Stylized Social Security Reforms with Labor Market Frictions

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This draft version: January 4, 2021

Abstract

This paper embeds search-matching labor market frictions in an overlapping generations model to study stylized Social Security reforms in the US. The model produces new channels through which the long-term beneficial outcomes of policies encouraging private saving and labor force participation are magnified. A cut in benefits or increase in retirement age decreases the equilibrium unemployment via (a) higher labor demand due to a fall in the interest rate, (b) reduced job search slack, (c) a small reinforcing feedback effect between labor demand and labor supply. On the other hand, the delayed retirement of older workers may have a negative effect on the employment rates of the younger workforce if the interest rate does not fall sufficiently. The model also predicts that relative to the increase in social security tax, a cut or delay of benefits will hurt the poorest elderly Americans.

JEL Classification: D15, E13, H55, J11, J26, J64
Keywords: life cycle, retirement, social security, unemployment, job search, overlapping generations

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1 Introduction

Social Security provides essential retirement protection for nearly all elderly and disabled Americans. It provides 33% of all elderly income and is associated with a significant reduction in poverty among individuals 65 and over. In fact, according to Social Security Administration (SSA), for over half (quarter) of older Americans, social security benefits make up at least 50% (90%) of their income. Demographic changes, however, make the current benefits level unsustainable. The estimates by the SSA predict a decline in Trust Fund assets to begin in 2021 and the eventual depletion of the Trust Fund to occur in 2034 after which the program can only provide three-quarters of the current level of benefits. The inevitable social security reforms will have a profound effect on the well-being of the nation's current and future working and elderly population. To better understand how proposed Social Security reforms may affect the welfare of Americans in the near and long-term, I utilize a novel general equilibrium model that incorporates labor market frictions.

I find that policies that encourage private saving and labor force participation, such as a decrease in benefits or an increase in eligibility age to receive benefits, have more beneficial long-run outcomes than an increase in social security taxation to sustain the current benefits level. By creating incentives to increase labor supply and accumulate private savings, such policies increase aggregate capital and labor supply and allow for higher consumption in the long run. Moreover, I identify four labor market channels that are in effect when social security reforms take place. I call them labor demand, job search slack, labor market participation, and worker competition channels. Reducing benefits and increasing retirement age create downward pressure on the interest rate that increases the firms' investment and, subsequently, hiring (labor demand channel). The same reforms also increase the necessity to work and save; thus, the unemployed put more effort into job-search (or reduce the job search slack) decreasing the equilibrium unemployment. There is also a positive feedback effect between aggregate job search level and firms' job openings (labor market participation channel). Finally, social security reforms may also shift employed worker age profile. Increased older worker participation in the labor market negatively affects the employment of the young if the interest rate does not decrease sufficiently (unemployed competition channel). I conclude that muting labor market frictions (and thus these channels) understates the beneficial long-run outcomes of reducing the social security benefits or increasing the retirement age. However, I also find that a benefits cut and an increase in retire-

ment age decreases the consumption and well-being of the poorest and increase wealth inequality

This paper is among many that study the effects of fiscal reforms addressing the projected deficit of Social Security in the US. Among the many notable contributions, Conesa, Krueger, et al. (1999); De Nardi, Imrohoroğlu, and Sargent (1999); Kotlikoff, Smetters, and Walliser (1999); İmrohoroğlu, İmrohoroğlu, and Joines (1999); Altig, Auerbach, Koltikoff, Smetters, and Walliser (2001); Kotlikoff, Smetters, and Walliser (2007); Nishiyama and Smetters (2007); Attanasio, Kitao, and Violante (2007) study various ad hoc Social Security reforms in the tradition of general equilibrium life-cycle models. Most of the original research assumes either exogenous or endogenous labor supply only on the intensive margin. Imrohoroğlu and Kitao (2012) and Kitao (2014) introduce the endogenous labor supply on the extensive margin but none of the previous research of Social Security reforms in the US considers labor market frictions. However, labor market frictions play an important role in life-cycle decision making. The possibility of becoming unemployed reinforces precautionary savings, and thus labor supply. As recently shown by Coile and Levine (2007, 2011); Hairault, Langot, and Zylberberg (2015), labor market frictions also affect the timing of retirement. To take these into account, I build an overlapping generations model with labor market based on search-matching frictions.

Among the recent literature, De la Croix, Pierrard, and Sneessens (2013) examine population aging and pension reforms in France in an overlapping generations model with search-matching frictions. They find that ignoring labor market imperfections may bias the evaluation of policy reforms, especially when they affect the interest rate. Relative to the model of De la Croix, Pierrard, and Sneessens (2013), I include the following innovations: (1) endogenous labor supply on the intensive margin, (2) endogenous job search intensity, and (3) heterogeneous agents. Labor supply endogeneity on the intensive margin allows agents to adjust their labor supply decisions in response to implemented reforms. It also allows the elderly to decrease their labor supply in the later stages of their careers and thus affects retirement timing. Hours worked vary considerably across age groups and retirement timing is essential for both revenues and expenditures of Social Security, thus I allow endogenous labor supply on the intensive margin. Kanfer, Wanberg, and Kantrowitz (2001); Bloemen (2005); Saks (2006); Khaskhoussi et al. (2009); Karadakic (2018) show that job search behavior varies based on age, financial need, marginal benefits and costs of job search, and that job search intensity is positively related to finding employment. Since social security

reforms affect the financial need and the benefits of job search, I introduce innovation (2) that allows agents to increase their own likelihood of finding employment and, ceteris paribus, decrease others' likelihood due to congestion in the labor market. This innovation allows reforms to affect some agents' job search behavior directly, and others - indirectly - through changes in the labor market tightness. Finally, innovation (3) permits me to study the distributional consequences of reforms.

I calibrate the model to the US and study three debated stylized social security reforms: an increase in labor income tax, a reduction in social security benefits, and an increase in eligibility age to receive Social Security benefits.

In the next sections, I describe the model (Section 2) and the benchmark economy (Section 3), simulate aging and four stylized social security reforms (Section 4), discuss the results (Section 5), and conclude (Section 6).

2 Model

I build a discrete-time general equilibrium overlapping generations (OLG) model with search-and-matching features based on De la Croix, Pierrard, and Sneessens (2013).

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In the following subsections, I describe the agents, the firm, and the government.

2.1 Agents

2.1.1 Demographics

Every period, a new generation of agents of age j_0 enters the economy. Each new generation is of equal size and enter the model with no assets. Agents face lifespan uncertainty and can live up to the terminal age of j_T. The probability that an agent of age j survives to $j+1$ is denoted by m_j with $m_{j_T} = 0$.

Throughout their lives, agents go through spells of employment (E) and non-employment (U),[1] before choosing to retire (R). Retirement is a consuming state.

Agents are heterogeneous in age, j, accumulated assets, a, exogenous skill level, z, idiosyncratic stochastic productivity, η_s, and labor market state, L. All these agents' characteristics define the agent's state vector, $x = \{j, a, \eta_s, L, z\}$.

[1] In the model, I use the term non-employment instead of unemployment because not all agents without a job may choose to search for work. In other words, non-employment includes unemployed and those who are not in the labor force.

2.1.2 Preferences

Agents derive utility from consumption and leisure according to a time-separable utility function with subject discount factor β.

$$E\{\sum_{j=j_0}^{j_T} \beta^{j-j_0} U(c,l)\} \tag{1}$$

2.1.3 Productivity, Job Search and Earnings

Each agent in a state x has one unit of disposable time to allocate between work, n_x (if employed), or job search, s_x (if unemployed), and leisure, l_x. Agents face productivity, η_x, that evolves stochastically. Agent's productivity affects both the effective labor supply and job search effectiveness.

Employed agent in state x earns a labor market income y_x. It depends on the market wage rate w and her effective labor supply, which is a function of her exogenous skill level, idiosyncratic productivity, and the number of hours worked.

$$y_x = w_x \hat{n}_x = w n_x \eta_x \tag{2}$$

An unemployed agent's effective job search, $\hat{s}_x$, depends on her idiosyncratic productivity and her job search effort. The probability of job search success, p, depends on her effective job search and the labor market conditions further discussed later in Section XYZ.

$$p(\hat{s}_x) \qquad \text{where} \qquad \hat{s}_x = s_x \eta_x \tag{3}$$

2.1.4 Agents' Recursive Problem

Agents age, j, accumulated assets, a, exogenous skill level, z, idiosyncratic stochastic productivity, η_s, and labor market state, L, define the agent's state vector, $x = \{j, a, \eta_s, L, z\}$. Given the state vector, agents optimize consumption, c, saving, $\tilde{a}$, labor supply, n, job search, s, and retirement timing, ret.

Retirement state is distinguished into multiple states by the timing of retirement that determine the benefits $R = \{R_{j_e} R_{j_e+1} ... R_{j_f}\}$ where j_e is the earliest age at which an agent qualifies for social security benefits, and j_f is the age at which the benefits are maximum and do not increase even if retirement is further delayed.

Employed agents are subject to capital gains, τ_a, labor income, τ_n, and consumption,

τ_c, taxation. Labor income taxes only apply to y_s level of earnings. Employed agent's value function:

$$\text{Employed: } V^{j,a,\eta_s,E,z} = \max_{c,\tilde{a},n,ret} \Big\{ U(c,n,0) + \beta m_j [\{(1-\chi)E[V^{j+1,\tilde{a},\tilde{\eta}_s,E,z}] + (\chi)E[V^{j+1,\tilde{a},\tilde{\eta}_s,U,z}]\}(ret=0) + V^{j+1,\tilde{a},R_{j+1}}(ret=1)] \Big\} \quad (4a)$$

subject to:

$$[1 + r(1-\tau_a)]a + (\hat{n}w - \tau_n \min\{\hat{n}w, y_s\}) = (1+\tau_c)c + \tilde{a} \quad (4b)$$

Non-employed agents receive non-employment benefits from the government, nb. Non-employed agent's value function:

$$V^{j,a,\eta_s,U,z} = \max_{c,\tilde{a},s,ret} \Big\{ U(c,0,s) + \beta m_j [\{p(\hat{s})E[V^{j+1,\tilde{a},\tilde{\eta}_s,E,z}] + (1-p(\hat{s}))E[V^{j+1,\tilde{a},\tilde{\eta}_s,U,z}]\}(ret=0) + V^{j+1,\tilde{a},R_{j+1}}(ret=1)] \Big\} \quad (5a)$$

subject to:

$$[1 + r(1-\tau_a)]a + nb = (1+\tau_c)c + \tilde{a} \quad (5b)$$

Retired agents receive social security benefits, $rb(x)$, that are a fraction of average earnings and depend on the timing of retirement. Retirement is a consuming state in which agents cannot work or search for work. Retired agent's value function:

$$\text{Retired: } V^{j,a,R_j} = \max_{c,\tilde{a}} \Big\{ U(c,0,0) + \beta m_j V^{j+1,\tilde{a},R_{j+1}} \Big\} \quad (6a)$$

subject to:

$$[1 + r(1-\tau_a)]a + rb(R_j) = (1+\tau_c)c + \tilde{a} \quad (6b)$$

2.2 The Firm

There exists one profit-maximizing

firm that employs all workers and rents capital from capital owners. The firm's production follows the Cobb-Douglas production function with constant returns to scale.

$$Y = F(K,N) = K^{\alpha} N^{1-\alpha} \quad (7)$$

where, K is the aggregate capital, L is the effective aggregate labor, A is the total factor productivity and α is the capital's share of output.

Every period, the firm decides how much capital to rent and how many vacancies, V, to post. The firm's problem can be stated as follows.

$$W = \max_{V,K}\{F(K,N) - (r+\delta)K - wN - vV + E[\tilde{W}]\} \tag{8}$$

here v is the cost of posting a vacancy, and δ represents capital depreciation.

The firm pays the marginal product of capital net of depreciation to capital owners and a fraction of the marginal product of labor to workers.

$$w = \gamma_w F_N \tag{9}$$

$$r = F_K - \delta \tag{10}$$

2.3 Government and Social Security

The government revenues consist of social security taxes on labor income, capital gains, and consumption taxes represented by τ_n, τ_a, and τ_c. Labor income is taxed up to an income level equal to y_s. The government pays for social security and unemployment benefits. It also fully taxes and consumes all of the firm's profits and accidental bequests ($G = \Pi + b$).[2] The government adjusts consumption taxes so that the budget is balanced.

$$\sum_x \mu(x)[min\{\hat{n}(x)w, y_s\}\tau_n + a(x)r\tau_a + c(x)\tau_c] + \Pi + b = \sum_x \mu(x)[rb(x) + nb(x)] + G \tag{11}$$

where $\mu(x)$ is the measure of individuals in individual state x, $\hat{n}(x)a(x), c(x)$ represent the effective labor supply, asset holdings and consumption decision of agents in state x, and $rb(x), nb(x)$ represent social security and non-employment benefits going to agent in state x. As mentioned earlier, social security benefits depend on the agents retirement date with j_e being the age at which agents first qualify for reduced benefits, and j_f being the age at which the benefits are maximized.

[2] In an alternative specification, the firm's profits and bequests are distributed among all of the living agents. The results of the model are qualitatively identical.

2.4 Labor Market Flows

The labor market is driven by the endogenous decisions of unemployed agents and the firm. Labor market matches follow a standard Cobb-Douglas matching function as follows.

$$M = A_M V^{\phi} S^{1-\phi} \tag{12}$$

where, A_M is the matching technology, V is the number of posted vacancies, S is the cumulative effective job search of all unemployed (which can be thought of as the number of all job applications sent out by the unemployed), and ϕ is the matching elasticity parameter.

The probability for an unemployed agent to find a job, $p(\hat{s})$, and the probability for the firm to fill a vacancy, q, are as follows.

$$p(\hat{s}) = \hat{s} A_M V^{\phi} S^{\phi} \qquad \text{with} \qquad p(\hat{s}) \in [0, 0.99] \tag{13}$$

$$q = A_M V^{\phi-1} S^{1-\phi} \tag{14}$$

Job destruction, χ, is exogenous.

2.5 Stationary Equilibrium

Given the demographic, labor market, and policy variables, an intertemporal equilibrium with labor market frictions is such that:

1. consumption, saving, job search and retirement decisions maximize agents' utility (eqs. 4a, 5a, 6a) subject to their budget constraints (eqs. 4b, 5b, 6b);
2. posted vacancies and hired capital maximize firms profits (eq. 8);
3. population, capital and total effective labor and job search satisfy aggregation conditions: $P = \sum_x \mu(x)$, $K = \sum_x \mu(x) a(x)$, $S = \sum_x \mu(x) \hat{s}(x)$, $L = \sum_x \mu(x) \hat{n}(x)$.
4. the labor market flows satisfy eqs. 12, 13, 14.
5. consumption tax is such that government budget (eq. 11) is balanced;
6. the aggregate variables, and the distribution of agents across states is stationary: $\mu(x) = \Gamma \mu(x)$, where Γ is a one-period transition operator.

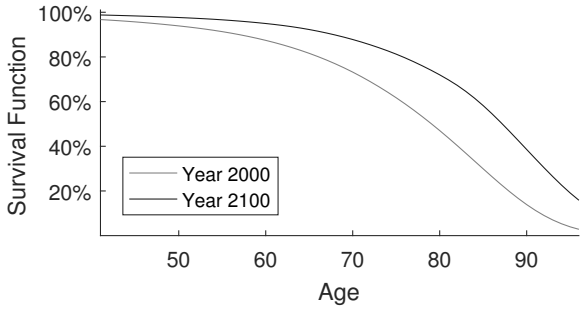
2.6 Calibration

I calibrate the employment by age group and social security to broadly match the US in the year 2000 and examine how changes in taxation and social security benefits affect the economy, especially through changes in the labor market. I describe all calibrated parameters below and summarize them in Table 1.

2.6.1 Demographics

The model period represents one year. Agents enter the the model at the age of $j_0 = 18$ as unemployed without any assets. They live up to the age of $j_T = 100$ but due to uncertain mortality, they may not reach the terminal age. The fertility is kept constant[3] and normalized to one, and conditional survival probabilities are set according to Bell and Miller (2005) life tables for the year 2000 for the initial steady state. The "aged" economy is represented by survival probabilities as projected by Bell and Miller (2005) for the year 2100. Survival functions are presented in Figure 1.

Figure 1: Survival Functions for the Year 2000 and 2100



Survival functions for the years 2000 and 2100 according to life tables in Bell and Miller (2005).

2.6.2 Preferences

I use the following consumption-leisure and time separable utility function.

$$U(c, n, s) = \frac{c^{1-\gamma_1}}{1-\gamma_1} + D_j \frac{(1-n-s)^{1-\gamma_2}}{1-\gamma_2} \tag{15}$$

where $s = 0$ for employed agents, and $n = 0$ for non-employed agents. The curvature parameter, γ_1, in the utility function is set to 2 which yields a coefficient of relative risk

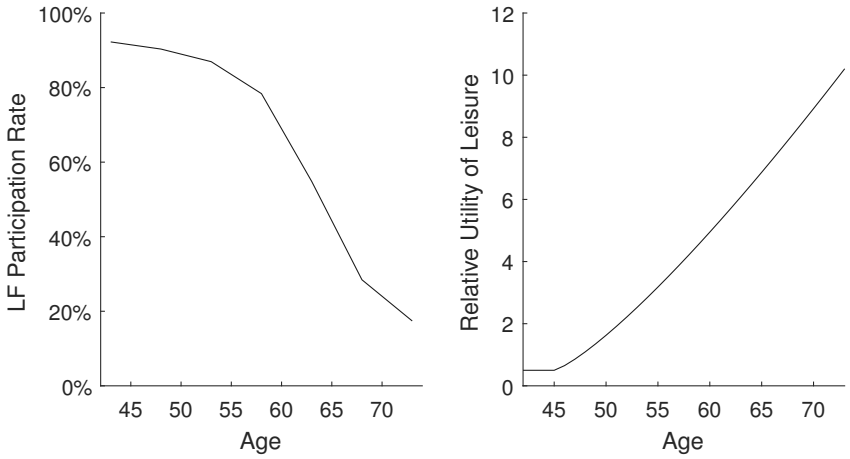
[3]There is no consensus yet on how increasing life expectancy or decreasing mortality affects fertility (For research on aging, mortality and fertility see Hazan and Zoabi (2006); Acemoglu and Johnson (2007); Lorentzen, McMillan, and Wacziarg (2008); Mizuno and Yakita (2013).

aversion equal to 1.33 which is between typically used values for CRRA. The parameter γ_2 is set to 4 which with employed agents on average spending half of their time on labor supply yields an intertemporal labor elasticity of 0.3.

D_j represents a time-dependent utility weight on leisure relative to consumption. To have agents spend half of their disposable time on labor supply, I set d_0 to equal 0.6, and to replicate the observed labor force participation rates at older age, D_j is increasing over time following the function below with $j_n = 45$, $d_1 = 0.17$ and $d_2 = 1.1$.

$$D_j = \begin{cases} d_0 & \forall j < j_n \\ d_0 + (d_1 j)^{d_2} & \forall j \geq j_n \end{cases} \tag{16}$$

Figure 2: Relative Importance of Utility of Leisure



Left figure shows labor force participation rate for males in the US in the year 1999 (BLS). Right figure shows calibrated weight of utility from leisure relative utility from consumption, D_j.

Subjective discount rate, β, is set to 0.98.

2.6.3 Productivity

Agent's productivity, η, at age j is determined by an exogenous component, η_z, and a stochastic idiosyncratic component, η_s.

$$\eta = \eta_z(j)\eta_s \tag{17}$$

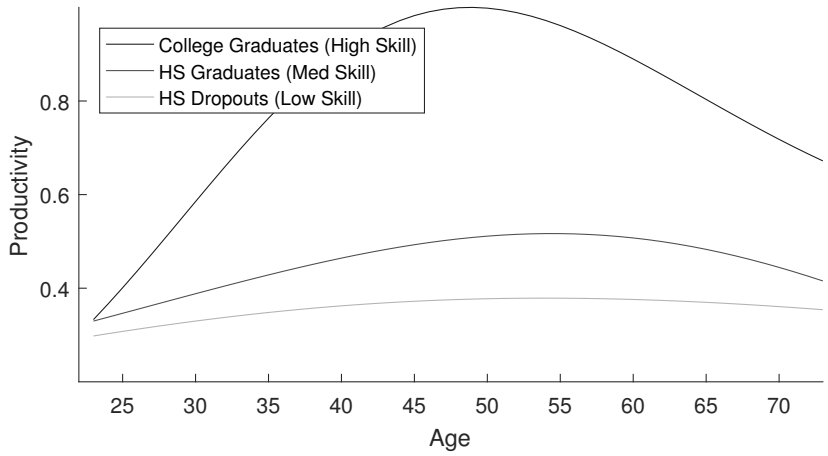
η_s is specified as a first-order autoregressive process with $\rho = 0.97$ and $\sigma^2 = 0.02$ as is standard in the literature.I approximate this process to three states using Tauchen (1986) method.

$\eta_z(j)$ is a deterministic function that depends exogenous skill level, z, and revolves around age, j.

$$\eta_z(j) = f(j, z) \tag{18}$$

I estimate the age-dependent productivity using PSID data in 1999 by regressing the log of the wage rate of male heads of families on the cubic function of age for three education groups: (1) without a high school degree, (2) with a high school degree but no college degree, and (3) with a college degree and above. These three groups in the model are represented by low, medium and high skilled workers. Productivity is normalized to lie between 0 and 1. Figure 4 shows the estimated age-productivity profiles.

Figure 3: Age-Productivity Profiles



Productivity (η_z) profile is measured by regressing log wage rate of male family heads on cubic age function using PSID for the year 1999. Maximum productivity level of high skill individuals is normalized to one.

The skill distribution of newborn agents is fixed to educational attainment in the year 2000. According to U.S. Census Bureau, in the year 2000, there were approximately 20% Americans without a high school (HS) degree, 56% with HS but without a college degree, and 24% with a college degree. While educational attainment is increasing and is expected to further increase in the near term, there are no reliable long-term projections, and thus I assume that the skill-level in the economy is fixed. In the discussion section, I consider how the results change if educational attainment (skill-level) increases between 2000 and 2100.

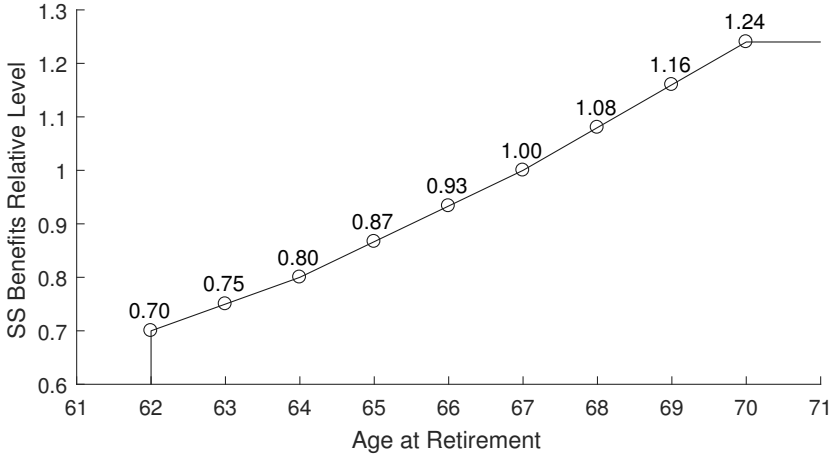
2.6.4 Firm and Production

The income share of capital parameter in the production function is 0.4 as is estimated in the US (Giandrea and Sprague, 2017). The depreciation rate is set to match the US capital-to-output ratio of 3.0 on a yearly basis. Vacancy cost is calibrated so that employment to population by age group matches the adjusted US employment to population in the year 2000.[4]

2.6.5 Government

The government runs a simplified pay-as-you-go social security program in which retirement benefits at full retirement age are approximately 40% of average earnings. To simplify the problem, the benefits are only dependent on agent's retirement age. Early retirement penalty and late retirement credit replicates the current US Social Security regulations. Agents can start receiving social security benefits starting age $j_e = 62$ with a 30% penalty. Full retirement is at $j_n = 67$ with benefits credit increasing until age $j_f = 70$.

Figure 4: Social Security Relative Benefits Level



Benefits .

Since all non-working agents receive these benefits independently of their work history, I do not calibrate them to match actual US unemployment benefits. Modeling the actual unemployment benefits based on past earnings would decrease the need for as high precautionary savings, but otherwise would have virtually no affect. Non-employment benefits are set to 2% of average earnings to prevent agents from zero

[4]Since all agents in the model participate in the labor force at least for one period, data is adjusted to exclude people who never join the labor force.

consumption. To pay for benefits, the government sets a social security tax rate of 12.4% on labor income representing the actual 6.2% tax rate on the employer and employee in the US since 1990. Labor income is taxed up to a maximum level y_s. y_s is calibrated to match \$76,200 for the year 2000 which I set to be around 2.5 times above the average earnings. As in the data, approximately 6% of workers have income above the taxable maximum (Whitman and Shoffner, 2011). Capital gains tax is set to zero while the consumption tax is determined within the model.

2.6.6 Labor Market

Labor market flows are driven by a Cobb-Douglas matching function with constant returns to scale. As is standard, the elasticity of matches with respect to vacancies, ϕ, and parameter γ_w representing workers' bargaining power are set to 0.50 (). The matching scale parameter, A_M, is set to unity.

Due to the time aggregation error, finding the exogenous job separation rate is not straightforward. Since most unemployment is short-term, most of the workers who lose jobs regain employment before the end of the year. For instance, Fujita and Ramey (2006) find that monthly employment to unemployment transition probability is around 1.5 percent, while unemployment to employment probability is approximately 50 percent. A simplistic computation taking into probabilities of losing and regaining employment yields that after a 12-month period, there will be a stock of around 3% of newly unemployed agents. I set yearly job destruction parameter, χ, to equal 0.03.

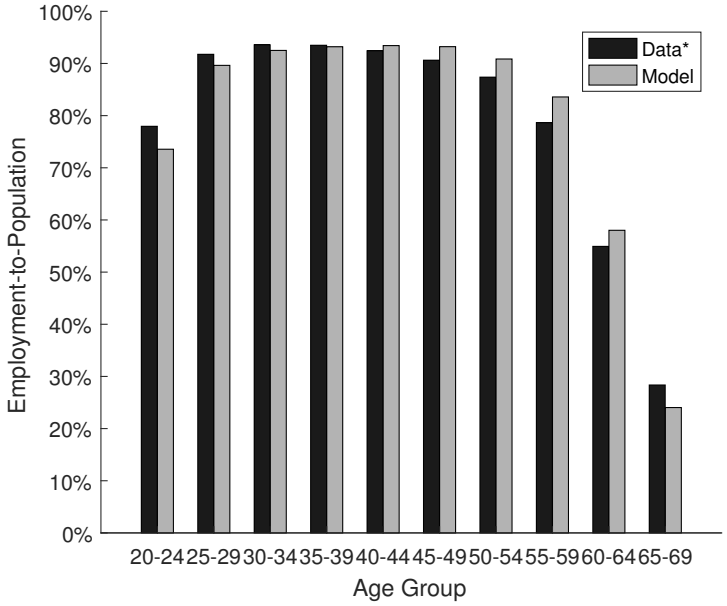
3 The Benchmark Economy

Figure 5 shows the employment-to-population of the benchmark economy. Despite simplifying several important features, it replicates the adjusted[5] US employment-to-population in the US in the year 2000 fairly well. The employment-to-population follows a traditional hump-shape with a peak in the age demographic of 30-45. In the model, all agents retire by age 70 at which the social security benefits are at their highest level.

Agents accumulate assets to insure themselves against employment and idiosyncratic productivity shocks, and to be able to supplement social security income in retirement. As is seen in Figure 6, capital accumulation for an average worker continues until age 60 after assets are used to supplement social security income in retirement. Of course,

[5] Adjusted US employment-to-population excludes a fraction of population that never joins the labor force.

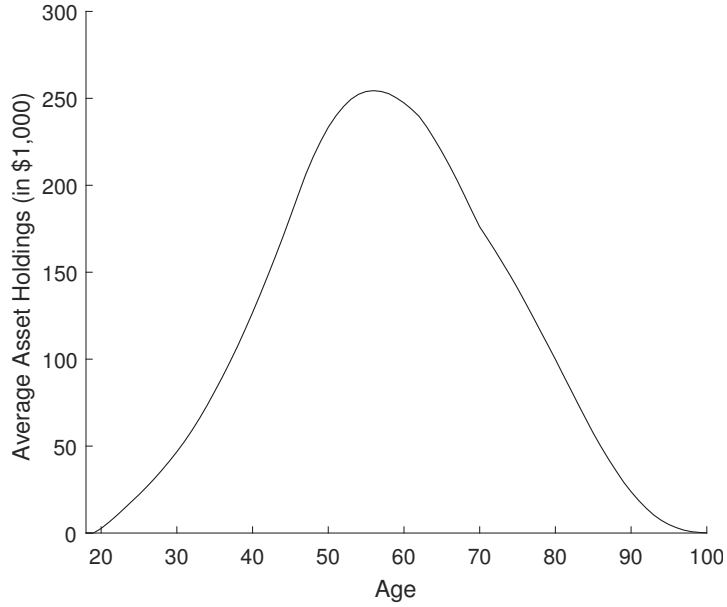
Figure 5: Employment



Employment by age group in the model and in the year 2000 adjusted for population that never joins the labor force.

having no bequest motive and possibility of large medical expenses at old age, agents dis-save much more aggressively than is found in the data.

Figure 6: Mean Asset Holdings

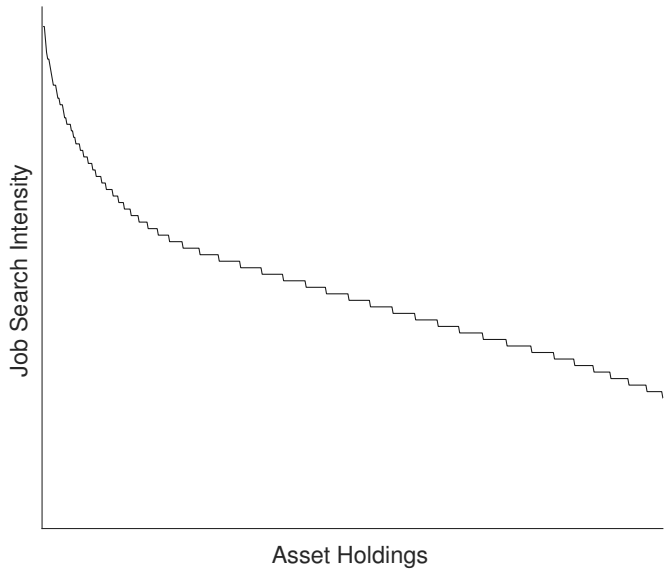


Average asset holdings by age. Benchmark model simulation.

The emphasis of the model is on the agents' endogenous job search and retirement decisions. Figure 7 shows the job search policy functions of workers in different life-cycle stages. Younger workers with a higher expected net present value of future labor income find it optimal to look for work with more intensity than older workers with fewer years remaining to retirement. Similarly, workers with a higher skill level search for work with more intensity. Across all ages and skill levels, agents with a lower asset level and low level of consumption have a high marginal utility of consumption and find it optimal to exert higher levels of job search intensity.

Policy functions for saving, labor supply, job-search, retirement, and consumption indicate that agents are smoothing consumption over time by working more and saving in the first half of their lives and dis-saving in retirement. Agents with lower asset holdings choose to work more to increase precautionary savings and consumption. The unemployed whose alternative to retirement is an uncertain job search, retire sooner than those who are employed. Policy functions are presented in appendix B.

Figure 7: Job Search Policy Function



Job search effort policy function at age 20. Benchmark model simulation.

4 Aging and Reforms

To stylistically replicate population aging and evaluate how fiscal reforms affect the budget deficit, employment, and the overall economy, I simulate the mortality rate to match the estimated survival function for the year 2100.

Significantly higher survival rates of older individuals (seen in Figure 1) greatly increase the old-age dependency ratio. Without changes to taxation or benefits, this leads to an inevitable social security budget deficit. To close this budget deficit, I consider two reforms that reduce social security program commitments and two reforms that involve increasing taxation.

The level of each reform is such that, assuming no change in agent behavior, the reform would balance the deficit. Of course, since agents alter their behavior in light of changed policies, endogenous consumption tax balances the remaining budget deficit or surplus. Reform 1 increases the social security tax on labor income from 12.4% to 19.5%, while Reform 1b increases the income tax rate to 19.2% but also removes the social security taxable maximum. Reform 2 decreases the benefits by 32.4%, while Reform 3 delays the qualifying age for social security by 7 years. Table 2 shows the main results for each of the reforms relative to an increase in social security tax (Reform 1).

4.1 Reform 1: Increase in Social Security Taxes

Under Reform 1, the social security tax is increased by 7.1 percentage points to 19.5%. This affects the agents and the overall economy through a number of direct and indirect channels.

Across all variations of the model, higher social security tax reduces the after-tax labor income which dis-incentivizes labor supply. Under this reform, labor supply falls which then also negatively affects agents' ability to accumulate assets. One could also expect other possible ways the taxable labor income can be affected such as occupational choice, risk-taking, fringe benefits, and other (Feldstein, 2005).

Once we explicitly consider unemployment and job search, an increase in taxes on labor income creates additional effects. Social security tax decreases the value of employment which reduces the job search intensity and labor force participation, especially among older workers. Employed and unemployed agents retire sooner. This leads to lower employment, labor supply, and the ability to accumulate assets for all age groups.

A more dynamic search and matching labor market creates additional mechanisms. First, a larger decrease in aggregate labor supply than aggregate capital increases the interest rate. At a higher interest rate, the firm rents less capital which reduces the marginal product of labor. Since the demand for labor falls, the firm reduces hiring. Second, a decrease in job search efforts makes it more difficult for the firm to fill a

vacancy and decreases the expected profitability of a given vacancy. Given a fixed vacancy posting cost, the firm responds by further reducing the number of new job openings.

Compared to all other reforms, an increase in social security taxes leads to the lowest employment, aggregate labor supply, capital, consumption, and welfare in the long run.

4.1.1 Reform 1b: Removing the Taxable Maximum

In a given year, around 6% of workers earn more than the taxable maximum (Whitman and Shoffner, 2011). Without the taxable maximum, the social security taxes are applied to total labor income. Without the changes in the social security benefits formula, eliminating the maximum makes the social security system more progressive. Alternatively, some researchers suggested to increase benefits with higher taxes paid which would keep a more traditional link between taxes and benefits but would do less to close the deficit.

Reform 1b removes the social security taxable maximum on labor income. Increasing the base of taxable earnings means that the necessary increase in social security taxes is lower: from 12.4% to 19.2%. If the model better replicated the top of the income distribution, removing the taxable maximum would have a stronger effect on government revenues and the necessary increase in social security taxes would likely be slightly lower. It would also have a much more negative effect on the top income earners. This is in line with previous research. For example, Whitman (2009) found that majority of workers would be completely unaffected by this reform while also increasing long-term actuarial balance by 2.2% of taxable payroll. More recently, Li (2018) estimated that increasing the taxable maximum to cover 90% (instead of the current 83%) of covered earnings would decrease the long-run deficit by around 30%. If the increase in taxes paid above the old max increased the benefits, the effects of such reforms would, of course, be smaller.

The effects of this reform are different for individuals above and below the taxable maximum. For individuals with high earnings, as expected labor supply falls as all income is being taxed, and subsequently, capital accumulation falls. As there are a few affected agents and their incomes are not as well replicated, the effect on the top earners is rather small. However, a more accurate representation of top earnings distribution and consideration of other aspects could lead to much more profound effects. One could expect the top earners to significantly reduce labor supply, and as discussed by

Feldstein (2005), one could also expect a decrease in taxable earnings, for example, due to compensation shift towards untaxed fringe benefits.

The majority of the workers are not directly affected by the removal of the taxable maximum directly. However, increasing or removing the taxable maximum would require a lower social security tax. As labor disincentives decrease with a lower tax on labor income, an average employed worker supplies more labor and accumulates more capital. Lower social security taxes on labor would incentivize staying in the labor force longer even though some accumulate larger savings which allow for earlier retirement. Figure 9 shows that older worker employment decreases under Reform 1b.

While higher capital stock increases the MPL and incentivizes the firm to create more job openings (increase labor demand), an increase in average labor supply per worker and delayed retirement has the opposite effect. The two effects almost perfectly cancel each other out so that number of job openings stays almost unchanged. These effects are rather small since the social security tax that agents pay under each of these reforms (1 and 1b) are very similar. A better replication of top earnings may provide additional insights into these effects.

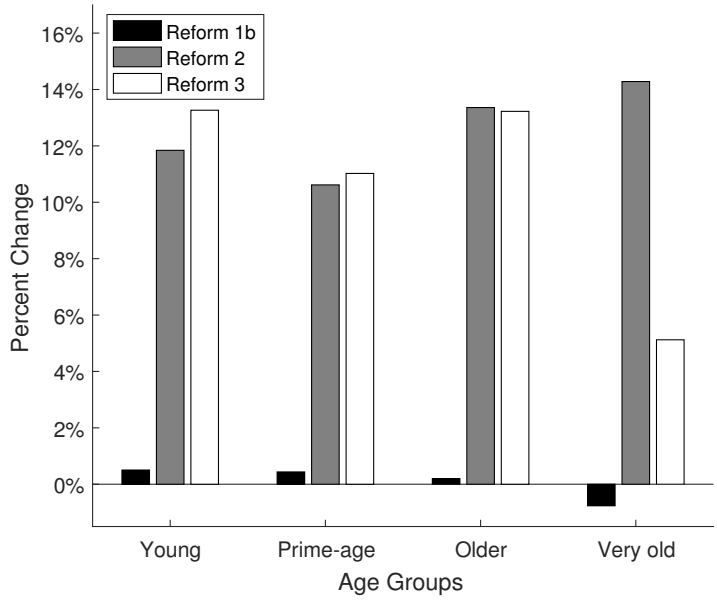
As social security reforms have the most significant effects on the elderly, I study how this reform affects the wealth holdings of the poorest and richest elderly (over 65). Figure 11 shows that while the assets held by the bottom of the wealth distribution are not affected, removal of the taxable maximum slightly reduces the holdings of the richest elderly. The differences between Reforms 1 and 1b are minimal with regards to consumption as is seen in Figure 12. The small increases in consumption of the poorest elderly are due to a slightly higher (less than 1%) after-tax wage rate.

An increase in taxable income increases the government revenues, and even without a change in aggregate labor supply significantly increases social security revenues. Comparing the consumption tax under Reform 1 and Reform 1b, shows that the budget deficit is about half the size when the taxable maximum is removed. Unsurprisingly, this idea is gaining popularity, even though it further breaks the link between taxes and entitled benefits.[6]

In general, a shift in tax burden towards individuals with higher income and wealth levels negatively affects a small fraction of top income earners. Lower social security taxes for most workers leads to smaller labor supply disincentives and better long-run equilibrium outcomes.

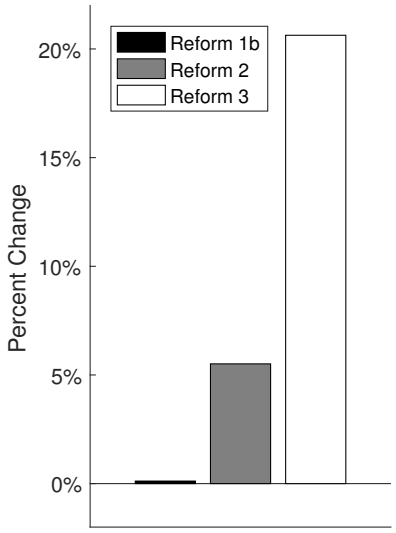
[6]For example, read Diamond and Orszag (2005) and Li (2018).

Figure 8: Capital Stock by Age Group



Capital stock by age group in which agents of age 18 to 29 are considered "young", 30 to 49 – "prime-age", 50-69 – "older", 70 and above – "very old".

Figure 9: Older Worker Employment



Percentage change in older (age 50 and above) agents' employment relative the benchmark reform (Reform 1).

4.2 Reform 2: Social Security Benefits Cut

The stylized Reform 2 decreases the social security expenses instead of increasing revenues through taxation. Under this reform, social security benefits are 32.4% smaller.

During the working years, employed agents increase their labor supply and save more to be able to supplement lower social security benefits

in older age. Capital stock increases by over 12%. Figure 8 shows that agents, on average, hold significantly larger savings across the working years and in retirement.

A larger increase in capital stock than aggregate labor supply decreases the interest rate and increases the wage rate. As also discussed by Kitao (2014), this flattens the labor supply profile: younger workers work slightly less while older workers – slightly more.

The explicit introduction of the search and matching labor market creates additional feedback effects. First, a decrease in the interest rate increases investment (rental capital) and labor demand and the firms increase job openings. Compared to Reform 1, the job openings increase by almost 3% that decreases the equilibrium unemployment rate.

Under this reform, older workers not only dis-save assets at a slower rate but also stay in the labor force longer and exert higher job search efforts even right before retirement. Figure 9 shows that under Reform 2 compared to Reform 1, the older worker employment rate increases by over 5%.

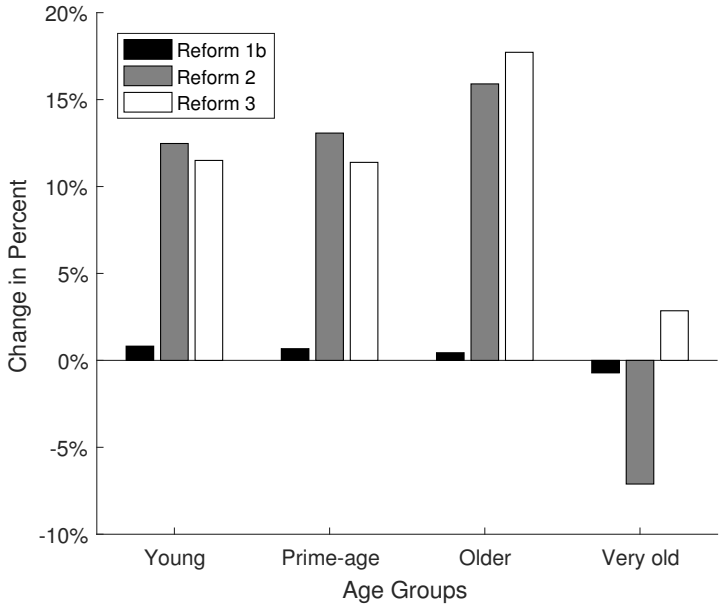
More older workers remaining in the workforce and participating in job search with higher effort even at older ages makes it more difficult for younger unemployed to get their first jobs. However, the increase in job openings is large enough so that the unemployment rate for the young is almost unaffected. Higher aggregate employment contributes to higher labor supply, capital stock, and aggregate consumption. However, as Figure 10 shows, consumption is lower among the old. While they do save more to replace the reduced social security benefits, the need to maintain some savings into older age requires agents to dis-save slowly that, on average, they do by reducing consumption.

The bottom 50% of the elderly wealth distribution hold significantly more assets. With lower benefits, they have accumulated private savings to supplement their income in old age. The effect on the very rich is relatively small. As social security benefits make up only a small fraction of their income, they only respond to Reform 2 by holding marginally more wealth. The top 20% hold only around 7% more capital compared to Reform 1.

While the increase in aggregate consumption is significant (12% compared to Reform 1), the increase in welfare/utility is under 3%. This is because there are significant consumption and utility losses to the elderly. For a fraction of agents who do not

accumulate any or almost any savings into old age, consumption and thus utility in older age are drastically lower. Figure 12 shows that only the top half of the distribution manage to increase their consumption under this reform. Consumption losses to the bottom half of the distribution of elderly are large. Moreover, before retirement, unemployed agents exert more job search effort, and employed agents supply more labor. Both of these outcomes under standard assumptions reduce the well-being of agents. This is in line with much of previous research suggesting that either a benefits cut or increase in retirement age would more than proportionately hurt the bottom of the wealth distribution and increase inequality (Rosnick and Baker, 2012). Some have noted that such reform would also likely increase racial inequities as racial minorities are more likely to be in lower-pay jobs (Moore, Ghilarducci, and Webb, 2019).

Figure 10: Consumption by Age Group



Consumption by age group in which agents of age 18 to 29 are considered "young", 30 to 49 – "prime-age", 50-69 – "older", 70 and above – "very old".

4.3 Reform 3: Increase in Retirement Age

Reform 3 delays the social security benefits by 7 years while keeping the social security taxes and benefits at the same level. Although the outcomes of this reform are similar to a decrease in benefits, there are some important differences.

Postponement of social security benefits induces agents to stay in the labor force and keep the labor supply higher in the later stages of their lives. Figure 9 shows

that delay of benefits, compared to benefits cut, have a much more profound effect on employment rates of older workers. However, due to increasing labor dis-utility at older ages, older workers supply less labor than younger or prime-age workers. Those who become unemployed in the later stages of their careers, remain in the labor force and participate in the job search before they reach retirement age. Older agents, however, exert much lower job search efforts as the remaining net present value of expected future labor income is much lower than that of younger workers. Due to this shift in the unemployed age profile, the average job search effort decreased by 20% as is seen in Table 2.

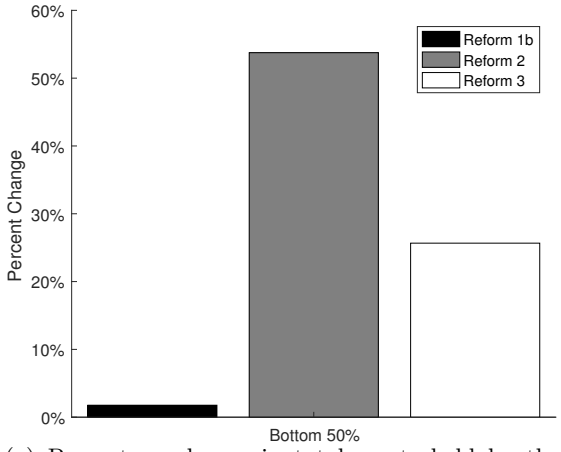
Asset accumulation behavior is also much different. Compared to Reform 2 (a decrease in benefits), agents accumulate capital more aggressively in the first part of their careers, start dis-saving sooner and use these private savings to supplement lower labor income at older age before retirement. This is because, by assumption, older agents experience increasing labor dis-utility causing agents to work relatively few hours before receiving social security benefits. To bridge lower income before receiving benefits, agents aggressively consume private savings and leave much less for those fewer years in retirement (see Figure 8).

Compared to higher social security taxation (Reform 1), an increase in retirement benefits yields higher consumption across all age groups. A closer look at the consumption of the poorest workers over 65 in Figure 12a shows that the least lucky are worse of due to the delay of retirement. Consumption of the bottom 40% and 20% percent of the wealth distribution indicate losses of 7% and 3%, respectively, which would likely be disproportionately born by non-whites. Moore, Ghilarducci, and Webb (2019) suggest that increasing the retirement age would disproportionately hurt black workers who, on average, have poorer health and shorter life expectancy. They are also more likely to face old-age and racial discrimination in the labor market (Neumark, 2018) making it even harder to stay in the labor force longer.

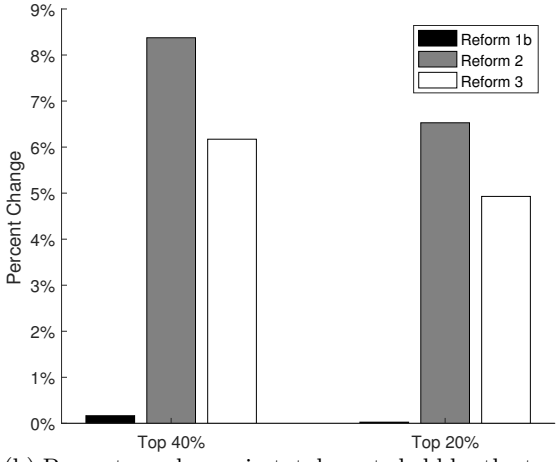
At the same time, the consumption of the top of the distribution of agents above 65 has increased. This is largely because more workers are working in to their late 60s. Under Reform 3, the inequality among the older population is the highest.

As with a decrease in benefits, the increase in aggregate welfare is much lower. This is due to significantly higher labor supply and job search levels among the older workers, and very low consumption of a group of older workers who do not manage to accumulate sufficient private savings by age 62 and must remain in the labor force for at least additional 7 years before claiming retirement benefits.

Figure 11: Elderly Wealth Inequality

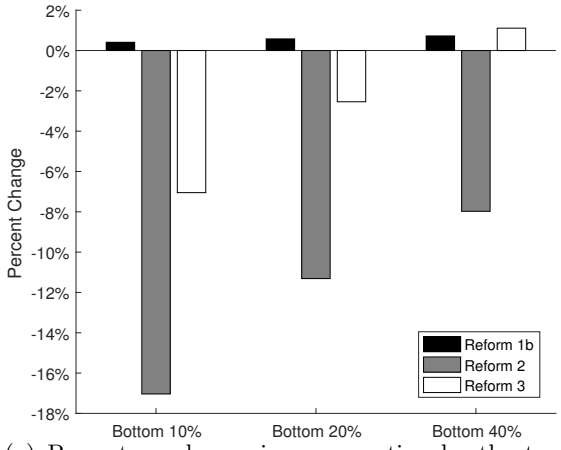


(a) Percentage change in total assets held by the bottom 50% of the wealth distribution at a given point in time compared to the benchmark reform (Reform 1).

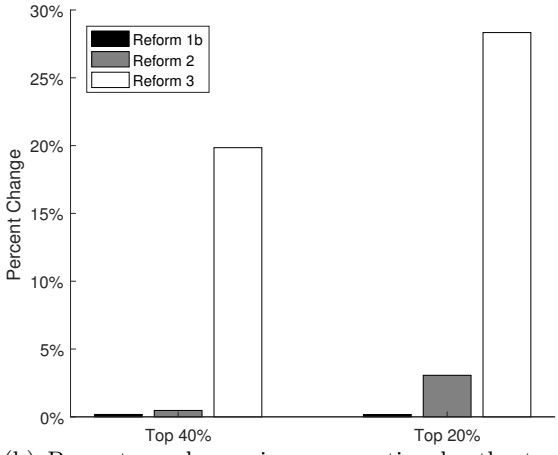


(b) Percentage change in total assets held by the top 40% and 20% of the distribution at a given point in time compared to the benchmark reform (Reform 1).

Figure 12: Elderly Consumption Inequality



(a) Percentage change in consumption by the top 10%, 20% and 40% of the distribution at a given point in time compared to the benchmark reform (Reform 1).



(b) Percentage change in consumption by the top 40% and 20% of the distribution at a given point in time compared to the benchmark reform (Reform 1).

5 Sensitivity Analysis

The results of the numerical simulations rest on several assumptions used in the development of the model. In this section, I analyze a few of those assumptions and compute the results under alternative assumptions. First, I discuss how changes in preferences for leisure and dis-utility of labor in old age affect agent behavior and the

government deficit. Second, I study how changes in the educational attainment affect the government deficit.

5.1 Preferences

We experienced a dramatic increase in healthy (Beltrán-Sánchez, Soneji, and Crimmins, 2015) and total life expectancy in the last decades. Healthier elderly have fewer obstacles to working longer. With more people working longer into older age, it is possible that working at old age will become more commonplace. To take this into account, I let the dis-utility of labor supply in older age to start decreasing later than in the benchmark case. More specifically, I increase j_n to 52 which means that the dis-utility of labor starts to increase after age 52 instead of 45.

The results under the alternative assumption are shown in Table 3. In general, the results are qualitatively similar. While there are some changes to job search, labor supply, and capital accumulation decisions before age 45, the major behavioral changes occur in old age. Older workers stay in the labor force longer, either searching for work with more intensity or supplying more labor.

Another difference is the budget deficit. Under this assumption of lower labor dis-utility in older age increases the labor supply and thus the social security taxable base. The reforms thus are more likely to balance the budget. The endogenous consumption tax, that balances the remaining budget deficit, is cut in half under this assumption.

While this is great for the public finances, increases in health and longevity are not happening uniformly across all population groups. Crimmins and Saito (2001) show that healthy life expectancy widened between low and high education groups. If taken into account, it would worsen social and economic inequality within and between different educational and racial groups.

5.2 Education

In the main analysis of stylized social security reforms in the US, I assumed that the exogenous skill level (educational attainment) will stay constant. The US has experienced a rapid rise in high school and college completion rates in the twentieth century but concerns about decreasing college educational enrollment around the year 2000 and again after the Great Recession (Dunbar, Hossler, Shapiro, Chen, Martin, Torres, Zerquera, and Ziskin, 2011), brought about uncertainty about the future level of educational attainment (Day and Bauman, 2000). However, since the year 2000 educational increased all attainment levels (Schmidt, 2018), thus, in this section, I

consider stylized social security under an assumption that educational attainment is higher than in the year 2000.

To my knowledge, there are no projections about the educational attainment levels in the year 2100 but IIASA[7] published predictions up to 2050 (Barakat, 2016). They predicted that primary, secondary, and tertiary highest levels of education achieved in 2050 in the US will be 6.8%, 70.8%, and 36.5%, respectively.

Table 4 presents the results under this assumption. With more highly educated and high-income workers, removing the taxable limit has a more profound positive effect on public deficit despite negative effects on employment and labor supply. In general, the results are qualitatively and quantitatively very similar.

6 Labor Market Channels

As in De Nardi, Imrohoroğlu, and Sargent (1999), Imrohoroğlu and Kitao (2012), Kitao (2014) and others, I find that policies that encourage private saving and labor force participation have significantly better outcomes in the long run compared to reforms that involve higher labor income taxation. However, compared to previous research on US social security reforms, I implement a frictional labor market that creates new labor market channels through which the reforms affect agent behavior and aggregate outcomes. These new labor market channels affect the labor supply on the extensive margin (workers employed) due to changes in the unemployed agents' job search and retirement (labor supply), and firms' hiring behavior (labor demand).

The extensive margin has major welfare implications. Research on various policy reforms indeed suggests that effects along the extensive margin may be more substantial than along the intensive margin of labor supply (Eissa and Liebman, 1996; Meyer and Rosenbaum, 2001; Meyer, 2002; Eissa and Hoynes, 2006). To highlight how reforms through these channels affect aggregate capital stock, labor supply, consumption, and well-being, I develop an analogous model but with perfectly competitive labor markets[8] and re-run identical stylized reforms as in Section 4.

Although the overall results are qualitatively and quantitatively similar, there are some important differences. In the following subsections, I describe each of those channels and how they affect workers and the overall economy.

[7] International Institute for Applied Systems Analysis
[8] The model is explained in Appendix B.

6.1 Labor Demand Channel (Maybe Interest Rate or Vacancy Channel)

As first discussed by De la Croix, Pierrard, and Sneessens (2013), there is a connection between the interest rate and unemployment. Policies that incentivize private saving create downward pressure on the interest rate. Firms increase capital investment that increases the marginal product of labor and, thus, labor demand. While in frictionless labor market models, an increase in labor demand manifests in higher wages, in a model of this paper, the firm responds by also creating more job openings contributing to increased matching rate and lower unemployment.

This is important because, for agents who are already employed, an increase in the wage rate (decrease in interest rate) can cause incentivize an agent to work only so much more since they face already high marginal labor utility costs. The newly employed, on the other hand, who were previously bounded to zero labor supply, now can make a large jump in labor supply, start accumulating savings and enjoy much larger consumption and welfare gains.

For all agents, an overall increase in labor demand also works to reduce the future possibility of long-term unemployment as an increase in vacancies increases job search efficiency and reduces the length of an average spell of unemployment.

6.2 Job Search Slack Channel

Policy reforms that directly affect employed or retired individuals, also have an indirect effect on the unemployed agents. For example, an increase in social security taxes on labor income diminishes the value of employment and the value difference between employment and unemployment. This reduces the incentive to look for work and thus unemployed agents reduce job search effort (increase job search slack). This finding is in line with the extensive literature on the duration of unemployment and unemployment insurance.[9] A decrease in after-tax wage is the opposite to a decrease in unemployment insurance benefits that have a strong positive effect on job search intensity (Krueger and Mueller, 2010) and job-finding rate (Card, Chetty, and Weber, 2007). On the other hand, a decrease in retirement benefits increases the need to accumulate private savings. Since unemployment income is too low to accumulate savings, agents respond by increasing the job search effort (or reducing job search slack) to increase the likelihood of attaining employment. Higher job search effort across the distribution of unemployed increases the matching rate and reduces the

[9] For a review, see Krueger and Meyer (2002).

equilibrium unemployment.

6.3 Labor Market Participation Feedback Effect (Maybe too long of a name?)

I find that there is a reinforcing feedback effect between the job search decisions of the unemployed and vacancies posting decisions by the firm. An increase in job search levels by the unemployed increases the probability for a given firm to fill a vacancy, and thus increases the marginal benefit of posting another vacancy while the vacancy posting costs stay fixed. Firms posts more vacancies. An increase in vacancies increases the probability of a given worker's application to be successful increasing the marginal benefit of posting another vacancy. Workers respond by further increasing job search levels. Of course, the channel works in the other direction the same way too. This channel echoes the finding of DeLoach and Kurt (2013) that job searchers decrease search intensity when the probability of finding a job is low.

The labor market participation feedback effect amplifies the labor demand and job search slack channels. Policies that increase either job search effort or incentivize firms to increase job openings, may then, in turn, start a reinforcing feedback effect contributing to lower unemployment. Since policies that disincentivize job search or labor demand contribute to the opposite effect, the presence of these channels may amplify the effects of policy reforms on long-run equilibrium unemployment in either direction.

In Table 5, the model with search and matching features yields slightly higher capital stock, labor supply, consumption, and significantly higher welfare under Reforms 1b, 2 and 3 compared to Reform 1. This is largely due to downward pressure on the interest rates, incentivizing job search, and the LM participation feedback effect taking place. An increase in labor demand and job search effort levels leads to higher aggregate employment. The effect on welfare is relatively stronger than on consumption. This is because the marginal utility of consumption is highest for unemployed agents with little or no assets. With higher aggregate employment, fewer agents experience having little to no assets with no labor income leading to large aggregate welfare gains.

6.4 Worker Competition Channel and the Lump of Labor

Competition between the unemployed workers for the available vacancies creates an additional channel via which the reforms affect the long-run economic outcomes. Delayed retirement of older employed and unemployed workers have two effects. First,

reforms that decrease or delay benefits decrease the retirement rate and increases the labor supply per employed worker. Both of these cause the capital-labor ratio and thus the interest rate to fall which then decreases labor demand. Second, older unemployed keep their job search efforts higher which further increases competition in the labor market and decreases the probability of a single job application being successful. With fewer job openings and higher job search efforts of older unemployed workers, the younger unemployed have a harder time getting employed at the beginning of their careers complicating their opportunities further down in their lives.

This effect directly relates to the boxed economy or lump-of-labor view that increased elderly employment may decrease youth employment.[10] I find that this is indeed the case when demographic changes or a policy reform increases elderly LM participation without sufficiently incentivizing private saving. If private saving increases sufficiently, it creates downward pressure on interest rates which stimulates investment and labor demand (labor demand channel) and promotes employment of all groups.

Population aging itself incentivizes private saving as agents prepare for a longer expected retirement. Even if older workers choose to stay in the labor market longer, increased job search effort and capital accumulation via the labor demand and job search slack channels and LM participation feedback effect leads to lower equilibrium unemployment in the long run across age groups. Since increased employment allows the government to collect more tax revenues, ignoring these channels may overstate the negative effects population aging has on government deficits.

Similarly, social security reforms may also affect the demographic composition of the workforce. Reduction of social security benefits and increase in retirement age create incentives for workers to participate in the labor market longer which, all else equal, reduce the number of job openings posted and reduce the youth employment opportunities. On the other hand, elderly workers reduce their hours worked which has a positive effect on vacancies. Most importantly, Reforms 2 and 3 also create downward pressure on the interest rates (labor demand channel), increase job search levels (job search slack channel) leading to an overall increase in employment among the old and the young. It is important to discuss youth employment opportunities because lower youth employment has a long-lasting negative compounding effect on

[10] While most research points against claims of fixed amount of work (Gruber and Wise, 2010; Walker, 2007; Hebbink, 1993; Banks, Blundell, Bozio, and Emmerson, 2010; Börsch-Supan and Schnabel, 2010; Kalwij, Kapteyn, and De Vos, 2010), some find some degree of substitutability between cohorts (Hamermesh, 1993; Card and Lemieux, 2001; Fitzenberger and Kohn, 2006; Boeri, Garibaldi, and Moen, 2017).

saving and consumption on the agents' remaining life.

In Table 5 it is evident that the difference in Reform 2 welfare measure is large between SM and PC models. Different labor market variants do not deliver such big gains for Reform 3 under SM model. This is because of older workers. In the PC model version, due to postponed social security benefits, older workers stay in the labor force longer supplying slightly less labor every year before they choose to retire. In the model with frictions, some workers above 50 lose their jobs and don't find it optimal to exert a lot of job search effort or completely leave the labor force and make the gap to retirement by dis-saving. This is in line with Hairault, Sopraseuth, and Langot (2010) who also find that distance to retirement explains lower job search intensity and lower employment levels of workers just below the retirement age. Empirical research by Marmora and Ritter (2015) also find that exit from the labor force is affected by workers' labor market status with older unemployed workers exiting the labor force at much higher rates. While ignoring labor market complexities increases computational efficiency and may allow for a more detailed description of other parts of the economy, it also fails to capture important distributional effects of social security reforms.

7 Conclusion

I analyze stylized social security reforms in a novel overlapping generations model with search-and-matching features. Consistent with previous research, I find that increasing taxation to maintain unfunded social security benefits brings long-term consumption and welfare losses while decreasing benefits and/or delaying retirement deliver welfare-enhancing outcomes in the long run. Moreover, I find additional labor market mechanisms through which the reforms affect the economy. Labor demand, job search slack, and labor market participation channels amplify the results of previous research. Reforms such as social security benefits reduction or increase in retirement age seem to be more beneficial than in models without a frictional labor market, while increased taxation to keep the benefits level at the current level leads to even lower aggregate economic outcomes in the long-run. The worker substitution/competition channel suggests that the degree of displacement of younger by older workers may depend on the policy reform. When a decrease in interest rate is sufficiently large, increased older worker participation does not negatively affect the younger population's employment outcomes. However, when a reform creates incentives for the elderly to stay in the labor market longer without sufficiently affecting the saving and the interest rate, em-

ployment opportunities for the young may diminish. The introduction of frictions shows that delay of benefits creates another issue. A perfectly competitive labor market cannot capture a change in the unemployment rate and/or decrease in labor force participation of elderly workers. The negative effects of reducing benefits or delaying retirement fall mostly on the low wage and low wealth workers who disproportionately are non-white.

The introduction of additional shocks and increased worker heterogeneity may further expand welfare analysis. A more accurate representation of the US income and wealth distribution, introduction of health shocks among other innovations may provide new insights about social security reforms' distributive effects. It is left for future research.

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Table 1: Parameters

Demographics		
j_0	Age upon entry	18
j_T	Terminal age	100
m_j	Survival probabilities	Bell and Miller (2005)
f_{hi}, f_{me}, f_{lo}	Skill Distribution of newly born agents	0.20,0.56,0.24
Preferences		
β	Discount factor	0.98
j_n, d_0, d_1, d_2	Weight on leisure par.	$45, 0.5, 0.22, 1.25$
γ_1	Consumption utility curvature	2
γ_2	Consumption leisure curvature	4
Productivity		
ρ_{η_s}	Persistence parameter	0.97
$\sigma^2_{\eta_s}$	Variance parameter	0.02
η_z	Age-dependent productivity	see Section 2.6.3
The Firm and Production Technology		
A_P	Prod. technology par.	1.00
α	Prod elasticity par, CRS	0.40
δ	Depreciation par	0.08
v	Vacancy cost par.	0.10
Government		
τ_n	SS Tax on Labor Income	12.4%
j_e	Earliest age of retirement	62
j_f	Age of maximum ret. benefits	70
ss_1	Social security par.	0.115
ss_2	Social security par.	see Table **??**
nb	Non-employment benefits par.	0.01
y_s	Taxable earnings	0.045
Labor Market Technology		
A_M	Matching technology scale par.	1.00
φ	Matching elasticity par.	0.50
γ_w	Workers' bargaining power	0.50
χ	Job destruction par.	0.03

Calibrated parameters used in the numerical simulations.

Table 2: Simulation Results

	Reform 1	Reform 1b	Reform 2	Reform 3
K	–	0.12%	12.51%	10.91%
N	–	-0.04%	1.24%	2.88%
C	–	0.57%	12.34%	12.19%
W	–	0.92%	2.71%	3.09%
$\hat{s}$	–	0.30%	3.84%	-20.98%
V	–	-0.01%	2.97%	1.46%
E	–	0.17%	1.90%	7.00 %
r	4.17%	4.16%	3.43%	3.63 %
τ_c	0.70%	0.34%	0.39%	0.33 %

Reform simulation results. K, N, C, W refer to aggregate capital labor supply, consumption, and welfare. $\bar{\hat{s}}$, V, E refer to average job search intensity of unemployed agents, job openings posted by the firm, and employment. r and τ_c refer to the interest rate and consumption tax that balances the government budget. Model simulation results in percent changes from the benchmark reform (Reform 1).

Table 3: Simulation Results: Alternative Leisure Preferences Assumption

	Reform 1	Reform 1b	Reform 2	Reform 3
K	–	0.04%	11.88%	10.47 %
N	–	-0.15%	1.14%	2.30 %
C	–	0.58%	12.04%	11.73 %
W	–	-0.09%	3.24%	3.48%
$\hat{s}$	–	-0.70%	2.51%	-19.89%
V	–	0.22%	2.85%	1.88%
E	–	0.01%	1.45%	6.12 %
r	4.58%	4.57%	3.83%	4.00 %
τ_c	0.45%	0.09%	0.23%	0.15 %

Reform simulation results under alternative labor dis-utility assumption. K, N, C, W refer to aggregate capital labor supply, consumption, and welfare. $\bar{\hat{s}}$, V, E refer to average job search intensity of unemployed agents, job openings posted by the firm, and employment. r and τ_c refer to the interest rate and consumption tax that balances the government budget. Model simulation results in percent changes from the benchmark reform (Reform 1).

Table 4: Simulation Results: Alternative Education Assumption

	Reform 1	Reform 1b	Reform 2	Reform 3
K	–	0.04%	12.26%	10.24 %
N	–	-0.13%	1.18%	2.61 %
C	–	0.49%	12.14%	11.61 %
W	–	0.54%	2.06%	2.54%
$\bar{\hat{s}}$	–	-0.82%	2.89%	-22.59%
V	–	0.18%	2.88%	1.35%
E	–	-0.09%	1.74%	6.79 %
r	4.12%	4.11%	3.39%	3.63 %
τ_c	0.49%	0.04%	0.23%	0.18 %

Reform simulation results under assumption of higher education attainment in the future. K, N, C, W refer to aggregate capital labor supply, consumption, and welfare. $\bar{\hat{s}}$, V, E refer to average job search intensity of unemployed agents, job openings posted by the firm, and employment. r and τ_c refer to the interest rate and consumption tax that balances the government budget. Model simulation results in percent changes from the benchmark reform (Reform 1).

Table 5: Simulation Results

	Reform 1	Reform 1b		Reform 2		Reform 3	
		SM	PC	SM	PC	SM	PC
K	–	0.12%	0.03%	12.51%	10.81%	10.91%	9.92%
N	–	-0.04%	-0.07%	1.24 %	0.77%	2.88%	3.80%
C	–	0.57%	0.67%	12.34 %	11.41%	12.19%	11.73%
W	–	0.92%	0.11%	2.71%	0.49%	3.09%	2.26%

Reform simulation results for four lump-sum hiring subsidy magnitudes. K, N, W, and C refer to aggregate capital labor supply, welfare, and consumption, respectively. SM represents the model of this paper with search and matching frictions and PC represents model variation with perfectly competitive labor market as described in Appendix B. Reform results are presented as a percent change from Reform 1 of the respective model variation, that is Reform 2 in model PC is compared to Reform 1 in model PC.