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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 reduces 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 70 percent, and increased these original agents' welfare by the equivalent of 3.5% 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 mitigate welfare losses during deep economic downturns (Peterman and Sommer (2014)), a large literature has shown that the current program reduces steady state 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 welfare costs in the steady state—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 adoption 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 that 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 transition path to a new, post-Great Depression steady state with Social Security fully phased in. Third, along the transition 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 transition 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 and, second, we calculate the average size of the welfare gains for agents in these cohorts. 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 estimate that the original program benefited households alive at the time of the program's adoption with a likelihood of over 70 percent, and increased these original agents' welfare by the equivalent of 3.5% of their 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 time of 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] However, 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.

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 could have 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 Social Security did not receive Social Security benefits for many years to

[1] This calculation also includes the effects of a lower payroll tax rate faced by this agent because the payroll tax rate was scaled up to its steady state value over a number of years.

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 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).[2] 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.[3] 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 steady state 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, a 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 analyzes either the welfare implications of reforming Social Security or the implications of the program during

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

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

a particular business cycle episode. For example, Peterman and Sommer (2014) shows that Social Security mitigated a notable amount of the potential welfare losses from the Great Recession, particularly for poorer and older agents. Examples of studies that assess 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. 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 program.

This paper is organized as follows: Section 2 introduces the computational model. Section 3 presents the dynamic programming problem. 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, after which the economy transitions on a perfect foresight path. However, 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.[4]

[4]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.

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 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 $\nu_2 0 = 0$. The exogenous unemployment shock, D_j, is discretized to two values, zero and $d \in (0, 1]$. The positive value d, which 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: $E_2 0 \sum_{j=20}^{J} \beta^j U(c_j, h_j, I_j)$, 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.[5]

Agents can hold savings in the form of assets, $a_j \geq 0$. 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.

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.[6] Government consumption, G_t, is exogenously determined, and is modeled as proportional to the total output in the steady state economy, so that

[5]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.

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

$G_t = \phi Y_t$. 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 $\bar{y}$) 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.[7]

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 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

[7]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).

Security tax that corresponds to the benefit-contribution cap.[8] 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:

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

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 departure from the current system, for each year that agents pay payroll taxes, their benefits are scaled up by the equivalent of one percent, in line with the original program. 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 who enters the economy in 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.

[8] 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):

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

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, $a' \geq 0$, the fraction of available time endowment spent on working, h, 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:

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

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}, one the program is implemented.

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 taken 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 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.[9]

Ideally, to calibrate the wage process, we would rely on panel data on wages. However, such historical data are 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.[10] We restrict the estimation sample to male household heads who were between ages 20

[9] 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).

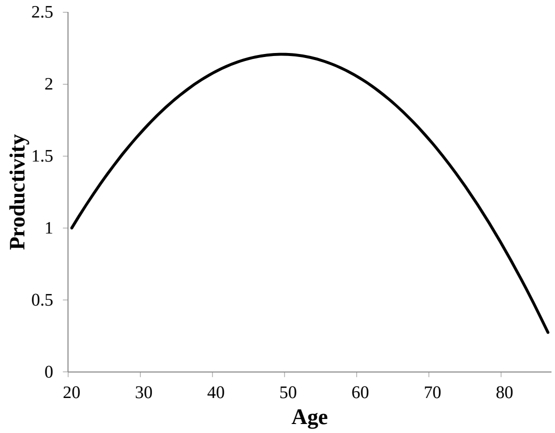
[10] Ideally, the productivity process would be calibrated from data prior to the Great Depression and the implementation of Social Security. Unfortunately, to the best of our knowledge, such data are not readily available prior to 1940. To reduce the effects of the adoption of Social Security in 1940 on our estimates, our analysis focuses on observations

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^{**}	0.9845	$\frac{K}{Y} = 3.0$
Risk aversion: γ	2	Conesa et al. (2009)
Frisch Elasticity: σ	0.5	Data; Intensive Frisch= $\frac{1}{2}$
Disutility to Labor: χ_1^{**}	67.2	Avg. h_j = .282
Fixed Cost to Working: χ_2^{**}	0.344	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	0.437	1940 Census
Unemployment Rate: p_d	4.1%	Data
Unemployment Duration: d	0.30	Palmer (1937)
Government Parameters:		
Υ_0^{***}	.059	Mrkt Clearing
Υ_1^{***}	.298	.5 Avg. Earnings
ϕ	2.8%	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***}	4.45%	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**



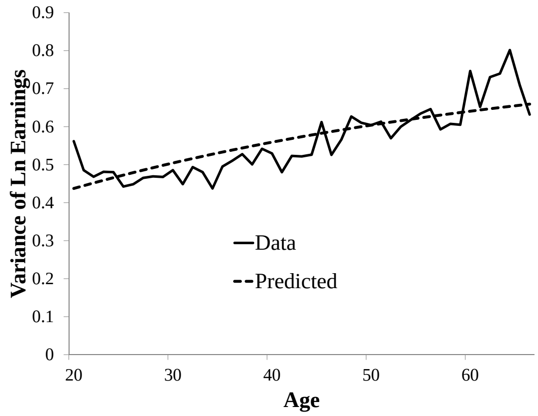
and 64, worked at least five weeks, and worked more than 1,248 hours over the year. To pin down the deterministic age-specific productivity profile, we regress natural log of average wages on a quadratic polynomial of age, and normalize the exponential transformation of this profile to one at age 20. 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 0.437 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.[11]

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 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 unem-

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.

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

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



ployment rate over the period 1945-1950 in the NBER unemployment series.[12]

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.[13] We model the preferences within each sub-period as additively separable between consumption (c) and labor (h):

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

where $\gamma > 0$, $\sigma > 0$, $\chi_1 > 0$, $\chi_2 > 0$, 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 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.[14] However, more

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

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

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

recent research shows that these estimates may be biased downward.[15] Again, given the lack of historical estimates, we 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, agents spend on average 28.2 percent of their time endowment working prior to reaching the NRA, corresponding to the 1940 Census in which male household heads worked on average 1,760 hours per annum.[16] Additionally, consistent with the 1930 Census, the fixed cost of working, χ_2, is calibrated so that 14.3 percent of male head of households retire by the NRA.[17,18] Finally, the discount factor, β, is calibrated to 0.9845 to endogenously match the U.S. capital-to-output ratio of 3.0.[19]

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 age 60+ who are not in the labor force in the data against the fraction of retired agents in the model's initial steady state without Social Security. Even though we only directly target the fraction of retired households at age 65 (14.3 percent) in the calibration, the average retirement decisions across the whole age range generated by the model look remarkably similar to 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 such that the investment to output ratio is 25.5 percent, as reported by the BEA in 1929 and 1930.

(1999).

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

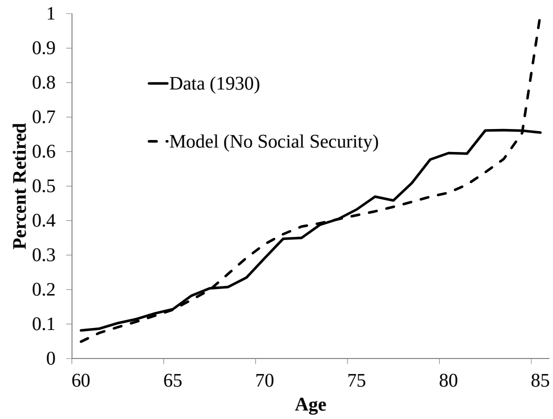
[16] Ideally hours would be calibrated to the data prior to the implementation of Social Security. However, hours data are not available from the Census until 1940. In order to get around the effects of Social Security on hours, we calibrate to hours worked for individuals who are too young to be eligible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

[17] Given that the Census data for this period does not directly report retirement status, 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.

[18] 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.

[19] 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 are from the 1930 Census. We limit the sample to males who are head of their household. Given that the Census data for this period does not directly report retirement status, in the data, individuals who are not in the labor force are considered to be retired. The model captures the percent of retired individuals in the steady state without Social Security.

4.3 Government

Government spending in the unproductive sector, ϕ, is set to 2.8 percent of GDP, consistent with the ratio of Federal Government expenditures 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. In particular, a large fraction of taxable income was tax-exempt, and the rest was taxed at a low marginal flat rate of 4 percent for most individuals.[20] Consequently, close to 50 percent of tax returns had zero or negative tax liability in the 1930s.[21] 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 50 percent of tax filers do not pay any taxes in the initial steady state. Moreover, we calibrate

[20]The first $2,500 of income for married households and $1,000 for single filers was tax-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 then increased only very gradually for higher income. These exemption levels and the limit on the first tax bracket were quite high compared to the mean income of $1,054 in 1929 (calculated from the Macroeconomic historical data from the National Bureau of Economic Research).

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

Υ_0 such that the government budget constraint clears. We find that the marginal rate of 5.94 percent clears the government's budget, implying an average tax rate of 3.5 percent. This rate is generally consistent with the average historical income tax rates listed in Table 2, which varied between 2.6 and 4.3 percent from 1923-1930.

Table 2: **Average Income Tax Rates**

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

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

In accordance with the historical law, we set the NRA to 65 and set marginal replacement rates (τ_{r1}, τ_{r2}) to their respective values in the data of 0.4 and 0.1.[22] Similarly, 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.[23]

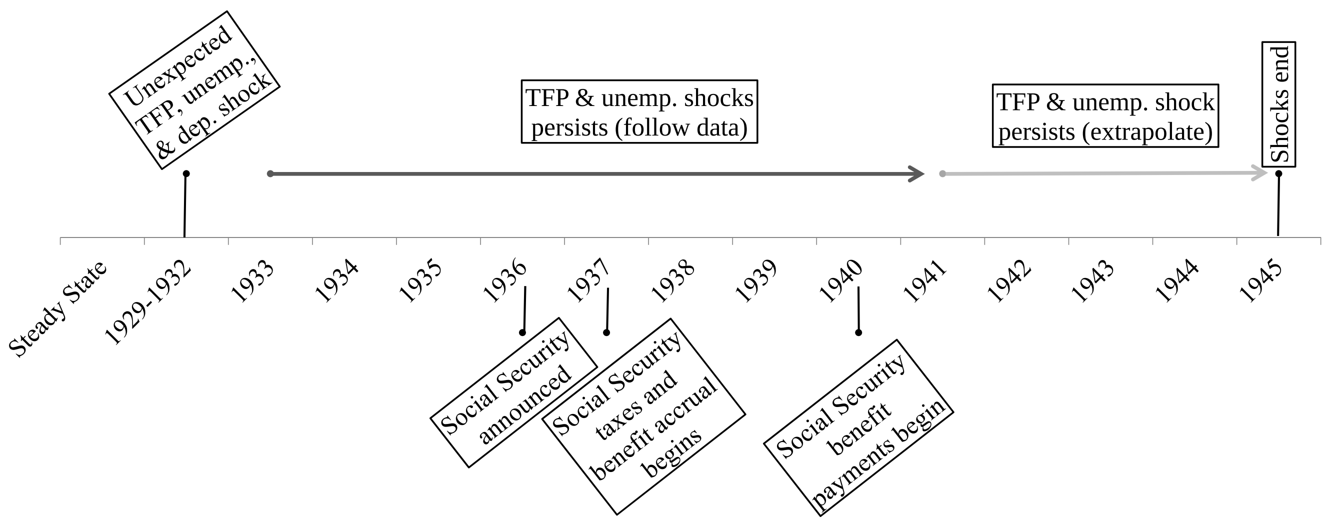
5 Calibration of the Transition Path

Having calibrated the initial and final steady states, this section parameterizes (i) the economic shocks associated with Great Depression and (ii) the phase-in of the original Social Security program as the economy transitions from the initial steady state without Social Security to the final steady state with Social Security. Both the Great Depression and the phase-in of Social Security

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

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

Figure 4: **Timeline**



are incorporated in the model consistent with the actual historical experience. Figure 4 outlines the timeline of these events which are discussed in the subsequent sections.

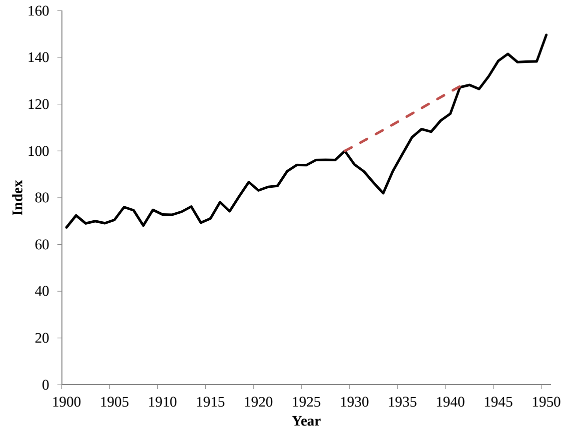
5.1 The Great Depression

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).[24] 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 after 1932 are no longer treated as a surprise.

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

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

Figure 5: **Total Factor Productivity**



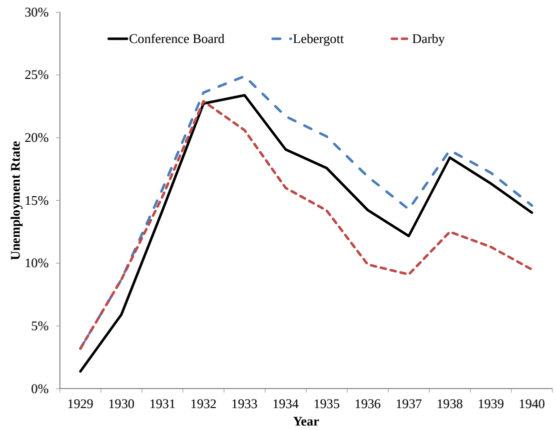
Note: The solid black line is TFP reported in Kendrick et al. (1961). The dashed red line is predicted TFP using a regression that excludes the dummy for years during Great Depression.

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.[25] 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.

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

[25] 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 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.

for the economy to rebuild the lost capital.

Finally, Figure 6 plots several 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 indicate a sharp increase in unemployment of about 20 percentage points between 1929 and 1932.[26] 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 displays the deviations (in percentage points) in unemployment rates from their initial steady state level throughout the Great Depression that we derive from the Conference Board data and incorporate in the model. Similar to TFP, we do not want to incorporate the decrease in the unemployment rates that are due to WWII, so we assume the shocks to the unemployment rates from 1941-1945 linearly decline to zero.

[26]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 3: **Shock to the Initial Steady State Unemployment Rate (in Percentage Points)**

Year	Shock
1932	18.6%*
1933	19.3%
1934	15%
1935	13.5%
1936	10.2%
1937	8.1%
1938	14.3%
1939	12.3%
1940	10.5%
1941	8.4%
1942	6.3%
1943	4.2%
1944	2.1%
1945	0%

Notes: Shock represents increase in the unemployment rate, in percentage points, due to the economic downturn. * Denotes an unexpected shock to the unemployment rate, all subsequent changes in the unemployment rate are not unexpected. To avoid the boost to economic activity from WWII, for 1941-1945, the deviations are extrapolated assuming that the shock recedes in a linear manner over this period.

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 January 1940 (i.e., two years ahead of the initial schedule), and (iii) income earned by agents after reaching the NRA was included in the calculation of the Social Security benefits (b^{ss}). For computational tractability, we assume that agents learn about both the original law and these later amendments at the end of 1935.[27] Second, we ignore further amendments after 1940 which were not part of the initial program that was implemented.

During the initial phase-in, the program differed from the its steady state version in several important ways. First, unlike in the steady state where all agents were eligible to collect Social

[27]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%

Notes: The payroll tax rates from 1937 through 1945 are equal to their historical values. After 1945 they are set at 4.5%, consistent with the rate that clears the Social Security budget constraint in the steady state.

Security 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 transition, agents who never contributed payroll taxes were ineligible for Social Security.[28] Second, in accordance with the historical experience, we let the payroll tax rate vary along the transition path. In particular, we set the 1940-1945 rates equal to their historical levels (see Table 4). However, after 1945, we set $\tau^{ss} = 0.045$, the rate at which the Social Security program's budget is balanced in the final steady state.[29] Third, and most important for the welfare implications, benefits were calculated from the average lifetime earnings only after the program was adopted.[30] Thus, along the transition 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 agent's age in 1937.

[28]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.

[29]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.

[30]This modified formula is consistent with the actual formula.

6 Results

6.1 Welfare Effects of Social Security in the Steady State

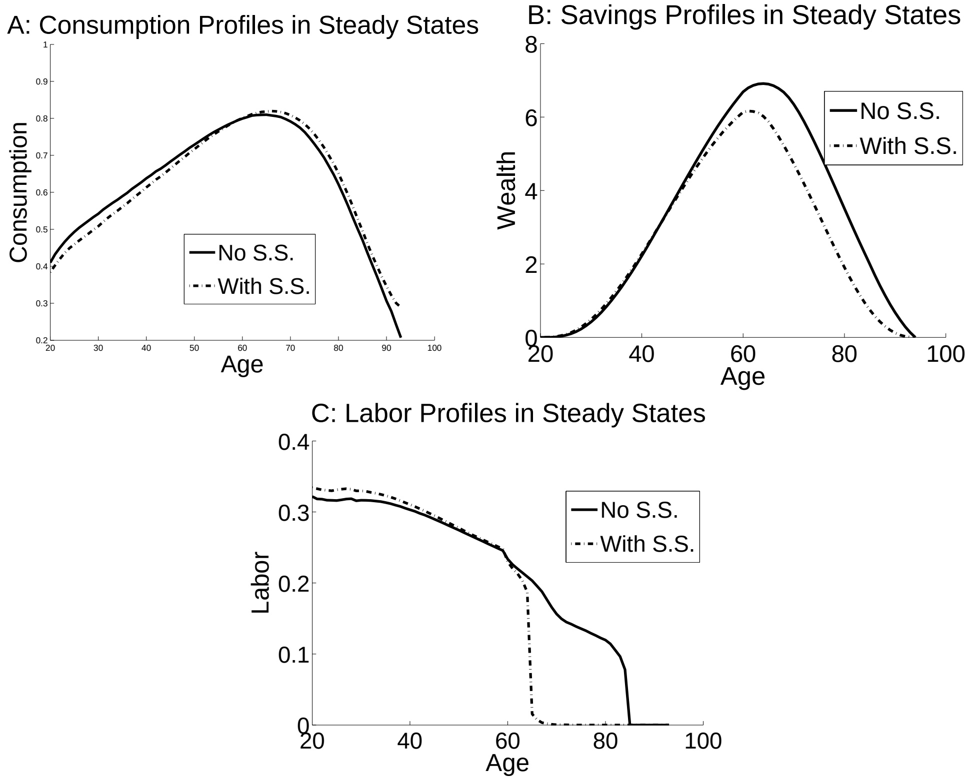
This section compares the steady state economies without Social Security (the initial steady state) and with Social Security (the final steady state). Table 5 shows the aggregate variables in each economy while Figure 7 depicts the life cycle profiles. As shown Panel B of Figure 7 and in Table 5, the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

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

Aggregate	**No S.S.**	**With S.S.**
Y	0.86	0.83
K	2.6	2.38
N	0.47	0.46
w	1.19	1.16
r	0.05	0.06
tr	0.07	0.05
τ^{ss}	0	0.04
Avg. Retirement Age	76.7	64.3

Table 6 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). Consistent with the existing studies, Table 6 confirms that Social Security is associated with lower long-run welfare. In particular, newborn agents in the steady state economy with Social Security would be willing to give up approximately 4.7 percent of their expected future per-period consumption in order to be born into an economy without Social Secu-

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.

rity. Moreover, the likelihood that a newborn agent experiences more welfare in the steady state with Social Security relative to the steady state without it is only a 0.5 percent.[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. These potential effects are partly offset by two channels. First, the payroll tax makes it harder for younger and low-wage agents to earn enough after-tax income to accumulate precautionary savings and smooth consumption. In addition, the progressive contribution-benefits formula distorts agents' labor sup-

[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.

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

		Contribution From:	
	Total Effect	**Direct Effects**	**G.E. Effects**
Welfare (CEV)	-4.7%	-0.5%	-4.3%

Note: CEV measures the uniform change in expected per-period consumption that an agent would require to be indifferent between living in an economy without Social Security and an economy with Social Security. 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.

ply 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.

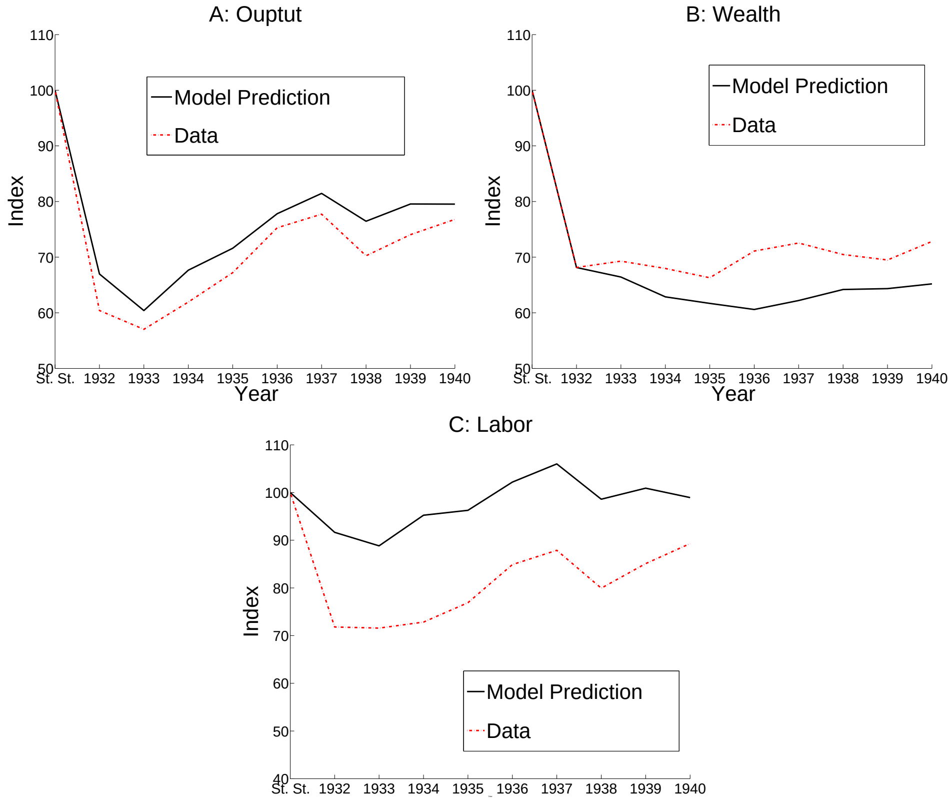
We next decompose the overall steady state welfare loss into effects that are transmitted through the direct vs. general equilibrium channels. The direct effects are determined by comparing the welfare of agents born into the steady state without Social Security and with Social Security, holding factor 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 decrease welfare by 0.5 percent of CEV, indicating that—at least for the original program—the positive welfare effects from the insurance are smaller than the negative welfare effects from the distortions on agents' decisions and from the adverse effect of payroll taxes on budget constraints. The general equilibrium effects are much stronger, leading to an additional reduction in welfare of 4.3 percent of CEV, accounting for almost 90 percent of the total welfare loss.

6.2 Welfare Effects of Social Security During Transition

In order to assess the welfare effects of adopting Social Security for the original cohorts, we calculate two separate transition 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 between these

Figure 8: **Predicted Fluctuations versus Actual Fluctuations**



Note: The black lines capture the simulated changes in economic aggregates along the transition path relative to their original values in the steady state without Social Security. The dashed red lines capture 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).

two transition paths pins down the welfare effects from adopting Social Security.

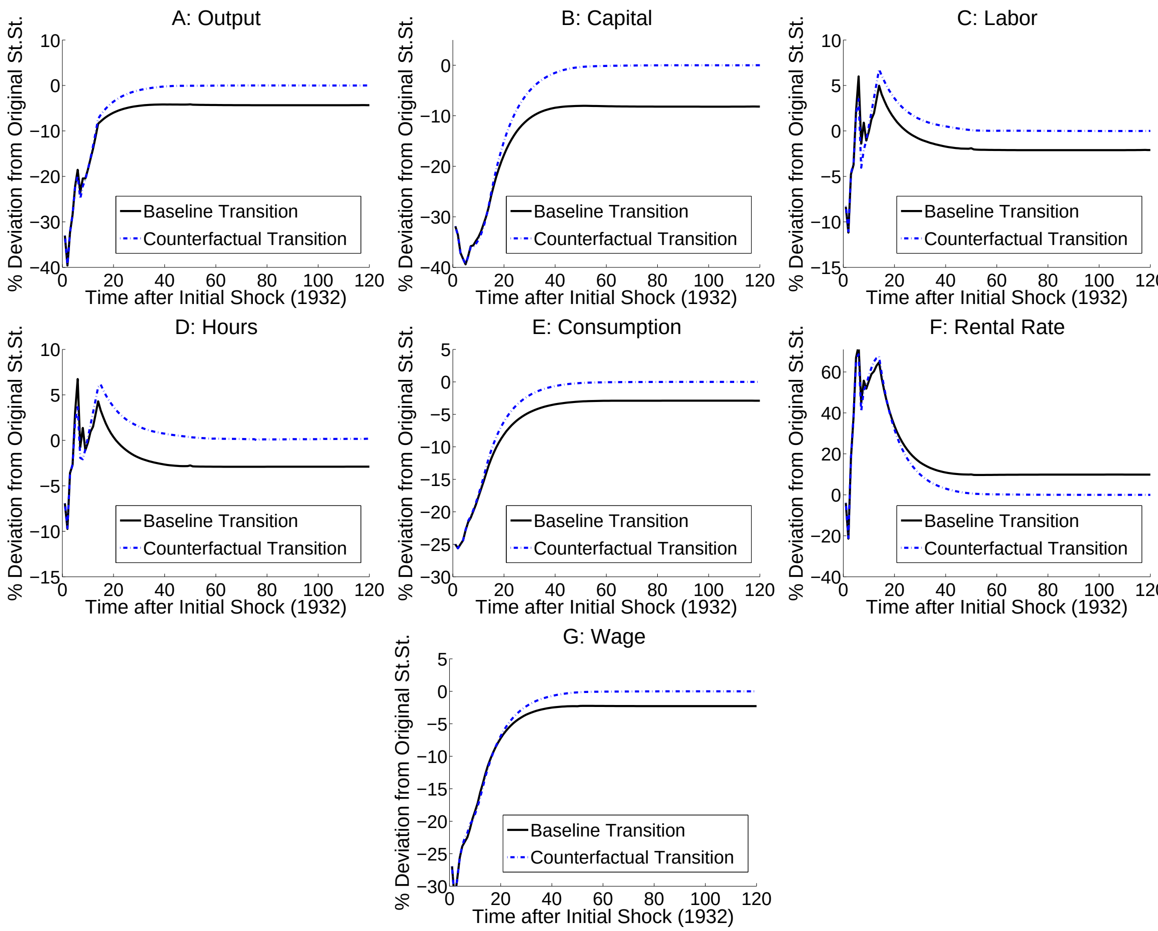
Figure 8 shows how closely fluctuations in aggregate output, wealth, and labor in baseline transition (which includes the historical events of the Great Depression and the subsequent adoption of Social Security) match the fluctuations in the actual data.[32] Overall, the model does a good job predicting 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 transition paths. (Appendix B discusses these dynamics in details.)

We use two welfare metrics to gauge the welfare effects from adopting Social Security for the

[32] We end the comparison in 1940 since by 1940 the war build-up may potentially have begun to affect 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 9: **Aggregate Fluctuations Over Transition**



Note: The black lines capture the percent changes in economic aggregates along the baseline transition 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 transition path from the original steady state without Social Security to the Great Depression 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**
CEV^{trans}	3.5%	5.7%	-0.9%	-1.2%

Note: All welfare effects are calculated as the difference in the welfare for agents living in an economy where Social Security is adopted and where Social Security is not adopted. The total effect captures the average welfare gain across all living cohorts. The Great Depression effects are calculated as the difference between the total welfare effects when the Great Depression is included and the welfare effects in simulations when the Great Depression is not included. The direct effect is calculated as the welfare effect in simulations where the Great Depression is eliminated and factor prices are held constant at their initial steady state levels throughout the transition. The general equilibrium effects are calculated in simulations that exclude the Great Depression. In particular they are calculated as the difference in the welfare effects when factor prices are allowed to fluctuate and when they are held constant at their initial steady state levels.

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:

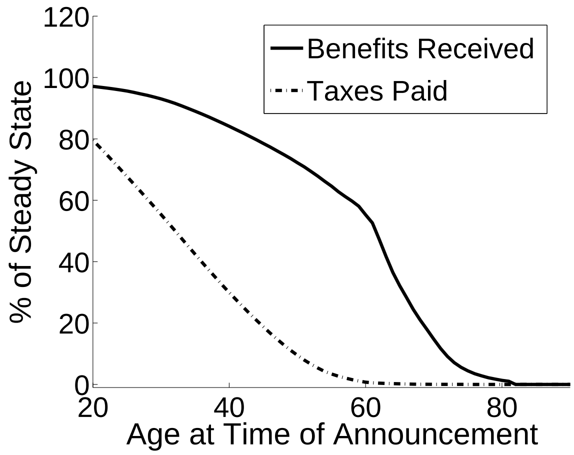
$$\Pi^{trans}\left[U\left(c_j^{\mathrm{B}},h_j^{\mathrm{B}}\right)+\sum_{s=1}^{J-j}\beta^s U\left(c_{j+s}^{\mathrm{B}},h_{j+s}^{\mathrm{B}}\right)>U\left(c_j^{\mathrm{C}},h_j^{\mathrm{C}}\right)+\sum_{s=1}^{J-j}\beta^s U\left(c_{j+s}^{\mathrm{C}},h_{j+s}^{\mathrm{C}}\right)\right], \tag{11}$$

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 counterfactual transitions:

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

A positive CEV^{trans} implies a welfare gain from the program's adoption. When examining the welfare effects for 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.

Figure 10: **Effect of Gradual Implementation**



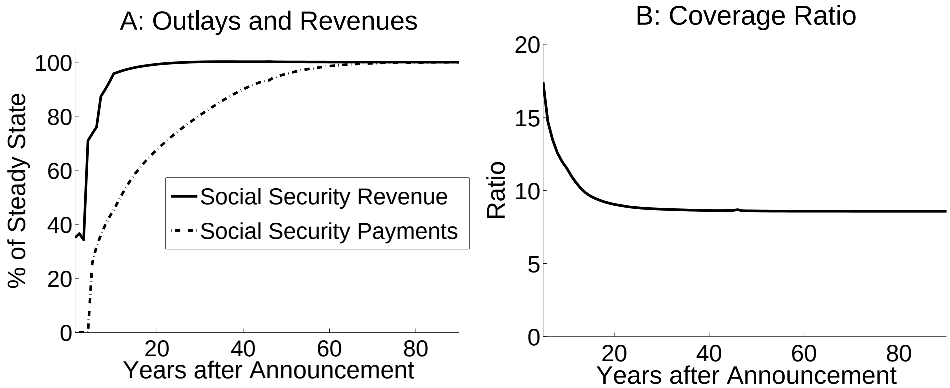
Note: The values indicate the average percent each agent pays into and receives from Social Security compared to the value the respective values if these agents lived in the steady state with Social Security. The values are the average within a cohort.

Table 7 shows CEV^{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 original Social Security program led to large welfare gains among the original living cohorts. In particular, the average expected welfare gain from Social Security for agents in the economy at the time of announcement is the equivalent of 3.5 percent of expected future consumption, compared to a welfare loss in the steady state. Moreover, the likelihood that these agents gain welfare from the adoption of Social Security (Π^{trans}) is estimated at 73.7 percent, compared to mere 0.5 percent 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 the legend in Table 7 for details on how we do this). Column (2) shows that, unlike in the steady state, the direct equilibrium effects are associated with large welfare gains for the original cohorts. The primary reason for this difference is the relatively faster speed at which Social Security benefits were phased in compared to the contributions. To illustrate this, the solid and dashed lines in Figure 10 plot the average lifetime Social Security benefits received and taxes paid by living cohorts in the benchmark transition

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

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.

(expressed as a fraction of their final steady state values), respectively. The difference between the two lines demonstrates that most agents in the economy during the transition received far 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 relatively less into the Social Security system for two reasons. First, the payroll tax rates 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 implemented immediately, though the scaling factor based on years of employment somewhat lowered the benefits for the transitional agents because these agents did not pay as many years into the system. Overall, this implies that the Social Security benefits were 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]

[35] Similarly, through 1960 annual total expenditures from the Old Age Survivorship Disability Insurance (OASDI)

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, this 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, along the transition, the general equilibrium effect merely mutes the overall welfare gain 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 Social Security 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 Depression exacerbated welfare losses caused by the economic downturn for 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.

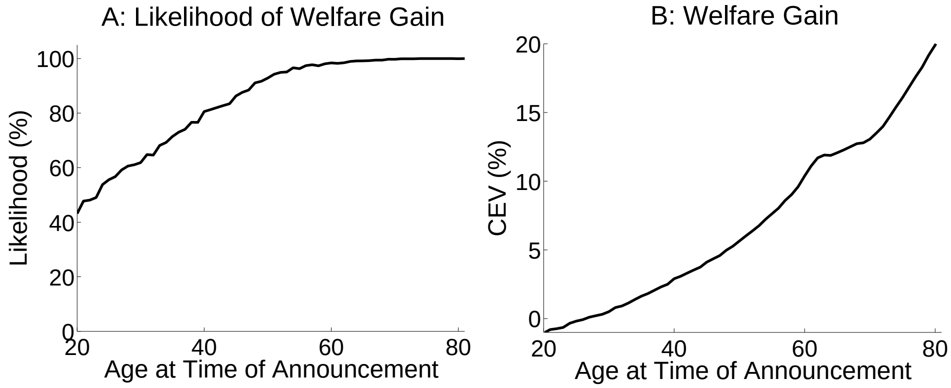
6.3 Welfare Effects by Age

Next, we examine how the 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 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]

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.

[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.

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.

6.3.1 Eligible Agents

We start by focusing on the welfare effects from the adoption of Social Security for agents in the model 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 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 rises 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 was at the time of the program's adoption the fewer years of payroll taxes the agent contributed

[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.

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 essentially all eligible agents in age cohorts 40+ enjoyed 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.[38] Yet, despite paying considerably less payroll taxes, this agent would be entitled to a Social Security benefit that was only 40 percent lower.[39]

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 rises for all cohort. However, unlike in the left panel, the speed of the increase in the CEV^{trans} slows temporarily for cohorts age 62 to 70. What causes the CEV^{trans} to rise less rapidly for cohorts in this particular age range? To understand these dynamics, one has to examine the composition of the welfare effects from the program by agents' wealth and age.

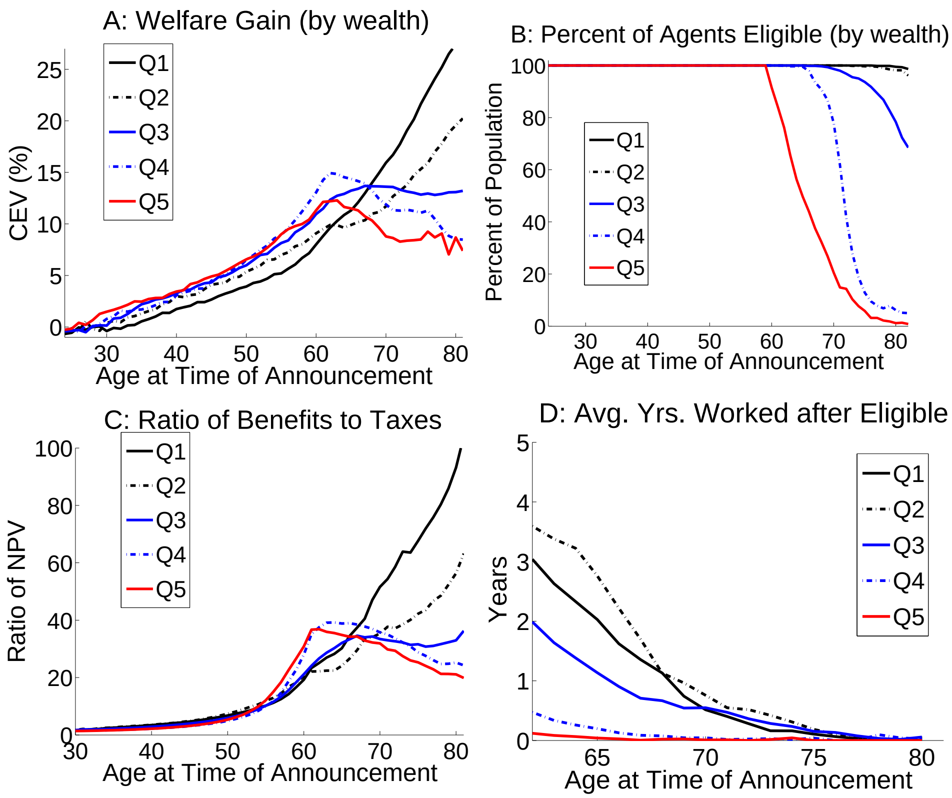
The upper left panel of Figure 13 plots the CEV^{trans} by age for each quintile of the wealth distribution.[40] After age 62, the welfare gains from the adoption of Social Security decline for agents in the top two quintiles. In contrast, the welfare gains continue to rise or hold steady for cohorts ages 62+ in the lowest three quintile. Since the higher-wealth agents tend to retire earlier, eligible cohorts ages 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, whose CEV^{trans} decreases with age, is large enough to cause a slowing in the increase in the aggregate CEV^{trans}. 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} rise at an increasing speed.

[38]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.

[39]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.

[40]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.

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.

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 wealth quintiles, the ratio peaks round age 62 and subsequently falls for agents older at the time of the adoption.

Why does the NPV benefits-contribution ratio rise for the bottom wealth quintiles even as it falls for the top quintile? The different dynamics are primarily driven by the differences in retirement decisions across wealth quintiles. The lower left panel in Figure 13 plots the average number of years that a transitional agent works after becoming eligible to collect Social Security benefits by wealth quintile. Irrespective of their age at the time of the program's announcement, agents in the top wealth quintile generally retire immediately after becoming eligible for benefits (i.e., after contributing three years of payroll taxes).[41] As a result, the NPV of these agents' Social Security contributions is quite similar irrespective of their age at the announcement. In contrast, the NVP of the total benefit received declines the older an agent is at the time of the program's adoption due to rising mortality risk.[42] Thus, the overall welfare gain for these high-wealth individuals' decreases the older an agent is at the time of the program's adoption. In a marked contrast, for low-wealth agents, the number of years that a transitional agent works after becoming eligible to collect benefits declines with the agent's age at the time of the program's adoption. For these older low-wealth agents, the NPV of the benefits-contribution ratio tends to rise because the ratio of expected years receiving Social Security benefits vs. contributing payroll taxes rises with their age at the time of the program's announcement.

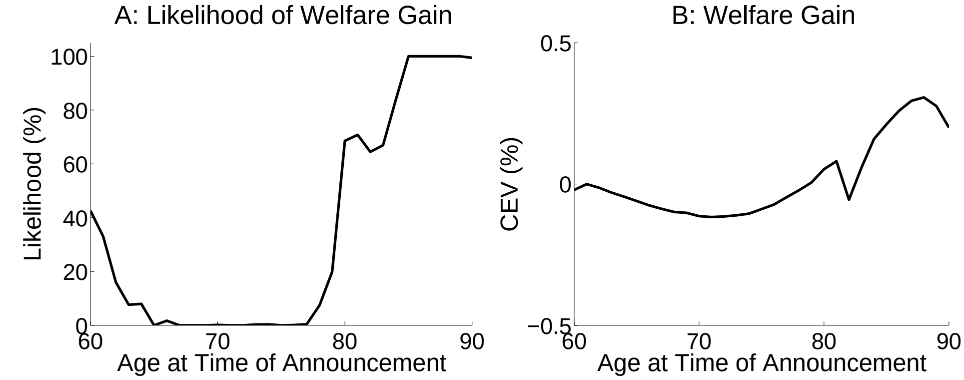
6.3.2 Ineligible Agents

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

[41]These three years are from the beginning of the taxes being collected in 1937 until benefits begin being paid in 1940.

[42]The decline in the NPV is because the older an agent is, in expectation, the fewer years he has to live and to collect the benefits. Moreover, on average older agents receive lower wages causing the eventually Social Security payment to be lower at the time of retirement.

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



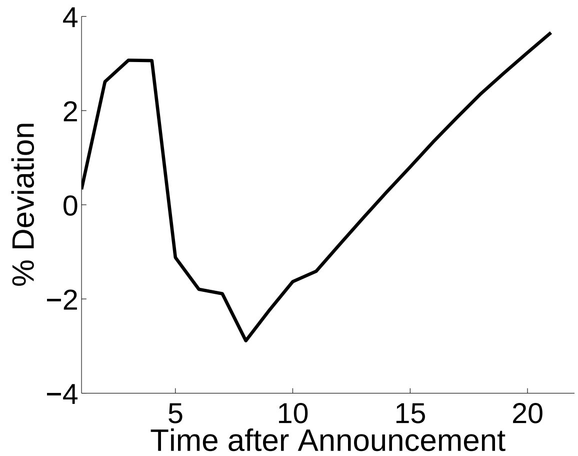
Note: The values are the average within each cohort for agents that are eligible to receive Social Security benefits.

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+.[43]

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

[43]There is a kink in the welfare effects for age 80 cohorts. This kink arises because the composition of ineligible agents is different for cohorts who were under 80 at the time of the adoption versus older cohorts. In particular, since agents with higher incomes tend to retire earlier (see bottom left panel of Figure 13), they make up a relatively larger fraction of the ineligible agents in cohorts under 80. Moreover, these higher income agents tend to benefit more from the higher rental rate.

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

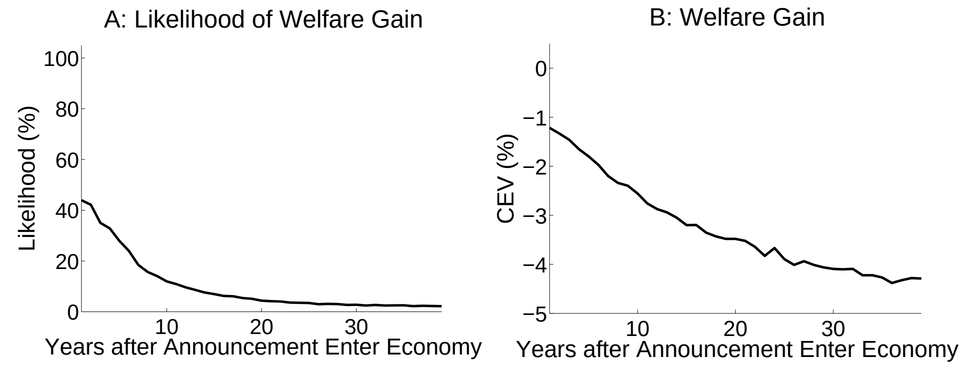


Note: The figures represent the percent difference in the rental rate between the transition with Social Security and the counterfactual transition without Social Security.

initial relative increase.[44]

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 aggregate labor.[45] 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.

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).

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 loss from the program. We find that the likelihood of a welfare gain for these agents is just slightly above forty percent and the expected welfare loss for these agents are around one percent of their expected lifetime consumption. As time passes, the likelihood of experiencing a welfare gain decreases for new entrants just as the size of the average expected welfare loss rises. This is because 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 as the payroll tax rate is phased in only gradually over a period of ten years. Over time, both the likelihood of a welfare gain and the size of the average welfare losses trend towards their steady state values.

[44] 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.

[45] 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.

6.4 Sensitivity Analysis

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.[46] 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.[47] Fourth, 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 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 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 and fifth row, respectively, adopting the program at the onset of the depression, and incorporating idiosyncratic risk to the returns to savings both 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, liquidity constraints 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,

[46]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.

[47]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.

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 8: **Sensitivity Exercises**

	CEV	**Likelihood**
Benchmark	3.5%	73.7%
65+ Excluded	2.1%	71.3%
Immediate Adoption	4.0%	74.7%
Unemployment Insurance	7.8%	88.1%
Idiosyncratic Risk to Savings Return	3.5%	73.4%

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 70 percent, and increased these agents' welfare by the equivalent of 3.5 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.[48] 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 ($T : \mathbb{R}_+ \rightarrow \mathbb{R}_+$), Social Security tax rate τ^{ss}, Social Security benefits formula ($B^{ss} : \mathbb{R}_+ \times j \rightarrow \mathbb{R}_+$), a production plan for the firm (N,K), and a utility function ($U : \mathbb{R}_+ \times \mathbb{R}_+ \rightarrow \mathbb{R}_+$), 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

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

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

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:

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

[48] 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.

B Transitional Dynamics of Aggregates

This section examines the benchmark transition of the economy from the steady state without Social Security to the new steady state with Social Security. 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 (i.e., until the year 1970).

Over the transition, aggregate output, aggregate capital, aggregate consumption, and the wage rate all fall drastically immediately upon the shock's impact, continue to decline for a few extra periods, and then gradually transition back to their new steady state values. The remaining aggregates—labor, hours, and the rental rate—suffer two sharp declines over the transition before eventually ending up at their new steady state values.

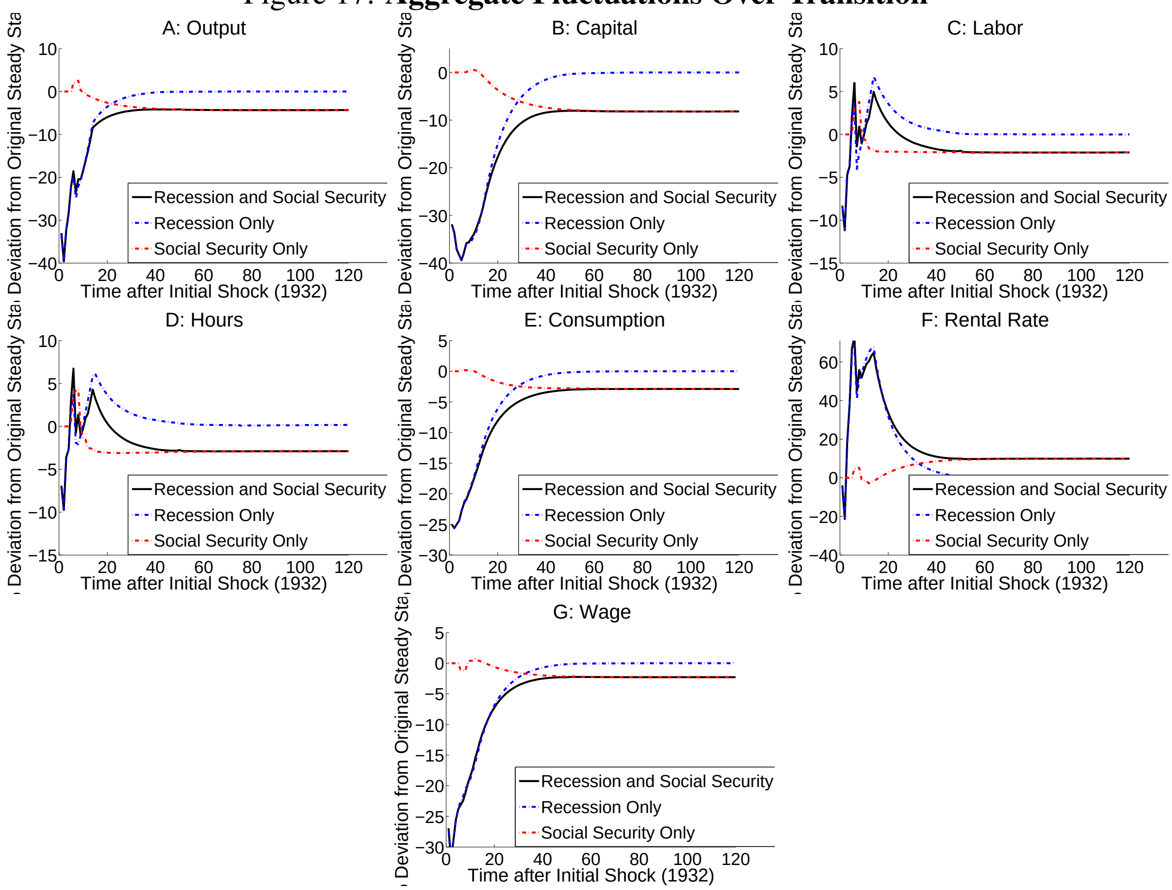
The fluctuations in the aggregate economic variables over the transition come from two channels: (i) the economic shocks associated with the Great Depression, and (ii) the adoption of Social Security. In order to decompose these two effects, Figure 17 determines the percentage changes in the aggregate economic variables relative to their initial values in the steady state without Social Security under three alternative 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. 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.

Turning to Panels A, B, E, and G of Figure 17, 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. In these transitions, the initial declines in output, capital, consumption, and wages and the subsequent recovery are primarily caused by the shocks associated with the Great Depression. The subsequent 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 has 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,[49] while the quick initial recoveries in these aggregates are due to the decline in the size of the shocks and also due to the implementation of Social Security (see the blue and red lines in Figure 17).[50] In particular, 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 increase their future Social Security benefit by working more. Both of these factors drive up the aggregate labor supply and rental rate. However, these increases are 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.

[49]The fluctuations in the rental rate are primarily driven by the changes in the ratio of aggregate labor to output.
[50]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 transition 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 transition 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 transition path when Social Security is adopted but there is no Great Depression. All the values are percentages relative the initial value in the steady state without Social Security.