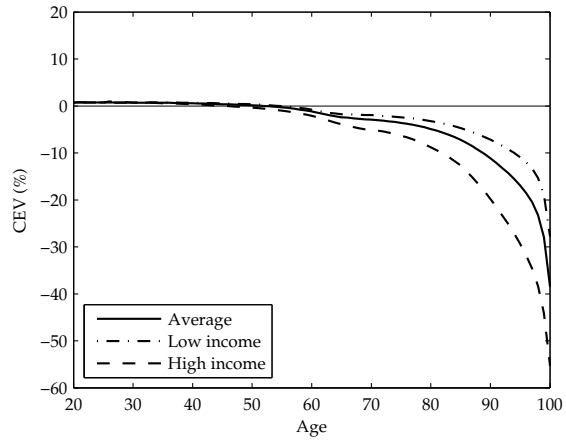
(a) No taxation



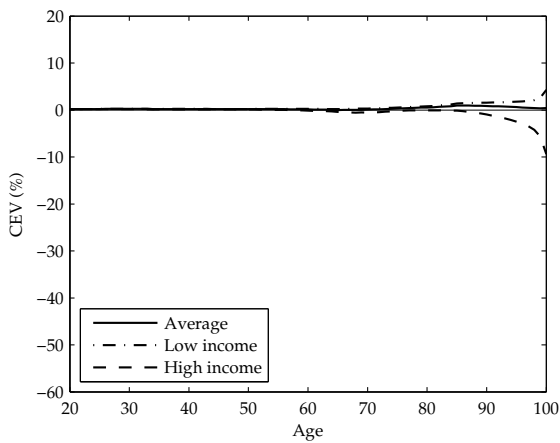
(b) No earnings test



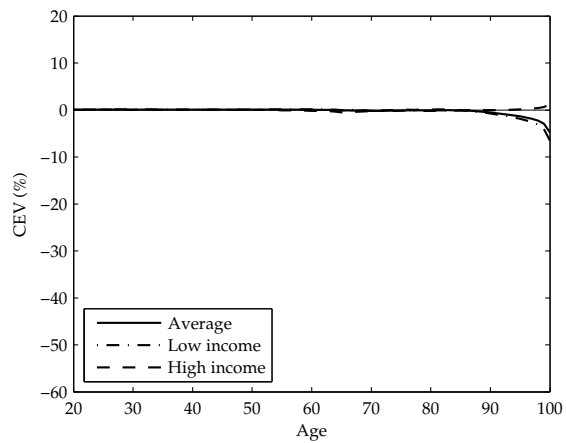
(c) Neither



(d) All taxable



(e) Single threshold



(f) Threshold indexed

Figure 8: CEV for Each Policy Reform, by Age and by Earnings Group

As reported in Table 4, the ex-ante CEV is 0.32%, indicating that eliminating the tax increases welfare. The work disincentives of the benefit tax are most potent at older ages, when labor supply is extremely elastic. Replacing it with a payroll tax that operates evenly at all ages shifts the tax to less elastic workers. Figure 8(a) displays the CEV by age and by earnings index. As shown in the figure, the reform benefits individuals of most age groups at both income levels, with the exception that it creates a small loss for high-income individuals around age 60. The loss arises because individuals respond to the change in tax distortions by shifting their labor supply to older ages, leading individuals around age 60 to be worse off.

The comparisons plotted in Figure 8 are between two permanent tax regimes, where individuals face the same tax incentives over their entire lives. Figure 8(a) thus does not give the change in welfare for a, say, 60-year-old in the baseline model who is suddenly switched to the no-benefit-taxation regime, and is thus not a direct guide to how people in the baseline economy would vote if given the opportunity to end the income taxation of Social Security benefits. Nonetheless, Figure 8(a) suggests that proposals to eliminate benefit taxation should receive broad political support.

Table 5: Effects of Eliminating Benefit Taxation by Earnings Quintile and Age Group

Earnings Quintile	Change in Employment		Change in Hours Work	
	Ages 60-69	Ages 70-84	Ages 60-69	Ages 70-84
Bottom	0.003	0.023	0.000	0.014
Second	0.007	0.034	0.002	0.013
Third	0.017	0.044	0.000	0.012
Fourth	0.028	0.064	-0.003	0.002
Top	0.050	0.084	-0.009	-0.026

Notes: Comparison uses distribution of state variables found in benchmark economy. Earnings quintiles based on the earnings index at age 60.

To further illuminate the mechanics of benefit taxation, Table 5 shows how eliminating the tax affects employment and hours at different lifetime earnings quintiles. To construct Table 5 we sort individuals by their age-60 earnings index (e_{60}) and then calculate differ-

ences in average employment and hours of work for different older age groups. Using the distribution of the state variables generated by the benchmark model at every age, we evaluate both the benchmark decision rules and the no-tax decision rules at every point in the state space, then take averages. Because we are holding fixed the distribution of state variables, the differences shown in Table 5 are essentially static – they are the immediate responses to an unexpected policy change. This makes them easier to interpret but different from the results in Table 4 and Figure 7.

Table 5 shows that removing benefit taxation has almost no effect on employment in the bottom lifetime earnings quintile. The earnings of these individuals are so low (on average, $e_{60} = \$18,988$) that their combined income usually lies below the taxation threshold. At higher lifetime earnings quintiles, in contrast, employment increases significantly when benefit taxes are removed, as these individuals have more benefits subject to taxation and higher marginal income tax rates on earnings.

Individuals with sufficiently high unearned income, however, will have their benefits taxed fully even if they don't work at all. For these people, removing benefit taxation results in a pure income effect that discourages labor supply. Page and Conway (2015) find that the introduction of the benefits tax in 1983 caused individuals with high combined income to increase their participation. This contrasts with our model, where eliminating benefit taxation increases labor supply even at the highest income quintile, suggesting that the substitution effects of the benefits tax still dominate the income effects. Our results may differ because the 1993 modifications increased both the rate at which benefits become taxable and the total potential tax liability, or because we sort on lifetime earnings rather than combined income. As we show below in experiment 4, making benefits fully taxable leads individuals to supply more labor, which is evidence for the income effect.

The last two columns of Table 5 show that eliminating benefit taxation leads hours of work to increase at the bottom of the earnings distribution but decrease (or increase much less) at the top. Two mechanisms are at play. Individuals who worked under benefit

taxation work more hours when the taxes are eliminated. However, eliminating the tax also leads new workers to enter the market. The new entrants tend to work fewer hours, reducing the overall average. The first effect dominates at the bottom of the earnings distribution, where there are few new workers, while the composition effect dominates at the top earnings quintiles. Overall, we find that for all income quintiles and both age groups, the extensive margin of adjustment (employment) is much more important than the intensive margin of adjustment (hours of work).

Burman et al. (2014) examine the distribution of combined income among Social Security recipients to see if income is bunched at either of the benefit taxation thresholds. Finding no evidence of bunching except among some of the self-employed, they conclude that benefit taxation has little effect, probably because its mechanisms are too complicated for retirees to understand. To check for bunching, Figure 9 shows the distribution of combined income generated by the model under different policy regimes. Panel (a) shows income distributions for Social Security recipients aged 62-64, while panel (b) shows distributions for people aged 70-84 who all have received Social Security benefits. In the benchmark specification of the model, there are no jumps in the distribution function around the earnings threshold. Moreover, while eliminating benefit taxation shifts the distribution of combined income to the right, the shape of the distribution function is very similar to the shape of the distribution function in the benchmark specification. This is consistent with the general finding that in our model the aggregate effects of benefit taxation occur mainly along the extensive margin.²³ In practice, Social Security beneficiaries deciding whether to work at all do not need to know the exact taxation formula; they need only to know that working will lead to significantly higher income taxes. Bunching analyses cannot identify these effects.

²³Table 5 suggests that eliminating benefit taxation does increase hours of work among those aged 70-84 in the bottom four quintiles. Figure 9(b) shows that even among this group, there is little evidence of bunching.

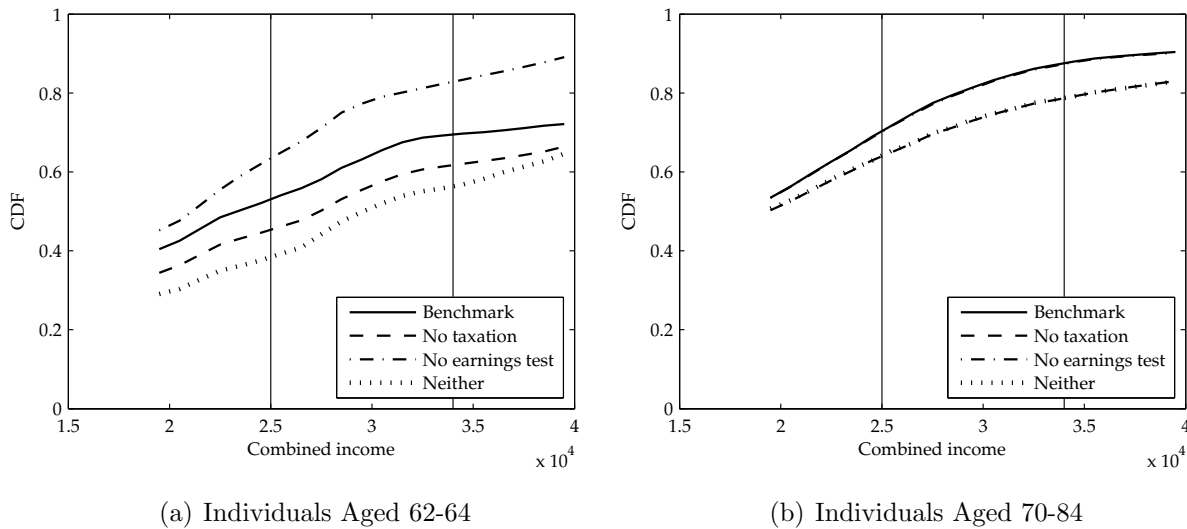


Figure 9: Cumulative Distribution Functions of Combined Income among Social Security Recipients: Experiments (1)-(3)

5.2 No Earnings Test

Column (2) of Table 4 shows the outcomes that result when the Earnings Test is eliminated. Eliminating the Earnings Test has very modest effects on participation and total efficiency units, while hours of work are almost unchanged. Recall that the Earnings Test reduces current benefits but increases future benefits. Because the crediting rates are close to actuarially fair, the net tax generated by the Earnings Test is close to zero. There is also a key interaction between the Earnings Test and benefit taxation. Because the effect of benefit taxation is capped by the size of the benefit itself, the Earnings Test reduces the impact of benefit taxation on current work, by reducing current benefits, and it increases its effect on future work, by increasing future benefits. Since most people work more at younger ages, the way in which the Earnings Test moves the tax burden to the future may well increase lifetime labor supply.

Eliminating the Earnings Test has a larger effect on Social Security claiming. Figure 7(c) shows that removing the Earnings Test reduces the number of Social Security

recipients at ages 62-69. There are several competing forces. For people who wish to receive benefits early and continue working, removing the Earnings Test eliminates a disincentive to early claiming. For people who prefer to gradually shift from labor income to Social Security benefits over several years and use the Earnings Test as a way to regulate their benefits, removing the Earnings Test may discourage early claiming. Moreover, removing the Earnings Test leaves more current benefits vulnerable to income taxation, which also discourages early claiming. The latter two forces dominate the first, resulting in claiming delays.

A number of studies have shown that the distribution of earnings among Social Security recipients is bunched just below the earnings tax thresholds: see the review in Engelhardt and Kumar (2014). The standard interpretation is that many of the beneficiaries are unaware of the crediting dimension of the Earnings Test and view it as a pure tax (Engelhardt and Kumar, 2014). The smooth distribution functions shown in Figure 9(a) suggest that the Earnings Test generates no earnings bunching within our model.²⁴ This in large part reflects the fixed cost of work, which leads the labor supply decision to be one mostly of participation rather than hours. Nonetheless, hours decisions in the data do appear to be more sensitive to the Earnings Test than benefit taxation.²⁵ One reason for this may be that individual earnings are easier to measure and control than combined income, which includes asset and spousal income. From this perspective, it is not surprising that Burman et al. (2014) find the most evidence of income bunching among the self-employed, who have more control over their total incomes.

Turning to welfare implications, the elimination of the Earnings Test produces an ex-ante gain equivalent to 0.04% of the lifetime consumption. However, as shown in Figure 8(b), the experiment makes older groups worse off, as individuals who claim early need to pay more income taxes on their Social Security benefits.

²⁴Plotting the distribution of earnings, rather than combined income, does not change the conclusion.

²⁵Engelhardt and Kumar (2014) conclude that “there is little consensus on the extensive margin (participation) response” to the Earnings Test (page 456).

5.3 No Earnings Test or Benefit Taxation

Column (3) of Table 4 shows the outcomes that result when we combine the previous two experiments and eliminate both the Earnings Test and the income taxation of Social Security benefits. This exercise is particularly useful in illustrating the interactions between benefit taxation and the Earnings Test. When benefits are not taxed, removing the Earnings Test increases efficiency units by 0.28% (1.23% – 0.95%), almost tripling the increase of 0.10% shown in column (2), where benefits are taxed;²⁶ moreover, removing the earnings test increases welfare by 0.28% (0.60% – 0.32%), seven times the increase of 0.04% shown in column (2). However, the effects of removing the Earnings Test on labor supply and ex-ante welfare are always smaller than those of removing benefit taxation.

5.4 Unconditional Benefit Taxation

Our next experiment is to assume that 85% of Social Security benefits are subject to income taxation in all circumstances. With this change, the “double taxation” of earnings, where higher earnings increase the portion of benefits subject to taxation, no longer occurs. By reducing the after-tax value of Social Security benefits, benefit taxation still reduces the lifetime returns to working. But this forward-looking substitution effect is much smaller than the sum of forward-looking and direct substitution effects found in the benchmark economy, while the income effect is much larger than in the benchmark economy. Moreover, as column (4) of Table 4 shows, the increase in income-related benefit taxes allows the government to *lower* the payroll tax, from 12.40% to 11.46%. It is thus not surprising that making benefit taxation independent of combined income leads to significant increases in employment (0.30%), hours (0.36%), labor supply (0.85%) and wealth (2.39%).

²⁶As shown in Figure 7(a), employment increases sharply around age 25, because individuals of this age group are close to indifferent between working or not, as evidenced by the change in employment between ages 20 and 30 (Figure 3), and their labor supply decisions are sensitive to how benefit taxation affects the total returns to work.

Our findings are consistent with Page and Conway's (2015) empirical results. They conclude that among the beneficiaries who would pay the full benefit tax even if they didn't work, the introduction of the benefit tax in 1983 led to higher employment. We find that average hours of work increase as well, in contrast to all the other experiments in Table 4. With less after-tax income, but a lower marginal tax rate on earnings, older workers increase their hours.

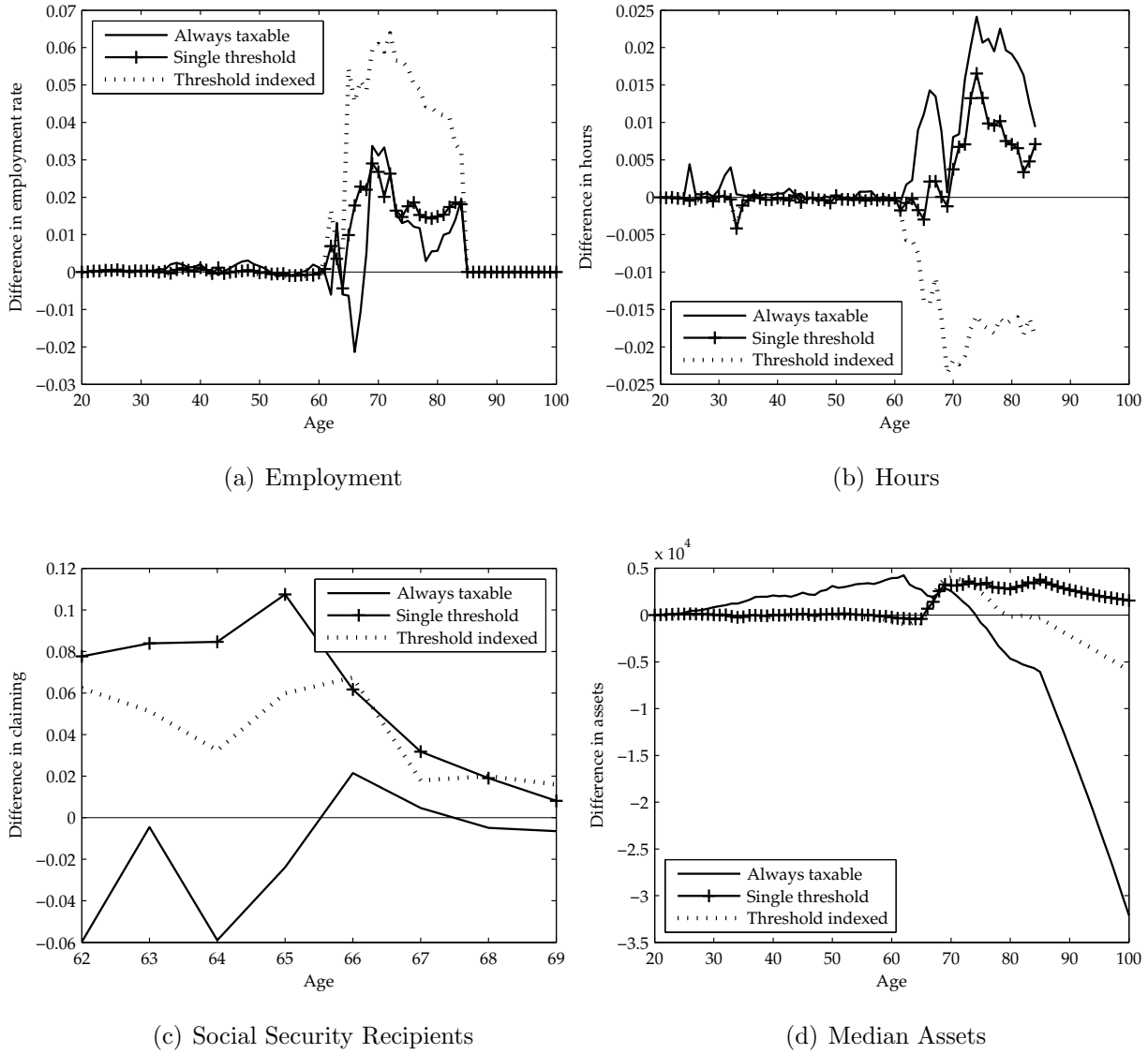


Figure 10: Life-cycle Effects of Policy Reforms: Experiments (4)-(6)

Figure 10(a) shows that much of the employment increase occurs after age 68, when most individuals have claimed Social Security benefits (see Figures 4 and 10(c)). Employment also increases before age 50, suggesting that the effect of a lower current payroll tax rate dominates the effect of lower future after-tax Social Security benefits. Figure 10(c) shows that making benefits unconditionally taxable also leads to significant delays in Social Security claiming. With progressive income taxes, tax rates on benefits likely fall with age. Working individuals may be willing to trade current benefits for higher future benefits if the latter are taxed at lower rates. Table 4 shows that aggregate Social Security benefits do rise, albeit modestly.

From an individual's perspective, however, later claiming reduces the present discounted value of benefits. With later claiming and more income taxes on benefits, older individuals receive fewer after-tax benefits over their retirement and rely more heavily on their savings. Figure 10(d) shows when benefits are taxed unconditionally, individuals bring more wealth into retirement but consume it at a faster rate. After age 80, assets fall below their benchmark levels.

Overall, making benefits unconditionally taxable leads to higher consumption and a shift from regressive payroll taxes to progressive income taxes. The ex-ante CEV for this reform is 0.74%, the highest across all experiments. As shown in Figure 8(d), however, older individuals, especially those with high income, lose from the reform. This suggests that proposals to make Social Security benefits fully and unconditionally taxable would face significant political opposition from the elderly.

5.5 A Single Threshold for the Income Taxation of Benefits

For our fifth experiment, we remove the benefit taxation provisions introduced in 1993. In particular, we remove the second combined income threshold of \$34,000 and the associated rate at which benefits are converted to taxable income, 85%, but keep the original income

threshold of \$25,000 and the original conversion rate of 50%. Column (5) of Table 4 and the crossed lines in Figure 10 show the outcomes. Because this reform is essentially a partial elimination of benefit taxation, its effects are reduced versions of the effects shown in column (1), where benefit taxation was eliminated completely.

5.6 Indexing the Income Thresholds in the Benefit Taxation Formula

The final reform we consider is to raise the combined income thresholds for benefit taxation, which are not indexed, to reflect inflation between 1993 and 2006. Column (6) of Table 4 displays the results. Raising the taxation thresholds reduces the income effect and shifts the substitution effect from individuals who have lower combined income to individuals who have greater combined income. Figure 10 shows that while raising the thresholds increases participation at older ages, hours of work fall. This is consistent with substitution effects operating along the intensive margin for individuals who would work more hours if the thresholds are not indexed to inflation. (As before, there are composition effects as well.) Moreover, increasing the thresholds reduces the revenues collected through the progressive income tax, necessitating an increase in the regressive payroll tax. It is instructive to compare the effects of this reform to the effects of making benefit taxation independent of other income. The current reform, which weakens income effects and alters substitution effects in ambiguous ways, leads to higher payroll taxes. The earlier reform, which weakened substitution effects while preserving income effects, led to lower payroll taxes.

6 Institutional Knowledge

In the above analysis, we assumed that individuals have perfect information about how their Social Security benefits are taxed. This may be a strong assumption: Greenwald et al. (2010, Figure 8) find that only 57% of those aged 25-65 are aware that they may have to pay income taxes on their Social Security benefits. In practice, many individuals may not understand the tax treatment of Social Security benefits until they begin receiving benefits themselves. At that point, individuals owing income taxes on their benefits will have to either include them in their quarterly estimated tax payments or have them withheld from their benefits (Social Security Administration, 2016b), making them much better informed. To assess the importance of the full-information assumption, we simulate a limited-information version of the model where individuals first learn about Social Security benefit taxation the year after they claim benefits. To isolate the effect of information, throughout the experiment we hold all general equilibrium variables at their benchmark economy values.

Conforming with the guess in Section 4.5, imposing limited information raises the amount of income taxes collected from Social Security benefits. Compared to the benchmark economy, we find the percentage of Social Security recipients who pay taxes on their benefits rises from 31.4 to 33.4%, and the ratio of benefit taxes to total benefits rises by 0.4 percentage points (from 2.3 to 2.7 percent).

Figure 11 displays the changes in employment, hours of work, Social Security claims, and median assets from the benchmark economy for two counterfactual economies: one with limited information and income taxes on Social Security benefits (solid line), and the other without income taxes on Social Security benefits (dashed line). The latter specification appeared above, with general equilibrium effects added, as experiment 1. As shown in Figure 11(c), these two counterfactual economies have identical Social Security claiming patterns, as workers in both economies make their claiming decisions under the

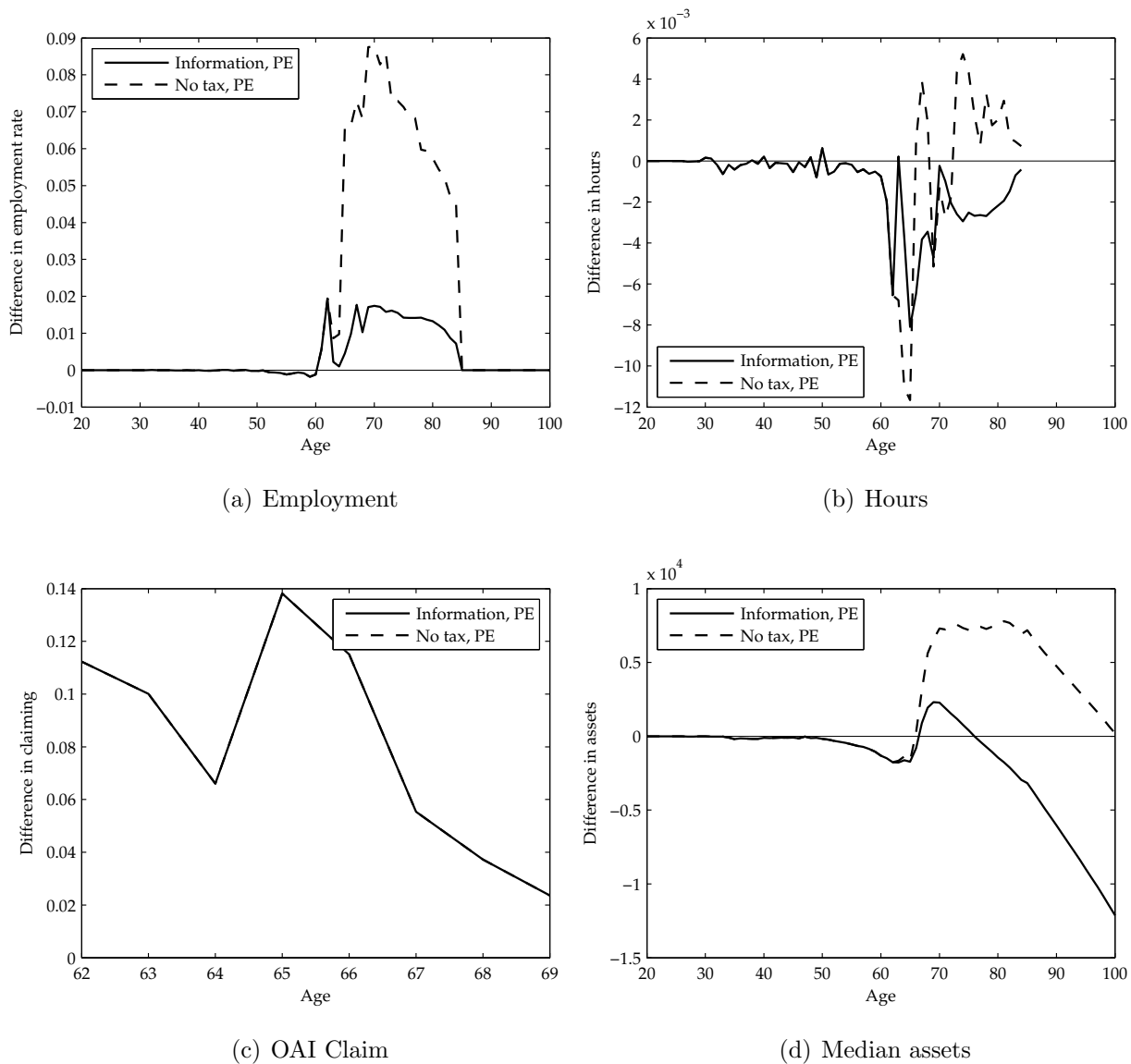


Figure 11: Life-Cycle Profiles under Limited Information and No Benefit Taxation: Partial Equilibrium Changes from the Benchmark Economy

assumption of no taxes. Comparison with the benchmark economy suggests that advance knowledge of income taxation leads individuals to delay claiming.

Figure 11(a) shows that the employment rate is greater in the counterfactual economy with limited information than in the benchmark economy. After becoming aware of the negative effect of benefit taxation – not accounted for in their prior decisions –

individuals want to work more to pay for the unexpected tax burden. The change in employment between the benchmark economy and the economy with limited information is much smaller, however, than that between the economy with limited information and the economy without benefit taxation; the effects of removing advance knowledge of benefit taxation are much smaller than the effects of removing the taxes themselves. This suggests that the taxation of Social Security benefits has significant effects even when (initially) unanticipated.

7 Concluding Remarks

In 2000, President Clinton signed the Senior Citizens Freedom to Work Act, which eliminated the Earnings Test for Social Security beneficiaries at or beyond the NRA. The effects of this act, and the Earnings Test in general, have been studied in some detail. In contrast, relatively little attention has been given to another tax provision that may discourage work at older ages, namely the income taxation of Social Security benefits. This is an unfortunate oversight. Because the portion of benefits subject to taxation is increasing in combined income, benefit taxation can at times significantly reduce the after-tax returns to work.

In this paper, we have assessed the taxation of Social Security benefits using a detailed dynamic life-cycle model of labor supply, saving and Social Security claiming. Our principal finding is that the way in which the taxes are calculated significantly lowers the returns to work at older ages, when labor supply is especially elastic. Severing this link by either eliminating benefit taxation or, even better, making the portion of benefits that are taxed completely independent of other income, would be quite beneficial.

We also find that among many dimensions the effects of reforming or eliminating the benefit tax are much larger than the effects of eliminating the Earnings Test. It may be the case that misunderstandings of the tax code lead older workers to overreact to

the Earnings Test and under-react to the taxation of benefits. The magnitudes of our results suggest, however, that the reform of the benefit taxation provisions deserves serious consideration.

References

- Aaronson, Daniel and Eric French**, “The Effect of Part-Time Work on Wages: Evidence from the Social Security Rules,” *Journal of Labor Economics*, 2004, 22 (2), 329–352.
- Blundell, Richard, Eric French, and Gemma Tetlow**, “Retirement Incentives and Labor Supply,” UCL Working Paper 2016.
- Braun, R. Anton, Karen A. Kopecky, and Tatyana Koreshkova**, “Old, Sick, Alone and Poor: A Welfare Analysis of Old-Age Social Insurance Programs,” *The Review of Economic Studies*, 2016, p. rdw016.
- Burman, Leonard E, Norma B Coe, Kevin Pierce, and Liu Tian Tian**, “The Effects of the Taxation of Social Security Benefits on Older Workers Income and Claiming Decisions,” *National Tax Journal*, 2014, 67 (2), 459–486.
- CBO**, “The Taxation of Social Security Benefits,” Policy Report 2015.
- Centers for Medicare and Medicaid Services**, “2007 Annual Report of the Board of Trustees of the Federal Hospital Insurance and Federal Supplementry Medical Insurance Trust Funds,” 2007.
- Chetty, Raj**, “Bounds on Elasticities with Optimization Frictions: A Synthesis of Micro and Macro Evidence on Labor Supply,” *Econometrica*, 2012, 80 (3), 969–1018.
- Cogan, John**, “Fixed Costs and Labor Supply,” *Econometrica*, 1981, 49 (4), 945–963.
- Cooley, Thomas F.**, *Frontiers of Business Cycle Research*, Princeton University Press, 1995.
- De Nardi, Mariacristina**, “Wealth Inequality and Intergenerational Links,” *The Review of Economic Studies*, 2004, 71 (3), 743–768.

- , **Eric French**, and **John Bailey Jones**, “Why Do the Elderly Save? The Role of Medical Expenses,” *Journal of Political Economy*, 2010, 118 (1), 39–75.
- Engelhardt, Gary V and Anil Kumar**, “Taxes and the Labor Supply of Older Americans: Recent Evidence from the Social Security Earnings Test,” *National Tax Journal*, 2014, 67 (2), 443–458.
- Feldstein, Martin and Jeffrey B Liebman**, “Social Security,” *Handbook of Public Economics*, 2002, 4, 2245–2324.
- French, Eric**, “The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behaviour,” *The Review of Economic Studies*, 2005, 72 (2), 395–427.
- and **John Bailey Jones**, “The Effects of Health Insurance and Self-Insurance on Retirement Behavior,” *Econometrica*, 2011, 79 (3), 693–732.
- French, Eric B and John Bailey Jones**, “Public Pensions and Labor Supply over the Life Cycle,” *International Tax and Public Finance*, 2012, 19 (2), 268–287.
- Giandrea, Michael D, Kevin E Cahill, and Joseph F Quinn**, “Bridge Jobs: A Comparison Across Cohorts,” *Research on Aging*, 2009, 31 (5), 549–576.
- Gourinchas, Pierre-Olivier and Jonathan A Parker**, “Consumption over the Life Cycle,” *Econometrica*, 2002, 70 (1), 47–89.
- Gouveia, Miguel and Robert P Strauss**, “Effective Federal Individual Income Tax Functions: An Exploratory Empirical Analysis,” *National Tax Journal*, 1994, pp. 317–339.
- Greenwald, Mathew, Arie Kapteyn, Olivia S. Mitchell, and Lisa Schneider**, “What Do People Know about Social Security?,” Financial Literacy Consortium Report to the SSA September 2010.

- Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L Violante**, “The Macroeconomic Implications of Rising Wage Inequality in the United States,” *Journal of Political Economy*, 2010, 118 (4), 681–722.
- Hubbard, R. Glenn, Jonathan Skinner, and Stephen P. Zeldes**, “Precautionary Saving and Social Insurance,” *Journal of Political Economy*, 1995, 103 (2), 360–399.
- Imrohoroglu, Selahattin and Sagiri Kitao**, “Social Security Reforms: Benefit Claiming, Labor Force Participation, and Long-Run Sustainability,” *American Economic Journal: Macroeconomics*, 2012, 4 (3), 96–127.
- Jeske, Karsten and Sagiri Kitao**, “US Tax Policy and Health Insurance Demand: Can a Regressive Policy Improve Welfare?,” *Journal of Monetary Economics*, 2009, 56 (2), 210–221.
- Karabarbounis, Marios**, “A Road Map for Efficiently Taxing Heterogeneous Agents,” *American Economic Journal: Macroeconomics*, 2016, 8 (2), 182–214.
- Kitao, Sagiri**, “A Life-Cycle Model of Unemployment and Disability Insurance,” *Journal of Monetary Economics*, 2014, 68 (0), 1 – 18.
- Kopecky, Karen A. Kopecky and Tatyana Koreshkova**, “The Impact of Medical and Nursing Home Expenses on Savings,” *American Economic Journal: Macroeconomics*, 2014, 6 (3), 29–72.
- Low, Hamish W**, “Self-insurance in a Life-cycle Model of Labour Supply and Savings,” *Review of Economic Dynamics*, 2005, 8 (4), 945–975.
- Mendoza, Enrique G, Assaf Razin, and Linda L Tesar**, “Effective Tax Rates in Macroeconomics: Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption,” *Journal of Monetary Economics*, 1994, 34 (3), 297–323.

Meyerson, Noah, “Social Security: Calculation and History of Taxing Benefits,” Congressional Research Service Report RL32552 2014.

Page, Timothy F. and Karen Smith Conway, “The Labor Supply Effects of Taxing Social Security Benefits,” *Public Finance Review*, 2015, 43 (3), 291–323.

Pashchenko, Svetlana and Ponpoje Porapakarm, “Quantitative Analysis of Health Insurance Reform: Separating Regulation from Redistribution,” *Review of Economic Dynamics*, 2013, 16 (3), 383 – 404.

Ruhm, Christopher J, “Bridge Jobs and Partial Retirement,” *Journal of Labor Economics*, 1990, 8 (4), 482–501.

Social Security Administration, “The 2007 Annual Report of the Board of Trustees of the Federal Old-age and Survivors Insurance and Federal Disability Insurance Trust Funds,” 2007.

– , “Annual Statistical Supplement to the Social Security Bulletin, 2007,” 2008.

– , “National Average Wage Index,” 2015. <https://www.ssa.gov/oact/cola/AWI.html>.

– , “The 2016 Annual Report of the Board of Trustees of the Federal Old-age and Survivors Insurance and Federal Disability Insurance Trust Funds,” 2016.

– , “Benefits Planner: Income Taxes and Your Social Security Benefits,” 2016. <https://www.ssa.gov/planners/taxes.html>.

The World Bank, “Global Development Indicators,” 2016. <http://data.worldbank.org/indicator/NE.CON.GOVT.ZS>.

Towns, John, Timothy Cockerill, Maytal Dahan, Ian Foster, Kelly Gaither, Andrew Grimshaw, Victor Hazlewood, Scott Lathrop, Dave Lifka, Gre-

gory D Peterson et al., “XSEDE: Accelerating Scientific Discovery,” *Computing in Science & Engineering*, 2014, 16 (5), 62–74.

United States Census Bureau, “National Intercensal Estimates (2000-2010),” 2016.
<https://www.census.gov/popest/data/intercensal/national/nat2010.html>.

Whitman, Kevin and Dave Shoffner, “The Evolution of Social Security’s Taxable Maximum,” *Social Security Administration Policy Brief*, 2011, (2011-02), 1–02.