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

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Abstract

A well-established result in the literature is that Social Security tends to reduce steady state welfare in a standard life cycle model. However, less is known about the historical effects of the program on agents who were alive when the program was adopted. In a computational life cycle model that simulates the Great Depression and the enactment of Social Security, this paper quantifies the welfare effects of the program's enactment on the cohorts of agents who experienced it. In contrast to the standard steady state results, we find that the adoption of the original Social Security tended to improve these cohorts' welfare. In particular, we estimate that the original program benefited households alive at the time of the program's adoption with a likelihood of over 80 percent, and increased these agents' welfare by the equivalent of 5.9% of their expected future lifetime consumption. The welfare benefit was particularly large for poorer agents and agents who were near retirement age when the program was enacted. Through a series of counterfactual experiments we demonstrate that the difference between the steady state and transitional welfare effects is primarily driven by a slower adoption of payroll taxes and a quicker adoption of benefit payments during the program's phase-in. Overall, the opposite welfare effects experienced by agents in the steady state versus agents who experienced the program's adoption might offer one explanation for why a program that potentially reduces welfare in the steady state was originally adopted.

JEL: E21, D91, H55
Key Words: Social Security, Recessions, Great Depression, Overlapping Generations.

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> *"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 implemented amidst the Great Depression, and represented the largest U.S. social insurance program at the time. While Social Security has been shown to generally lessen welfare losses during deep economic downturns (Peterman and Sommer (2014)), a large literature has shown that the current program in the long run reduces welfare and also has explored the welfare implications of various reforms. However, the existing literature has been mostly silent on why the program—given its long-run welfare costs—was implemented in the first place. To this end, our paper uses a general equilibrium, heterogeneous-agents life cycle model to quantitatively examine the welfare effects of the Social Security program's adoption on the original cohorts of agents who experienced it. In particular, we ask three questions. First, what were the overall welfare effects on individuals who were alive at the program's adoption? Second, who were the winners and losers from the program's enactment? And third, what were the main channels through which the implementation of the original program affected welfare?

We examine these questions in three steps. First, we build a rich heterogeneous agent, general equilibrium life cycle model with endogenous labor and retirement which matches the U.S. economy just before the Great Depression and the enactment of the original Social Security program. Second, we introduce two sudden and unexpected shocks—the Great Depression and the subsequent adoption of the original Social Security—and calculate the transitional path to a new, post-Great Depression steady state with the Social Security program fully phased in. Third, along the transitional path, we study the welfare of the original cohorts of agents who lived through the Great Depression and the subsequent enactment of Social Security, and compare it to the welfare of agents who experienced a counterfactual transitional path where the Great Depression occurs but Social Security is not adopted.

We measure the welfare effects of the original Social Security in two distinct ways. First, we determine the likelihood of a welfare gain from the adoption of Social Security for these original cohorts. Second, we calculate the average welfare gains and losses from the program for agents alive at the program's adoption. Our quantitative experiments suggest that the original program benefited a vast majority of agents who were alive at the time of the program's enactment, with the average welfare effect being large and widespread. In particular, we find over an 80 percent chance that the adoption of Social Security increases the welfare for these original cohorts. Moreover, the average welfare effect was the equivalent of a 5.9 percent increase in expected future lifetime consumption. These welfare benefits were particularly large for working-age individuals close to retirement and also for agents with relatively less savings.

We find that the welfare benefit from the adoption of the original program can largely be explained by the relative speeds at which the different parts of the program were phased in. In particular, the structure of the original Social Security program meant that many (especially older working) agents who were alive at the program's adoption received far greater benefits from Social Security than the amount they contributed to fund it. For example, a transitional agent who retired five years after the inception of Social Security would face a lifetime payroll tax burden that was approximately 95 percent lower than that of an agent who lived their whole lifetime with Social Security, largely because this transitional agent would only pay payroll taxes for five years instead of his whole working lifetime.[1] In contrast, because of how the benefits were phased in, this transitional agent would be entitled to a Social Security benefit that was only 40 percent lower.[2]

Interestingly, and perhaps counter to simple intuition, we find that adopting the program during the Great Depression in fact tapered the welfare benefits from the program for the original cohorts. At first blush, one might be tempted to think that the Great Depression bolstered the welfare gains because the insurance from the Social Security benefits would be more valuable during the Great Depression when large amounts of wealth and income were lost. On the other hand, imposing a payroll tax on agents during the Great Depression when agents suffered from tighter budget constraints due to the adverse shock could lower the welfare gains from the program's adoption. On balance, we find that this latter channel dominates because most agents who were eligible for

[1] In addition, this agent would enjoy a lower payroll tax rate since the payroll tax rate was scaled up to its steady state value over a number of years.

[2] For the convenience of exposition of this argument, in this example we assume that an agent's income was constant across his working life cycle and the discount rate is one.

Social Security did not receive Social Security benefits for many years to come, but had to start funding the system immediately.

This paper is related two strands of literature that examine the effect on welfare of Social Security. The first strand tries to measure the steady state 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—which, 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. (1998), and Hong and Rìos-Rull (2007).[3] Moreover, Krueger and Kubler (2006) and Harenberg and Ludwig (2013) examine the steady state 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 program imposes.[4] Similar to these papers, we 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 welfare effects of the program once it is well established. Overall, our findings that the welfare effects of Social Security are the opposite for agents in the steady state versus agents who experienced the program's adoption might offer one explanation for why a program that potentially reduces welfare in the steady state was originally adopted. In addition, to the authors' 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.

Similar to this paper, the second strand of the literature focuses on the transitional welfare as opposed to the steady state welfare implications of Social Security. However, instead of examining the welfare implications of adopting Social Security, this strand of the literature determines either

[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.

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 transitional 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 steady state welfare, 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, we determine the transitional welfare effects on living agents. However, we examine the welfare implications during a transitional period that includes the implementation of Social Security, rather than a reform or a phase-out of an already existing system.

This paper is organized as follows: Section 2 introduces the computational model. Section 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 general equilibrium, life cycle economy with overlapping generations of heterogeneous agents, uniquely built and calibrated to quantify the welfare effects of the adoption of the original Social Security program on agents who were alive at the program's adoption. The initial steady state is calibrated to the U.S. economy prior to the Great Depression in which no Social Security exists. We then introduce the Great Depression which starts the economy on a perfect foresight transitional path. This path is altered by a second unexpected shock, the introduction of Social Security. Thus, the final steady state represents the U.S. economy after a transition through the Great Depression and the adoption of Social Security in accordance with historical law.[5]

2.1 Demographics

Time is assumed to be discrete, and the model period is equal to one year. Agents enter the model when they start working, which is approximated to be at age 20. Agents can live to a maximum possible age of J. Thus, in each period, the economy is populated by $J-19$ overlapping generations of individuals of ages $20, 21, ..., J$. 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 Conesa 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 endogenously choose the age $j = R$ at which the retire. The binary decision to retire (i.e., $I = \{0,1\}$ where $I = 1$ denotes the event of retirement) is considered irreversible and is restricted to be within the age range of $[\underline{R}, \overline{R}]$.

2.2 Endowments, Unemployment, Preferences and Market Structure

In 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 the process: $\log \omega_t = \theta_j + \alpha + \nu_t$. In this specification, θ_j, which is deterministic, governs the average age-profile of wages (or age-specific human capital), $\alpha \sim NID(0, \sigma_\alpha^2)$ is an individual-specific fixed ability shock that is observed when an agent enters the economy 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: $\nu_t = \rho \nu_{t-1} + \psi_t$, with $\psi_t \sim NID(0, \sigma_\nu^2)$ and $\nu_1 = 0$. The exogenous unemployment shock, D_j, is discretized to two values, zero and $d \in (0,1]$. The positive value d, which

[5] We focus on the welfare effects of the original Social Security program that was implemented between 1938 and 1940 and thus we do not incorporate any subsequent changes to government programs.

indicates an unemployment spell, 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: $E_0 \sum_{j=0}^{J} \beta^j U(c_j, h_j, I_j)$, 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, $U(c_j, h_j, I_j)$, 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: $U(c_j, h_j, I_j) = (1 - D_j)u(c_j, h_j, I_j) + D_j u(c_j, 0, I_j)$. Modeling 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.[6]

Agents can hold savings in the form of assets, $a_t \geq 0$. Agents choose to save for two reasons. First, they save to partially insure against idiosyncratic labor productivity, unemployment, and mortality risks. Moreover, they save in order to help fund their post-retirement consumption. Once Social Security is adopted, the program provide another source of post-retirement consumption.

2.3 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, 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, where factor prices r_t and w_t are equated to their marginal productivity. The aggregate resource constraint is: $C_t + K_{t+1} - (1 - \delta)K_t + G_t \leq AK_t^{\zeta} N_t^{1-\zeta}$ where, in addition to the above described variables, C_t and G_t represent aggregate individual and government consumption, respectively.

[6]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.

2.4 Government Policy

The government distributes accidental bequests to the living in a form of lump-sum transfers, Tr_t, and consumes in an unproductive sector.[7] Government consumption, G_t, is exogenously determined, and is modeled as proportional to the total output in the steady state economy, so that $G_t = \phi Y_t$. The level of government spending is determined in the steady state without Social Security and is held constant throughout the transition. Once Social Security 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 $\overline{y}$) to finance Social Security payments, b_t^{ss}, for retired workers.

The government taxes income according to a schedule $T(\tilde{y}_t)$ in order to raise revenue to finance its spending in the unproductive sector. The taxable income, $\tilde{y}_t$, is defined as: $\tilde{y}_t = y_t + r_t(Tr_t + a_t) - 0.5\tau_t^{ss}\min\{y_t, \overline{y_t}\}$. 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. In the benchmark steady state with no Social Security, τ_t^{ss} is set to zero.

Similar to the current system, the original Social Security benefits were calculated as an increasing, concave, piecewise-linear function of worker's average level of labor earnings. However, the original program was considerably less progressive, with the benefits formula being governed by a single bend point and two marginal replacement rates. Unlike the current program, the original Social Security benefits were adjusted for the number of years in which an individual contributed payroll taxes and the benefits were disbursed only after an agent reached the normal retirement age (NRA) of 65.[8]

Social Security payments are computed using equation:

$$b^{ss} = f(x_j) \times (1 + \frac{Jr}{100}), \tag{1}$$

and are calculated in three steps. First, we compute each worker's average level of labor earnings

[7] 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.

[8] The current system has two bend points and three marginal replacement rates. Moreover, it allows individuals to claim Social Security benefits, though actuarially adjusted, prior to reaching their NRA. Finally, there are no adjustments to the Social Security benefits for the number of years worked, only the top thirty years of income are considered, and earned income only through age 70 is factored into the calculation of the Social Security benefit. For a detailed review of the current system, see Peterman and Sommer (2014).

over the working life cycle, $x_{j=R}$. At every age, the total accumulated earnings follow the law of motion:

$$x_{j+1} = \frac{\min\{y_j, \bar{y}\} + (j-1-19)x_j}{j-19}, \tag{2}$$

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.[9] Second, the pre-adjustment Social Security benefit, $b^{ss}_{base} = f(x_{j=R})$, for each retiree is calculated using a convex, piecewise-linear function of average past earnings observed at retirement age, $x_{j=R}$, so that the marginal benefit rate varies over three levels of taxable income:

$$\begin{array}{lll} \tau_{r1} & \text{for} & 0 \leq x_R < b_1 \\ \tau_{r2} & \text{for} & b_1 \leq x_R < b_2 \\ 0 & \text{for} & x_R \geq b_2. \end{array} \tag{3}$$

The parameter 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. Finally, an adjustment is made to the benefits to account for the number of years of payroll tax contributions. In particular, in a sharp departure from the current system, for each year that agents pay payroll 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: $b^{ss} = b^{ss}_{base} \times (1 + \frac{R}{100})$ with $b^{ss} \in [b^{ss}_{min}, b^{ss}_{max}]$.

3 Dynamic Program and Definition of Equilibrium

For expositional convenience, this section introduces the dynamic program of an individual born in to the final steady state with Social Security. The program simplifies into the problem solved in the initial steady state economy with no Social Security once τ^{ss} and b^{ss} are set to zero. The Appendix provides a formal definition of the market equilibrium.

[9] If an agent chooses to retire prior to the NRA, then their average earnings for non-working years prior to reaching the NRA are populated with zero. Additionally, if an agent chooses to work past the NRA then the additional years worked past the NRA are factored into their lifetime average earnings from which the ultimate Social Security benefits are computed.

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 (suppressing time subscripts):

$$V_t(a,x,\alpha,\nu,j,d) = \begin{cases} \max_{c,a',x',h} U(c,h,D) + \beta s_j EV_{t+1}(a',x',\alpha,\nu',j+1,D') & \text{if} \quad j \leq \underline{R}, \\ \max_{c,a',x',h,I=\{0,1\}} U(c,h,D) + \beta s_j EV_{t+1}(a',x',\alpha,,\nu',j+1,D') & \text{if} \quad \underline{R} < j \leq \overline{R}, \end{cases} \tag{4}$$

subject to

$$\begin{aligned} c+a' &= (1+r)(Tr+a) + y - T(\tilde{y}) - \tau^{ss}\min\{y,\bar{y}\} & \text{if} \quad I = 0, \\ c+a' &= (1+r)(Tr+a) - T(\tilde{y}) + b^{ss} & \text{if} \quad I = 1. \end{aligned} \tag{5}$$

by choosing consumption, $c > 0$, savings, $a' \geq 0$, time spent working, $h \in (0,d]$, and whether to permanently retire, $I \in \{0,1\}$. 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 $\tilde{y}$ defines the taxable income on which the income tax, T, is paid. $D \in \{0,d\}$ is the state variable for the fraction of the period an agent is exogenously unemployed. The Social Security tax rate, τ^{ss}, is applied to the pre-tax labor income, y, up to an allowable taxable maximum, $\bar{y}$, and b^{ss} denotes the individual-specific constant Social Security benefit that is received by retired agents every period after reaching the NRA.

3.2 Dynamic Program of a Previously Retired Agent

Retired agents are no longer affected by labor productivity or unemployment shocks because they no longer work. As such, a retired agents indexed by type (a_t, b^{ss}, j) solves the dynamic program:

$$V_t(a,b^{ss},j) = \max_{c,a'} U(c,h) + \beta s_j EV_{t+1}(a',b^{ss},j+1), \tag{6}$$

subject to

$$c+a' = (1+r)(Tr+a) + b^{ss} - T(\tilde{y}), \tag{7}$$

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. These agents who are older than the NRA also receive the constant per-period Social Security payment, b^{ss}.

4 Calibration of the Steady States

We begin by calibrating the initial steady state that excludes Social Security. Thus, to the extent that reliable data are available, we use historical data prior to the adoption of the original Social Security program to calibrate the initial steady state model with no Social Security. When available, parameter values are sourced directly from the data. The remaining parameters in the model are set such that the model reproduces key historical moments of the U.S. data. After calibrating the benchmark economy without Social Security, we parametrize the original Social Security program and compute the final steady state while keeping all the non-Social Security parameters at their levels in the benchmark model. 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 $j = 20, ..., 93$. The population growth rate, n, is set to 1.6 percent to match the average U.S. annual population growth (reported by the Census Bureau) 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)). To increase the computational tractability of the model, the minimum and maximum ages at which an agent is allowed to retire ($\underline{R}$ and $\overline{R}$) in the model are set at 60 and 85, respectively.[10]

Ideally, to calibrate the wage process, we would rely on panel data on wages. However, such historical data is not available. Given the lack of data, we follow Conesa et al. (2009) in calibrating the process for the labor productivity, ω, based on cross-sectional wage data from the 1940 Census.[11] We restrict the estimation sample to male household heads who (i) were between ages 20 and 64, (ii) worked at least five weeks and 1,248 hours over the year. To pin down the deterministic age-specific productivity profile, we regress natural log of average wages on a quadratic polyno-

[10]Constraining the binary retirement decisions to 25 years reduces number of periods in which such decisions are made, thereby reducing the state space. That said, disallowing agents from retiring prior to age 60 in the model does not seem to be inconsistent with the data, as less than 10 percent of all male household heads were reported out of labor force in either the 1920 or the 1930 Census (i.e., in a period prior to the adoption of the original Social Security program).

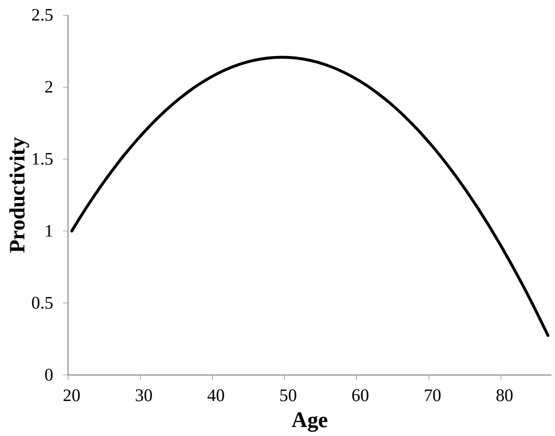
[11]Ideally, the productivity process would be calibrated from data prior to the Great Depression and the implementation of Social Security. Unfortunately, to the best of our knowledge, such data are not readily available prior to 1940. To reduce the effects of the adoption of Social Security in 1940 on our estimates, our analysis focuses on observations for individuals who were younger than the NRA in 1940. However, we are unable to control for the effects that the adoption of Social Security might have had on labor supply and wage wage dynamics of younger individuals.

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

Parameter	Value	Source/Target
Demographics:		
Normal Retirement Age: NRA	65	U.S. SS Program
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 age 65
Productivity Parameters:		
Persistence Shock: σ_ν^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.

Figure 1: **Deterministic Age Profile of Wages**



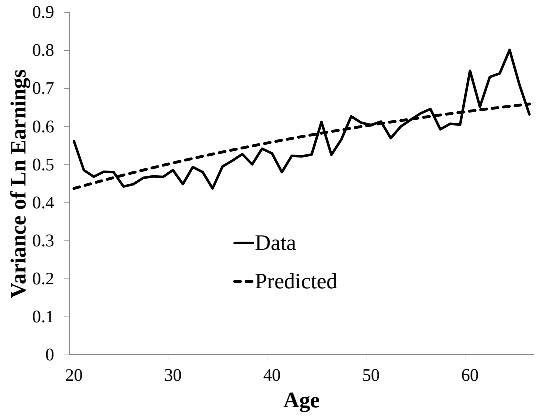
mial of age, and normalize the exponential transformation of this profile to one at age 20. This exponential transformation is shown in Figure 1. Having calibrated the deterministic age-profile, we next use the age-specific variance of the natural log of wage by age (shown in Figure 2) to infer the parameter values for the permanent and persistent shocks to the individuals' productivity. First, we set the variance of the permanent shock, σ_{α}^2, to 0.191 in order to match the minimum variance of the natural log of wages between ages 20 and 30 in the data. Second, turning to the persistent productivity shock, we set $\rho = 0.990$ to match the linear growth of the variance in wages over the life cycle, depicted by the solid line in Figure 2. Finally, we set σ_{ν}^2 so that its calibrated value minimizes the sum of squared percentage deviations between the empirical and simulated variance of wages at each age (plotted in Figure 2). In order to solve the model, we discretize the permanent and persistent shock with two and five states, respectively.[12] For expositional convenience, we refer to the two different states of the permanent shock as high and low ability types.

To calibrate the unemployment shock we rely on the data from the Philadelphia Labor Survey (Palmer (1937)), a historical survey of the Philadelphia labor market from 1929 to 1937. Using the 1929 data, we calibrate the unemployment shock $D \in \{0, d = 0.3\}$, so that prior to the Great Depression unemployed agents spend roughly thirty percent of the year unable to work. Turning to the probability of an unemployment shock, we set $p_d = 0.041$ to match the national average unemployment rate over the period 1945-1950 in the NBER unemployment series.[13]

[12] Given the highly persistent process, we use the Rouwenhorst method to discretize the productivity process.

[13] The NBER series compiles estimates from several different sources. The 1929-1944 estimates are based on

Figure 2: **Unconditional Variance of Natural Log of Wages**



As discussed in Section 2.2, the per-period utility, $U(c,h,I)$, 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.[14] We model the preferences within each sub-period as additively separable between consumption (c) and labor (h):

$$u(c_{it},h_{it},I_{it}) = \frac{c_{it}^{1-\gamma}}{1-\gamma} - \chi_1 \frac{h_{it}^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}} - \chi_2(I_{it}-1), \tag{8}$$

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 (though generally based on more recent data) typically range between 1 and 3. Given the lack of historical estimates, we thus 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.[15] However, more

Conference Board data, whereas the 1945-1946 estimates are from Census Bureau's "Current Population Reports." Finally, 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. This average estimate for the 1945-1950 period is fairly close to the available estimates for 1929 of about 3 percent from Darby (1975) and Lebergott (1964).

[14]If $D = 0$ then an agent is always employed and only one sub-period is included.

[15]See, for example, Kaplan (2012), Altonji (1986), MaCurdy (1981), Domeij and Floden (2006) or Browning et al. (1999).

recent research shows that these estimates may be biased downward.[16] Again, given the lack of historical estimates, we thus calibrate σ to 0.5—the upper range of the available estimates.

Turning to the remaining preference parameters, the scaling constant χ_1 is calibrated such that, on average, agents work 28.2 percent of their time endowment working prior to the normal retirement age, corresponding to the 1940 Census in which male household heads worked on average 1,760 hours per annum.[17] 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 NRA.[18,19] Finally, the discount factor, β, is calibrated to 0.9945 to endogenously match the U.S. capital-to-output ratio of 3.0.[20]

Given the number of simplifying assumptions due to the lack of historical data, it is helpful to compare the endogenously generated retirement decisions in the baseline model against the available historical estimates. Figure 3 plots the fraction of male household heads who are not in the labor force in the data and the fraction of retired agents in the initial steady state without Social Security. Even though we only directly target the fraction of retired households at age 65 (14.3 percent), the predicted average retirement decisions across the whole age range look remarkably similar in the model and the data.

4.2 Firm

The aggregate production function is Cobb-Douglas, with the capital share parameter, $\zeta = 0.36$. The depreciation rate is calibrated to endogenously match the investment to output ratio of 25.5 percent reported by the BEA in 1929 and 1930.

[16] See Imai and Keane (2004), Domeij and Floden (2006), Pistaferri (2003), Chetty (2009), Contreras and Sinclair (2008), and Peterman (2012).

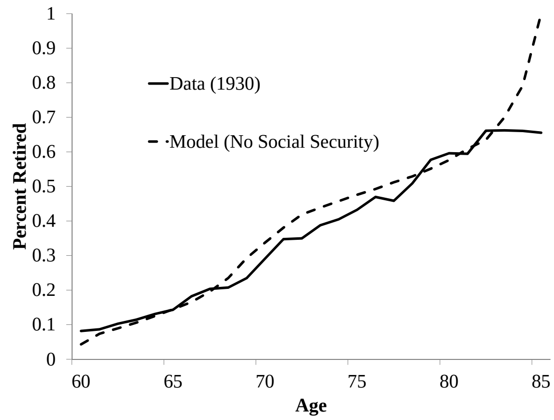
[17] Ideally hours would be calibrated to the data prior to the implementation of Social Security. However, hours data is not available from the Census until 1940. In order to get around the effects of Social Security on hours, we calibrate to hours worked for individuals who are too young to be eligible to collect Social Security benefits.

[18] For calibration, individuals who are not in the labor force in the Census data are considered retired. This assumption seems reasonable for younger agents since less than five percent of heads of households under the age of 55 are not in the labor force in the Census data.

[19] The fixed cost $\chi_2 > 0$ implies that the disutility from working discontinuously increases when an agent goes from zero to positive hours worked. See Peterman and Sommer (2014) for a discussion of this modeling approach used in a similar framework.

[20] Capital is calculated as the sum of private fixed assets and consumer durables reported by the Bureau of Economic Analysis. The values are not reported prior to 1929. However, the ratio is centered around 3 from 1929 through 1931.

Figure 3: **Percent Retired**



Note: The data is from the 1930 Census. We 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.

4.3 Government

We 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.

Turning to the income tax function, in the 1930s, the federal tax policy was much less progressive than the current system. Namely, a large fraction of taxable income was tax-exempt, and the rest was taxed at a low flat rate of 4 percent for most individuals.[21] Consequently, close to 50 percent of tax returns had zero or negative tax liability in the 1930s.[22] Thus, we model the stylized income tax policy as:

$$T(\tilde{y}_t; \Upsilon_0, \Upsilon_1) = \Upsilon_0 \max\{\tilde{y}_t - \Upsilon_1, 0\}, \tag{9}$$

where Υ_0 is the flat marginal tax rate and Υ_1 controls the level of the tax exemption. Υ_1 is calibrated so that in the initial steady state approximately 50 percent of tax filers don't pay any taxes. Moreover, we calibrate Υ_0 such that the government budget constraint clears. We find that the marginal

[21] 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 was 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 the Macroeconomic historical data from the National Bureau of Economic Research of $1,054.

[22] Source: Tax Foundation (http://taxfoundation.org/article/federal-individual-income-tax-returns-zero-or-negative-tax-liability-1916-2010)

rate of 4.6 percent clears the governments budget.

In accordance with the historical law, we set the NRA to 65 and let marginal replacement rates (τ_{r1}, τ_{r2}) at their historical respective values of 0.4, and 0.10.[23] Next, in the spirit of Huggett and Parra (2010), we set the bend point (b_1), the maximum earnings ($\bar{y}$), the maximum benefit (b^{ss}_{max}), and the minimum benefit (b^{ss}_{min}) so that they occur at 0.57, 2.84, 0.97, and 0.11 times mean earnings in the economy.[24]

5 Calibration of the Transitional Path

Having calibrated the initial and final steady states with no and the original Social Security programs, respectively, this section parameterizes (i) the economic shocks associated with Great Depression and (ii) the implementation path of the original Social Security program as the economy transitions from one steady state to the other. Both of these historical events are incorporated in the transition such that the model's transition is consistent with the actual historical experience. Figure 4 outlines the timeline of events, and we also describe it in further detail below.

5.1 The Great Depression

We model the initial unexpected economic downturn associated with the Great Depression as one that affects the economy through three distinct channels: an adverse TFP shock, an adverse capital depreciation shock, and an adverse unemployment shock. We calibrate these shocks to match the total changes in the available empirical estimates of the TFP, capital stock and unemployment rate between 1929 and 1932 (see timeline in Figure 4).[25] After these initial sudden and unexpected shocks, we model the rest of the Great Depression through elevated unemployment risk and depressed TFP that persist through 1945. Unlike the initial shocks, these persistent aggregate shocks are no longer treated as a surprise.

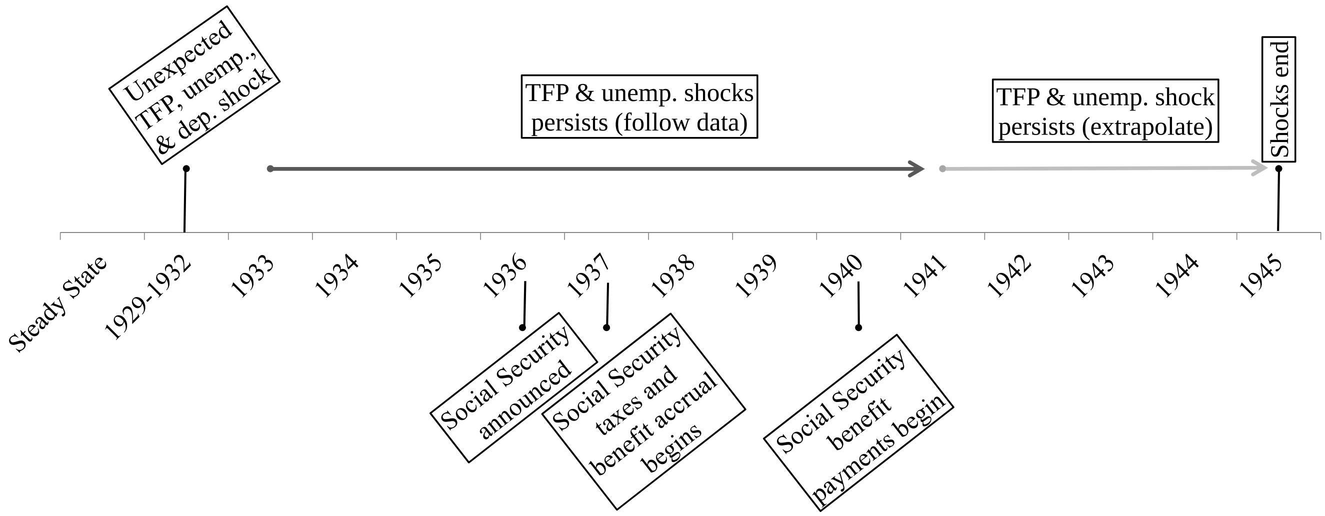
Figure 5 shows the 1890-1950 historical estimates of TFP from Kendrick et al. (1961). With

[23] 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.

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

[25] For computational convenience, the initial 1929-1932 changes in TFP, capital stock and unemployment are condensed into a single period.

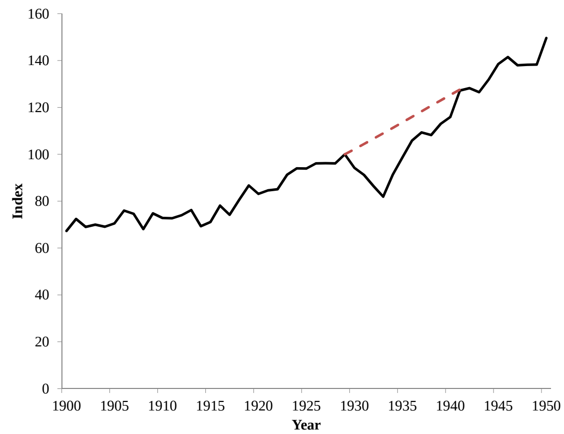
Figure 4: **Timeline**



the exception of the Great Depression, Kendrick's TFP series is generally increasing throughout the first half of the 20th century. In order to isolate the change in TPF (or the TFP shock) due to the Great Depression, we control for the observed time trend by regressing Kendrick's TFP series on a third order polynomial in time and a binary indicator for the Great Depression (1930-1940). The red dashed line in Figure 5 depicts the predicted TFP from the regression (excluding the effect of the indicator variable for the Great Depression). For every year between 1930 and 1940, we define the TFP shock associated with the Great Depression as the difference between the actual TFP (black line) and the predicted counterfactual TFP (red dashed line) that excludes the effects of the Great Depression. After 1940, one complicating factor of our analysis is the presence of the economic effects associated with World War II (WWII) that were probably not anticipated at the time when Social Security was adopted.[26] To exclude the extra boost to TFP from WWII, we assume that instead of recovering immediately, TFP linearly recovers to its expected 1945 value from its 1940 value over the next five years.

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

Figure 5: **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.

Turning to the capital depreciation stock, according to the BEA, the fixed assets fell by 24 percent between 1929 and 1932. To implement this shock, we introduce a one-time increase of 24 percentage points to the depreciation rate, δ. The one-time increase in δ is assumed to be unexpected and immediately dissipates, though its effects on the economy persist as it takes time for the economy to recover the lost capital.

Finally, Figure 6 plots the various estimates of unemployment rate between 1929 and 1940 (the last year in the model that is treated as unaffected by the economic activity associated with WWII), sourced from the NBER-Conference Board, Lebergott (1964) and Darby (1975). Despite some differences caused in part by varying definitions of the unemployed, all three series generally point to a sharp increase in unemployment of about 20 percentage points between 1929 and 1932.[27] After that, with the exception of 1938, all three series slowly converge to their long-run rate of about 4 percent (calculated for the period 1945 to 1950). Table 3 lists the unemployment rates throughout the Great Depression (derived from the Conference Board data) that we incorporate in the model and the deviations from the steady state. Similar to TFP, we do not want to incorporate the decrease in the unemployment rates that are do World War II, so we assume the shocks to the

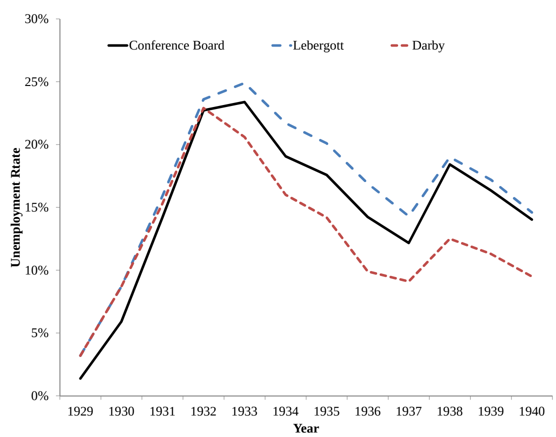
[27]One reason why Lebergott's and Darby's series diverge in later years is that Lebergott (1964) considers individuals in "work relief" programs as unemployed while Lebergott (1964) considers these individuals employed. The Conference Board series does not report whether they include individuals in "work relief" programs as unemployed. See Margo (1993) for a description of the differences between some of these estimates. Of note, Lebergott's series is based on seasonally adjusted monthly estimates which we then convert to annual estimates by taking the average over the year.

Table 2: **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.

Figure 6: **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.

unemployment rates from 1941-1945 linearly decline to zero.

Table 3: **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.

5.2 Social Security

Social Security was initially signed into law amidst the Great Depression in late 1935. According to the original law, all eligible agents were scheduled to start funding the system in 1937, with the first benefits payments being paid out in 1942. However, the 1939 amendments introduced three notable changes: (i) the program became more inclusive, (ii) eligible agents were allowed to receive benefit payments already in 1940 (i.e., two years ahead of the initial schedule), and (iii) income after the NRA was included in the Social Security benefit (b^{ss}) calculation. For computational tractability, we assume that agents learn about both the original law and these later amendments at the end of 1935.[28] Second, we ignore further amendments after 1940 since these were not part of the initial program that was implemented.

During the initial phase-in of Social Security, the program had a few important differences

[28] Therefore, prior to 1936 agents are unaware that the program will be enacted and act as if the program will not exist.

Table 4: **Social Security Tax Rates**

Year	Payroll Tax Rate
1937	2.0%
1938	2.0%
1939	2.0%
1940	2.0%
1941	2.0%
1942	2.0%
1943	4.0%
1944	4.0%
1945	4.0%
1946	4.6%
1947	4.6%

Notes: The payroll tax rates from 1937 through 1945 are equal to their historical values. After 1945 they are set at the rate that clears the Social Security budget constraint in the steady state.

from the steady state. First, unlike in the final steady state where all agents were eligible to collect Social Security payments after retirement because they paid into the system, not all agents in the original cohort were eligible for Social Security benefits. In particular, along the transitional path, agents who never contributed payroll taxes were ineligible for Social Security.[29] Second, in accordance with the historical experience, we let the payroll tax rate vary along the transitional path. In particular, we set the 1940-1945 rates equal to their historical levels (see Table 4). However, after 1945, we calibrate $\tau^{ss} = 0.046$ so that the Social Security program's per-period budget is be balanced in the final steady state.[30] Third, and most important for the welfare implications, benefits were calculated from the average lifetime earnings only after the program was adopted. Thus equation 2 is altered to,

$$x_{j+1} = \frac{\min\{y_j, \bar{y}\} + (j-1-19-s)x_j}{j-19-s}, \tag{10}$$

where s is the age at the time earnings begin to be recorded (1937).

[29] On exception to this general rule were agents who turned 65 between 1937 and 1940. These agents paid Social Security taxes until they turned 65, but did not qualify for the standard retirement benefit calculation as described in Section 2.4. Instead, these agents were reimbursed 175% of the amount they contributed in payroll taxes in a lump sum payout. This exception is incorporated into our model.

[30] In reality, the actual rate hovered around a slightly higher level of about 5 percent over this period. However, some of this revenue was used to fund other parts of the Social Security program that were not related to the retirement benefits, suggesting that our calibration likely represents a reasonable approximation of the world at the time.

6 Results

6.1 Welfare Effects of Social Security in the Steady State

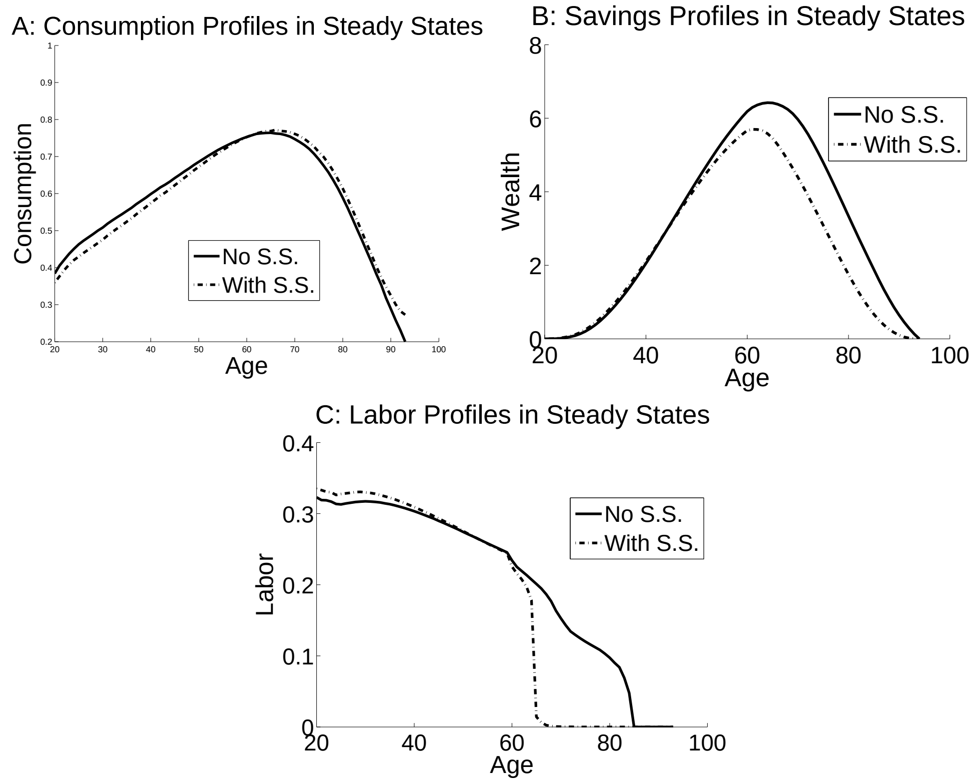
This section compares the steady state economies without Social Security (the initial steady state) and with Social Security (the final steady state). Table 5 shows the aggregate variables in each economy while Figure 7 depicts the life cycle profiles. As shown Panel B of Figure 7 and in Table 5, the average savings profile as well as the level of aggregate capital K is lower in the final steady state. This is because, in the final steady state with Social Security, agents only finance part of their postretirement consumption from private funds, as some is financed with Social Security benefits. The lower K, paired with the aggregate labor supply N that is roughly identical between the two economies, translates into a higher return to capital r and lower market wage w. In turn, the higher return r in the final steady state with Social Security affects the inter-temporal allocation of consumption and leisure, inducing agents to consume less and to enjoy less leisure early in life (Panel A and Panel C of Figure 7). Finally, in the final steady state with Social Security, agents on average retire 10 years earlier than in the initial steady state without Social Security.

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 steady state welfare consequences of implementing Social Security. The first row shows 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 (CEV). The second row shows the likelihood that a newborn agent experiences more welfare in the the steady state with Social Security relative to the state state without it. Consistent with the existing studies, Table 6 confirms that Social Security is associated with lower

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.

long-run welfare. In particular, newborn agents in the final steady state economy with Social Security would be willing to give up about 2.5 percent of their expected future per-period consumption in order to be born into an economy without Social Security. In addition, there is only a 7.8 percent chance that agents will experience a welfare gain over their lifetime in the economy with Social Security relative to the economy without a program.[31]

The channels associated with the reduced welfare are standard. The program affects welfare both through direct channels and also through general equilibrium effects. With regards to the direct effects, Social Security provides both inter- and intra-generational insurance. However, the

[31] That said, the reduction in welfare due to the presence of the original program is substantially lower than that associated with the current Social Security, largely because the original program was much smaller. Peterman and Sommer (2014) estimate welfare losses from the current program of about 13 percent. Hong and Rìos-Rull (2007), Storesletten et al. (1998) and Imrohoroglu et al. (2003) report ex-ante welfare losses from the current program between 3.7 percent and 12.9 percent–somewhat smaller than those estimated in Peterman and Sommer (2014). Unlike Peterman and Sommer (2014) and this paper, those papers generally do not simultaneously include endogenous labor, endogenous retirement, and idiosyncratic labor productivity, unemployment and mortality risk.

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 distorts agents' labor supply decisions. With regards to the general equilibrium effects, the program "crowds-out" private savings, thereby reducing the stock of aggregate capital, which affects the marginal product of both capital and labor in the general equilibrium.

We next decompose the overall steady state welfare effect into effects that are transmitted through the direct vs. general equilibrium channels. The direct effects are determined by comparing the welfare of agents born into the steady state without Social Security and with Social Security, holding factor prices constant at the levels of the steady state without Social Security. The general equilibrium effect is calculated as a difference between the overall and direct effects. We find that the direct effects from Social Security increase welfare by 0.6 percent CEV, indicating that the positive welfare effects from the insurance are larger than the negative welfare effects from the distortions on savings and labor decisions and from the adverse effect of payroll taxes on budget constraints. Consistent with the small increase in average welfare, we find that the direct effects result in a 50.4 percent likelihood that agents experience more welfare in a steady state with the original Social Security. In contrast, the general equilibrium effects are quite strong, leading to a reduction in welfare of 3.1 percent CEV. Accordingly, we find that incorporating these effects lowers the likelihood that an agent will experience higher welfare by 42.6 percentage points.

Table 6: **Decomposition of Steady State Welfare Effects from Social Security**

		Contribution From:	
	Total Effect	**Direct Effects**	**G.E. Effects**
Welfare (CEV)	-2.5%	0.6%	-3.1%
Likelihood of Gain	7.8%	50.4%	42.6%

Note: "Total Effect" denotes the expected steady state welfare effects. In particular, CEV is the welfare change 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. The Likelihood of gain is the probability an agent will experience more welfare living in the steady state with Social Security as opposed to the steady state without Social Security. "Direct Effects" captures the amount of the change is 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.

6.2 Welfare Effects of Social Security During Transition

In order to assess the welfare effects of adopting Social Security on the original cohorts, we calculate two separate transitional paths. First, we simulate the baseline transition from the initial steady state without Social Security to the final steady state with Social Security along which the Great Depression happens. Second, we simulate a counterfactual transition in which Social Security is not adopted, but the Great Depression still occurs. Comparing the welfare of agents in each of these two transitional paths quantifies the welfare effects from adopting Social Security.

Figure 8 shows how closely fluctuations in aggregate output, wealth, and labor in baseline transition (which includes the historical events of the Great Depression and the subsequent adoption of Social Security) match the fluctuations in the actual data.[32] Overall, the model does a good job predicting the actual fluctuations in output and wealth. However, the model underpredicts the fluctuations in labor.[33] Next, Figure 9 compares the evolution of macroeconomic aggregates along the baseline and counterfactual transitional paths.

We use two welfare metrics to gauge these welfare effects from Social Security on the original cohorts. First, we calculate the ex-post likelihood that an agent will experience greater total lifetime utility in the benchmark transition in which Social Security is adopted than in the counterfactual transition in which Social Security is not adopted. We refer to this likelihood as Π^{trans}, and define it as:

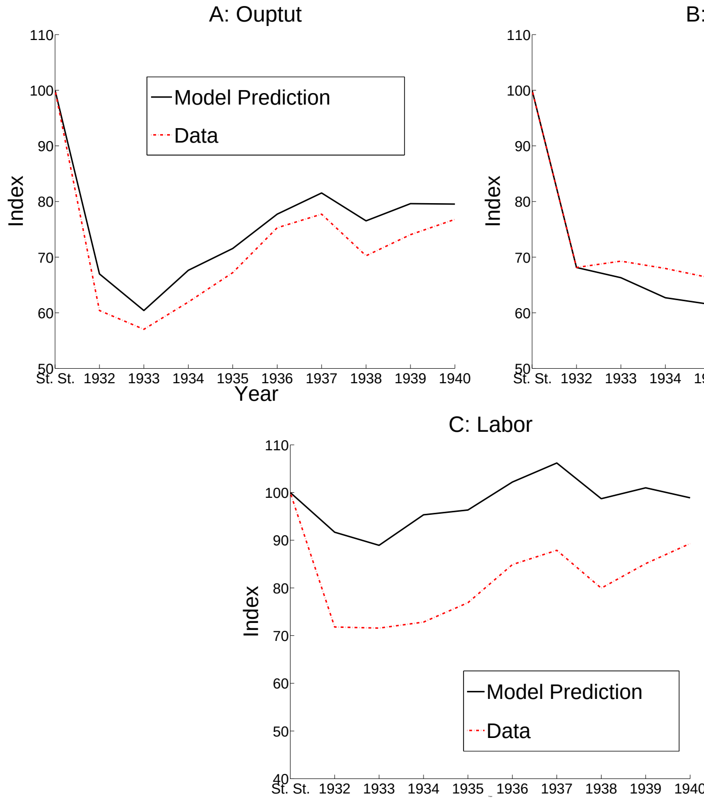
$$\Pi^{trans}\left[U\left(c_j^{\mathrm{B}},h_j^{\mathrm{B}}\right)+\sum_{s=1}^{J-j}\beta^s U\left(c_{j+s}^{\mathrm{B}},h_{j+s}^{\mathrm{B}}\right)>U\left(c_j^{\mathrm{C}},h_j^{\mathrm{C}}\right)+\sum_{s=1}^{J-j}\beta^s U\left(c_{j+s}^{\mathrm{C}},h_{j+s}^{\mathrm{C}}\right)\right], \tag{11}$$

with c_j^{B} and c_j^{C} denoting the per-period consumption levels in the benchmark transition and the counterfactual transition, respectively. Second, we define *transitional* CEV (or CEV^{trans}) as the uniform percent increase in expected consumption in each period over the remainder of an agent's lifetime that makes the agent indifferent between experiencing the benchmark and the counterfac-

[32]We end the comparison in 1940 since by 1940 the war build up may potentially have begun affecting these aggregates.

[33]The underprediction from the model may be due to the model not incorporating underemployment during the Great Depression. As such, the model may underpredict the total harm from the Great Depression.

Figure 8: **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. All three historical data series comes from Kendrick et al. (1961).

tual transitions:

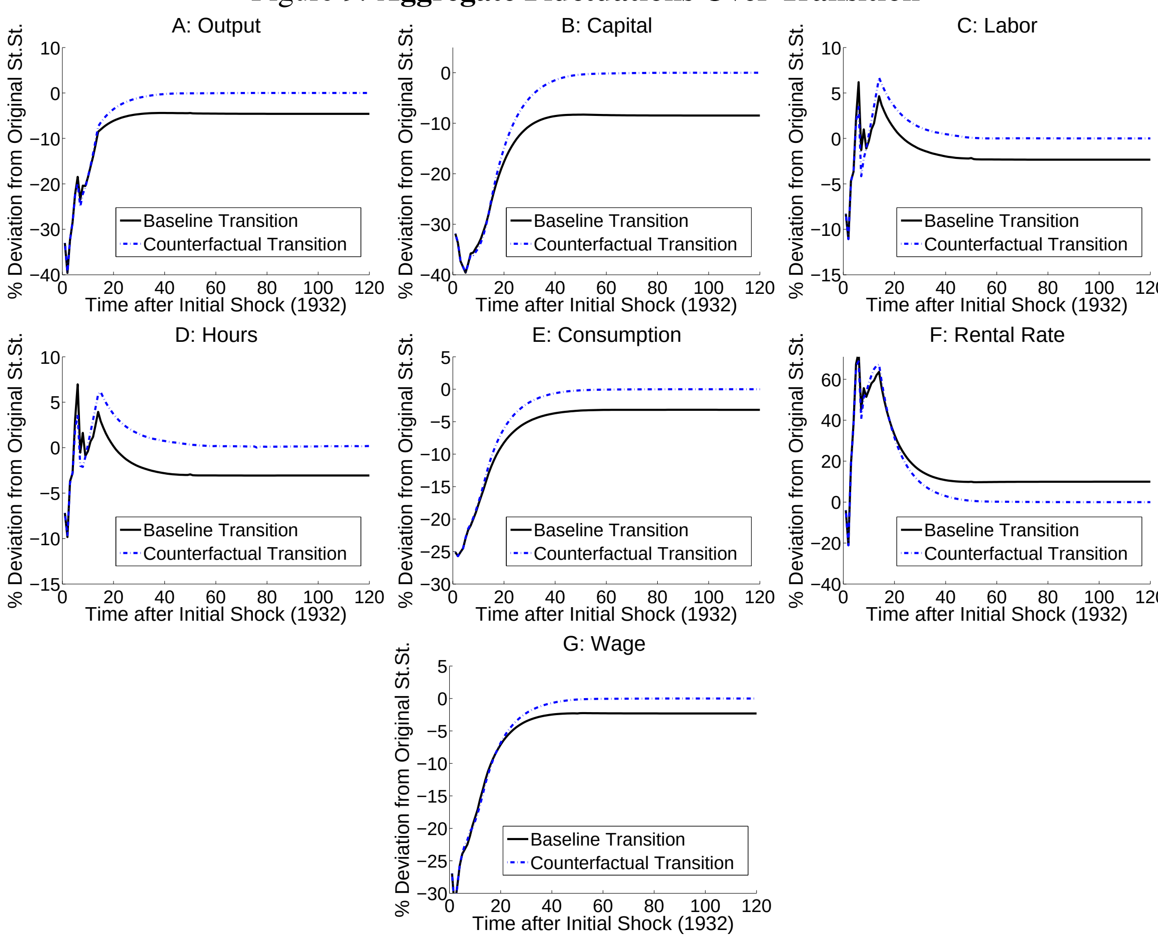
$$E\left[U\left(c_j^{\mathrm{B}}, h_j^{\mathrm{B}}\right) + \sum_{s=1}^{J-j} \beta^s U\left(c_{j+s}^{\mathrm{B}}, h_{j+s}^{\mathrm{B}}\right)\right] = E\left[U\left((1+\tfrac{\mathrm{CEV}^{trans}}{100})c_j^{\mathrm{C}}, h_j^{\mathrm{C}}\right) + \sum_{s=1}^{J-j} \beta^s U\left((1+\tfrac{\mathrm{CEV}^{trans}}{100})c_{j+s}^{\mathrm{C}}, h_{j+s}^{\mathrm{C}}\right)\right]. \tag{12}$$

A positive CEV^{trans} thus implies a welfare gain from the program's adoption. When examining the welfare effects on specific cohorts, we index *living* cohorts by their age at the time when Social Security is announced, and *future* cohorts by the number of years after the announcement that they enter the economy.

Column (1) in Table 7 shows CEV^{trans} and Π^{trans} for the original living cohorts.[34] In contrast to the welfare effects of Social Security in the steady state, we estimate that the adoption of the

[34]The economy-wide average of the transitional welfare effects is calculated as the population-weighted average across cohorts.

Figure 9: **Aggregate Fluctuations Over Transition**



Note: The black lines capture the percent changes in economic aggregates along the baseline transitional path from the original steady state without Social Security to the new steady state with Social Security during the Great Depression. The blue dashed lines capture the percent changes in economic aggregates along the counterfactual transitional path from the original steady state without Social Security to thru the Great Depresion without the adoption of Social Security.

Table 7: **Decomposition of Transitional Welfare Effects from Social Security**

		Contribution From:		
	Total Effect	**Direct Effects**	**G.E. Effects**	**Great Depression**
Welfare Effect (CEV^{trans})	5.9%	7.8%	-0.5%	-1.4%
Likelihood of Gain (Π)	83.4%	90.1%	-0.2%	-6.4%

Note: Total effect denotes the average welfare measure for all living individuals. The direct effect is calculated by eliminating the Great Depression in the simulations and holding the factor prices constant throughout the transition. The general equilibrium effects are calculated as the difference between the welfare results from simulations when the Great Depression is not included but factor prices are allowed to fluctuate and the direct welfare effects. The Great Depression effects are calculated as the difference between the total effects and the welfare effects when the Great Depression is not included.

original Social Security program led to large and broad-based welfare gains among the original living cohorts. In particular, among these cohorts, the likelihood that an agent gains welfare from Social Security is estimated at 83.8 percent, compared to mere 7.8 percent in the steady state. Moreover, the average expected welfare gain from Social Security for agents in the economy at the time of announcement is the equivalent of 5.9 percent of expected future consumption, compared to a welfare loss in the steady state.

In the steady state, we decomposed the average welfare effect into two subcomponents: the welfare effect that is transmitted through general equilibrium vs. direct channels. We conduct a similar decomposition for the transitional welfare effects; however, we isolate the welfare effects of the Great Depression into its own separate category (see Table 7). Column (2) shows that, similar to the steady state, the direct equilibrium effects are associated with welfare gains. However, these gains are much larger for the original cohorts than for agents born into the final steady state. The primary reason for this difference are the relative speeds at which Social Security benefits vs. contributions were phased in over the transition. Figure 10 demonstrates the speed at which the different parts of the Social Security program were implemented. The solid and dashed lines plot the average lifetime Social Security benefits received and taxes paid by living cohorts in the benchmark transition (expressed as a fraction of their final steady state values), respectively. Overall, the difference between the two lines demonstrates that most agents in the economy during the transition received on average more benefits relative to their Social Security contributions than what they would have had they lived their entire life in the steady state with Social Security.

The original cohorts contributed less into the Social Security system for two reasons. First, the payroll taxes were initially introduced at the low level of 2 percent (less than half of the steady state level), and stayed low for a number of years. Second, the original cohorts did not start paying into the system until the program was adopted, part way through their life. In contrast, the benefits were fully phased immediately, though the scaling factor based on years of employment lowered the benefits a bit for the transitional agents because these agents did not pay as many years into the system. Overall, this implies that the Social Security benefits are on net more generous relative to agents' contributions during the transition.

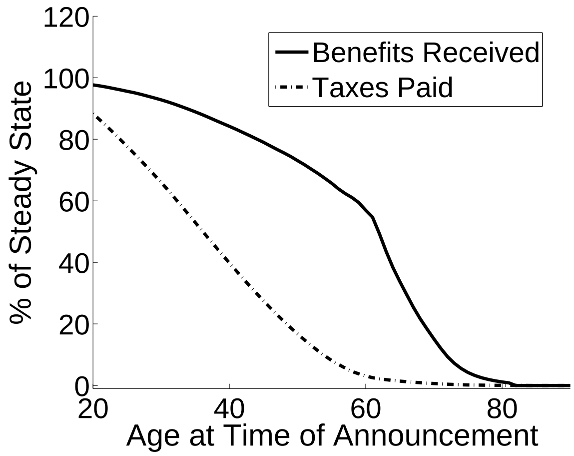
Although the program is structured such that the taxes are more gradually implemented than the benefits, we find that the program does not run a deficit. The left panel in Figure 11 plots the total outlays and revenues for Social Security in each year after the program is announced. We find that in all periods revenues either equal or exceed outlays, largely because the number of individuals contributing payroll taxes exceeds the number of Social Security beneficiaries in a given period by roughly a factor of 10 (right panel in Figure 11).[35]

Column (3) shows that, similar to the steady state, the general equilibrium effects have a negative contribution to the overall welfare effects because the program crowds out capital. However, along the transition, the negative effect is much smaller because it takes many periods for agents to adjust their savings levels in response to the program's adoption, so the crowd out of capital takes a long period of time to be fully realized (see Figure 9). Thus, unlike in the steady state where the negative general equilibrium welfare effect dominates, this effect only mutes the overall welfare gains from the program's adoption for the original cohorts.

Perhaps surprisingly, Column (4) demonstrates that, adopting the program during the Great Depression tapered the potential overall welfare benefit from adopting the program. 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 when large amounts of wealth and income were lost. However, while the adoption of Social Security during the Great Depression increased the welfare gains from the program's adoption for some (generally older) agents relative to its adoption during "normal times," adopting Social Security during the Great

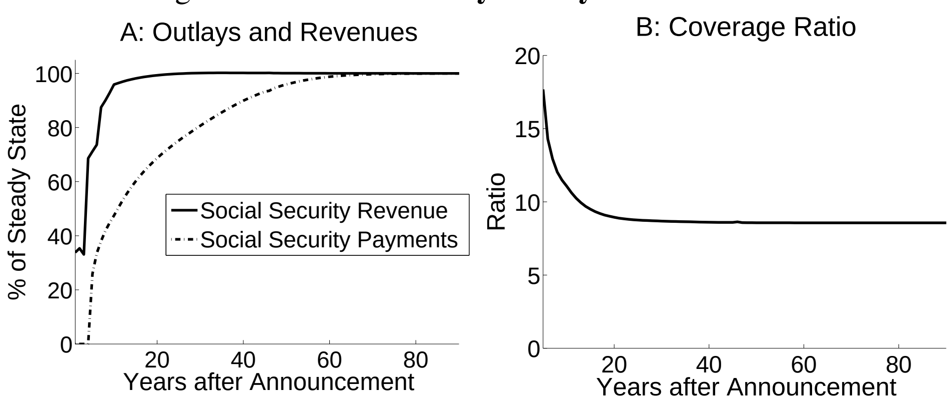
[35]Similarly, through 1960 annual total expenditures from the Old Age Survivorship Disability Insurance (OASDI) trust fund were less than annual revenues. However, making this comparison in the data and the model is not completely equivalent for two reasons. First, both revenues and expenditures in the data include parts of OASDI other than just the old-age consumption insurance. Second, further amendments of Social Security made the program larger. The larger size of benefits relative to the original program modeled here induces earlier retirement, thereby reducing the fraction of covered workers to beneficiaries.

Figure 10: **Effect of Gradual Implementation**



Note: The values indicate the average percent each agent pays into and receives from Social Security compared to the value the respective values if these agents lived in the steady state with Social Security. The values are the average within a cohort.

Figure 11: **Social Security Outlays and Revenues**



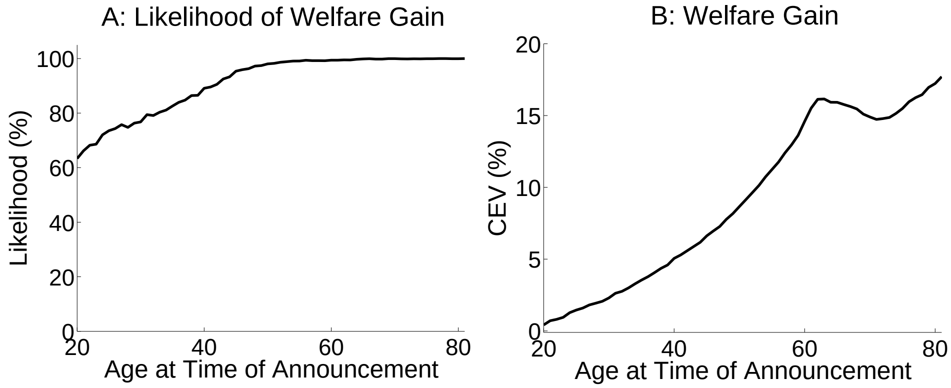
Note: The values are the total outlays or revenues received in a particular year. The values are normalized as a percent of the total outlays and revenues received in the steady state with Social Security. Outlay equal revenues in this steady state. The right panel is the ratio of agents paying payroll taxes to the number of agents receiving benefits.

Depression exacerbated welfare losses caused by the economic downturn among most agents. These agents did not receive Social Security payments for many years to come, but had to start funding the system immediately, at a time when economic conditions were especially weak.

6.3 Welfare Effects by Age

Next, we examine how the transitional welfare effects from adopting Social Security vary by the agent's age at the time of the announcement. We separate the agents into three groups: (i) agents

Figure 12: **Welfare Effect for Eligible Agents from Implementing Social Security by Age**



Note: The values are the average within each cohort for agents that are eligible to receive Social Security benefits.

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 (because they had already retired), (iii) agents who have not entered the model at the time of the announcement.[36]

6.3.1 Eligible Agents

We start by focusing on the welfare effects from the adoption of Social Security for agents who were eligible for Social Security benefits at some point in their lifetimes: over 90 percent of all agents alive at the time of the program's announcement. The fraction of agents eligible for Social Security is high for two main reasons. First, the fraction of the population eligible was largely determined by the share of agents who worked at the time of the program's announcement. Prior to the adoption of Social Security, many worked until advanced ages and some (especially lower-income agents) worked until they died.[37] Second, the Great Depression caused some agents to further delay their retirement to make up for the lost wealth and income.

The left panel in Figure 12 plots each eligible cohort's likelihood of gaining welfare due to the implementation of Social Security. Perhaps not surprisingly, the likelihood of welfare gains rises with the cohort's age at the time of the program announcement. In particular, the likelihood of an increase in welfare due to the adoption of the program is only 60 percent for households

[36] 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.

[37] In the initial steady state without Social Security, the average age of death (conditional on agent's surviving through age 20) is 66 in the model, whereas the average retirement age (for agents who do not die prior to them retiring) is 76 in the model.

age 20 at the time of the program's announcement, whereas the likelihood increases to close to 100 for households ages 40+. The likelihood of gains is generally rising for two reasons. First, individuals who are younger at the time of the program's announcement are more likely to be adversely affected by the payroll taxes because they tend to be more liquidity constrained. Second, the older an agent is at the time of the program's adoption the fewer years of payroll taxes the agent contributed prior to receiving Social Security benefits. While fewer years of contributed payroll taxes lower the post-retirement benefit size, this reduction in benefits is relatively smaller than the decrease in total payroll tax liability, meaning that a essentially all eligible agents in age cohorts 40+ enjoy higher welfare due to the adoption of the program. For example, an agent who retired five years after the inception of Social Security would face a lifetime payroll tax burden that was approximately 95 percent lower than that of the same agent who paid payroll taxes throughout their entire working lifetime. This tax burden would be reduced for two reasons. First, the agent would only pay payroll taxes for five years, as opposed to 45 years if they lived in the steady state. Second, the payroll tax rates began at a much lower rate and were phased in over a number of years. Despite paying considerably less payrol taxes, this agent would be entitled to a Social Security benefit that was only 40 percent lower.[38]

The right panel shows each cohort's expected ex-ante gain from the adoption of Social Security (CEV^{trans}). Similar to the left panel, the profile generally rises for cohorts between ages 20 and 62 at the time of the program's announcement. However, unlike in the left panel, the CEV^{trans} starts declining for cohorts age 62 before rising again for cohorts ages 70+. What causes the CEV^{trans} to fall and then rise again for these older cohorts? To understand these dynamics, one has to examine the composition of the welfare effects from the program by agents' wealth and age.

The upper left panel of Figure 13 plots the CEV^{trans} by age for each quintile of the wealth distribution.[39] After age 62, the welfare gains from the adoption of Social Security decline for agents in the top three quintiles. In contrast, the welfare gains continue to rise for cohorts ages 62+ in the lowest quintile. Since the higher-wealth agents tend to retire earlier, eligible cohorts ages

[38]The 40 percent reduction represents the agent paying into the system for 40 less years and thus receiving a scale up factor of only 5 percent as opposed to 45 percent. For the convenience of exposition of this argument, in this example we assume that an agent's income was constant across his working life cycle, the discount rate is one, and the agent retires at age 65.

[39]The wealth quintiles are determined for each agent by comparing the total wealth at the time of the announcement of Social Security within each cohort.

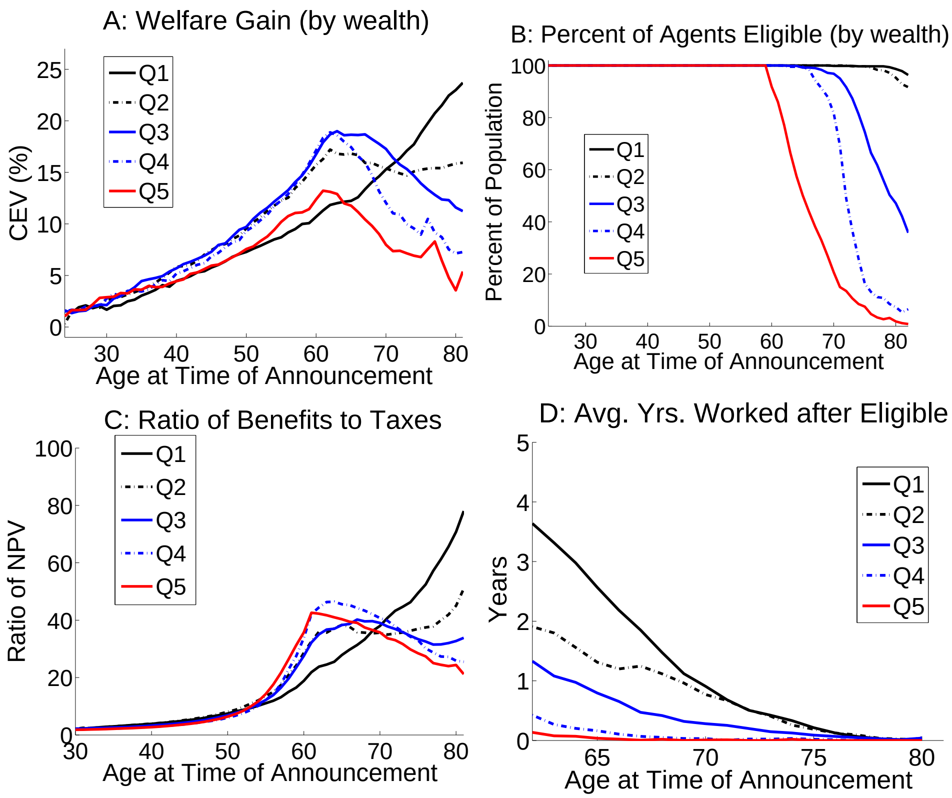
70+ are disproportionately made up by low-wealth agents (Panel C in Figure 13). Hence, among cohorts who are in their sixties at the program's announcement, the fraction of wealthy agents is large enough to cause the CEV^{trans} to fall. However, among cohorts who are in their seventies, the lower wealth quintile makes up a large enough fraction of the eligible agents in these cohorts so that the CEV^{trans} continues to rise.

The different dynamics of the CEV^{trans} by age for the different wealth quintiles can be explained by the relative size of the total benefits received compared to the total payroll taxes paid. The lower left panel in Figure 13 plots the discounted net present value (NPV) of the ratio of the expected benefits to payroll taxes for these agents by wealth quintile. For the bottom wealth quintile, the NPV benefits-contribution ratio rises monotonically with age at the time of the adoption. In contrast, for the top three wealth quintiles, the ratio peaks round age 62 and subsequently falls for agents older at the time of the adoption.

These dynamics are primarily driven by the differences in retirement decisions across wealth quintiles. For each wealth quintile, the lower left panel plots the average number of years that a transitional agent works after becoming eligible to collect Social Security benefits. Irrespective of their age at the time of the program's announcement, agents in the top wealth quintile retire immediately when they are eligible to start receiving benefits. In a marked contrast, agents in the bottom wealth quintile tend to work several years after becoming eligible for Social Security benefits. Moreover, the number of years these agents work after becoming eligible declines with the agent's age at the program's announcement. For agents in the top quintiles, the NPV of the total benefit collected is on average lower the older the agent is at the program's announcement because the expected number years of collected benefits is lower for older agents.[40] On the other hand, their total tax liability is quite similar, because these agents generally contribute only until they become eligible to start receiving payments. In marked contrast, for low-wealth agents, the NPV of the benefits-contribution ratio tends to rise with cohort's age at the program's announcement because not paying the additional years of payroll taxes dominates.

[40]Moreover, on average older agents receive lower wages causing the eventually Social Security payment to be lower at the time of retirement.

Figure 13: **Effect by Age and Wealth**



Note: The upper left panel plots the welfare gain in terms of CEV by age and wealth quintile. The upper right panel describes the percent of agents who are eventually eligible to receive benefits. The lower left panel plots the ratio of the net present value of the lifetime benefits received from the program relative to the lifetime payroll taxes paid. The lower right panel describes the number of years agents work after becoming eligible to start receiving Social Security benefits.

6.3.2 Ineligible Agents

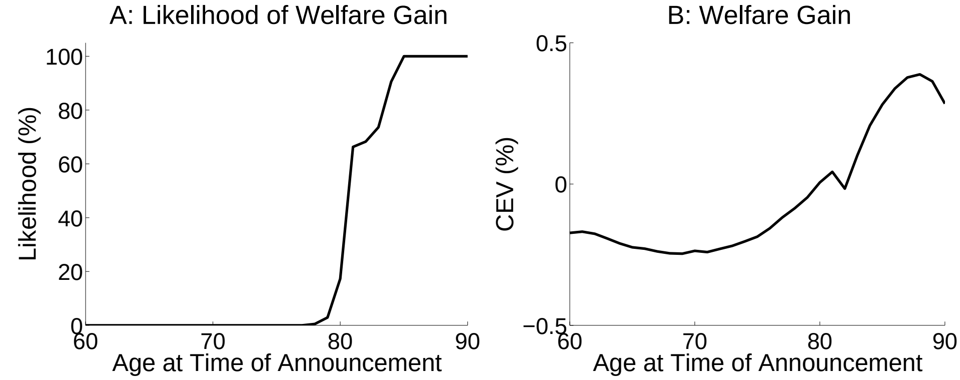
This section focuses on the welfare effects of the program's adoption on agents who are alive at the time of the program's enactment but are already retired and, therefore, ineligible to collect benefits: less than 10 percent of the living population. Figure 14 shows that the welfare effects of the program's adoption on these agents are overall small and largely depend on these agents' age when the program is announced. In particular, for ineligible agents ages <80, the program's adoption is generally associated with a small reduction in welfare, compared to a small increase in welfare for agents ages 80+.

Through which channels are ineligible agents affected? Given that these agents are already retired, they are not affected by the direct effects from Social Security nor are they affected by the relative dynamics of the wage rate. Instead, the driving factor behind the measured welfare effects is the relative change in the rental rate between the benchmark and counterfactual transitions, shown in Figure 15. The figure shows that the relative return to savings rises but subsequently dips for a few periods in the benchmark transition in which Social Security is implemented compared to the counterfactual transition in which it is not. The relatively higher rental rate following the program's announcement causes the small welfare gain for the ineligible agents ages 80+. These agents benefit from the increase in the return to savings, but generally do not live long enough to also experience its subsequent decline. In contrast, the subsequent dip in the relative rental rate causes the small welfare loss for ineligible agents ages <80 for whom the negative welfare effect of the experienced relative decline in the interest rate more than offsets the positive effect of its initial relative increase.[41]

The higher rental rate in the baseline transition relative to the counterfactual transition following the program's announcement is caused by an increase in the relative amount of labor supplied: when the program is announced, eligible agents work more as their labor income is being counted toward their future Social Security benefits. After this initial increase, two competing effects determine the subsequent dynamics of the relative rental rate. First, agents tend to retire earlier in the baseline transition when Social Security is adopted, thereby lowering the relative level of ag-

[41] The subsequent increase in the relative rental rate has limited effect on ineligible agents since it takes place more than 15 years after the program is announced when these ineligible agents are either already dead or have very little savings since they will only live for a few more periods.

Figure 14: **Welfare Gain from Implementing Social Security For Ineligible Cohorts**



Note: The values are the average within each cohort for agents that are eligible to receive Social Security benefits.

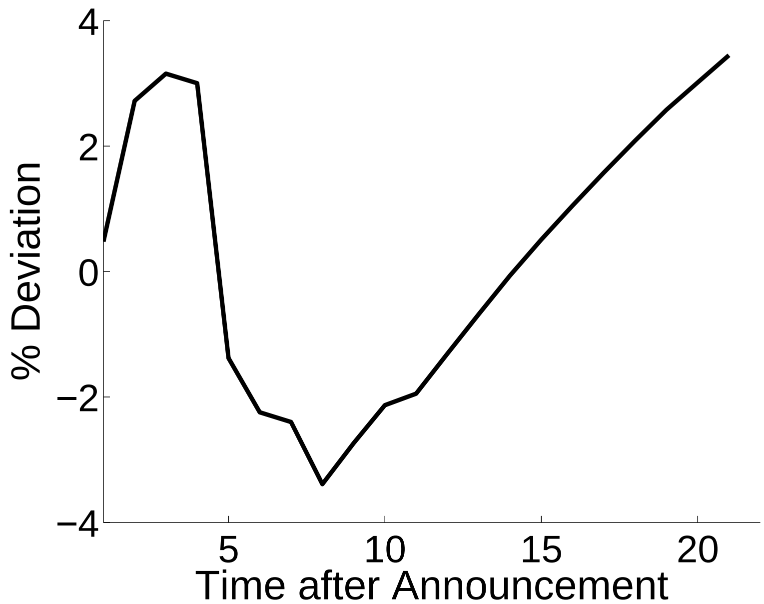
gregate labor.[42] Second, agents tend to hold relatively less savings in the baseline transition since they no longer have to fund all of their post-retirement consumption with private savings. The first effect initially dominates since agents' labor supply decisions are more flexible, causing the temporary decrease in the relative rental rate. However, the de-accumulation of capital is eventually large enough that the second effect dominates in the long run and the rental rate in the baseline transition returns to its relatively higher original level.

6.3.3 Future Cohorts

Finally, we turn to agents who enter the model after the program is implemented. We 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. We find that the likelihood is just slightly above sixty percent. However, the expected welfare gains for these agents are quite small (less than 0.5% of expected lifetime consumption). As time passes, the likelihood of experiencing a welfare gain decrease for new entrants. These cohorts who enter the model many periods after the adoption of Social Security tend to pay relatively more in payroll taxes than agents who enter the model immediately after the announcement because the payroll tax is gradually implemented over ten years. Thus, the likelihood of experiencing a welfare gain falls and the average welfare affect switches from positive to negative for cohorts who enter the model further in the future. Eventually, both the likelihood of a welfare gain and the size of the average welfare losses trend

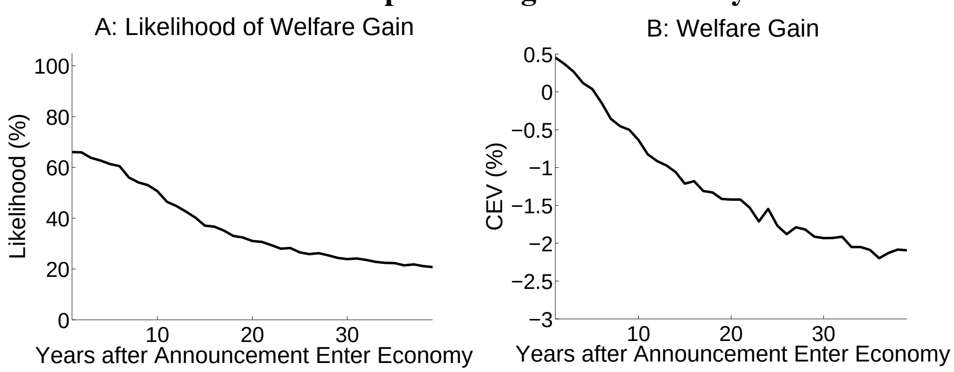
[42]Early retirement does not affect aggregate labor in the first few periods after the program is announced because agents must work until 1940 before they can start collecting benefits.

Figure 15: **Fluctuations in Rental Rate due to Social Security**



Note: The figures represent the percent difference in the rental rate between the transition with Social Security and the counterfactual transition without Social Security.

Figure 16: **Welfare Gain from Implementing Social Security For Future Cohorts**



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).

towards their steady state values.

6.4 Sensitivity

Finally, we determine the sensitivity of the results with respect to five dimensions. First, we compute the welfare effects under the alternative assumption that only agents under age 65 are eligible to receive Social Security benefits.[43] Second, we compute the welfare effect under the alternative wherein Social Security is adopted immediately at the onset of the Great Recession, as opposed to in the midst of it. Third, we include a reduced-form unemployment insurance that replaces 35% percent of average earnings in the economy.[44] Fourth, in addition to increasing the likelihood of an unemployment spell during the Great Depression in the benchmark experiment, we also increase the duration of unemployment spells so that it is consistent with Table 8.[45] Fifth, we determine the welfare effects if agents additionally face idiosyncratic i.i.d. shocks to the depreciation rate of their assets. Introducing these shocks means that retired agents not only hold savings to fund post-retirement consumption but also as a form of precautionary savings against these depreciation shocks. The shocks are set at mean zero with a coefficient of variation equal to 1.15, consistent with Krueger and Kubler (2006).

Table 8: **Increase in Duration**

Year	**Duration**	**Shock**
1929	30%	
1931	69%	
1932	94%	68%
1933	134%	68%
1934		68%
1935	211%	68%
1936	210%	68%
1937	213%	68%
1938	190%**	68%
1939	167%**	68%
1940	144%**	68%
1941	121%**	68%
1942	99%**	69%
1943	76%**	46%
1944	53%**	23%
1945	30%**	0%

Table 9 presents both the likelihood and average level of welfare gains for transitional agents in each of these sensitivity exercises. As in our baseline experiment, the welfare gains are derived

[43] Understanding the effects of this assumption is relevant because the original law excluded agents over 65, however, these agents were included in the amendment passed in 1939.

[44] Between 1943 and 1960, the average replacement rate for unemployment insurance is 35%. See The Employment and Training Financial Data Handbook 394 Report from the United States Department of Labor.

[45] The increase in duration are taken from Palmer (1937).

from an experiment that compares welfare in the baseline transition in which both the Great Depression and the adoption of Social Security occur to the alternative transition in which the Great Depression takes place but Social Security is not adopted. Focusing on the third, fifth and sixth row, respectively, adopting the program at the onset of the depression, including an increase in the duration of unemployment spells, and incorporating idiosyncratic risk to the returns to savings all have only minimal effects on the welfare gains from Social Security for transitional agents.

Onto the remaining experiments, when program eligibility is restricted to agents under 65 at the time the program is announced in the second row, the welfare gains are reduced relative to our baseline results, largely because fewer agents are eligible for the retirement benefits in this alternative experiment. In contrast, when unemployment insurance is included in the fourth row, the program becomes even more beneficial in welfare terms. When the baseline Social Security program is augmented with unemployment insurance, the liquidity constraint are eased since agents no longer need to hold as much savings to insure against an unemployment shock. The easing of the liquidity constraints makes the negative distortions from the payroll tax less painful. Overall, despite these small differences, the overall conclusion that Social Security tends to increase welfare for agents alive when the program is adopted seems fairly robust to the alternative specifications considered here.

Table 9: textbfSensitivity Exercises

	CEV	**Likelihood**
Benchmark	6.0%	83.8%
65+ Excluded	4.4%	81.4%
Immediate Adoption	6.5%	84.7%
Unemployment Insurance	9.2%	90.3%
Duration Shock	6.1%	74.1%
Idio. Risk to Savings Return	5.0%	79.7%

7 Conclusion

This paper quantifies the welfare effects of Social Security for transitional agents who experienced the program's adoption. We find that the adoption of the program benefited a vast majority of these transitional agents. In particular, we estimate that the program benefited households alive at the time of the program's adoption with a likelihood of over 80 percent, and increased these agents' welfare by the equivalent of 5.9 percent of their expected future lifetime consumption.

Through a quantitative decomposition of the overall welfare effects, we find that the adoption of the program was largely beneficial because of the relative speeds at which the different parts of the program were phased in. In particular, the structure of the program's phase-in was such that most transitional agents received far greater monetary benefits in a form of Social Security payments than the amount they contributed to the system through payroll taxes. Moreover, and perhaps interestingly, we find that adopting the program in the midst of the Great Depression had only a modest effect on the welfare implications of the program's adoption and, if anything, reduced the welfare gains from Social Security for the transitional agents.

This paper highlights that the welfare implications for agents alive when the program is adopted were quite different than the steady state welfare effects. Overall, the divergent welfare benefits for agents who experienced the program's enactment versus those experienced by agents born into the steady state with Social Security might offer one explanation for why a program that potentially reduces welfare in the steady state was originally adopted.

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A Equilibrium

In this section we define a stationary steady state competitive equilibrium with Social Security.[46] 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 4 - 7, with c, h,a', and I as associated policy functions.

2. The prices w_t and r_t satisfy

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

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

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:

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

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

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.

A.1 Transitional Dynamics of Aggregates

Next, we 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 9 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, we 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, we 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 17 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 transitional 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 17, we 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 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.

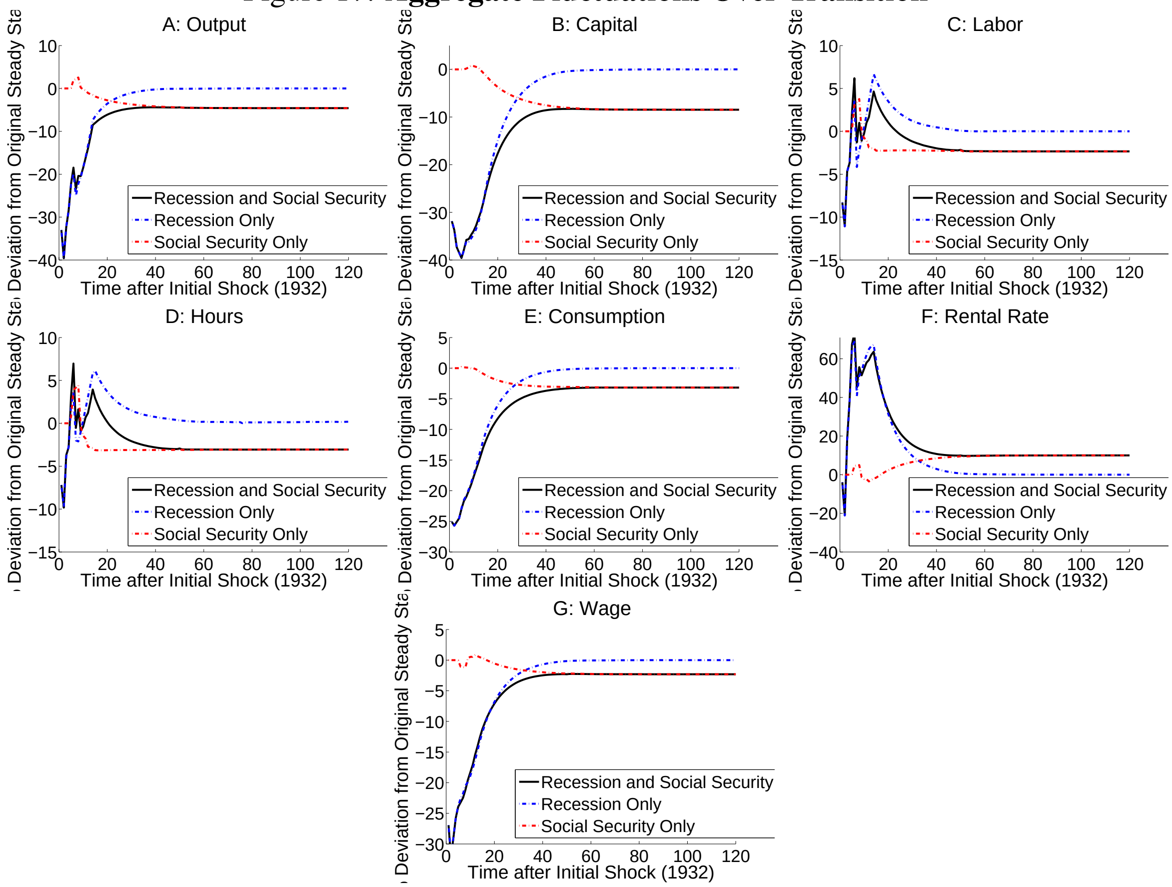
Turning to Panels C, D, and F, the transition of labor, hours, and the rental rate tends to be more dynamic with multiple peaks and troughs. Comparing the fluctuations of these three aggregates over all three transitions, the original declines are primarily driven by the business cycle shocks. The initial fall in all three aggregates is due to the drop in TFP and increase in the unemployment rate.[47] 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 17).[48] 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 17). 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 8 plots the predicted fluctuations in aggregate output, capital, and labor in the model

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

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

Figure 17: **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.

and compares them to the fluctuations in the data. In the model, we calculate the values as the percent change from the initial steady state without Social Security. In order to determine the changes in the data, we need to account for the trend growth over time. We 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, we 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.