A Historical Welfare Analysis of Social Security: Who Did the Program Benefit?*

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Abstract

This paper builds a computational life cycle model and simulates the Great Depression in order to assess the historical welfare implications of implementing Social Security during this business cycle episode. A well established result in the literature is that when comparing steady states with and without Social Security in a standard life cycle model, long-run welfare tends to be lower with Social Security. Consistent with these previous results, this paper determines that on average in the steady state the original Social Security program lowers welfare by the equivalent of 4.5% of expected lifetime consumption. Moreover, the likelihood that this Social Security program causes a decrease in an agent's welfare in the steady state is 92%. However, this paper finds that the welfare effects of implementing Social Security on agents in the economy at the time the program is adopted is very different than the long-run welfare effects. In particular these living agents experience an increase in their lifetime welfare due to the implementation of Social Security that is equivalent to 4.4% of their expected future lifetime consumption. Moreover, the paper finds that the likelihood that these living agents experience an increase in their lifetime welfare due to the adoption of the program is 83%. The divergence in the short-run and long-run welfare effects is primarily driven by a slow adoption of payroll taxes and a quicker adoption of benefit payments. This divergence could be one explanation for why a program that decreases long-run welfare was originally implemented.

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Key Words: Social Security, Recessions, Overlapping Generations.

"We can never insure one hundred percent of the population against one hundred percent of the hazards and vicissitudes of life, but we have tried to frame a law which will give some measure of protection to the average citizen and to his family against the loss of a job and against poverty-ridden old age."

F.D. Roosevelt during the signing of The Social Security Act of 1935

1   Introduction

Social Security was designed in the wake of the Great Depression, in part, to provide insurance for older-age individuals.[1] At the time President Franklin D. Roosevelt signed the law, he said, "We can never insure one hundred percent of the population against one hundred percent of the hazards and vicissitudes of life, but we have tried to frame a law which will give some measure of protection to the average citizen and to his family against the loss of a job and against poverty-ridden old age." Focusing on the insurance against poverty-ridden old age, the program provides consumption insurance for older-age individuals by redistributing both within and between generations. However, Social Security is not without costs. The retirement benefits and payroll taxes associated with the program distort agents' labor and savings decisions. In order to assess the effectiveness of the program previous research tends to focus on the long-run welfare consequences of the program. The long-run welfare consequences are determined by comparing the expected average lifetime welfare in the steady state of an economy with Social Security to the expected average lifetime welfare in the steady state of another economy without Social Security. These studies generally find that the economic costs of the distortions dominate, leading to the conclusion that Social Security reduces long-run expected average lifetime welfare.

Given the general finding that Social Security decreases long-run welfare, one may wonder why the program even exists? However, when determining why Social Security exists, the long-run welfare implications are not the relevant comparison because agents in the economy at the time the program is approved do not live their entire life in the new steady state with Social Security. Instead these agents experience part of their life in the steady state without Social Security and then experience the transition to the new steady state with Social Security. Therefore, when thinking

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[1] In addition to insuring old age consumption, Social Security provides disability insurance. In this paper, I abstract from the disability insurance aspect of the program and focus only on the part of the program that insures post-retirement consumption.

about why Social Security was implemented, the relevant assessment is to determine whether, in expectation, the program increases lifetime welfare for a majority of people in the economy at the time the program is approved. Motivated specifically by this question, this paper determines the welfare consequences of implementing Social Security for agents in the economy at the time the program is approved (short-run welfare) and compares these effects to the long-run welfare consequences of the program.[2]

In order to assess the short-run welfare implications of Social Security, this paper begins by building a life cycle economy that is calibrated to match the pre-Great Depression U.S. economy. In this model, I simulate two separate transitions through the Great Depression. First, I simulate a transition in the benchmark model that includes the implementation of Social Security in accordance with historical law. Second, I simulate a counterfactual transition through the Great Depression, in which Social Security is not implemented. Comparing the welfare an agent enjoyed in the benchmark transition, in which Social Security is implemented, with the welfare the agent would receive in the counterfactual transition, in which Social Security is not enacted, provides an assessment of the short-run welfare implications of the program.

I find that overall, there is an 83 percent likelihood that an agent in the model at the time the program is approved will experience higher welfare due to the implementation of Social Security. On average, I find that the expected welfare gain from adopting Social Security for these agents is the equivalent of 4.4 percent of expected future consumption. In contrast, I find that Social Security generally decreases long-run welfare. In particular, I find that there is only a 8 percent likelihood that an agent will experience higher welfare if they live their entire life in the steady state with Social Security as opposed to living their life in the steady state without Social Security. Moreover, I find that the expected long-run welfare loss from living in an economy in the steady state with Social Security, as opposed to an economy without Social Security, is the equivalent of 2.5 percent of expected lifetime consumption. Taken as a whole, these results demonstrate that the short-run and long-run welfare effects from implementing Social Security are considerably different.

Next, I examine three potential causes for the divergence between the short-run and long-run

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[2]I define the short run welfare implications as the welfare effect on agents who are in the economy during the transition from the steady state without Social Security to the steady state with Social Security.

welfare implications of Social Security. First, the program is implemented during the Great Depression. Implementing Social Security during a business cycle episode may increase the welfare gain because the retirement payments may be particularly valuable after agents suffer a shock to wealth. However, the business cycle episode may also cause the distortions from the payroll taxes and retirement benefits to be enhanced. Second, during the transition from the steady state without Social Security to the steady state with Social Security, the levels of aggregate capital and labor fluctuate which implies that the rental rate and wage rate also change. Agents in the economy during this transition will experience different prices over their lifetime than they would experience if they lived in the steady state with Social Security which may also affect their welfare. Third, Social Security is gradually implemented such that both the benefit payments and the payroll tax rates do not immediately increase to their new levels in the steady state with Social Security. The relative speed at which these parts of the program are fully adopted could imply more or less favorable short-run welfare effects for agents in the economy during this transition compared to the long-run welfare implications.

Through a series of computational experiments, I determine the role that each of these potential explanations plays in causing the divergence between the short-run and long-run welfare implications of Social Security. I find that the difference between short-run welfare gains, as opposed to the long-run welfare losses, is primarily due to the gradual implementation of Social Security. The gradual implementation of Social Security increases short-run welfare through two specific channels. First, the lifetime payroll tax burden for these agents is smaller since they pay taxes for less years due to the fact that the program is adopted midway through their lifetime. In contrast, the benefit formula is structured in such a way that there is only a minor reduction in these eligible agents benefits to account for the smaller lifetime payroll tax burden. Second, the payroll tax rate starts at a relatively low level and slowly transitions to the higher new steady state rate. This transition of the payroll tax rate further decreases the payroll tax burden for these agents in the model when the program is adopted. All told, the relatively larger Social Security payments compared to tax burdens causes an increase in welfare for these agents in the model when the program is adopted. Interestingly, despite these agents paying less in payroll taxes, I still find that annual outlays from the program never exceed the revenues during this transitional period. Despite the relatively lower payroll tax burdens for these agents, the Social Security budget is still balanced

3

each period because the stock of Social Security recipients is smaller than the stock of tax payers during the transition. In particular, agents are only eligible to receive Social Security benefits if they pay payroll taxes. This eligibility requirement implies that at the time the program is adopted, the stock of agents receiving benefits is zero and grows slowly through the transition as agents reach the retirement age. In contrast, the stock of agents paying payroll taxes immediately reaches its new steady state level when the program is adopted. Therefore the short-run welfare increase versus long-run welfare losses are not due to a deficit in the program's budget, but instead are due to the program taking advantage of the slow growth in the stock of beneficiaries as eligible agents reach retirement age.

In contrast to the relative speed of implementation, I find that the other two reasons have small and mostly offsetting effects on the short-run welfare consequences of implementing Social Security. In particular, experiencing the transitional prices causes a small increase in the short-run welfare effects compared to the long-run welfare consequences primarily because agents enjoy higher wages during the transition than in the new steady state with Social Security. Moreover, I find that adopting the program during the Great Depression causes slightly smaller short-run welfare gains because the distortions from the program are enhanced during the Great Depression.

This paper's main contribution is that it provides a quantitative assessment of the welfare implication for living agents of the implementation of Social Security and determines why these effects differ from the long-run implications. This analysis provides one explanation for why a program that decreases long-run welfare was adopted. In addition, to the author's knowledge, this is the first life cycle model calibrated to analyze the historical episode of the Great Depression that includes endogenous retirement, endogenous labor supply, and idiosyncratic earnings risk. This paper is related two two strands of literature that examine the effect on welfare of Social Security.

The first strand tries to measure the long-run implications on welfare of Social Security. These works try to weigh the relative benefit from providing partial insurance for risks in which no market option exists, against the welfare costs of distorting an individual's incentives to work and save. These studies, that largely focus on the benefit of providing intra-generational insurance for idiosyncratic earnings and mortality risks, include Auerbach and Kotlikoff (1987), Hubbard and Judd (1987), Hubbard (1988), Imrohoroglu et al. (1995), Fuster et al. (2007), Storesletten et al.

4

(1998), and Hong and Rìos-Rull (2007).[3] Moreover, Krueger and Kubler (2006) and Harenberg and Ludwig (2013) examine the long-run welfare implications of Social Security with a moderate level of aggregate risk, designed to weigh the inter-generational insurance benefits from Social Security against the program's economic costs. By and large, the studies find that Social Security is not welfare improving: the insurance benefits from Social Security are outweighed by the distortions that the the program imposes.[4] Similar to these papers, I aim to examine the welfare consequences of Social Security. However, this study is different in that it focuses on the welfare implications of the Social Security program over the transitional period after the program is adopted, as opposed to focusing on the long-run welfare effects of the program.

Similar to this paper, the second strand of the literature focuses on the short-run welfare as opposed to the long-run welfare implications of Social Security. However, instead of examining the welfare implications of adopting Social Security, this strand of the literature determines either the welfare implications of reforming Social Security or the implications of the program during a particular business cycle episode. For example, Peterman and Sommer (2014) determines that Social Security mitigates a notable amount of the potential welfare losses for living agents due to the Great Recession, particularly welfare losses for poorer and older agents. Examples of studies that determine the short-run welfare implications of reforming Social Security include: Olovsson (2010), Imrohoroglu and Kitao (2012), Kitao (2012), Huggett and Parra (2010), and Huggett and Ventura (1999). These papers generally find that although reforms to Social Security will increase long-run welfare, short-run welfare decreases during the transition. For example, Olovsson (2010) examines the welfare gains of a Social Security program that efficiently shares aggregate risks between generations. The author finds that although agents would prefer to live in an economy with these more efficient programs, the welfare costs during the transition outweigh the benefits for living agents. In the spirit of both of these types of papers, I determine the short-run welfare effects on living agents. However, I examine the welfare implications during a transitional period that includes both the implementation of Social Security and a business cycle episode.

This paper is organized as follows: Section 2 introduces the computational model. Section

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[3]For a theoretical discussion of the different types of risks that Social Security can provide insurance against see Shiller (1998).

[4]One exception is Imrohoroglu et al. (2003), which find that if preferences are time-inconsistent then the benefits of Social Security outweigh the costs.

3 presents the competitive equilibrium. Section 4 describes the functional forms and calibration parameters. Section 5 describes the computational experiment. Section 6 reports the results of the computational experiment. Section 7 concludes.

2   Model

Our framework is a Aiyagari-Bewley-Huggett-Imrohoroglu economy with overlapping generations of heterogeneous agents. In this framework, we aim to determine the effect of adopting Social Security. Hence, we compute the transition between two steady states. The initial steady state is calibrated to the U.S. economy *prior* to the Great Recession in which no Social Security exists. The final steady state represents the U.S. economy *after* a transition through the Great Depression and the adoption of Social Security. The transition between these two steady states captures the historical episode of the Great Depression, as well as implementation of the original Social Security in accordance with historical law.

In the model, agents derive utility from consumption and leisure, and supply labor elastically in exchange of a stream of earnings that is governed by their labor decisions, productivity shocks, and the dynamics of the market efficiency wage. Agents make joint decisions about their consumption, labor supply, retirement, and savings. Idiosyncratic productivity shocks can be partially insured through accumulating precautionary savings. Moreover, once Social Security is enacted, eligible retired agents receive retirement benefits payments from a Social Security system that is funded through income taxation of working-age individuals. Social Security payments provide another margin of consumption insurance at old age. An important feature of the model is that agents choose the age at which they retire.

2.1   Demographics

Time is assumed to be discrete, and the model period is equal to one year. In each period, the economy is populated by J overlapping generations of individuals of ages $j = 20, 21, ..., J$, with J being the maximum possible age. The size of each new cohort grows at a constant rate n. Lifetime length is uncertain with mortality risk rising over the lifetime. The conditional survival probability from age j to age $j + 1$ is denoted Ψ_j where $\Psi_J = 0$. Annuity markets do not exists to insure

life-span uncertainty and agents are assumed to have no bequest motive. In the spirit of Consea et al. (2009), accidental bequests, which arise from the presence of mortality risk, are distributed equally amongst the living in the form of transfers Tr_t.

Agents work until they choose to retire at an endogenously determined age $j = R$. In the model, upon reaching the minimum possible retirement age $j = \underline{R}$, an agent chooses every period whether to retire or not. I assume that the binary decision to retire (i.e., $I = \{0,1\}$ where $I = 1$ denotes the event of retirement) is irreversible, making retirement a self-absorbing state.

2.2 Endowments, Preferences and Unemployment Risk

Each period t, an agent is endowed with one unit of time that can be used for leisure or market work. An agent's labor earnings are given by $y_t = w_t \omega_t h_t (1 - D_t)$, where w_t represents the wage rate per efficiency unit of labor, h_t is the fraction of the available time endowment spent on labor market activities, D_t is the fraction of the time endowment in each period that the agent is exogenously unemployed, and ω_t is the idiosyncratic labor productivity which follows:

$$\log \omega_t = \theta_j + \alpha + \nu_t. \tag{1}$$

In this specification, θ_j governs the average age-profile of wages (or age-specific human capital), $\alpha \sim NID(0, \sigma_\alpha^2)$ is an individual-specific fixed effect (or ability) that is observed at birth and stays fixed for an agent over the life cycle, and ν_t is a persistent shock, received each period, which follows a first-order autoregressive process:

$$\nu_t = \rho \nu_{t-1} + \psi_t \text{ with } \psi_t \sim NID(0, \sigma_\nu^2) \text{ and } \nu_1 = 0. \tag{2}$$

Additionally, the exogenous unemployment shock, D_j, is discretized to two values, zero and $d \in [0,1]$. The positive value d arrives with a probability p^U. When the unemployment spell hits, the agent loses the option to work during d percent of their time endowment.

Agent's preferences over the stream of consumption, c, and labor supply, h, are governed by a time-separable utility function:

$$E_0 \sum_{j=0}^{J} \beta^j U(c_j, h_j), \tag{3}$$

where β is the discount factor and where the expectation is taken with respect to the life-span uncertainty, the idiosyncratic labor productivity process, and the unemployment process. The period utility function, $U(c_j,h_j)$, is modeled as the weighted average of the utility from the sub-period in which an agent is employed and the sub-period in which the agent is unemployed:

$$U(c_j,h_j) = (1-D_j)u(c_j,h_j) + D_j u(c_j,0).^5 \tag{4}$$

Modeling the the per-period utility function as the weighted average of the utility flows from the two sub-periods allows us to pick a relatively longer, computationally more tractable model period (one year), but still incorporate unemployment spells that are shorter than one year. We make the additional assumption that consumption is constant within the sub-periods. Since we use a utility function that is separable in consumption and hours worked, the constant consumption assumption is not binding as long as the agent realizes D_j at the beginning of the period and can participate in intra-period borrowing.

2.3 Market Structure

The markets are incomplete and agents cannot fully insure against the idiosyncratic labor productivity, unemployment, and mortality risks by trading state-contingent assets. They can, however, partially self-insure these risks by accumulating precautionary asset holdings, a_t. The stock of assets earns a market return r_t. I assume that agents enter the economy with no assets and are not allowed to borrow against future income, so that $a_0 = 0$ and $a_t \geq 0$ for all t.

2.4 Technology

Firms are perfectly competitive with constant returns to scale production technology. Aggregate technology is represented by a Cobb-Douglas production function of the form $Y = F(A,K,N) = AK^\zeta N^{(1-\zeta)}$, where A, K, N, and ζ are aggregate Total Factor Productivity (TFP), capital, labor (measured in efficiency units), and the capital share of output, respectively. Capital depreciates at a constant rate $\delta \in (0,1)$. The firms rent capital and hire labor from agents in competitive markets,

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[5]It is assumed that c_j, the flow of consumption, is equal in each of the sub-periods.

where factor prices r_t and w_t are equated to their marginal productivity. The aggregate resource constraint is:

$$C_t + K_{t+1} - (1-\delta)K_t + G_t \leq AK_t^\zeta N_t^{1-\zeta}, \tag{5}$$

where, in addition to the above described variables, C_t and G_t represent aggregate individual and government consumption, respectively.

2.5 Government Policy

In the benchmark steady state with no Social Security, the government distributes accidental bequests to the living in a form of lump-sum transfers, Tr_t, and consumes in an unproductive sector.[6] Following Conesa et al. (2009), Kitao (2012) and Imrohoroglu et al. (1995), the government consumption, G_t, is exogenously determined, and is modeled as proportional to the total output in the steady state economy, so that $G_t = \phi Y_t$.[7] Once the Social Security program is enacted, the government additionally collects a proportional Social Security tax, τ_t^{ss}, on pre-tax labor income of working-age individuals (up to an allowable taxable maximum $\bar{y}$) to finance Social Security payments, b_t^{ss}, for retired workers (for details, see Section 2.7). In both economies, the government taxes income according to a schedule T in order to raise revenue to finance its spending in the unproductive sector, with the taxable income, $\tilde{y}_t$, defined as:

$$\tilde{y}_t = y_t + r_t(Tr_t + a_t) - 0.5\tau_t^{ss}\min\{y_t, \overline{y_t}\}. \tag{6}$$

In the benchmark steady state with no Social Security, τ_t^{ss} is set to zero, while in an economy with Social Security the part of the pre-tax labor income (y_t) that is accounted for by the employer's contributions to Social Security ($0.5\tau_t^{ss}\min\{y_t, \overline{y_t}\}$) is not taxable.

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[6]By the timing convention, agents realize at the beginning of the period whether they die. Subsequently, the transfers are received at the beginning of the period before agent's idiosyncratic labor productivity status is revealed.

[7]The level of government spending is determined in the steady state without Social Security and is held constant throughout the transition.

2.6   Social Security

We model the Social Security system to mimic the U.S. system that was originally implemented during the Great Depression. Signed into law in August 1935, the original program was phased in over time. According to the original law, payroll tax collection and benefit accrual began in 1937, with the first benefit payments initially scheduled to begin in 1942. However, in 1939 the law was amended so that benefits began to be paid already in 1940, two years ahead of the original schedule.

Given many similarities but also several key differences between the current and original programs, it is worth reviewing the main features of the original Social Security. Similar to the current system, the original program was progressive, with Social Security benefits calculated as an increasing, concave, piecewise-linear function of worker's average level of labor earnings. The progressivity of the benefits formula was originally governed by a single bend point plus the benefits-contribution cutoff and two marginal replacement rates.[8] Moreover, in contrast to the current system, the original Social Security benefits were also adjusted for the number of years in which an individual paid payroll taxes. Finally, in contrast to the current program in which individuals are allowed to retire prior to reaching the normal retirement age (NRA), the original program did not allow for early retirement. In the original program, individuals were not eligible for benefits until they reached the NRA of 65 and *also did not receive benefits during the years in which they were still working.* Notably, agents who reached 65 prior to 1940 were not eligible to receive Social Security benefits.[9]

To model these features of the U.S. Social Security system, we proceed in three steps. First, following Huggett and Parra (2010) and Kitao (2012), we calculate the model analog of each worker's average level of labor earnings over the working life cycle. At every age, the total accumulated

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[8]The current system has two bend points plus a benefits-contribution cutoff and three marginal replacement rates declining in worker's average earnings. For a detailed review of the current system, see Peterman and Sommer (2014).

[9]Agents who turned 65 after 1937 but prior to 1940 paid payroll taxes during this transitional period prior to turning 65. These agents were reimbursed at the age of 65 175% of the amount they paid in taxes. However, during this initial three year period, individuals did not payroll taxes on income after they turned 65. After 1940 all working agents paid payroll taxes, however for computational convenience these agents who turned 65 prior to 1940 do not pay payroll taxes after 65 and are always considered ineligible for Social Security benefits. In actuality, on additional change in the 1939 amendment was that these agents who turned 65 prior to 1940, but paid Social Security taxes over more than half of the time between 1937 their retirement were eventually made eligible to collect Social Security benefits. I do not include this change in the model. The effects of ignoring this change are somewhat mitigated since this amendment was not passed until just prior to 1940, many of these individuals would already have retired.

earnings follow the law of motion:

$$x_{j+1} = \frac{\min\{y_j, \bar{y}\} + (j-1)x_j}{j} \tag{7}$$

where x_j is the accounting variable capturing the equally-weighted average of earnings before the retirement age J_r; and $\bar{y}$ is the maximum allowable level of labor earnings subject to the Social Security tax that corresponds to the benefit-contribution cap. If agent's choose to retire prior to the NRA, then a zero is included in their average earnings for these years in which they do not work. Additionally, if an agent chooses to work past the NRA then the additional years are factored into their average earnings.

Second, the pre-adjustment Social Security benefit, b^{ss}_{base}, for each retiree is calculated using a convex, piecewise-linear function of average past earnings observed at retirement age, x_R, so that the marginal benefit rate varies over three levels of taxable income:

$$\begin{array}{ll} \tau_{r1} & \text{for} \quad 0 \le x_R < b_1 \\ \tau_{r2} & \text{for} \quad b_1 \le x_R < b_2 \\ 0 & \text{for} \quad x_R \ge b_2, \end{array} \tag{8}$$

where b_1 is the first bend point, b_2 is the benefit-contribution cut-off point $(b_2 = \bar{y})$, and $\{\tau_{r1}, \tau_{r2}\}$ represent the marginal replacement rates for the pre-adjustment Social Security benefit.

Third, an adjustment is made to the benefits to account for the number of years that an agent paid payroll taxes. In particular, for each year than an agent pays taxes, their benefits are scaled up by the equivalent of one percent. As a result, the total Social Security benefit b^{ss} obtained by the retiree is defined as:

$$b^{ss} = b^{ss}_{base} \times (1 + \frac{Jr}{100}) \tag{9}$$

Finally, this Social Security benefit is restricted to be below b^{ss}_{max} and above b^{ss}_{min}.[What are these? Also, how we treat the ineligible agents?]

2.7 Social Security

I model the Social Security system to mimic the U.S. system that was originally implemented during the Great Depression. [Quite different than the current program; mamy notable differences which we incorporate in our model.] In August 1935, Social Security was signed into law. However, the program was not immediately implemented. Payroll taxes began to be collected in 1937. Originally, benefits were not scheduled to begin until 1942, however, the law was amended in 1939 so that benefits began to be paid in 1940. Individuals are not eligible for benefits until the reached the normal retirement age (NRA) of 65 and cannot receive benefits during years in which they are still working. Agents who reached 65 prior to 1940 are not eligible to receive Social Security benefits.[10]

The Social Security benefits for retired workers are based on each worker's average level of earnings and also number of years paying payroll taxes. The benefit formula is comprised of two different parts. First, benefits are calculated as an increasing function of the worker's average level of labor earnings implying that the Social Security system is progressive. In particular, the marginal replacement rate declines when earnings reach a bend point. The second (implicit) bend point is the cutoff on Social Security benefits and contributions. The cutoff limits not only the maximum earnings used to calculate the Social Security benefits, but as the annual amount of earnings subject to payroll taxation. The second part of the the benefits are determined by the years an individual works. In particular, benefits are scaled up more as an individual has more years that they are paying Social Security taxes.

To model these features of the U.S. Social Security system, I proceed in three steps. First, following Huggett and Parra (2010) and Kitao (2012), I calculate the model analog of each worker's average level of labor earnings over the working life cycle. At every age, the total accumulated

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earnings follow the law of motion:

$$x_{j+1} = \frac{\min\{y_j, \bar{y}\} + (j-1)x_j}{j} \tag{10}$$

where x_j is the accounting variable capturing the equally-weighted average of earnings before the retirement age J_r; and $\bar{y}$ is the maximum allowable level of labor earnings subject to the Social Security tax that corresponds to the benefit-contribution cap. If agent's choose to retire prior to the NRA, then a zero is included in their average earnings for these years in which they do not work. Additionally, if an agent chooses to work past the NRA then the additional years are factored into their average earnings.

Second, the pre-adjustment Social Security benefit, b_{base}^{ss}, for each retiree is calculated using a convex, piecewise-linear function of average past earnings observed at retirement age, x_R, so that the marginal benefit rate varies over three levels of taxable income:

$$
\begin{array}{ll}
\tau_{r1} & \text{for} \quad 0 \le x_R < b_1 \\
\tau_{r2} & \text{for} \quad b_1 \le x_R < b_2 \\
0 & \text{for} \quad x_R \ge b_2,
\end{array} \tag{11}
$$

where b_1 is the first bend point, b_2 is the benefit-contribution cut-off point $(b_2 = \bar{y})$, and $\{\tau_{r1}, \tau_{r2}\}$ represent the marginal replacement rates for the pre-adjustment Social Security benefit.

Third, an adjustment is made to the benefits to account for the number of years that an agent paid payroll taxes. In particular, for each year than an agent pays taxes, their benefits are scaled up by the equivalent of one percent. As a result, the total Social Security benefit b^{ss} obtained by the retiree is defined as:

$$b^{ss} = b_{base}^{ss} \times (1 + \frac{Jr}{100}) \tag{12}$$

Finally, this Social Security benefit is restricted to be below b_{max}^{ss} and above b_{min}^{ss}.

3 Dynamic Program and Definition of Equilibrium

In what follows, for expositional convenience, we introduce the dynamic program of an individual born in to the final steady state with Social Security. The program reduces to the problem solved

in the initial steady state economy with no Social Security once τ^{ss} and b^{ss} are set to zero.

3.1 Dynamic Program of a Previously Working Agent

An agent who was working in the previous period and is indexed by type $(a_t, x_t, \alpha, \nu_t, j, D)$ solves the dynamic program:

$$
V_t(a, x, \alpha, \varepsilon, \nu, j, d) = \begin{cases} \max_{c,a',x',h} U(c,h,D) + \beta s_j EV_{t+1}(a',x',\alpha,\nu',j+1,D') & \text{if } j \leq \underline{R}, \\ \max_{c,a',x',h,I=\{0,1\}} U(c,h,D) + \beta s_j EV_{t+1}(a',x',\alpha,,\nu',j+1,D') & \text{if } \underline{R} < j \leq \overline{R}, \end{cases}
$$

(13)

subject to

$$
\begin{aligned}
c + a' &= (1+r)(Tr+a) + y - T(\tilde{y}) - \tau^{ss}\min\{y,\overline{y}\} & \text{if } I = 0, \\
c + a' &= (1+r)(Tr+a) - T(\tilde{y}) + b^{ss} & \text{if } I = 1.
\end{aligned}
$$

(14)

by choosing consumption, c, savings, a', time spent working, h, and whether to retire, $I \in \{0,1\}$. The accounting variable x is the average lifetime labor earnings as of age j and follows the law of motion specified in equation 10. Agents earn interest income $r(Tr+a)$ on the lump-sum transfer, Tr, from accidental bequests and on asset holdings from the previous period, a. y represents the pre-tax labor income of the working agents and is described in Section 2.2. $\tilde{y}$ defines the taxable income on which the income tax, T, is paid, and follows the process in equation 6. D is the state variable for the fraction of the period an agent is exogenously unemployed. Finally, τ^{ss} is the Social Security tax rate that is applied to the pre-tax labor income, y, up to an allowable taxable maximum, $\overline{y}$. Upon reaching the minimum retirement age, agents make a permanent decision to retire, with $I = 1$ signifying an agent who has retired ($I = 0$ otherwise). Agents of age $j < $ NRA that have chosen to retire are not eligible for Social Security benefits until they reach the age NRA. Finally, agents are forced into a mandatory retirement after reaching age $\overline{R}$.

3.2 Dynamic Program of a Previously Retired Agent

Upon reaching the minimum retirement age $\underline{R}$, agents are allowed to retire permanently. Retired agents older than the NRA receive a constant stream of Social Security payments whose size is determined by the level of the average life cycle labor earnings observed at the retirement period, x_R, and the number of years they work. Retired agents are no longer affected by labor productivity

14

shocks because they no longer work. As such, a retired agents indexed by type (a_t, x_R, j) solves the dynamic program:

$$V_t(a, x_R, j) = \max_{c,a'} U(c,h) + \beta s_j EV_{t+1}(a', x_R, j+1), \tag{15}$$

subject to

$$c + a' = (1+r)(Tr+a) + b^{ss} - T(\tilde{y}), \tag{16}$$

by choosing consumption, c, and savings, a'. Similarly to non-retired agents, retirees earn interest income $r(Tr+a)$ on the transfer, Tr, and their existing asset holdings, a. Additionally, these agents who are older than the NRA also receive the Social Security payment, b^{ss}.

3.3 Equilibrium

In this section I define a stationary steady state competitive equilibrium with Social Security.[11] An agent's state variables, Ξ are assets (a), average past earnings (x), age (j), ability (α), persistent shock (ν), unemployment shock (D), retirement status (I). For a given set of exogenous demographic parameters (n, Ψ_j), a sequence of exogenous age-specific human capital ($\{\theta_j\}_{j=1}^{\overline{R}}$), government tax function ($T : \mathbb{R}_+ \to \mathbb{R}_+$), Social Security tax rate τ^{ss}, Social Security benefits formula ($B^{ss} : \mathbb{R}_+ \times j \to \mathbb{R}_+$), a production plan for the firm (N,K), and a utility function ($U : \mathbb{R}_+ \times \mathbb{R}_+ \to \mathbb{R}_+$), a steady state competitive equilibrium consists of agent's decision rules for c, h, a, and I for each state variable, factor prices (w, r), transfers (Tr), and the distribution of individuals $\mu(\Xi)$ such that the following holds:

1. Given prices, policies, transfers, and initial conditions the agent solves the dynamic programming problem in equations 13 - 16, with c, h, a', and I as associated policy functions.

2. The prices w_t and r_t satisfy

$$r_t = \zeta A (\frac{N_t}{K_t})^{1-\zeta} - \delta$$

$$w_t = (1-\zeta)A(\frac{N_t}{K_t})^{\zeta}.$$

___
[11]Condition 3 is not relevant in a steady state with no Social Security.

3. The Social Security policies satisfy:

$$\sum \min\{wD\omega h, \bar{y}\}\tau^{ss} \mu(\Xi) = \sum b^{ss} I \mu(\Xi).$$

4. Transfers are given by:

$$Tr = \sum (1 - \Psi_j)a \mu(\Xi).$$

5. Government budget balance:

$$G = \sum T^y[r(a+Tr) + wD\omega h - .5\tau^{ss}\min\{wD\omega h, \bar{y}\}] \mu(\Xi) \mu(\Xi).$$

6. Market clearing:

$$K = \sum a \mu(\Xi), \ N = \sum \omega h \mu(\Xi) \text{ and}$$

$$\sum c \mu(\Xi) + \sum a \mu(\Xi) + G = AK^\zeta N^{1-\zeta} + (1-\delta)K.$$

7. The distribution of $\mu(x)$ is stationary, that is, the law of motion for the distribution of individuals over the state space satisfies $\mu(x) = Q_\mu\mu(x)$, where Q_μ is a one-period recursive operator on the distribution.

4   Calibration

The model is calibrated in two stages. In the first stage, values are assigned to parameters that can be determined from the data without the need to solve the model. In the second stage, the remaining parameters are estimated by matching key historical moments of the U.S. cross-sectional and aggregate data. These parameters determined in the second stage are done so in a model without Social Security. All the parameters values are summarized in Table 1.

4.1   Demographics, Endowments, Unemployment risk and Preferences

There are 74 overlapping generations of individuals of ages $j = 20, ..., 93$. I set the population growth rate, n, to 1.6 percent to match the average annual population growth, reported by the Cen-

Table 1: **Calibration Parameters in Steady State**

Parameter	Value	Source/Target
Demographics:		
Normal Retirement Age: NRA	65	By Assumption
Minimum Retirement Age: $\underline{R}$	60	By Assumption
Maximum Retirement Age: $\overline{R}$	85	By Assumption
Max Age: J	93	By Assumption
Surv. Prob: Ψ_j		Bell and Miller (2002)
Pop. Growth: n	1.6%	Conesa et al. (2009)
Firm Parameters:		
ζ	.36	Data
δ	6.90%	$\frac{I}{Y} = 25.5\%$
A	1	Normalization
Preference Parameters:		
Conditional Discount: β^{**}	0.9945	$\frac{K}{Y} = 3.0$
Risk aversion: γ	2	Conesa et al. (2009)
Frisch Elasticity: σ	0.5	Data; Intensive Frisch$=\frac{1}{2}$
Disutility to Labor: χ_1^{**}	69.5	Avg. $h_j = .282$
Fixed Cost to Working: χ_2^{**}	0.50	14.3% retired at NRA
Productivity Parameters:		
Persistence Shock: σ_v^2	0.007	1940 Census
Persistence: ρ	0.990	1940 Census
Permanent Shock: σ_α^2	0.191	1940 Census
Unemployment Rate: p_d	4.1%	Data
Unemployment Duration: d	0.30	In Progress
Government Parameters:		
Υ_0^{***}	.043	Mrkt Clearning
Υ_1^{***}	.276	.5 Avg. Earnings
ϕ	2%	Data
Social Security:		
τ_{r1}	40%	U.S. SS Program
τ_{r2}	10%	U.S. SS Program
b_1^{**}	.57 x Avg Earnings	U.S. SS Program & NBER
$\overline{y}^{***}$	2.84 x Avg Earnings	U.S. SS Program & NBER
b_{min}^{ss***}	0.11 x Avg Earnings	U.S. SS Program & NBER
b_{max}^{ss***}	0.97 x Avg Earnings	U.S. SS Program & NBER
τ^{ss***}	4.6%	Mrkt Clearing

Note: ** denotes parameters either calibrated through the Method of Simulated Moments or were determined in equilibrium through market clearing. *** denotes parameters based off of aggregates that are determined in the equilibrium.

sus Bureau, in the U.S. economy from 1920 through 1928. The conditional survival probabilities, Ψ_j, are derived from the period U.S. life tables for the 1930s (Bell and Miller (2002)). The minimum age that agents can retire is set at 60 and the maximum retirement age is 85. Disallowing agents from retiring prior to age 60 does not seem to be a binding constraint since less than 10% of males who were the head of households were not in the labor force in both the 1920 and 1930 census.

Figure 1: **Deterministic Age Profile of Wages**
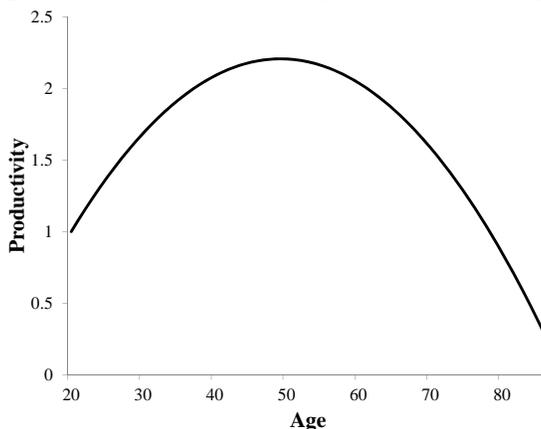
Following Conesa et al. (2009), the process for the labor productivity, ω, is calibrated based off of estimates from cross-sectional wage data reported in the 1940 Census.[12] I restrict the sample to individuals who are male, head of the household, work at least 1,248 hours annually, and work at least five weeks a year. The deterministic age-specific productivity profile, $\exp^{\theta_j}$, is shown in Figure 1. The profile is determined by regressing a quadratic of age on the natural log of average wages by age, limiting the sample to male head of households that are ages 20 to 64.[13] I normalize the profile such that the value equals one at age 20. The permanent and persistent idiosyncratic shocks to individual's productivity are determined from the variance of the natural log of earnings by age shown in Figure 2. I set $\sigma_\alpha^2 = 0.191$, the minimum variance in the natural log of wages by age. In order to fit the persistent component of the shock process, I set $\rho = .990$ since variance

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[12]Ideally the productivity process would be calibrated from data prior to the Great Depression. Unfortunately, there is little income data prior to 1940. Since after the implementation of Social Security in 1940, selection likely biases estimates of the labor productivity process, the estimates focus on observations for individuals who are younger than 65.

[13]I exclude individuals 65 and over since once Social Security benefits are available selection may be an issue.

Figure 2: **Unconditional Variance of Natural Log of Wages**
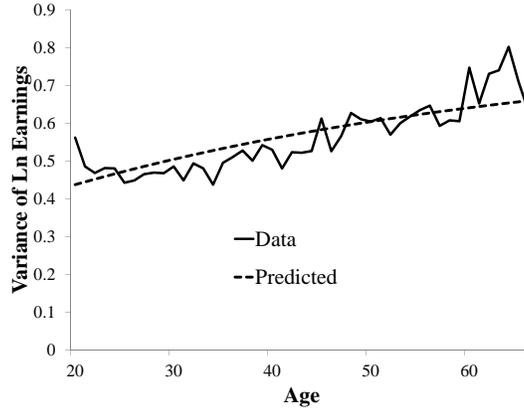
tends to grow linearly over the lifetime. Moreover, I set σ_v^2 by minimizing the squared percent deviation in the variance by age and the predicted variance from the shock process. The predicted unconditional variance by age from the shock processes and the actual variance by age are plotted in Figure 2. I discretize both of the shocks in order to solve the model, representing the permanent shock with two states and the persistent shock with five states. For expositional convenience, I refer to the two different states of the permanent shock as high and low ability types.

The unemployment shock, *D*, which represents the fraction of the period during which an agent is unemployed, is discretized to take on two values so that $D \in \{0, d\}$. *d* is set at 0.3 which implies that when agents are unemployed they spend thirty percent of the year unable to work.[14] The probability of a non-zero unemployment shock, p_d, varies throughout the business cycle. In the steady state it is set such that the unemployment rate is 4.1%, which is the average value from 1945-1950 in the series estimated by the NBER from Conference Board data.

As discussed in Section 2.2, the per-period utility, $U(c,s)$, is modeled as the weighted average between the utility flows from the sub-period in which the agent is unemployed and the sub-period in which the agent is employed.[15] I model the preferences within each sub-period as additively

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[14]I am in the process of obtaining data that will allow me to calibrate this parameter in the steady state and also the variation over the business cycle episode.

[15]If $D = 0$ then there is only one sub-period.

separable between consumption (c) and labor (h):

$$u(c_{it}, h_{it}) = \frac{c_{it}^{1-\gamma}}{1-\gamma} - \chi_1 \frac{h_{it}^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}} - \chi_2(I-1), \tag{17}$$

with $\gamma > 0$, $\sigma > 0$, $\chi_1 > 0$, $\chi_2 > 0$, and I is an indicator for whether an agent is retired. The constant relative risk aversion preferences over consumption are characterized by the risk aversion coefficient, γ, which determines an agent's desire to smooth consumption across time and states. The existing estimates of γ typically range between 1 and 3; thus in this paper, I set $\gamma = 2$. The parameter σ represents the Frish labor supply elasticity on the intensive margin. Past microeconometric studies estimate the Frisch elasticity to be between 0 and 0.5 (see, for example, Kaplan (2012), Altonji (1986), MaCurdy (1981), Domeij and Floden (2006) or Browning et al. (1999)). However, more recent research shows that these estimates may be biased downward (see Imai and Keane (2004), Domeij and Floden (2006), Pistaferri (2003), Chetty (2009), Contreras and Sinclair (2008), and Peterman (2012)). As such, I calibrate σ at 0.5 – the upper range of the available estimates. The scaling constant χ_1 is calibrated such that, on average, agents work 28.2 percent of their time endowment prior to the normal retirement age which corresponds to male head of households working on average 1,760 hours annually in the 1940 census.[16] Additionally, consistent with the 1930 Census, the fixed cost of working, χ_2, is calibrated so that 14.3 percent of male head of households retire by the normal retirement age.[17] The fixed cost $\chi_2 > 0$ implies that the disutility from working discontinuously increases when an agent goes from zero to positive hours worked. Figure 3 plots the percent of the males who are head of their household who are not in the labor force in the data and also the percent of agents retired in the steady state of the model without Social Security. Even though I only target the retirement rates at the age of 65, the predicted average retirement decisions from the model look similar to the decisions in the data. Finally, in order to characterize the agent's preferences described in equation 3, I calibrate the discount factor, β, to 0.9945 to match the U.S. capital-to-output ratio of 3.0.[18]

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[16] Ideally hours would be calibrated to the data prior to the implementation of Social Security. However, hours data is not available from the Census until 1940. Therefore, I calibrate to hours worked for individuals who are too young to be eligible to collect Social Security benefits.

[17] For calibration, individuals who are not in the labor force in the Census data are considered retired. This assumption is consistent with less than five percent of heads of households who are under the age of fifty five not being in the labor force.

[18] Capital is calculated as the sum of private fixed assets and consumer durables reported by the Bureau of Economic

Figure 3: **Percent Retired**
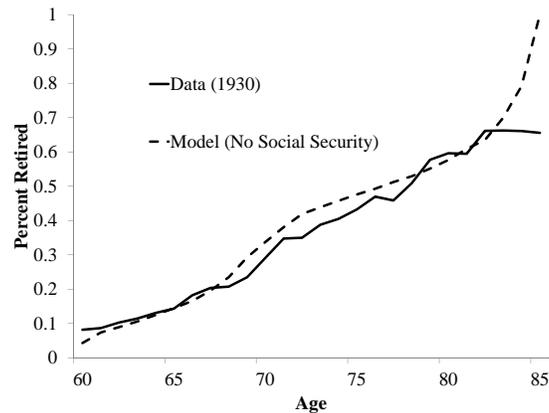
Note: The data is from the 1930 Census. I limit the sample to males who are head of their household. In the data, individuals who are not in the labor force are considered to be retired. The model is the percent retired in the steady state without Social Security.

4.2 Firm

I assume the aggregate production function is Cobb–Douglas. The capital share parameter, ζ, is set at .36. The depreciation rate is set to target the observed investment output ratio of 25.5 percent which is consistent with the ratio reported by the BEA in 1929 and 1930. These parameters are summarized in Table 1.

4.3 Government

I set the government spending in the unproductive sector to 2 percent of GDP in the steady state ($\phi = 0.02$) consistent with the ratio of Federal Government expenditures less spending on national defense to GDP reported by the BEA in 1929 and 1930.

During this period, the federal tax policy was much flatter than the current income tax policy. In particular, the first $2,500 of income for married households and $1,000 for single filers was exempt. Moreover, the marginal tax rate for the part of the first $4,000 of income that is not exempt was flat at four percent and increased very gradually. These historical exemption levels and the limit on the first tax bracket were quite high compared to the mean income in 1929 calculated from

Analysis. The values are not reported prior to 1929. However, the ratio is centered around 3 from 1929 through 1931. Outside of this period the ratio is a less reliable estimate of the steady state since the Great Depression begins to have notable effects on the economy.

the Macroeconomic historical data from the National Bureau of Economic Research of $1,054. Moreover, according to the Tax Foundation, close to 50 percent of tax returns had zero or negative tax liability in the 1930s. Given the relatively flat effective tax rates for a majority of individuals, I choose to model the income tax policy as:

$$T(\tilde{y}_t; \Upsilon_0, \Upsilon_1) = \Upsilon_0 \max\{\tilde{y}_t - \Upsilon_1, 0\}. \tag{18}$$

In this tax function, Υ_0 is the marginal tax rate and Υ_1 controls the level of the exemption. I calibrate Υ_1 such that it is equal to the average earnings in the economy in steady state to capture the fact that close to 50 percent of tax filers had negative or zero tax liability. Moreover, I calibrate Υ_0 such that the government budget constraint clears. I find that the rate of 4.6 percent, which implies an average tax rate of 2.3 percent, clears the governments budget. This rate is generally consistent with the average tax rates listed in Table 2, which varied between 2.6 and 4.3 percent from 1923 - 1930.[19]

Table 2: **Average Income Tax Rates**

Year	Rate
1923	2.6%
1924	2.7%
1925	3.3%
1926	3.3%
1927	3.5%
1928	4.3%
1929	3.8%
1930	2.8%

Notes: The values are calculated as the ratio of the total income to total tax liability. The data is from the Tax Policy Center.

4.4 Transitional Parameters

Next, I determine the parameter values that are only necessary for the transition and new steady state with Social Security. These parameters are either related to the Social Security program or

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[19]The average tax rate in my economy is 2.3 percent slightly less than in the data. However, my rate should be lower than the average rate in the U.S. economy since I am excluding government expenditures on defense.

the business cycle episode.

4.4.1 Social Security

Social Security was initially signed into law in late 1935. Therefore, prior to 1936 agents are unaware that the program will be enacted and act as if the program will not exist. The original law proposed starting taxes in 1937 and starting benefit payments in 1942 for eligible individuals. However, the law was amended in 1939 causing three notable changes: (i) the program was more inclusive, (ii) income after the NRA was included in the average income calculation, and (iii) eligible agents were allowed to receive benefit payments starting in 1940. For computational tractability I assume that agents learn about both the original law and the later amendments at the end of 1935.[20] I follow the actual benefit and tax schedules in the law that went into effect in 1940 and ignore further amendments after 1940 since these were not part of the initial program that was implemented.

Consistent with the original program, I set the NRA to 65. Following the original U.S. Social Security system, agents cannot receive social security benefits until they are 65. If an agent chooses to work after age 65 then the income from those years is subjected to the payroll tax and also factored into their average income. Additionally, agents are disallowed from collecting Social Security benefits if they are still working. Agents who turn 65 prior to 1940 are never eligible to collect Social Security benefits. However, these agents that turn 65 after the program is announced, pay Social Security taxes until they turn 65 and then are reimbursed 175% of the amount they paid in a lump sum payout. Unlike agents eligible for annual benefits, these agents do not pay payroll taxes after they turn 65.[21]

The marginal replacement rates in the progressive Social Security payment schedule (τ_{r1}, τ_{r2}) are also set at their historical respective values of 0.4, and 0.10.[22] Moreover, the benefits are scaled up 1 perecent for every year an agent works. Finally, I follow Huggett and Parra (2010) in setting the bend point (b_1), the maximum earnings $(\bar{y})$, the maximum benefit (b_{max}^{ss}), and the minimum benefit (b_{min}^{ss}) equal to the actual multiples of mean earnings so that b_1, b_2, $\bar{y}$, b_{max}^{ss}, and b_{min}^{ss} occur

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[20]I found that the implications of this assumption were limited.

[21]In the U.S. these agents did pay payroll taxes after 1940, however, for tractability I ignore th=is part of the amendment.

[22]These replacement rates were set in the 1939 amendment. In the original law the programs parameters were less progressive and more heavily dependent on the number of years an individual worked.

at 0.57, 2.84, 0.97, and 0.11 times mean earnings in the economy.[23] I set the Social Security tax rate through 1945 equal to the historical rates. After 1945, I set the Social Security tax, τ^{ss}, such that the Social Security program's per-period budget will be balanced in the terminal steady state. I find that the tax rate that balances the budget in the terminal steady state is 4.6%.[24]

4.4.2 The Great Depression

I model the Great Depression effecting the economy through three channels: TFP, unemployment, capital depreciation. I assume that the Great Depression is associated with an initial unexpected shock in all three channels that corresponds to the changes in the data 1929 through 1932. For tractability, I condense this period into a one time initial shock. After the initial unexpected shock, I model the Great Depression as consisting of an elevated risk of unemployment and depressed TFP. However, after this initial shock, the elevated unemployment risk and depressed productivity are no longer a surprise.

Figure 4: **Total Factor Productivity**
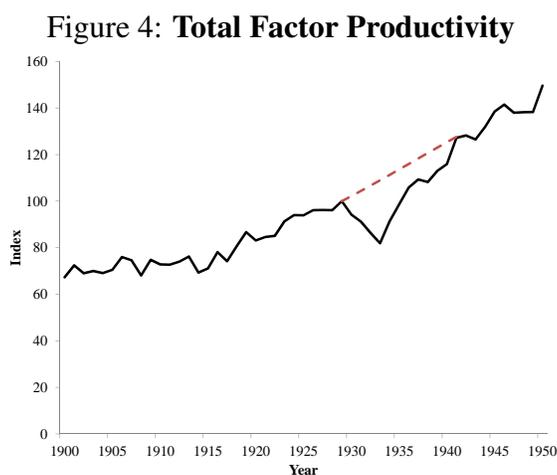
Note: The solid black line is TFP reported in Kendrick et al. (1961). The dashed red line is predicted TFP using a regression that excludes the dummy for years during Great Depression.

The aim of the exercise is to assess the expected welfare implications of enacting Social Security at the time the law was passed. One complicating factor is that there was an increase in economic activity due to the Second World War starting in 1941 that was probably not anticipated

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[23]See http://www.nber.org/databases/macrohistory/contents/.

[24]The actual rate was 5 percent, however some of the revenue from the payroll taxes was used to fund other parts of the Social Security program that were not related to the retirement benefits. Therefore, I use the rate that clears the budget in the terminal steady state.

at the time Social Security was adopted.[25] It is possible that this increase in economic activity could alter the welfare effects of enacting Social Security. Therefore, I eliminate this increase in economic activity by disregarding the effect of the war on TFP and the unemployment rate.

Table 3: **Total Factor Productivity**

Year	TFP
1932	81.3*
1933	75.5
1934	82.5
1935	87.3
1936	91.9
1937	93.1
1938	90.5
1939	92.7
1940	93.4
1941	94.7
1942	96
1943	97.4
1944	98.7
1945	100.0
Steady State	**100.0**

Notes: The values are an index and normalized such that 1929 is 100. * Notes an unexpected shock to TFP, all subsequent changes in TFP are not unexpected.

Focusing on TFP, Kendrick et al. (1961) provides estimates which are represented with the solid black line in Figure 4. Generally TFP is increasing throughout the first half of the 20th century. Therefore, in order to determine the shocks to TFP, I need to determine a counterfactual TFP series that excludes the effects of the Great Depression. In order to calculate this counterfactual TFP series, I regress TFP on a third order polynomial in time and an indicator variable for the Great Depression (1930 through 1940). The red dashed line in Figure 4 is the counterfactual TFP series, which is the predicted TFP from the regression (excluding the effect of the indicator variable for the Great Depression). I calculate the shock to TFP up until 1940 as the difference between actual TFP and the predicted counterfactual TFP. In 1940 TFP, is 6.4% bellow its expected value but rapidly approaches the counterfactual value due to World War II. In order to exclude these effects,

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[25]Although the United States did not enter the war until later, production for war activities abroad increased prior to the U.S. entering the war.

Figure 5: **Unemployment During Great Depression**
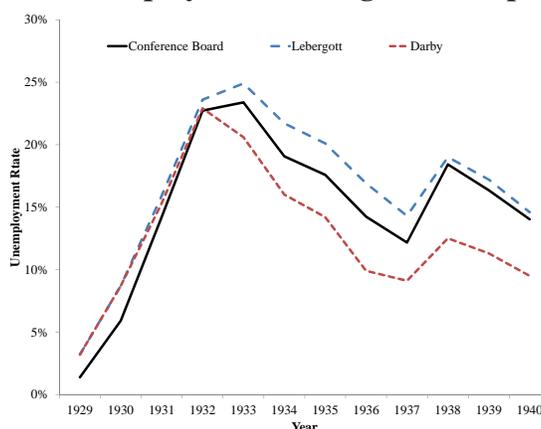
Note: The solid black line are the average monthly estimates from the Conference Board published in Moore (1961). The dashed blue line are the estimates from Lebergott (1964) which considers individuals in "work relief" as unemployed. The dashed blue line are the estimates from Darby (1975) which considers individuals in "work relief" as employed.

I assume that instead of recovering immediately, TFP linearly recovers to its expected value over the next five years. Table 3 details the evolution of TFP in the model over the Great Depression.

Figure 5 plots the various estimates of the unemployment rates during the Great Depression. The first series (solid black line) is from the NBER using the estimates by the Conference Board. The second series (dashed blue line) are the estimates from Lebergott (1964).[26] The third series (dashed red line) are the estimates from Darby (1975). The reason that the last two series diverge in later years is that Lebergott (1964) considers individuals in "work relief" programs as unemployed while Lebergott (1964) considers these individuals employed.[27] Despite the differences, the estimates of the unemployment rates are fairly close. The series describe a sharp increase (between 19 and 20 percentage points) in the unemployment rate between 1929 and 1932. Afterwards, all three series slowly decline during the Great Depression with the exception of 1938.

In the model, I focus on the unemployment rate estimates from the Conference Board. In order to determine the deviations from steady state, I need an estimate of the unemployment rate in the steady state. Using the average estimate of the unemployment rate from the NBER's estimates of the unemployment rate from 1945 - 1950, I determine that the steady state unemployment rate is

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[26]This series is seasonally adjusted monthly estimates which are converted to annual estimates by taking the average over the year.

[27]The Conference Board series does not report whether they include individuals in "work relief" programs as unemployed. See Margo (1993) for a description of the differences between some of these estimates.

Table 4: **Unemployment Rates**

Year	Unemployment Rate	Deviation from S.S.
1932	22.7%	18.6%*
1933	23.4%	19.3%
1934	19.1%	15%
1935	17.6%	13.5%
1936	14.2%	10.2%
1937	12.2%	8.1%
1938	18.4%	14.3%
1939	16.3%	12.3%
1940	14.6%	10.5%
1941	12.5%	8.4%**
1942	10.4%	6.3%**
1943	8.3%	4.2%**
1944	6.2%	2.1%**
1945	4.1%	0%**
Steady State	**4.1%**	

Notes: The unemployment rates from 1932 - 1939 are from the NBER and are determined from the estimates by the Conference Board. The 1940 estimate is from the NBER and determined from the estimates by the Census Bureau. * Notes an unexpected shock to the unemployment rate, all subsequent changes in the unemployment rate are not unexpected. ** Notes values that are extrapolated assuming that the deviation in the unemployment rate from the Steady State recedes in a linear manner from 1941 through 1945.

4.1%.[28] Table 4 lists the estimates of the unemployment rates throughout the Great Depression that I incorporate in my model and the deviations from the Steady State. Similar to TFP, I do not want to incorporate the decrease in the unemployment rates that are do World War II, so I assume the shocks to the unemployment rates from 1941 - 1945 linearly decline to zero.

The third channel by which I assume the Great Depression affects the economy is an exogenous loss of wealth which is transmitted through a one time unexpected increase in the depreciation rate. I calibrate this shock by examining wealth in the economy. According to the BEA, fixed assets fell by 24 percent between 1929 and 1932. Therefore, I assume the wealth shock is a one time increase of 24 percentage points in the depreciation rate. This increase is unexpected and immediately dissipates.

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[28]The estimates in 1945 and 1946 are from Census Bureau's "Current Population Reports." The estimates from 1947 - 1950 are from U.S. Bureau of Labor Statistics's "Employment and Earnings and Monthly Report on the Labor Force." See http://www.nber.org/databases/macrohistory/contents/chapter08.html for more details. Ideally, the steady state values would be calculated before Social Security was enacted, however, data limitations prevent this analysis.

5   Computational Experiment

In order to assess the welfare implications of adopting Social Security I simulate the transition from a steady state without Social Security to a steady state with Social Security during the Great Depression. I assume in the benchmark transition that Social Security is implemented during the Great Depression. Figure 6 describes the time line of exogenous shocks and implementation of Social Security which Sections 4.4.1 and 4.4.2 describe in detail. With regards to the business cycle episode, agents enter in 1932 after a one-time unexpected shock to TFP, unemployment, and depreciation that corresponds to the changes between 1929 and 1932. The shocks to TFP and unemployment persist, following the pattern in the data through 1941. After 1941, in order to abstract from the effects of the World War, I assume that these shocks linearly dissipate over the next four years. I assume that the changes in unemployment and TFP after the initial shock are fully anticipated. Social Security is announced at the end of 1935 and agents start incorporating the expectation of the forthcoming program in 1936. In 1937 Social Security taxes begin and follow the schedule detailed in Section 4.4.1. Also, in 1937 agents start accruing their average income which is used to determine Social Security benefits. In 1940, eligible agents can start receiving Social Security benefits.

Additionally, I simulate a counterfactual transition in which Social Security is not adopted but the business cycle fluctuations still occur. I then compare the welfare for agents in the economy at the time the program is announced in the two transitions. I use two welfare metrics. First, I calculate the likelihood that an agent will experience more welfare in the benchmark transition, in which Social Security is adopted, versus the counterfactual transition, in which Social Security is not adopted,

$$\Pi\left[U\left(c_j^{\text{bench}}, h_j^{\text{bench}}\right) + \sum_{s=1}^{J-j} \beta^s U\left(c_{j+s}^{\text{bench}}, h_{j+s}^{\text{bench}}\right) > U\left(c_j^{\text{counter}}, h_j^{\text{counter}}\right) + \sum_{s=1}^{J-j} \beta^s U\left(c_{j+s}^{\text{counter}}, h_{j+s}^{\text{counter}}\right)\right] \quad (19)$$

where *Pi*, c^{bench}, and c^{counter} is the probability, consumption in the benchmark transition, and consumption in the counterfactual transition.

Second, I calculate the level of the welfare effect in terms of the consumption equivalent variation (CEV). I define the short-run CEV as the uniform percent increase in expected consumption in each future period that an agent would need in order to be indifferent between experiencing either

Figure 6: **Timeline**
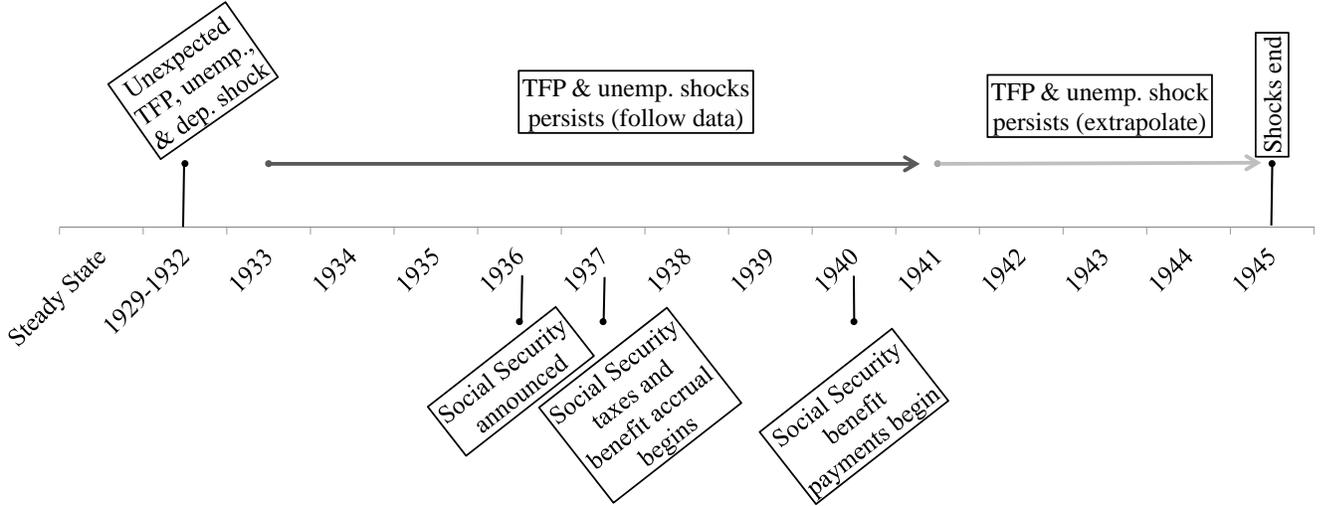
transition,

$$E\left[U\left(c_j^{\text{bench}},h_j^{\text{bench}}\right)+\sum_{s=1}^{J-j}\beta^s U\left(c_{j+s}^{\text{bench}},h_{j+s}^{\text{bench}}\right)\right]=E\left[U\left((1+\frac{\text{CEV}}{100})\times c_j^{\text{counter}},h_j^{\text{counter}}\right)+\sum_{s=1}^{J-j}\beta^s U\left((1+\frac{\text{CEV}}{100})\times c_{j+s}^{\text{counter}},h_{j+s}^{\text{counter}}\right)\right].$$

(20)

The expectation is taken with respect to an agent's expectations of mortality and productivity shocks. A positive number implies a welfare gain from implementing Social Security.

6 Results

6.1 Steady State Predictions

I begin by comparing the steady states without Social Security, which is where the economy starts, and the steady state with Social Security, which is where the economy ends after the transition through the Great Depression and the implementation of Social Security. Table 5 shows the aggregate variables in each economy while Figure 7 depicts the average life cycle profiles. As shown in Table 5 and Panel B of Figure 7, average savings and aggregate capital K are higher in the economy

without Social Security than in the economy with Social Security. This is because, without Social Security, agents finance all of their post-retirement consumption from private savings, as opposed to a part of their old-age consumption being funded by Social Security benefits. The lower K, paired with an aggregate labor supply N that is roughly identical in both economies, translates into a higher return to capital r and lower market wage w in the economy that includes Social Security. In turn, the higher return r in the model with Social Security affects the inter-temporal allocation of consumption and leisure. As illustrated in Panel A and Panel C of Figure 7, the higher r induces agents to both consume less and work more early in life. On the extensive margin, since the higher r increases the relative importance of leisure later in life, agents tend to retire at an earlier age in the economy with Social Security.[29]

Table 5: **Aggregates in the Steady States**

Aggregate	No S.S.	With S.S.
Y	0.80	0.77
K	2.41	2.21
N	0.43	0.42
w	1.19	1.16
r	0.05	0.06
tr	0.06	0.05
τ^{ss}	0	0.05
Avg. Retire. Age	75.6	64.3

Table 6 describes the long-run, ex-ante consequences of implementing Social Security. The first row documents the expected average welfare change for agents from being born into the steady state with Social Security versus the steady state without Social Security, measured in consumption equivalent variation. The second row indicates the likelihood of agents to experience more welfare if they live in the steady state with Social Security versus in the steady state without Social Security. I find that agents would willing to give up 2.5% of their expected consumption in each period (CEV) in order to live in the steady state without Social Security versus the steady state with Social Security. Moreover, I find that there is a 92.8 percent chance an agent will experience more

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[29]In addition to the change in r, if agents retire they can start receiving Social Security benefits at the age of 65. If they choose to delay receiving their benefits and continue to work their benefits are not increased to account for receiving benefits for less years. Therefore, it is actuarially unfair to continue to work which also causes agents to retire earlier in the model with Social Security.

Figure 7: **Life Cycle Profiles in Steady State**
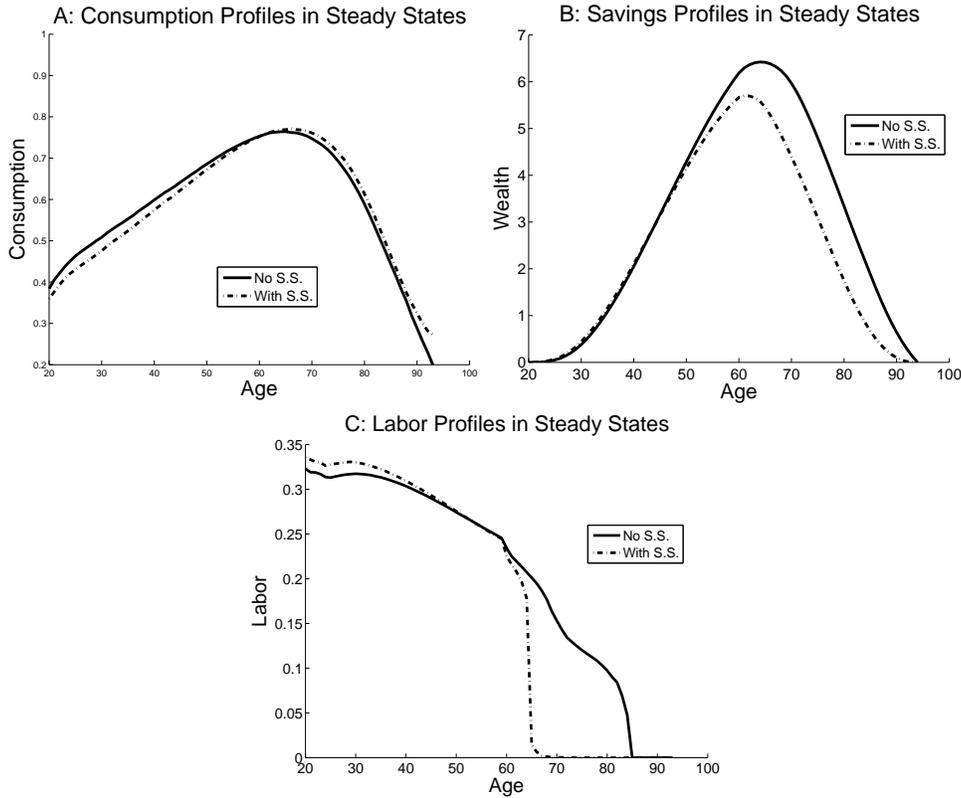
Note: "No S.S." denotes the steady state without Social Security. "With S.S." denotes the steady state with Social Security.

welfare living in the economy without Social Security than living in the economy with Social Security. These estimated long-run welfare effects are generally smaller than the effects estimated in other studies (see Huggett and Parra (2010), Hong and Rìos-Rull (2007), Storesletten et al. (1998), Peterman and Sommer (2014), and Imrohoroglu et al. (2003)) which find long-run welfare losses from the current U.S. Social Security program of between 3.7% and 12.9%.[30] It is not surprising that the welfare effects are smaller in this model since this model is studying the effects of the original Social Security program which is smaller than the current Social Security system. Moreover, I find that the probability that an agent would prefer to be born into the steady state with Social Security versus in the economy without Social security is only 7.8%

Social Security affects welfare through three channels. First, Social Security provides both

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[30]Huggett and Parra (2010) do not estimate the welfare gains from eliminating Social Security but instead estimate the welfare gains from a variety of reforms to the Social Security program and income taxation. From the results they report, it seems reasonable to assume that removing the program would lead to welfare gains within this range.

inter- and intra-generational insurance since the benefit formula is progressive. Second, the program directly distorting agents' savings and labor decisions. In particular, the payroll tax makes it harder for younger and low-wage agents to earn enough after-tax income to both smooth consumption over their lifetime and to accumulate precautionary savings. In addition, the progressive contribution-benefits formula affects agents' labor supply decisions. Third, the program effects welfare through general equilibrium effects. For example, the program "crowds-out" private savings, thereby reducing the stock of aggregate capital, which affects the marginal product of both capital and labor. I isolate how much of the overall welfare effect is due to the direct effect (which includes both the insurance and also the distortions to agent's decisions) and how much is due to the general equilibrium effects.[31] I find that overall the direct effects of Social Security increase welfare by 0.6% CEV indicating that the benefits from the insurance has a larger effect on welfare than the negative welfare effects from the distortions on savings and labor decisions. Consistent with the small increase in average welfare, I find that the direct effects result in a 50.4% likelihood that agents will experience more welfare. In contrast, I find that the general equilibrium effects are quite strong, leading to a reduction of welfare of 3.1% CEV.[32] Accordingly, I find that the likelihood that the general equilibrium effects will reduce welfare are over 99%.

Table 6: **Decomposition of the Long-run Effects from Social Security**

	Average	**Direct Effect**	**General Equilibrium**
Welfare (CEV)	-2.5%	0.6%	-3.1%
Likelihood of Gain	7.8%	50.4%	0.8%

Note: "Average" denotes the average, steady state welfare loss due to Social Security measured as the expected uniform change in consumption in each period an agent would require to be indifferent from living in an economy without Social Security versus and economy with Social Security. "Direct Effects" captures the amount of the average loss due to the direct effects associated with Social Security, while "General Equilibrium" captures the amount of the welfare loss due to the general equilibrium effects.

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[31]To isolate the effect of the direct distortions on agents' consumption-saving decisions, I conduct a partial equilibrium experiment in which I include Social Security but hold prices at the levels of the model without Social Security.

[32]These general equilibrium effects are mainly comprised of the lower wage rate due to Social Security "crowding out" capital.

6.2 Transitional Dynamics of Aggregates

Next, I examine the benchmark transition of the economy from the steady state without Social Security to the new steady state with Social Security. The panels in Figure 8 plots the transition of output, capital, labor, hours, consumption, rental rate, and wage, respectively, over the transition. Even though by 1945 the business cycle shocks dissipate and the Social Security program is fully implemented, the economy does not complete its transition to the new steady state for approximately an additional 25 years (1970). Over the transition, I find that aggregate output, aggregate capital, aggregate consumption, and the wage rate all fall drastically immediately after the shock, continue to decline for a few periods, and then gradually transition back to their new steady state values. In contrast, I find that aggregate labor, aggregate hours, and the rental rate suffer two sharp declines over the transition before eventually ending up at their new steady state values.

The fluctuations in the aggregate economic variables over the transition come from two channels. First, the economic shocks associated with the Great Depression. Second, the adoption of Social Security affects the aggregate economic variables. In order to decompose these two effects, Figure 9 determines the percentage changes in the aggregate economic variables relative to their initial values in the steady state without Social Security under three different transitions. First, the black lines plot the benchmark transition when the economy suffers the Great Depression and Social Security is implemented. The blue dashed lines plot the evolution of the aggregates in a counterfactual transition when the economy suffers through the Great Depression but Social Security is not adopted. Comparing the welfare in this counterfactual transition provides an estimate of the short-run welfare implications of adopting Social Security. Third, the red dashed lines describe the evolution of the aggregates in a second counterfactual transition when Social Security is adopted but there is no business cycle episode.

Focusing on Panels A, B, E, and G of figure 9, I find that the fluctuations in the benchmark transition (black line) and the transition which only includes the Great Depression (blue line) are similar for output, capital, consumption, and wages during the first 15 years of the transition. Therefore, the initial declines in output, capital, consumption, and wages and the subsequent recovery are primarily due to the shocks associated with the Great Depression. However, the later fluctuations in these aggregates in the benchmark transition and the counterfactual transition which

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Figure 8: **Aggregate Fluctuations Over Transition**
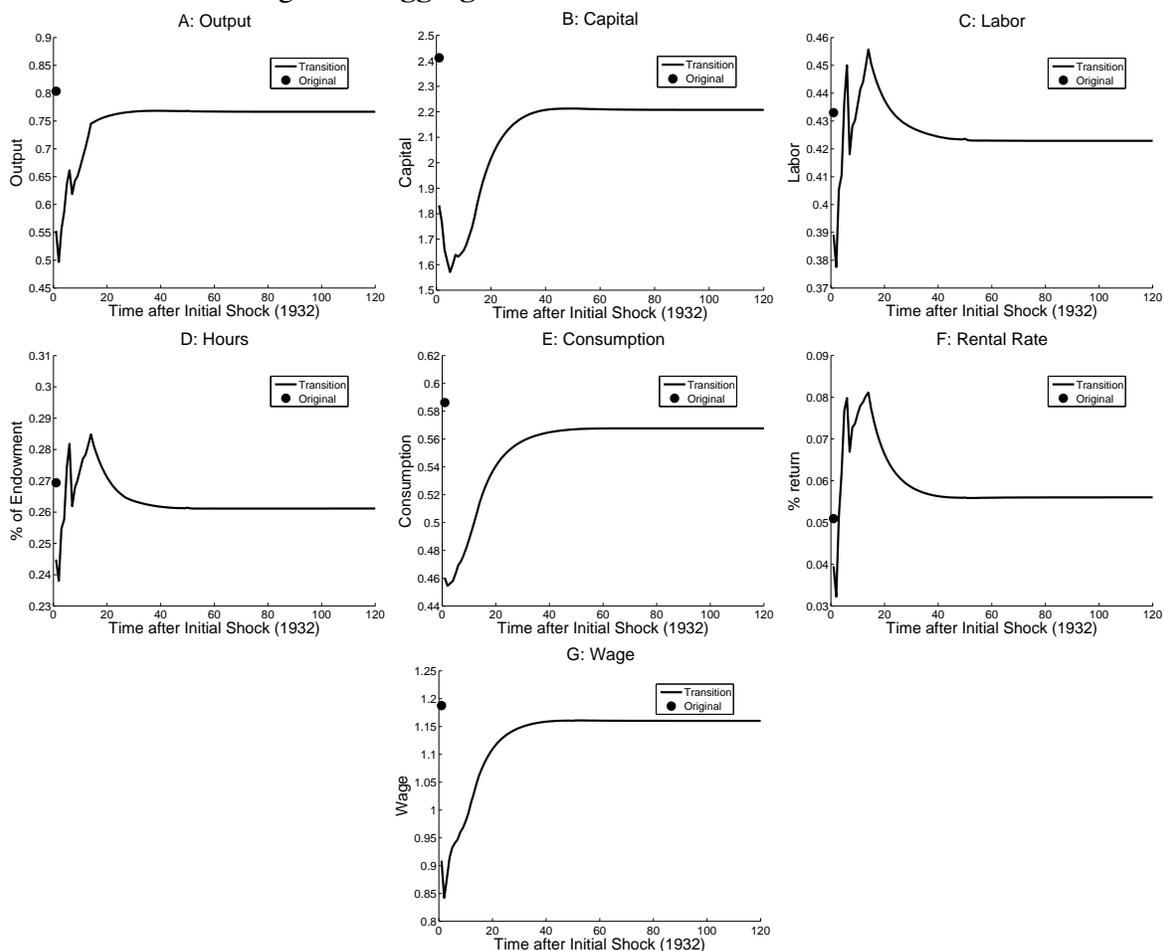
Note: The black lines capture the changes in economic aggregates along the transitional path from the original steady state without Social Security to the new steady state with Social Security during the Great Depression. The black dots represent the values in the initial steady state without Social Security.

Figure 9: **Aggregate Fluctuations Over Transition**
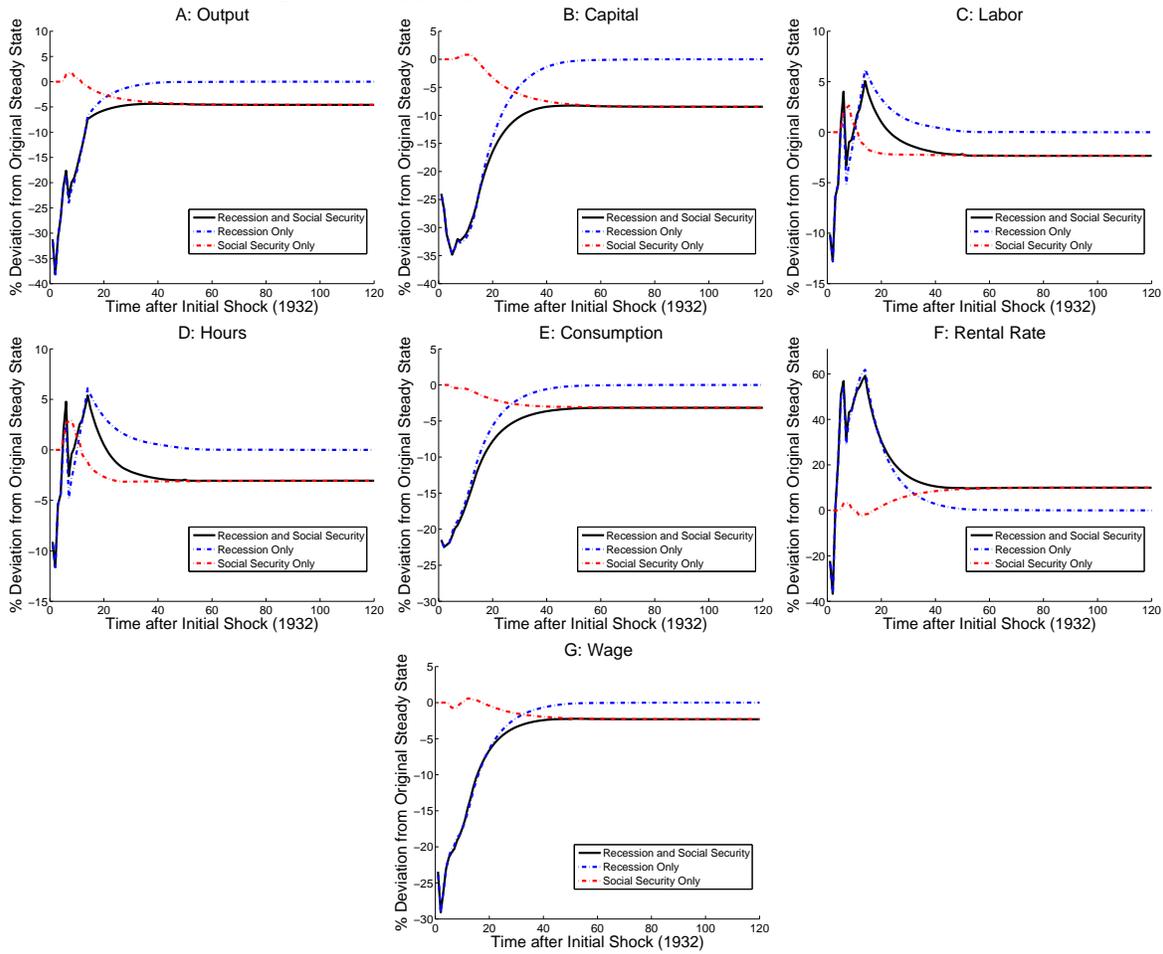
Note: The black lines capture the changes in economic aggregates along the transitional path from the original steady state without Social Security to the new steady state with Social Security during the Great Depression. The red dashed lines capture the changes in economic aggregates along the transitional path when the economy suffers the Great Depression but Social Security is never implemented. The blue dashed lines capture the changes in the economic aggregates along the transitional path when Social Security is adopted but there is no Great Depression. All the values are percentages relative the the initial value in the steady state without Social Security.

only includes the business cycle fluctuations tend to diverge. These later fluctuations are primarily driven by the adoption of Social Security and not the shocks to savings, TFP, and the unemployment rate.

Turning to Panels C, D, and F, the transition of labor, hours, and the rental rate tends to be more dynamic with multiple peaks and troughs. Comparing the fluctuations of these three aggregates over all three transitions, the original declines are primarily driven by the business cycle shocks. The initial fall in all three aggregates is due to the drop in TFP and increase in the unemployment

rate.[33] Moreover, the quick initial recoveries in these aggregates is due to the decline in the size of the shocks and also the implementation of Social Security (see the blue and red lines in Figure 9).[34] As the unemployment rate declines and TFP increases, agents tend to increase their hours. Additionally, in these first few periods after Social Security is announced, older agents can substantially increase their future Social Security benefit by working more. However, this increase in these aggregates is short lived, as the increase in the unemployment rate in period 7 (1938) causes a second fall in aggregate hours, aggregate labor, and the rental rate. The second spike occurs in period fourteen. Since this spike is primarily due to the business cycle episode (the shocks to unemployment and TFP shocks finally recede), it does not occur in the counterfactual transition without the shocks (see the red line in Figure 9). After the second spike in labor, hours, and the rental rate, all three aggregates slowly decrease for another 25 periods when they reach their new steady state values which are lower due to the implementation of Social Security.

Figure 10 plots the predicted fluctuations in aggregate output, capital, and labor in the model and compares them to the fluctuations in the data. In the model, I calculate the values as the percent change from the initial steady state without Social Security. In order to determine the changes in the data, I need to account for the trend growth over time. I determine a separate trend in all three series by regressing the aggregate values from 1900 through 1929 on a second order polynomial of time. Next, I calculate the percent deviations from this expected trend. I normalize the values to 100 in 1929.

Focusing on Panel A, the predicted fluctuations in output from the model are similar to the actual fluctuations in the data. Initially, output drops by approximately 40% in both the model and the data and slowly recovers over the next eight years. Although the fluctuations in output are similar in the model and the data, examining Panels B and C reveals that the sources of these fluctuations are somewhat different. In particular, the model predicts a much larger drop in aggregate capital initially compared to the data. Moreover, the model predicts much smaller fluctuations in aggregate labor than occurred in the data.

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[33]The fluctuations in the rental rate are primarily driven by the changes in the ratio of aggregate labor to output.

[34]Note that unemployment temporarily decreases over this period but increases again in period 7 (1938).

Figure 10: **Predicted Fluctuations versus Actual Fluctuations**
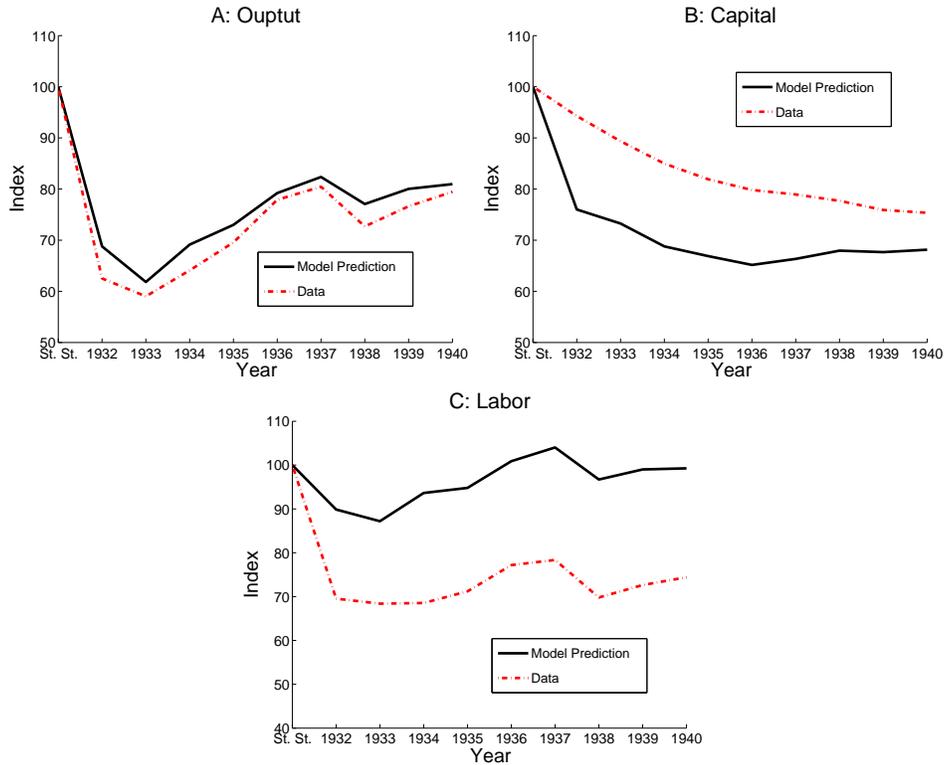
Note: The black lines capture the changes in economic aggregates along the transitional path relative to their original values in the steady state without Social Security. The dashed red line captures the actual changes in the aggregate economic variables relative to their trend. The trends are calculated using a second order polynomial using data from 1900 through 1929. All values are indexed to 100 in 1929, which is considered the steady state. The data comes from Kendrick et al. (1961)

6.3 Welfare Effects of Social Security During Transition

Next I assess the short-run welfare effects of implementing Social Security during the Great Depression by comparing the benchmark transition and the counterfactual transition which includes the business cycle episode but not the implementation of Social Security. For each cohort, I calculate both the expected CEV across the cohort and also the percent of agents who expect welfare gains due to the implementation of Social Security. I identify living cohorts as the age at the time Social Security was announced (1936), and future cohorts by the number of years after the announcement that they enter the economy.

Table 7 details the likelihood that individuals in the economy at the time of the announcement will experience an increase in welfare due to the implementation of Social Security.[35] The first

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[35]In particular, this is calculated as the percent of agents in the economy at the time of the announcement who

column describes the likelihood for all living agents. The second column focuses on agents who turned 65 after 1939 and therefore are eligible to receive annual Social Security benefits. The third column considers agents who are too old to be eligible to receive the annual Social Security benefits. I find on average for agents in the economy at the time of the announcement, the likelihood that these agents benefit from the implementation of Social Security is 83.4%. In contrast, comparing the long-run welfare effects of Social Security, I find that the likelihood that an agents would prefer to live in the steady state with Social Security as opposed to the steady state without Social Security is 7.8%. Not surprisingly, I find that the likelihood of experiencing a welfare improvement from the implementation of Social Security improves drastically if an agent is eligible for Social Security benefits. Turning to the size of the effect on welfare, I find that the average expected welfare gain from implementing Social Security for agents in the economy at the time of announcement is the equivalent of 4.5% expected future consumption. In contrast, I find that the average expected long-run welfare effect of Social Security is the equivalent of a 2.5% decrease in expected per-period consumption.

Table 7: **Likelihood of Welfare Gain from Implementation of Social Security**

All	Eligible	Ineligible
83.4%	90.8%	31.1%

Note: The table depicts the expected likelihood that an agents in the economy at the time of the announcement will experience a welfare gains due to the implementation of Social Security. Eligible agents are agents who turned 65 after 1939 and therefore were eligible for annual Social Security benefits. Agents who died prior to 1937 are not considered since the benchmark transition and counterfactual transition are identical until 1937 when Social Security was announced.

There are three potential reasons that the short-run and long-run welfare effects of Social Security could differ. First, Social Security is adopted during the Great Depression which could make the welfare benefit from the old age consumption insurance more valuable. However, it is possible that the effects of the Great Depression exacerbate the distortions introduced by both the payroll taxes and benefit formulae. In particular, agents who are young and liquidity constrained may find the payroll taxes particularly painful as it will make it more difficult for agents who receive bad idiosyncratic productivity shocks to smooth their consumption. I refer to this reason as the business cycle effect.

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experienced more welfare in the transition in which Social Security was implemented as opposed to the counterfactual transition in which Social Security was not implemented.

Second, during the transition from the steady state without Social Security to the steady state with Social Security the level of aggregate capital, labor, and output fluctuate which implies that the rental rate and wage rate also change. An agent in the economy during this transitions will experience different prices over their lifetime than they would have if they lived their whole life in the steady state with Social Security. The transition of prices may effect these agents' welfare. I refer to this second reason as the price transition effect.

Third, Social Security is gradually implemented into the economy. In particular, the payroll taxes are initially introduced at the low level of 2 percent, less than half of the steady state level. Moreover, the payroll taxes stay below their steady state level for many years. In contrast, the benefits are implemented much less gradually. In particular, in 1940 when agents begin to be eligible to receive payments, the benefits are fully implemented. Although the benefits formula does not change during the implementation of the program, the scaling factor based on years of employment will implicitly be lower for agents who were older at the time Social Security is implemented. However, at most this will cause a decrease in benefits of 32 percent. Therefore, the payroll taxes are introduced more gradually than the benefit payments. I refer to this third reason as the gradual implementation of Social Security taxes.

Table 8 decompose how much of the likelihood of experiencing a welfare gain for agents in the model at the time Social Security is announced are due to each of the three reasons by sequentially eliminating reasons. Table 9 performs a similar decomposition for the average expected welfare effects of implementing Social Security. The first, second, and third columns in each table examines all agents, agents eligible for Social Security benefits, and agents not eligible for Social Security benefits. The first row in each table is the welfare effects in the benchmark transition. The second row examines the welfare effects of implementing Social Security on living agents in a counterfactual transition which does not include the Great Depression. These welfare effects are determined by comparing the welfare for an agent who lives through a transition in which Social Security is adopted but there are no business cycle fluctuations to the welfare for an agent who lives in the steady state without Social Security. This row still incorporates the effect of both the changes in prices between the two steady states and also the gradual implementation of Social Security taxes. The third row determines the welfare effects in a second counterfactual transition when prices are held constant at the levels in the steady state with Social Security and compares against the welfare

in the steady state without Social Security.[36] This third row eliminates the price transition effect and focuses on the implications of the gradual implementation of Social Security taxes.

I find that excluding the business cycle only has modest effects on the welfare consequences of adopting Social Security. In particular, I find that without the business cycle shock, agents are a touch more likely to experience a welfare gain from the adoption of Social Security. Moreover, I find that the average welfare gain from adopting Social Security is also slightly higher when the program is implemented during normal times as opposed to in the midst of the Great Depression. This result may seem counterintuitive since the old age consumption insurance that the program provides would seem to be more beneficial in the midst of the Great Depression. However, I find that two factors offset this benefit. First, the business cycle episode exacerbates liquidity constraints for younger agents enhancing the welfare distortions from the payroll taxes associated with Social Security. Second, agents generally work more initially when Social Security is adopted. The increase in labor causes a temporary increase in the return to capital which is particularly beneficial for older agents. However, during the Great Depression agents have less ability to increase their labor supply due to elevated unemployment rates. Therefore, there is more scope for this positive price effect in the counterfactual transition without the Great Depression.

Table 8: **Decomposition of Likelihood of Welfare Gain from Social Security**

	All	**Eligible**	**Ineligible**
All Effects	83.4%	90.8%	31.1%
- Depression	85.7%	92.9%	35.2%
- Transition (General Equilibrium)	79.5%	89.9%	6%

Note: This table determines the likelihood of a welfare gain from implementing Social Security. The first row determines the total effect which includes the interaction of the effects of the business cycle, the change in prices over the life cycle, and the gradual implementation of Social Security taxes. The second row removes the effect of the business cycle. The third row removes the business cycle and also holds prices fixed throughout the transition at the steady state value with Social Security leaving only the effect of the gradual implementation of Social Security taxes.

When I exclude the transition in prices and only incorporate the gradual implementation of the Social Security program, I find that the likelihood of experiencing a welfare gain decreases a small amount to 79.5 percent. Moreover, the average welfare effect from implementing Social Security is the equivalent of 5.2% of expected future lifetime consumption, about 0.3 percentage

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[36]It is assumed that an agent lives in a counterfactual steady state prior to the announcement of the program in which the prices are equivalent to the prices in the steady state with Social Security. Similar to the second column, the benchmark for comparison in welfare calculations is an agent living in the Steady State without Social Security.

Table 9: **Decomposition of Welfare Effect from Social Security**

	All	**Eligible**	**Ineligible**
All Effects	4.4%	5%	-0.2%
Price Transition + Gradual Imp.	5.5%	6.3%	-0.2%
Gradual Imp.	5.2%	5.9%	0.0%

Note: This table determines the average expected welfare gain from implementing Social Security. The first row determines the total effect which includes the interaction of the effects of the business cycle, the change in prices over the life cycle, and the gradual implementation of Social Security taxes. The second row removes the effect of the business cycle. The third row removes the business cycle and also holds prices fixed throughout the transition at the steady state value with Social Security leaving only the effect of the gradual implementation of Social Security taxes. A positive number indicates a welfare improvement from adopting Social Security.

points lower than in the second row. The implementation of Social Security causes a decline in the wage rate and an increase in the rental rate. Excluding these changes in prices tends to decrease the welfare increase from adopting Social Security since agents no longer experience higher wages prior to the implementation of Social Security. This effect is enhanced for agents who are older at the time Social Security is adopted since, all else equal, they would have worked for more periods with higher wages prior to the adoption of Social Security.

The high likelihood and amount of welfare gains from implementing Social Security in this third counterfactual transition indicates that a majority of the overall gain is due to the gradual implementation of Social Security. Not surprisingly, the welfare effects in this scenario are concentrated in eligible agents. Agents who are too old to collect Social Security benefits when the program is implemented tend to see a negligible change in their overall welfare. Figure 11 further explores why the speed at which different parts of the Social Security program are implemented is responsible for the discrepancy between short-run and long-run welfare effects. In particular the solid line plots the average lifetime benefits received for different cohorts in the economy at the time the program was announced in the benchmark transition. The dashed line represent the average amount of Social Security taxes paid over the lifetime for each cohort. Both of the lines are determined as a percent of the lifetime totals that would occur if the agents lived in the steady state with Social Security. As is clear from the solid line, agents in the eocnomy during the transition tend to receive significantly more benefits relative to the taxes they pay. In contrast, lifetime benefits and taxes paid are equal for agents in the economy in the steady state since the program is PAYGO. Although the program is structured such that during the transition the taxes are more

Figure 11: **Effect of Gradual Implementation**
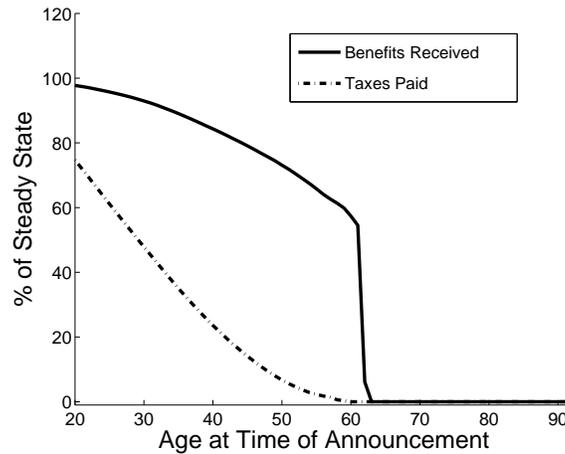
Note: The values indicate the percent an agent who experiences the transition either pays or receives compared to the value they would pay or receive if living in the steady state with Social Security.

Figure 12: **Social Security Outlays and Revenues**
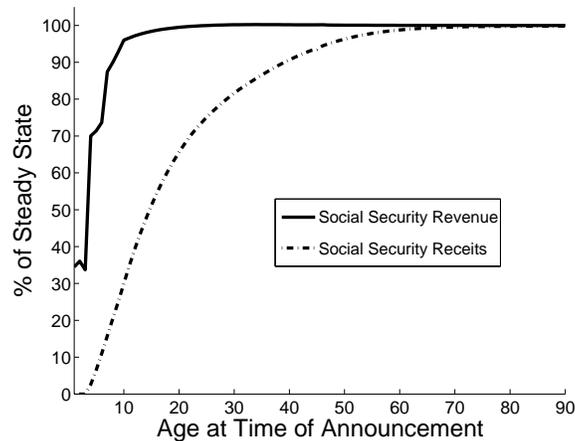

Note: The values are the total outlays or revenues received in a particular year. The values are normalized as a percent of the total outlays and revenues received in the steady state with Social Security. Outlay equal revenues in this steady state.

gradually implemented than the benefits, I find that the program does not run a deficit. Figure 12 plots the total outlays and revenues for Social Security in each year after the program is announced. I find that in all periods revenues either equal or exceed outlays.[37]

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[37]Similarly, through 1960 annual total expenditures from the Old Age Survivorship Disability Insurance (OASDI) trust fund were less than annual revenues. However, making this comparison in the data and the model is not completely equivalent since both revenues and expenditures in the data include parts of OASDI other than just the old-age consumption insurance.

Figure 13: **Likelihood of Welfare Gain from Implementing Social Security by Age**
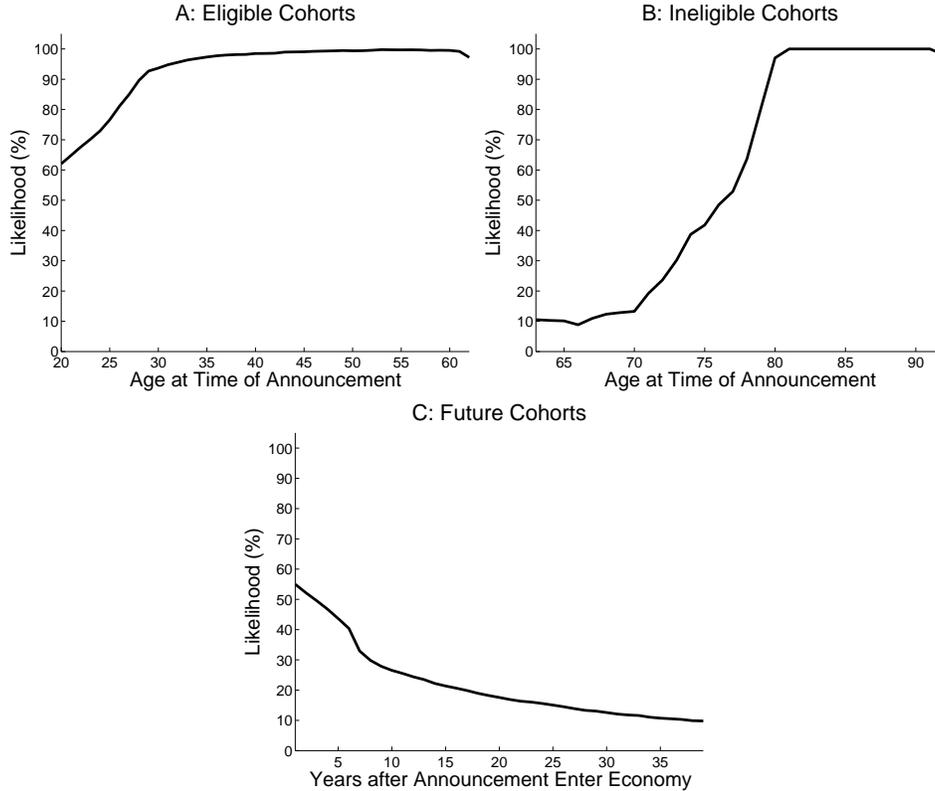
Note: Likelihood of gaining welfare is calculated as the percent of the cohort who experiences a welfare gain due to the implementation of Social Security. Ages in panel A and B are the age of agents when Social Security is announced. In panel C the cohorts are indexed by the number of periods after the announcement that they enter the economy (20 years old).

6.4   Welfare Effects by Age

Next, I examine how the short-run welfare effects from adopting Social Security vary by the agent's age at the time of the announcement. I examine the welfare gains by age because the strength of these different reasons for the discrepancy in the long-run and short-run welfare effects may vary by age. I separate the cohorts into three groups: (i) agents eligible for Social Security that are in the model at the time of the announcement, (ii) agents ineligible for Social Security that are in the model at the time of the announcement, (iii) agents who have not entered the model at the time of the announcement.[38]

Figure 13 plots each cohorts' likelihood of gaining welfare due to the implementation of Social

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[38]Agents enter the model at the age of 20. Therefore, this third group includes agents under the age of twenty at the time that the program is announced and agents yet to be born.

Figure 14: **Welfare Gain from Implementing Social Security by Age**
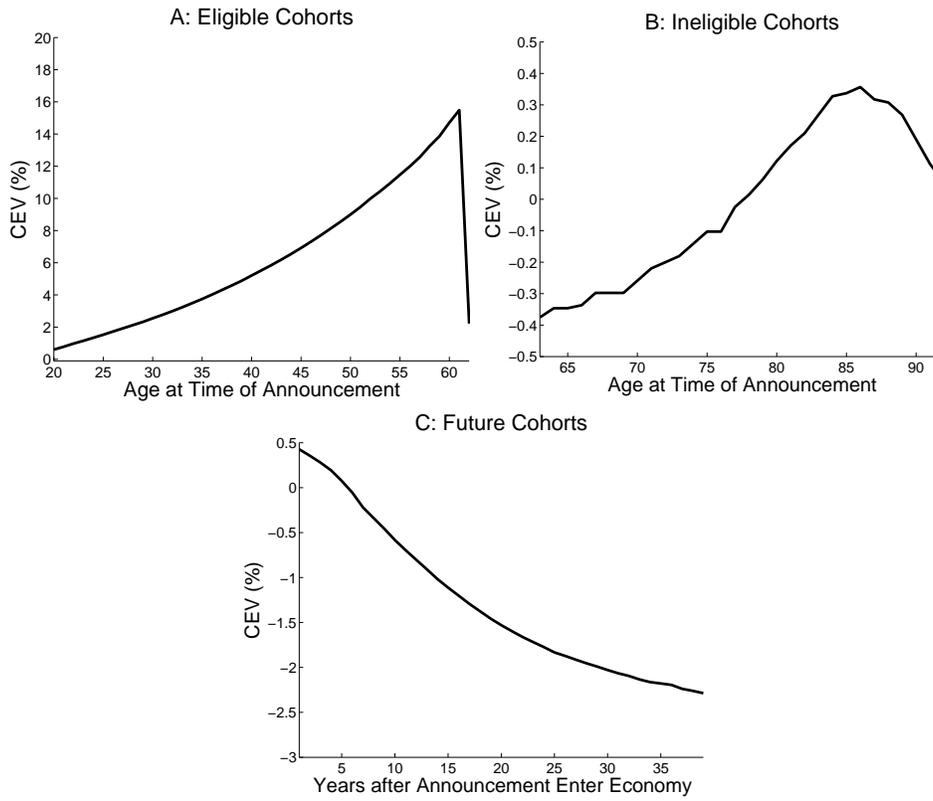
Note: Likelihood of gaining welfare is calculated as the percent of the cohort who experiences a welfare gain due to the implementation of Social Security. Ages in panel A and B are the age of agents when Social Security is announced. In panel C the cohorts are indexed by the number of periods after the announcement that they enter the economy (20 years old).

Security. Figure 14 plots each cohorts' average expected welfare gain, in terms of future expected consumption. In both figures, Panel A, B, and C, are for cohorts who are eligible for Social Security and in the model at the time of the announcement, who are ineligible for Social Security, and who enter the economy after the announcement, respectively. First I focus on agents who are in the model at the time of the announcement and are eligible for Social Security (Panel A). I find that all the cohorts within this group expect welfare gains due to the implementation of Social Security. There is a modest increase in the likelihood of a welfare gain for cohorts in this group if the cohort is older at the time of the announcement (increasing from 60 to 100 percent). Moreover, focusing on the level of the expected welfare gain, there is a large increase for these eligible agents who are older at the time of the announcement (0.5 to 16 percent of future expected lifetime consumption). This increase in the expected welfare effects within this group by age is not surprising since Figure

11 demonstrates that older eligible agents in the economy during the transition tend to receive relatively more in Social Security benefits than they pay in Social Security taxes. Moreover, the discrepancy between what agents pay and receive is even larger for agents who are older at the time of the announcement. The one exception are agents who are older than 62 at the time of the announcement. These agents receive the lump sum reimbursement payments for their payroll taxes but are not eligible to collect the reoccurring Social Security benefit payments.

Turning to agents who are ineligible to collect benefits, I find that there is great variation in their likelihood of experiencing a welfare benefit from the implementation of Social Security. On average, agents who are younger than 80 at the time of the announcement tend to expect a decrease in their welfare. In contrast, agents who are older than 80 at the time of the announcement tend to expected an increase in their welfare. However, examining Panel B in Figure 14, the magnitude of these gains and losses for each cohort in these groups is less than 0.5 percent of future expected consumption.

The price fluctuations over the transition are important for explaining the fluctuations in the welfare effects by age for the ineligible agents since they do not experience any direct effect from the payroll taxes or Social Security benefits. Figure 15 plots the percent deviation in the wage and rental rate in the benchmark transition when Social Security is implemented and the counterfactual transition which includes the business cycle episode but Social Security is not implemented. The relative fluctuations in prices over these two transitions isolates the effect of implementing Social Security for these older agents. After Social Security is announced and labor income begins to be counted towards the calculation of Social Security benefits, agents supply more labor which leads to an increase in the return to capital and decrease in the wage rate relative to the counterfactual transition. After a few periods, there are two trends that have counteracting effects on the prices. First, agents tend to retire earlier due to Social Security leading to lower aggregate labor. Second, agents tend to hold less savings. The first effect happens more quickly as agents are able to adjust their labor supply quickly. In contrast, the deaccumulation of capital takes more time. These fluctuations lead to a temporary decrease (increase) in the rental rate (wage) compared to the counterfactual transition when the first effect dominates. However, eventually when capital deaccumulation dominates, the relative rental rate (wage) increases (decreases) relative to the counterfactual economy.

Figure 15: **Fluctuations in Prices due to Social Security**
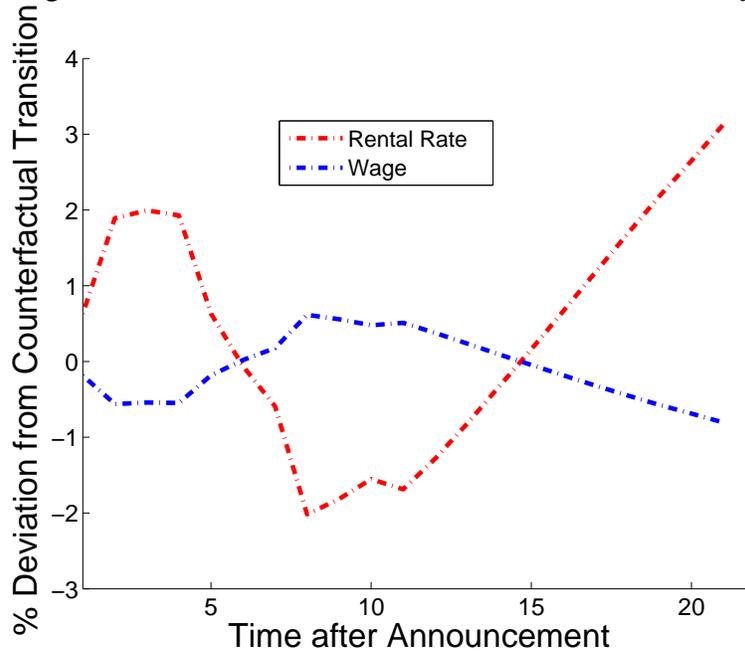
Note: The figures represent the percent difference in the prices between the transition with Social Security and the counterfactual transition without Social Security.

Starting with agents over 80 at the time of the shock, these agents are retired when Social Security is announced so only the relative fluctuation in the rental rate affects their welfare. The immediate temporary increase in the relative rental rate causes almost all of these agents to experience a welfare benefit, however the effects are modest. Turning to agents who are between the ages of 62 and 80 at the time the program is announced, both the relative fluctuations in wages and the rental rate affect their welfare. For these agents, the temporary decrease in the relative wage tends to dominate and a smaller fraction of these agents experience a welfare benefit from the implementation of Social Security. This effect is stronger for agents who are closer to 62 at the time of the announcement because the younger agents experience more periods in which they are working and the wages are relatively lower. Moreover, these agents also experience more of the periods in the medium term when the rental rate is temporarily depressed.

Finally, I find that agents who enter the model immediately after the implementation of Social Security on average expect to experience a welfare gain from the program. However, I find that the likelihood is just slightly above fifty percent. Moreover, the expected welfare gains for these agents are quite small (less than 0.5% of expected lifetime consumption). The likelihood of experiencing

a welfare gain decrease for agents who enter the model more years after the announcement of Social Security. These cohorts who enter the model more years after the program is announced tend to pay relatively more in payroll taxes than agents who enter the model immediately after the announcement and benefit from the gradual implementation of the taxes. Both the likelihood of not experiencing a welfare gain and the magnitude of the welfare losses from the program increase for cohorts who enter the model further in the future towards their steady state values.

7   Conclusion

This paper revisits the welfare effects of Social Security and determines if the short-run and long-run welfare effects are different. Similar to previous research, I find that an agent expects lower welfare if he lives in an economy in the steady state with Social Security as opposed to an economy without Social Security. I find that in expectation, the likelihood of an agent experiencing this decrease is over 90 percent. However, I find different short-run and long-run welfare effects from implementing Social Security. I find that over 80 percent of agents in the model at the time Social Security is announced expect to experience a welfare gain due to the implementation of the program.

Through a series of computational experiments I determine the relative strength for three potential reasons for the divergence between the short-run and long-run welfare effects of Social Security. I find that the implementation of Social Security in the midst of the Great Depression has only modest effects on the welfare implications of Social Security and causes the short-run benefits to be smaller. Moreover, I find that agents living through the transition experiencing different prices compared to the prices they experience in the steady state only modestly increases the short-run welfare benefits of implementing Social Security. In contrast, I find that the gradual implementation of the pieces of Social Security has large effects on the short-run welfare implications of Social Security. In particular, the relative magnitude of the benefits received compared to the payroll taxes paid tend to be large for the initial recipients. Despite these agents paying relatively lower lifetime payroll taxes, I find that aggregate Social Security outlays are not larger than aggregate benefits in any period during the transition. Instead, the program is implemented in a way to take advantage of the slow rate at which the initial number of eligible beneficiaries who

paid payroll taxes reach the retirement age.

This paper highlights that when evaluating social programs it is not sufficient to focus on the long-run welfare effects by comparing the welfare in one steady state without the program and in the steady state with the program. The short-run welfare is particularly important to consider since typically it is these living agents that are involved in the political process by which these programs are approved. Therefore, this divergence in the short-run and long-run welfare implications may help explain why a program that decreases welfare in the long-run was implemented. Moreover, these results demonstrate that how these programs are implemented can be of first order importance to the short-run welfare consequences.

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