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Home production and Social Security reform ☆

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ABSTRACT

This paper incorporates home production into a dynamic general equilibrium model of overlapping generations with endogenous retirement to study Social Security reforms. Specifically, home production takes housing, home input, and home hours as inputs and produces a good that is substitutable with market good. As such, the model differentiates both consumption goods and labor effort according to their respective roles in home production and market activities. Using a calibrated model, we conduct a policy experiment where we eliminate the current pay-as-you-go Social Security system. We find that the experiment has important implications for labor supply as well as consumption decisions and that these decisions are influenced by the presence of the home production technology. More importantly, comparing our economy to a one-good economy without home production, the welfare gains of eliminating Social Security are magnified significantly especially in the long run. The reasons are twofold and related to the general aspects of home production. First, home production implies a more elastic labor supply rendering the payroll labor tax more distortionary. Second, home production introduces insurance possibilities that are not present when only market-produced goods are available and, thus, reduces the need for government redistributive policies.

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1. Introduction

The significant challenges facing the unfunded U.S. Social Security system have stimulated a large literature analyzing the implications of Social Security reforms using a wide array of models.[1] This paper makes a contribution to this literature by investigating how the presence of home production influences the effects of Social Security reforms. Specifically, home production takes housing, home input, and home hours as inputs and produces a good that is substitutable with market good. The inclusion of home production in life-cycle models helps us to explain a number of important life-cycle behavior that provides compelling reasons for including it in the study of Social Security reforms.

The study of home production dates back to the seminal work of Becker (1965) and Mincer (1962). Its recent incorporation into standard life-cycle models has proven important in explaining a number of life-cycle facts. Home

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[1] These models include features such as altruism, liquidity constraints, longevity and individual income risks, the separation of labor participation and hours worked, endogenous benefit claims, and housing. See Fuster (1999), Fuster et al. (2003, 2007), Hurst and Willen (2007), Nishiyama and Smetters (2007), Imrohoroglu and Kitao (2009, 2012), Chen (2010), Yang (2013), and Laitner and Silverman (2012).

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production allows households to substitute labor supply between market hours and home hours and to substitute consumption between market-produced goods and home-produced goods. These margins of substitution are important in explaining a host of life-cycle features. For example, Rogerson and Wallenius (2009) demonstrate that home production alone is qualitatively capable of generating realistic retirement patterns. Guler and Taskin (2013) find a negative correlation between unemployment insurance and home production indicating a substitution between the two insurance mechanisms against loss of earnings during unemployment spells. Dotsey et al. (2014) document the close relationship between time use over the life cycle with the consumption patterns of the related goods and show that a life-cycle home production model can help explain this behavior. Further, Aguira and Hurst (2007) indicate that a home production model is useful for explaining the life-cycle pattern of time devoted to shopping, the differential in prices paid for similar goods, and importantly the substantial divergence between consumption and expenditure patterns over the life cycle. Additionally, Aguiar and Hurst (2013) show that the hump-shape pattern in consumption varies considerably across goods depending on the degree to which these goods are readily substitutable with goods that can be produced at home. Thus, it appears that over the life cycle home production is an important element governing the behavior of households.

Home production also forces one to think differently about model calibration as discussed in Gomme and Rupert (2007). In particular, what factors should be included in the productive capital stock, what is the appropriate capital/labor ratio, and what is the estimated labor elasticity that is consistent with various model moments are all affected by the inclusion of home production. More importantly, home production allows households a form of insurance because low productivity households can substitute into home production. All of these elements affect behavior and in particular the aggregate amount of desired savings. Hence, government policies such as Social Security, whose primary impact is on savings behavior, could potentially have very different effects depending on whether home production is a feature of the model. In turn, the welfare consequences of those policies could be drastically altered by the presence of home production.

To analyze the role that home production plays in the effects of eliminating Social Security, we look at two economies: one with home production that also uses housing as an input and one without. The latter is a standard one-good economy that has been widely used in the existing literature.[2] For both economies, we first estimate the parameters of the two models in order to match various aggregate moments of the microdata. We show that the matching of additional moments in our benchmark estimation implies parameter estimates that differ in important ways from those of the standard model. These differences imply that including home production produces larger long-run welfare gains in response to an elimination of Social Security benefits than would occur in a comparable model without home production. The reasons are twofold and related to the general aspects of home production just discussed. The first reason derives from the feature that home production generally leads to a model that implies a more elastic labor supply rendering the payroll labor tax more distortionary. The second is that home production introduces insurance possibilities that are not present when only market-produced goods are available and, thus, reduces the need for government redistributive policies.

To be more specific, in both models, the steady-state welfare improvements are largely driven by the removal of a distortionary tax and the increased desire for precautionary saving. As is standard, both channels imply a larger capital stock and a greater steady-state consumption. But the one-good economy lacks margins of substitution that are central features of the model of home production. One margin of substitution present in the home-production economy is the ability to substitute work at home for work in the market place and low productivity workers and retirees use this margin as an insurance mechanism. Thus, the insurance provision provided by Social Security is less valued in the home-production economy. Also, the home-production economy includes rental housing and the relative price of this good is directly influenced by the real interest rate. Because housing services indirectly contribute to utility and eliminating Social Security reduces the real interest rate, the existence of housing services that appear separately in the model provides for additional welfare gains. This channel has been explored by Chen (2010). The effect of adding these two channels results in a steady-state welfare gain of eliminating Social Security that is almost 21 percent in the home production economy as opposed to roughly 9 percent in the standard one-good economy. The welfare gains in the benchmark do not change much when we tighten the borrowing limit to zero or exclude housing from home production. However, aggregate market hours increase much more in both economies than the benchmark and aggregate capital also increases much more in the second economy. As one would expect, the welfare gains are even larger when we introduce additional capital and labor income taxes.

To separate out the effects of the two margins, we study several alternative economic specifications. The first one includes home production but excludes housing from the economy, while the second one includes housing in the utility but eliminates home production. The third one merges the home input with the market good. We recalibrate all three models to match corresponding micro consumption and labor supply data and conduct the same policy experiments. The welfare gains of eliminating Social Security amount to about 16 percent in both of the first two economies. The third economy has a welfare gain of about 13 percent. The first two experiments suggest that changes in the relative price of housing contribute to roughly half of the 12 percent total welfare gain and that home production is responsible for the other half.[3] The welfare contribution of housing is far smaller than in Chen (2010) as our economy allows for labor adjustment. Additionally, housing consumption is constrained by the provision of home hours in home production. Thus, the two additional margins in our

[2] For example, with the exception of Chen (2010), all existing studies of Social Security reforms (see those cited in footnote 1) are conducted in one-good economies.

[3] Experiment one implies that eliminating housing reduces welfare gains by 5 percent (21–16=5 percent) of the 12 percent gain. Experiment two suggests that eliminating only home production generates a drop of 5 percent (21–16=5 percent) in the welfare gain.

model are roughly of equal importance in accounting for the steady-state welfare results. The third experiment indicates that the size and hence importance of home production do matter in the policy experiment, as reclassifying the home input into a market good effectively reduces the amount of the home produced good.

Finally, we investigate what occurs along a transition path for the benchmark home production economy and the one-good economy. The particular path we analyze assumes a declining linear-labor tax along with additional government debt to offset the declining Social Security contributions. Eventually that debt is paid off, and the tax rate goes to zero. For both economies, future newborns benefit from the reform while existing generations pay a price. The general shapes of the gains and losses to succeeding future generations and across age groups are qualitatively similar, but the magnitudes of the welfare effects are quite different. For example, the current middle-aged suffer the most in both economies. The decline in the interest rate reduces the return on accumulated assets, and they suffer significant losses in Social Security benefits. They also have a limited amount of time for accumulating additional assets in order to compensate for the loss of Social Security income. Further, capital accumulation has not proceeded long enough for them to achieve significant increases in the wage rate. This latter effect is prevalent to a greater extent in the home-production economy and in part accounts for the greater welfare loss of initial working generations along the transition path. However, with home production, the time it takes before future generations are unambiguously better off is shorter than in the economy without home production. The decline in house prices and the substitution into home production allows newly born agents to increase consumption rather quickly because consumption is more highly weighted in the home-production economy. Eventually, the increase in the capital stock and the resulting rise in the wage rate, along with the decline in taxes, serve to make all newborns better off in both of the economies considered.

The rest of the paper is organized as follows. In Section 2, we describe the model economy and in Section 3, we present the model calibration. In Section 4, we conduct the experiment of eliminating Social Security, and in Section 5, we recalibrate the model with only one good and conduct the same policy experiment. In Section 6, we perform three robustness analyses. In Section 7, we study three alternative economies as an attempt to separate the role of housing from that of the traditional home production technology where housing is not part of the home input. Section 8 investigates the transition paths and Section 9 concludes.

2. The model economy

Our model economy follows Dotsey et al. (2014) with two exceptions. Social Security benefits now depend on households' average lifetime earnings, and households choose when to claim benefits, as in Imrohoroglu and Kitao (2012). Adding this important degree of realism to the model requires an additional state variable; so for computational reasons, we eliminate owner-occupied housing and instead treat all housing in the economy as rental. As is shown in Chen (2010), this simplification is not likely to noticeably affect our results.

2.1. Demographics

The economy is populated by overlapping generations of households of age $t = 1, 2, \ldots, T$, where T is the maximum possible age. The life span is uncertain and households of age t face an exogenous probability of survival, λ_t. Since the demographic patterns are stable, agents at age t constitute a constant fraction of the population at any point in time. Annuity markets are assumed to be absent, and accidental bequests are distributed to all households in the economy.

2.2. Preferences and home production

From a general perspective households derive utility from leisure, consumption of a market good, consumption of a good that is an input in home production, and housing services. We specify the exact way these underlying factors contribute to utility through a series of nested CES functions that lends itself to a home production interpretation. In our setting, households value consumption of a composite good c that consists of a market-produced nondurable good, c_m, and a home-produced good, c_h, and leisure, l. Preferences are assumed to be time separable, with a constant discount factor β.

Production of the home good requires a home input, housing, and labor. In particular,

$$c_h = f(d, s, n_h) = \left\{ \omega_2 \left[\omega_1 d^{1-1/\zeta_1} + (1-\omega_1) s^{1-1/\zeta_1} \right]^{(1-1/\zeta_2)/(1-1/\zeta_1)} + (1-\omega_2)(n_h)^{1-1/\zeta_2} \right\}^{1/(1-1/\zeta_2)}, \tag{1}$$

where d denotes the home input, s denotes the rental stock, and n_h denotes the labor input in home production.[4,5] We assume that renting is the only way of consuming housing services in this economy. The parameter ω_1 controls the weights

[4] McGrattan et al. (1997) and Greenwood and Hercowitz (1991), among others, also assume that home production takes nonmarket capital and hours as inputs where nonmarket capital consists of residential capital and consumer durables. While our housing corresponds to residential capital, our definition of home input consists of some nondurables such as food away from home as well as durables, see Section 3.2.

[5] For simplicity, we have combined both nondurable expenditures such as raw food with consumer durables such as appliances into a composite good. We call this composite good home input. An interesting extension would be to treat these separately, especially for modeling the cyclicality of consumption.

associated with home input, and the parameter ω_2 specifies the weight associated with the resulting composite good used in home production. The term ζ_1 measures the intra-class substitutability between the home input and housing, and ζ_2 governs the interclass elasticity of substitution between the composite good and hours.[6]

The period utility function is given by

$$U(c,l)=\frac{[\omega_4 c^{1-1/\zeta_4}+(1-\omega_4)l^{1-1/\zeta_4}]^{(1-\gamma)/(1-1/\zeta_4)}-1}{1-\gamma}, \tag{2}$$

where

$$c=\left[\omega_3 c_m^{1-1/\zeta_3}+(1-\omega_3)c_h^{1-1/\zeta_3}\right]^{1/(1-1/\zeta_3)}. \tag{3}$$

The term ω_4 measures the relative weight of the composite consumption good c in utility, ζ_4 represents the elasticity of substitution between the composite consumption good and leisure, γ is the relative risk aversion parameter, ω_3 measures the relative weight of the market good c_m in the composite consumption good, and ζ_3 denotes the elasticity of substitution between the market good and the home good.

Two features of our model are unique to the literature on Social Security, and we seek to better understand the importance of these features for Social Security reform. The first and most important is the introduction of home production, which allows households to substitute between market and nonmarket activities. The second is the modeling of different consumption goods, including housing, and allowing them to interact with nonmarket activity.

2.3. Labor productivity

Labor productivity consists of two components. The first is deterministic and age dependent with all workers of the same birth cohort facing the same exogenous profile, e_t. The second is stochastic with each worker, i, at age, t, receiving a productivity shock, ε_t^i, which follows a Markov process:

$$\ln\varepsilon_t^i=\rho_\varepsilon\ln\varepsilon_{t-1}^i+\upsilon_t^i,\quad \upsilon_t^i\sim N(0,\sigma_\varepsilon^2). \tag{4}$$

The Markov process is the same for all households, and there is no uncertainty over the aggregate labor endowment. The total productivity of a worker i at age t is then given by the product of the worker's age-t productivity shock and age-t deterministic efficiency unit: $e_t\varepsilon_t^i$. Thus, this part of our model follows the vast literature that assumes this parsimonious yet empirically plausible income process.

2.4. Borrowing constraints

We impose an exogenous borrowing constraint on the economy. In particular, at any given period the household's financial asset denoted by a' must satisfy

$$a'\geq -e'\underline{\varepsilon}'w, \tag{5}$$

where $\underline{\varepsilon}'$ is the next period's lowest possible realization of a labor efficiency shock, and w denotes the economy-wide wage per efficiency unit of labor for the next period. In other words, we require that a household can only borrow up to an amount that is equal to its lowest possible labor income next period, assuming that it spends all its time working for the market.

2.5. Market production

There is only one type of market good produced according to the aggregate market production function

$$F^m(K,N_m)=K^\alpha N_m^{1-\alpha}, \tag{6}$$

where K is the aggregate market capital stock and N_m is the aggregate market labor input. The final good can be directly consumed, invested in physical capital, or housing, or used as an intermediate input in home production. Physical capital and housing depreciate at rates δ^k and δ^s, respectively.[7]

[6] Following Sato (1967), we justify our specification of home production by the fact that intraclass elasticity between home input and housing is potentially higher than the interclass elasticity between home input and home hours, or housing and home hours, because home input and housing are more similar in techno-economic characteristics.

[7] We assume that the home input depreciates completely given that household appliances and equipment account for less than 10 percent of total home input.

2.6. Financial institutions

Following Gervais (2002), we assume that there exists a two-period-lived financial institution. At the end of the first period, the financial institution accepts deposits and buys residential capital. In the second period, it repays deposits with interest at rate r. Residential capital is then rented to agents at a price η per unit. At the end of the second period, the financial institution sells the nondepreciated residential stock to a new agency. The no-arbitrage condition implies that the rental rate on housing is given by

$$\eta = r + \delta^s. \tag{7}$$

2.7. Social security

The government operates a pay-as-you-go Social Security system similar to the current U.S. system. Specifically, the government taxes labor earnings below the Social Security cap $y_{\max}$, at a constant rate, τ. Retired households receive Social Security benefits each period, and these benefits are linked to their average lifetime earnings according to a piecewise linear function that resembles the current U.S. Social Security program. Additionally, the benefits depend on the age at which individuals begin claiming them.

2.8. Timeline

At the beginning of each period, after observing their current idiosyncratic labor shocks and their exogenous bequest, households make their labor supply and retirement decisions and rent capital to firms. They also rent housing and purchase home input, and conduct home production using labor, home input, and housing. Market production also takes place and after market production, households receive factor payments and make their consumption and asset allocation decisions. At the end of the period, capital and housing depreciate and uncertainty about early death is revealed. Accidental bequests from those who die early are distributed to newborn agents in the following period to first satisfy an exogenous beginning-of-period asset position and the leftover funds are distributed to all agents alive in the economy.

2.9. The household's problem

In a stationary equilibrium, the interest rate is constant at r as is the wage rate w per efficiency unit of labor. The household's state variables are given by $(t, a, \varepsilon, y, t_r)$, which denote the agent's current age (t), financial assets (a), labor productivity in the current period (ε), average lifetime earnings (y), and retirement age (t_r). We have

$$V(t, a, \varepsilon, y, t_r) = \max_{\{c_m, s, d, a', n_m, n_h, f'\}} \left\{ U(c, 1 - n_m - n_h) + \beta \lambda_t EV(t+1, a', \varepsilon', y', t_r') \right\} \tag{8}$$

subject to (1), (3), and

$$c_m + \eta s + d + a' \le b + (1+r)a + e_t \varepsilon w n_m - \tau \min(y_{max}, e_t \varepsilon w n_m) + pen(t_r, y), \tag{9}$$

$$y' = \left[(t-1)y + \min(e_t \varepsilon w n_m, y_{max}) \right] / t \quad \text{if} \quad t_r = 0, \tag{10}$$

$$y' = y \quad \text{if} \quad t_r > 0, \tag{11}$$

$$t_r' = t + 1 \;\; \text{if} \;\; f' = 1, \;\; t_r' = 0 \;\; \text{if} \;\; f' = 0, \tag{12}$$

$$c_m \ge 0, \quad s \ge 0, \quad 0 \le n_m, \quad n_h \le 1, \quad a' \ge -e_{t+1} \underline{\varepsilon}' w, \tag{13}$$

where $pen(t_r, y)$ is the pension after retirement and it depends on the retirement age and the average lifetime earnings at the time of retirement, and f' indicates the retirement decision. In any subperiod, an agent's resources depend on asset holdings a, labor endowment $e_t \varepsilon$, pension $pen(t_r, y)$, and received bequests b. Note that agents receive a pension only after claiming Social Security, and even after that, they can still work and are subject to the payroll tax. The composite consumption good c is defined as in Eq. (3) in which the home-produced good is defined as in Eq. (1) using current period housing s, home input d, and home hours n_h, as inputs. Average Social Security earnings accumulate according to Eq. (10) if the agent has not claimed any Social Security benefits.

A formal definition of a stationary equilibrium that includes market clearing conditions is provided in online Appendix A. Online Appendix B describes the computation algorithm we use to numerically solve the model.

Table 1
Calibration according to the data and the literature.

Parameters		Value	Source
Demographics			
T	Maximum life span	90	
λ_t	Survival probability	Fig. A1	Social security administration Life tables
Technology			
α	Capital share in National Income Accts	0.240	Authors' calculation
δ^k	Annual depreciation rate of capital	0.090	Authors' calculation
δ^s	Annual depreciation rate of housing	0.010	Authors' calculation
Endowment			
e_t	Age-efficiency profile	Fig. A1	French (2005)
ρ_ε	AR(1) coefficient of income process	0.96	Huggett (1996)
σ_ε^2	Innovation of income process	0.045	Huggett (1996)
σ_1^2	Variance of income process at age 1	0.38	Huggett (1996)
Government policy			
$pen(t_r, y)$	Social Security benefit		See text
Home production			
ζ_1	Sub. betw. d and h	1.588	Dotsey et al. (2014)
Preference			
γ	Risk aversion coefficient	1.500	Attanasio et al. (1999), Gourinchas and Parker (2002)

Table 2
Calibration results – benchmark.

Parameters (9)		Value
β	Discount factor	0.954
τ	Social Security tax rate	0.102
ω_1	Weight on home input	0.754
ζ_2	Sub. betw. d and h composite and n_h	0.800
ω_2	Weight on d and h composition	0.758
ζ_3	Sub. betw. market and home goods	2.186
ω_3	Weight on market goods	0.130
ζ_4	Sub. betw. consumption and leisure	1.522
ω_4	Weight on consumption	0.225

3. Calibration

We choose the parameters of our model in two steps. In the first step, we pick parameters that are based on economic statistics from the data as well as choosing parameters, such as relative risk aversion, that are consistent with the literature. In the second step, we jointly estimate the remaining parameters that minimize a loss function based on the difference between certain aggregate model and data moments on households' time use and consumption. The calibrated parameters and the statistics that generate them are given in Table 1 and the estimated parameters are given in Table 2. Table 3 indicates how close the model moments match the data moments.[8]

In modeling the home-production technology, we follow the literature by equating hours spent in home production with time spent on home in activities that are not enjoyable and also produce goods or services that can be purchased in the market.[9] Otherwise the time is classified as leisure. Restricting the definition of home work to activities that have market substitutes helps generate greater interaction between consumption of market- and home-produced goods.

As is standard in the literature, we include residential capital stock (housing) in home production. We, however, differentiate home input, an intermediate market good, from the residential capital stock and model it as an additional input into home production. We allow households' preference over different goods and leisure as well as their home-production technology to take flexible functional forms that exhibit constant elasticity of substitution. Additionally, we endogenize households' decisions to claim Social Security benefits along the lines of Imrohoroglu and Kitao (2012). Finally, our calibration captures many realistic features of the Social Security system, such as the link between households' Social Security benefits and their past earnings and age when benefits are initially claimed.

[8] Although our model is exactly identified, we are not able to match all the target moments exactly because the problem is highly nonlinear.

[9] An alternative approach would be to follow Becker (1965) where the enjoyment of each consumption good requires a combination of market expenditure and time inputs.

Table 3
Calibration to match data moments – benchmark.

Moments	Model	Data
Capital output ratio (K/Y)	1.714	1.714
Social Security budget balance	0.000	0.000
Home input/housing	0.102	0.102
The young (between ages 24 and 49)		
Average expenditure on home input goods/income	0.281	0.303
Average share of home hours	0.141	0.145
Average share of market hours	0.222	0.205
The old (between ages 50 and 80)		
Average expenditure on home input goods/income	0.310	0.292
Average share of home hours	0.160	0.158
Average share of market hours	0.112	0.118

3.1. First-Stage calibration

The model period is two years.[10] Each person enters the model at age 24. The maximum life span T is 90. The bottom panel of Fig. A1 in the Online Appendix shows the $1-\lambda_t$, the vector of conditional mortality probabilities. We use the mortality probabilities weighted by gender from the Social Security Administration life tables from 2000.

We calibrate the production parameters according to the National Income and Product Accounts (NIPA) and the Fixed Assets Tables for the years 1957–2007. The parameter α is the share of income that goes to the nonresidential stock of capital and is set at 0.24. This capital share is lower than in many real business cycle calibrations because housing is not part of our model's capital stock. We set δ^k to 0.09 and δ^s to 0.01, within the range of those used in the literature. The interest rate on capital net of depreciation, r, is set to 0.05. The implied capital-output ratio is 1.714.

The deterministic age profile of labor productivity, e_t, is taken from French (2005) and is shown in the top panel of Fig. A1 of the Online Appendix.[11] The labor-efficiency profile is hump-shaped, with a peak at mid- to late-40s. The persistence ρ_ε and the variance σ_ε^2 of the stochastic productivity process are 0.96 and 0.045, respectively, and the variance of the initial distribution of productivity is 0.38 (Huggett, 1996). For simplicity, we assume that the labor efficiency profile for home production is constant.

The Social Security earnings cap $y_{\max}$ is 2.47 of average earnings. The retirement benefit at age 66 is calculated to mimic the Old Age and Survivor Insurance component of the Social Security system:

$$pen(\tilde{y}) = \left\{ \begin{array}{cc} 0.9\tilde{y}, & \tilde{y} \le 0.2; \\ 0.18+0.32(\tilde{y}-0.2), & 0.2 \le \tilde{y} < 1.24; \\ 0.5128+0.15(\tilde{y}-1.24), & 1.24 \le \tilde{y} < y_{max}; \\ 0.6973, & \tilde{y} \ge y_{max}. \end{array} \right\}$$

The bend points and Social Security earnings cap, expressed as fractions of average earnings, and marginal rates, are from Huggett and Ventura (2000). If a household retires at the age of 62, it receives 75 percent of the full pension; at age 64, it receives 87 percent; at age 66, it receives the full pension; at age 68 it receives 1.16 percent; and it receives 1.32 percent if retirement is at any age greater than or equal to 70.

The parameter ζ_1 pins down the elasticity of substitution between housing services and the home input. We set this parameter to the value identified in Dotsey et al. (2014) because we no longer model owner-occupied housing in the current model.[12] As a result, the consumption of housing and home input will always be in constant proportion, and therefore, the parameter ζ_1 is not identifiable.

We take the risk aversion parameter γ to be 1.5, from Attanasio et al. (1999), and Gourinchas and Parker (2002), who estimate it from consumption data. The initial distribution over state variables (wealth, initial labor productivity level) for households of age 24 is calculated using data from the Survey of Consumer Finances (2001, 2004, and 2007) for households whose heads are between ages 23 and 26. Accidental bequests are first distributed to new agents to reproduce the distribution of capital endowments, which implies most households start with close to zero wealth. The rest of the bequests, if there are any, are distributed evenly to all living agents, which endogenously determines b.

[10] Given the model period, we adjust parameters in the model accordingly. We report parameters at annual frequency, unless stated otherwise.

[11] We scale up the profile by a factor of 26 to target an economy-wide income of $31,900, the average income calculated from Consumer Expenditure Survey (CEX) after taking out the family size, marital status, and interview year effect.

[12] We conduct a robustness analysis where we reduce the elasticity between the home input and housing by half, the results are not affected much.

3.2. Second-stage estimation

For the second-stage estimation, we use the NIPA and two microdata sets on households' consumption expenditures and time use, CEX, and the American Time Use Survey (ATUS). Dotsey et al. (2014) provide detailed information on these two data sets and the classification of consumption and time use into different categories. To reiterate, we follow the tradition of Reid (1934) and separate nonmarket time into pure leisure and home hours, where home hours comprise time spent on activities performed at home to produce goods and services that can also be purchased in the market and are, for the most part, not enjoyable to produce (Dotsey et al., 2014, Table 1).[13] In particular, we define home hours as time spent doing house work, house work service, shopping, pet care, car care, child care, adult care, shop search, car service, child care service, and professional service. We define market hours as the time the head of the household spends working, job searching, and commuting. We treat the remaining time as leisure.

For consumption, we include in our market good food consumed away from home, alcohol, tobacco, apparel, other lodging, fees and admissions for entertainment, and related equipment such as televisions, radios, sound systems, pets, toys, and playground equipment, reading, and personal care. We also include education expenses and out-of-pocket medical expenses in the market good, but our results are robust to the exclusion of these categories. We include in our home input food cooked at home, household operations, household furnishings and equipment, utilities, fuels, and public services. We prorate transportation expenses by travel time for home production or market production that we obtained from the ATUS. For housing, we use rental payments for renters, and we use homeowners' reported house value of owned residences. We then calculate the rental house size as rental payment divided by 6 percent, the value of η in our model.

Regarding the estimated moments, we deviate from Dotsey et al. (2014), who use differences across home owners and renters in estimation, and instead choose to match moments on consumption and time use calculated for the young (those between ages 24 and 49) and the old (those between ages 50 and 80).[14] Specifically, we choose the parameters, β, τ, ζ_i $(i=2,3,4)$, ω_i $(i=1,2,3,4)$, based on the following moments: K/Y, Social Security budget balance, the economy wide consumption of the home input relative to housing stock, the average home input of both the young and the old, and their respective average market hours and home hours. We also normalize the average expenditure by economy wide income. Thus, we simultaneously choose these nine parameters to match the nine selected moments as summarized in Table 3. The moments basically involve various expenditure income ratios as well as moments pertaining to the use of time. It is important to note that although our procedure jointly uses nine moments to identify nine parameters, certain moments are relatively more responsible for pinning down the shares and elasticities in the Constant Elasticity of Substitution (CES) aggregates.

For example, β is largely determined by K/Y and τ is mainly pinned down by Social Security budget balance. The three elasticity parameters (ζ_i, i=2,3,4) play crucial roles in determining households' supply of labor to different activities and consumption of different goods. Given ζ_1, which is taken from the paper mentioned earlier, we calibrate ω_1 by matching the ratio of home input to housing size. The relative amount of time spent in home production across the young and the old helps to pin down ζ_2 and ω_2. The difference in consumption of the market good across young and old helps to pin down ζ_3 and ω_3. Finally, the difference in the relative time worked in the marketplace by each of these cohorts is useful for identifying ζ_4 and ω_4 because they help determine leisure. However, the estimation is more complicated than indicated by the discussion here and is not totally driven by one set of moment differentials driving one pair of elasticity and share parameters.

3.3. Discussion

Though the target moments are somewhat different, the second-stage calibrated parameters are similar to those in Dotsey et al. (2014). Our estimation results indicate that the composite of home input and housing is complimentary with home hours in home production while the market good and the home good are substitutes.[15] Finally, the final composite consumption good made up of the market good and home good exhibits substitutability with leisure in households' utility. The existing literature on home production usually does not separate home hours and leisure in nonmarket hours, making it difficult to compare with our estimates. Nevertheless, there is some supporting evidence in the literature (see, for example, Abbott and Ashenfelter, 1976; Barnett, 1979; Greenwood and Hercowitz, 1991; McGrattan et al., 1997; Baxter and Rotz, 2009; McGrattan et al., 1997; Rupert et al., 2000). The estimate of ζ_2 has relatively important implications for our results. The complementarity between home hours and the composite of home input and housing ($\zeta_2=0.800$) implies that when more housing is purchased agents also devote more time to home production. Thus, any reform that increases the demand for housing will increase consumption through greater home production.

[13] Reid defines home production as "those unpaid activities which are carried on, by, and for the members, which activities might be replaced by market goods, or paid services, if circumstances such as income, market conditions, and personal inclinations permit the service being delegated to someone outside the household group." (Reid, 1934, p. 11)

[14] The reason for this departure is that we no longer have owner-occupied housing in the current setup.

[15] We pick ζ_1 from Dotsey et al. (2014) and set the home input and housing as Hicksian substitutes in the productions of the composite home good.

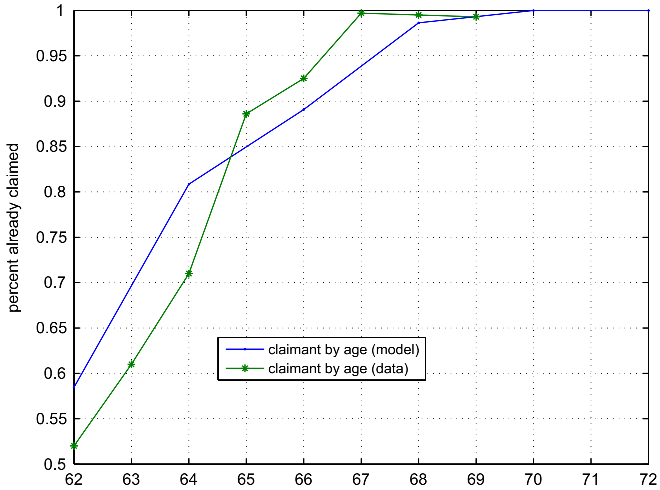

Fig. 1. Social Security claims by age.

We present the simulated life-cycle hours and consumption profiles against the corresponding data profiles in Fig. A2 of the Online Appendix.[16] The model does overall a reasonably good job at matching the data profiles and is consistent with the findings of Aguiar and Hurst (2013).[17] In Fig. 1, we plot the cumulative fraction of all retirees who claim an initial Social Security entitlement at a particular age for both the model and the data. The data come from the 2008 Social Security Annual Statistical Supplement Table 6.a4 Using statistics constructed from more years does not appreciably change the chart (see Imrohoroglu and Kitao, 2012). The model does a reasonably good job of matching the data profile except that the model predicts an initial entitlement age distribution that is a little flatter than the data. In other words, slightly more households claim their Social Security benefits at earlier ages in the model than in the data.

4. Policy experiments

Using the calibrated model, we now study the long-run effects of eliminating Social Security and the associated payroll taxes. We first report the aggregate statistics, the life-cycle effects, and then analyze the welfare implications of this reform.

4.1. *Aggregate statistics*

Table 4 summarizes the aggregate effects of removing Social Security by comparing our benchmark economy with and without Social Security benefits. Eliminating the Social Security pension has three effects on household savings. The first is the standard overlapping generations result that reducing pay-as-you-go Social Security increases saving and the capital stock. Second, reducing the pension is similar to reducing the annuity for old age households. Given an uncertain life span, households also save more to ensure that they have adequate wealth late in life. Third, the pension partly acts as a redistribution or insurance mechanism, with poor households receiving more payments than they otherwise could afford. Reducing the pension payment impels these households to save more for themselves.

When both aggregate capital K and aggregate labor N_m increase, the change of r and w depends on the relative increase of K/N_m as $r=\alpha(K/N_m)^{\alpha}-\delta^k$. According to our analysis, eliminating the Social Security system leads to a decline of 60 basis points in the equilibrium interest rate as households save more through the private market for their retirement and to insure against idiosyncratic income shocks. Accordingly, the aggregate capital output ratio increases to 1.80 from 1.71, an increase of close to 5 percent and the wage rate increases by 1.51 percent. The increase in the wage rate and the reduction in the payroll tax lead to an increase in market hours of about 5.62 percent compared to the benchmark with Social Security. Overall, households are also wealthier and the wealth effect attenuates the increase in hours worked.

In the absence of Social Security, households are wealthier, and thus they consume more. However, the increase in consumption varies substantially across goods. The fall in the interest rate reduces the relative cost of housing by directly lowering rents. Aggregate housing consumption rises by more than 20 percent in relation to the benchmark.[18] Households also substitute cheaper housing for home input. As a result, the 0.23 percent increase of the home input is much smaller than the increase in housing services. Households' consumption of market goods also increases, and the 3.35 percent

[16] The data profiles are created using the ATUS (2005–2011) and the CEX (2003–2010) as in Dotsey et al. (2014).
[17] Notice that in our model the consumption profile for the home input and housing track each other when measured as log deviations from their respective levels at age 40; thus we only depict the data for housing. Since the data profile for home input is more humped than that for housing, our model profile is actually a better fit for home input.
[18] This relatively large effect is also found by Chen (2010).

Table 4
Aggregate effects of eliminating Social Security benefits – benchmark.

Variable	SS benefits	No SS benefits (relative changes, %)
SS tax rate (τ)	0.102	0.000 (−100)
Interest rate (r)	0.050	0.044 (−12.976)
Wage (w)	0.724	0.735 (1.510)
Capital output ratio (K/Y)	1.714	1.797 (4.861)
Aggregate capital (K)	62.475	68.400 (9.483)
Aggregate labor (N_m)	76.540	78.725 (2.854)
Aggregate wealth	153.789	178.154 (15.843)
Total housing/income	2.505	3.011 (20.213)
Home input/income	0.255	0.256 (0.232)
Market cons./income	0.523	0.541 (3.351)
Market hours	0.165	0.174 (5.618)
Home hours	0.150	0.151 (0.927)
Leisure	0.685	0.675 (−1.552)

increase is larger than the increase in home input, but much smaller than the increase in housing services. The increase in the consumption of housing services induces households to increase their supply of home hours because housing services and home hours are complements in home production. However, the increase in market hours due to the increase in the wage rate has an offsetting effect on the supply of home hours that largely offsets the upward pressure from higher housing consumption. On balance, households' supply of home hours moves up by a slight 0.93 percent. Leisure, by comparison, falls by 1.55 percent. Aggregate effective labor, defined as hours weighted by efficiency units, increases less than total market hours, indicating that less productive individuals increase labor supply more than productive ones.

4.2. Life-cycle effects

In Table 5, we report consumption, market hours, and home hours, at different points of the life cycle before and after Social Security reform. Social Security reform increases the return to supplying market hours when there is no longer a payroll tax and the wage rate is higher due to a higher capital stock. The lower interest rate reduces the return to saving and, therefore, dampens the direct effect that a higher wage has on hours worked. This channel appears to be relatively stronger in the young. Turning to home hours, the reform increases hours spent in home production when households are young, as the lower interest rate makes housing more affordable and the complementarity of the home input results in more home input being purchased as well. The young actually substitute some market hours into home hours. Middle-aged households are affected less because they are relatively more productive, and using home hours is relatively expensive for them. The absence of Social Security benefits also gives older households additional incentives to work in the market. The end result is that households younger than 34 reduce their market hours and increase their home hours. By contrast, households older than 54 increase their market hours and reduce their home hours.

In terms of consumption, the lower interest rate enables households to choose a much flatter consumption profile over the life cycle. Note that in our economy, for a given interest rate, the ratio of the consumption of home input to housing is constant among households. The reduction in the consumption from age 54 to age 84 is less evident in the home input and housing than in market consumption. This is because in our model, home hours are complements to the aggregate of home input and housing. As hours working at home increase as households age, so do housing and home input, effectively flattening the associated life-cycle profiles.

4.3. Welfare implications

In this subsection, we explore the long-run welfare implications of Social Security reform. The transitional dynamics will be discussed in Section 8. Following McGrattan et al. (1997), the welfare effects are measured by the percentage changes in market consumption that makes an unborn household (before the realization of all state contingencies) indifferent between the two steady states holding the amount of leisure constant. We follow their procedure because market consumption is the only consumption good that is common across all models. By this measure, we find that aggregate welfare increases by 20.75 percent (see row 1 of Table 12) after the complete elimination of Social Security.

Social Security provisions affect welfare in several ways. On the positive side, Social Security benefits provide partial insurance against mortality risk. Social Security also redistributes wealth among retirees, and thus provides partial risk sharing against income uncertainty.[19] However, Social Security provisions are financed through distortionary payroll taxes, which lead to a reduction in labor supply and hence the capital stock. The reduction in labor supply leads to reduced income, which is particularly costly to those who are credit constrained. Social Security also reduces precautionary saving and hence

[19] For a useful discussion in a model with fixed labor supply, see Storesletten et al. (1999).

Table 5
Consumption and labor supply with/without Social Security – benchmark.

Age	Housing		Home Input		Market Cons.		Market Hour		Home Hour	
	SS	No SS	SS	No SS	SS	No SS	SS	No SS	SS	No SS
24	2.300	3.016	0.234	0.256	0.401	0.467	0.185	0.179	0.143	0.149
34	2.743	3.459	0.279	0.294	0.602	0.659	0.235	0.231	0.138	0.143
44	3.100	3.743	0.316	0.318	0.726	0.757	0.222	0.229	0.144	0.146
54	3.256	3.800	0.332	0.323	0.729	0.732	0.177	0.197	0.153	0.152
64	3.180	3.611	0.324	0.307	0.632	0.604	0.089	0.125	0.165	0.161
74	2.768	3.090	0.282	0.263	0.480	0.438	0.018	0.044	0.169	0.166
84	1.828	1.962	0.186	0.167	0.214	0.200	0.000	0.000	0.161	0.154

the capital stock implying that the productive capacity of the economy without Social Security is considerably greater. In our analysis, as in the existing literature, the distortionary effects outweigh the welfare-improving effects.

To explore the distributional effects of the reform, we group households according to their initial market labor productivities at age 24. Interestingly, the welfare gains of eliminating Social Security benefits are negatively correlated with an individual's initial productivity. The least productive households receive the most gains (43 percent) and the most productive households receive the least gains (5 percent). The welfare gains for the other three groups are 33 percent, 22 percent, and 14 percent, from less to more productive. These results suggest that the distortionary effects associated with payroll taxes and the lower wages associated implications with the existence of Social Security outweigh the distributional effects, and that these distortions are particularly acute for those individuals who face a borrowing constraint, namely the least productive households.

5. Analyzing the one-good economy

The traditional literature on Social Security reforms has exclusively focused on a one-good economy. To facilitate the comparison of our economy with the literature, we investigate an economy where households consume only one good, which is the sum of the market good, the home input, and housing services as defined in our benchmark economy. We, however, maintain the functional form of constant elasticity of substitution between aggregate consumption and leisure for the period utility.

5.1. Calibration

Specifying a one-good economy requires reclassifying hours, capital, and the output-capital ratio. In turn, in order to match various data moments, these changes imply very different parameters and in particular a lower labor supply elasticity. Specifically, in the one-good economy housing capital is now part of the aggregate capital stock, and for consistency, housing services are added to market output. With these adjustments, the new capital output ratio is 3.668, and the average depreciation rate is 0.042.[20] The resulting capital share in production α is now 0.339 in order to match the 5 percent interest rate that we used to calibrate the benchmark model. We rescale the labor efficiency profile to arrive at the same aggregate wealth as in the benchmark. We reestimate the discount factor β, Social Security payroll tax rate τ, the elasticity parameter for consumption and leisure ζ_4, and the weight on consumption ω_4. In particular, the elasticity parameter for consumption and leisure ζ_4 and the weight on consumption ω_4 are set to 1.521 and 0.069, respectively, to match the average market hours for the old (0.118) and the young (0.205). The implied Frisch labor-supply elasticity of the one-good economy is 2.84 as opposed to 5.11 in the benchmark.[21,22] The model implied market hours are 0.109 for the old and 0.220 for the young, roughly matching the empirical moments. We summarize our new calibration in Table 6 and chart the model implied life-cycle profiles and data generated profiles in the Online Appendix Fig. A3. While completely missing the profiles of home hours by construction, the model does a fairly good job at matching the market labor profile. However, it generates too pronounced a hump in the consumption profile when compared to the data.[23,24]

[20] Our housing measurement in the benchmark comes from CEX. As is well known, the number there is somewhat higher than that captured by NIPA. In order to facilitate comparison with the benchmark, we calibrate the capital output ratio in the one-good economy using the CEX implied housing stock. In the Online Appendix C, we provide the case where the one-good economy is calibrated according to NIPA, the results are very similar to what we have here.

[21] The elasticities are calculated using mean hours and consumption expenditures in the model for unconstrained households. The constrained households in the model would obviously face different elasticities.

[22] These estimates are close to the range of estimates of the Frisch elasticity calculated using macro data. For example, in the business cycle literature, Cho and Cooley (1994) and King and Rebelo (1999) choose Frisch elasticities that range from 2.6 to 4.0. In dynamic stochastic general-equilibrium (DSGE) models, Smets and Wouters (2007) obtain an estimate of 1.9.

[23] The empirical profile for aggregate consumption is generated using the same methodology as in the benchmark.

[24] Imrohoroglu and Kitao (2009) generate an even larger hump in consumption, which peaks much later in life than in the data.

5.2. Policy experiment

We then conduct the same policy experiment as in the benchmark model. We report the percentage change of aggregate statistics after the reform in Table 7. As can be seen, aggregate capital increases substantially, much larger than that in our benchmark economy. In the benchmark, the increase of total wealth after the reform is also very high. However, since most of the increase goes to housing, in the benchmark model, the increase in capital is more moderate, and as a result, the decrease in the interest rate and the increase in the wage rate are also smaller than in the one-good economy. The substantial increase in the wage rate in the one-good economy also explains why market labor supply increases by a rate larger than the increase in the benchmark despite the lower labor-supply elasticity. Overall, the change in consumption profiles behaves similar to those of the market good defined in the benchmark economy.

Finally, we show the welfare gain by initial productivity in row 2 of Table 12. The welfare gains of eliminating Social Security benefits drop to 9.20 percent, over 10 percentage points lower or roughly half as much as the welfare gains in the benchmark economy. One reason for this welfare result is the difference in estimated parameters in the utility function across the two models. Consumption varies much more than leisure when Social Security is eliminated and it has a greater weight in utility in the home production economy. Another reason is that the labor elasticity is higher in the benchmark economy than in the one-good economy making market hours less responsive in the one-good economy to an increase in the wage rate. Further, because the home-production economy provides some modest insurance against income risk Social Security is less valued in the benchmark economy.

Ranking households by their initial market labor productivity from lowest to highest, the welfare gains are 13.30 percent, 11.73 percent, 9.85 percent, 7.48 percent, and 3.82 percent. However, the gains are much smaller compared with the benchmark economy for households with lower initial labor productivity. This highlights the role of home production as an insurance mechanism for those agents with lower initial productivity who on average have low lifetime productivity in the market.

6. Robustness analysis

To explore the robustness of our policy results, we now conduct three robust analyses. Specifically, we (1) set households' borrowing limit to zero, (2) levy additional labor and capital income taxes and these taxes are used to fund other nonproductive and unvalued government expenditures, and (3) exclude housing from home production. We recalibrate all three models to match corresponding consumption and labor supply data moments and report recalibrated model parameters in Table 8. Then we study the steady state implications of eliminating Society Security in these economies (Tables 9 and 12).

6.1. Zero borrowing limit

With a zero borrowing limit, which is tighter than the borrowing limit in the benchmark, households are more liquidity constrained and need to save more for precautionary reasons. To achieve the same level of aggregate savings as in the data, the discount factor β decreases. The other parameters are roughly unchanged. With a lower discount factor, future consumption is less valued, and as a result after the reform saving increases by a little less, as does capital and housing. Compared to the benchmark, the lower housing stock leads to less hours in home production and some of those hours are now spent working in the market. With additional output, market consumption increases by more than that in the benchmark.[25] Furthermore, by their initial labor productivities, the welfare gains are much smaller for the low productivity households. This is because households with low initial productivities are more likely to have low productivities for longer periods as productivities are persistent. When borrowing constraints are tightened to zero and no longer depend on wages, as in the benchmark, constrained households no longer benefit from the endogenous relaxation of the constraint when their wages increase.[26]

6.2. Additional taxation

The benchmark economy abstracts from capital income taxes and other labor income taxes. When we introduce a 20 percent capital income tax and a 24.6 percent additional labor income tax, households have less incentive to save and to work in the market.[27] As a result, to match the capital/output ratio, the discount factor β increases, and to match market labor supply, the weight on home hours in home production decreases. With these additional taxes in the capital and labor market, Social Security provisions are more distortionary than in the benchmark, because the percentage decline in the after

[25] Total output increased by 4.71 percent as opposed to 4.41 percent in the benchmark.

[26] In the benchmark, borrowing limit is the same for households of the same age, the lowest wage they receive. The limit, however, does vary by age because labor productivities vary over the life cycle (see Fig. A1 in the Online Appendix). As a result, young households are more constrained than older households.

[27] With these tax rates we get a government expenditure share of 23%. This is a slightly higher number than in standard model calibrations, because our measure of output does not include housing services.

Table 6
Calibration results – one-good economy.

Parameters		
β	Discount factor	0.955
τ	Social Security tax	0.103
ζ_4	Sub. betw. consum. and leisure	1.521
ω_4	Weight on consumption	0.069

Table 7
Aggregate effects of eliminating Social Security benefits – one-good economy.

Variable	Relative changes after reform (%)
Interest rate	−13.981
Wage	4.119
Capital output ratio	8.910
Aggregate capital	17.786
Aggregate labor	4.615
Aggregate wealth	17.904
Market consumption	6.882
Market hours	7.738
Leisure	−1.499

Table 8
Calibration results – robustness analysis.

Parameters		Zero borrowing limit	Additional taxation	Housing not in home production
β	Discount factor	0.951	0.970	0.953
τ	Social Security tax rate	0.102	0.102	0.102
ζ_1	Sub. betw. home input and n_h			0.809
ω_1	Weight on home input	0.754	0.754	0.612
ζ_2	Sub. betw. d and h composite and n_h	0.801	0.801	0.772
ω_2	Weight on d and h composition	0.762	0.792	0.616
ζ_3	Sub. betw. market and home goods	2.207	2.215	1.895
ω_3	Weight on market goods	0.131	0.132	0.153
ζ_4	Sub. betw. consumption and leisure	1.517	1.530	1.565
ω_4	Weight on consumption	0.227	0.225	0.209

Note: ζ_1 and ω_1 are only recalibrated in the last experiment. Additionally, in the last experiment ζ_2 is the elasticity between home produced good and housing while ω_2 is the weight on home produced good. See Eq. (14).

Table 9
Aggregate effects of eliminating Social Security benefits – robustness analysis.

Variable	Relative changes after reform (%)		
	Zero borrowing limit	Additional taxation	Housing not in home prod.
Interest rate	−12.131	−18.873	−14.471
Wage	1.409	2.229	1.690
Capital output ratio	4.530	7.230	5.452
Aggregate capital	9.453	13.942	11.230
Aggregate labor	3.255	3.943	3.727
Aggregate wealth	15.050	25.091	13.204
Total housing	18.910	32.782	14.494
Home input	0.393	1.182	3.765
Market consumption	3.912	5.280	3.478
Market hours	5.923	5.973	7.071
Home hours	0.447	2.390	0.859
Leisure	−1.514	−1.957	−1.834

tax return from capital and labor is magnified when Social Security is abolished. Indeed, after the elimination of Social Security, households save much more than in the benchmark case with a resulting larger increase in the capital stock and the wage rate. The higher wage rate leads to a substantially higher supply of market hours. Output and consumption of all goods increase more than in the benchmark. Aggregate welfare gains from eliminating Social Security are thus much higher in the new economy than in the benchmark and this holds for households of all initial productivity levels.

6.3. Housing not in home production

In this last robustness analysis, we remove housing as an input in home production, but assume households still value the service it provides. This amounts to a somewhat different nesting of CES aggregators. Specifically, the home produced good is now specified as[28]

$$c_h = \left\{ \omega_2 \left[\omega_1 d^{1-(1/\varsigma_1)} + (1-\omega_1) n_h^{1-(1/\varsigma_1)} \right]^{(1-(1/\varsigma_2))/(1-(1/\varsigma_1))} + (1-\omega_2) s^{1-(1/\varsigma_2)} \right\}^{1/(1-(1/\varsigma_2))}. \tag{14}$$

With this new specification, the home input and housing are no longer proportional, which allows us to separately identify them. In other words, we recalibrate both ζ_1 and ω_1 along with the other parameters in this new economy. Additionally, some of the parameters have a different interpretation. Most importantly, the weight on home hours is now $1-\omega_1$ instead of $1-\omega_2$. The results of the calibration are reported in Table 8. With ζ_1 at 0.809, the home input remains a complement with home hours. Housing in turn is a complement with the good produced using the home input and home hours (ζ_2 is less than 1). To match data moments, it is still important that both d and s remain complements with n_h, but with the alternative nesting that requires that the home input and housing services also be complements. Compared with the benchmark calibration, the weight on home hours, $(1-\omega_1)$, is bigger than it is in the benchmark, $(1-\omega_2)$. The weight on the market good is slightly larger and the elasticity of substitution between it and the home produced good is somewhat smaller. Finally, the elasticity between consumption and leisure is slightly larger and the weight on total consumption smaller than in the benchmark.

After the elimination of Social Security, although wealth does not increase quite as much, a greater portion of that wealth is channeled into capital, as increasing housing is not as valuable as in the benchmark.[29] The lower marginal value of additional housing occurs because housing is now less substitutable with the home input than in the benchmark. As a result, the interest rate drops more and the wage rate increases by more than they do in the benchmark policy experiment. Households increase their consumption of the home input by much more in order to increase home production. The end result is that because of the limitation in home production, households spend more time working in the market than in the benchmark and consume more market good. In terms of welfare, after the elimination of Social Security, households are better off by almost the same percentage as in the benchmark reform, 20.20 percent versus 20.75 percent.

7. Other economic specifications

In order to better understand the driving forces behind the welfare differences between the benchmark and the one-good economy, we analyze three additional economies. In the first case, we remove housing services from home production, but maintain home production that uses a home good and home hours as inputs in producing a home consumption good. In this case, housing is returned to the definition of the capital stock as in the one good economy. In the second case, we remove productive home hours, but maintain a home-produced good that uses a combination of housing services and the home good as inputs. In the third experiment, we keep housing in home production but reclassifying the home input into market consumption. We conduct the same policy experiments as before. The recalibrated parameters are reported in Table 10 and policy experiment results in Tables 11 and 12.

7.1. With home production but no housing

In our first intermediate case with home production, but where housing is now part of the capital stock, the capital stock, capital–output ratio, and the capital income share are the same as in the one-good economy. We rescale the labor efficiency profile to arrive at the same aggregate wealth as in the benchmark. We then set ω_1 to 1 (ζ_1 is no longer relevant) and recalibrate the rest of the preference parameters to match the various data moments as in the benchmark except that we take out the home input/housing ratio. The calibration results remain close to those in the benchmark and are reported in Table 10. Specifically, the home input and home hours remain complementary in home production with an elasticity of substitution slightly below that in the benchmark. The market good and the home good are still highly substitutable with an elasticity that is also a bit less than that in the benchmark. The elasticity between the composite consumption good and leisure (ζ_4) is a bit larger than in the benchmark.

We then eliminate Social Security provisions and report changes in selected aggregate statistics in Table 11. As in the one-good economy, aggregate capital increases substantially. The decrease in the interest rate and the increase in the wage

[28] Strictly speaking, the home produced good should be $[\omega_1 d^{1-1/\varsigma_1} + (1-\omega_1) n_h^{1-1/\varsigma_1}]^{1/(1-1/\varsigma_1)}$. We do not change the notation in order to facilitate the comparison with previous experiments.

[29] After Social Security reform total wealth increases by 13.2 percent in the economy as opposed to 15.8 percent in the benchmark.

Table 10
Calibration results – alternative economies.

Parameters		Home production no housing	Housing no home production	No home input
β	Discount factor	0.953	0.954	0.955
τ	Social security tax	0.103	0.102	0.103
ζ_2	Sub. betw. composite good and n_h	0.785		0.804
ω_2	Weight on composite good	0.705		0.628
ζ_3	Sub. betw. market and home goods	2.007	2.186	2.209
ω_3	Weight on market goods	0.133	0.534	0.169
ζ_4	Sub. betw. consum. and leisure	1.567	1.460	1.502
ω_4	Weight on consumption	0.231	0.091	0.223

Table 11
Aggregate effects of eliminating Social Security benefits – alternative economies.

Variable	Relative changes after reform (%)		
	Home production no housing	Housing no home production	No home input
Interest rate	−13.547	−12.022	−12.550
Wage	3.983	1.396	1.459
Capital output ratio	7.876	4.488	4.694
Aggregate capital	17.670	10.210	9.626
Aggregate labor	4.915	4.025	3.205
Aggregate wealth	17.669	18.362	11.720
Total housing		23.929	13.226
Home input	3.835	4.798	
Market consumption	8.032	2.327	3.168
Market hours	7.270	6.735	6.443
Home hours	−0.527		0.871
Leisure	−1.548	−1.287	−1.704

Table 12
Welfare gain (%) – no SS benefits.

Model	All	Initial productivity				
		1st	2nd	3rd	4th	5th
Benchmark	20.750	43.380	32.836	22.295	13.634	5.464
One-good economy	9.196	13.303	11.734	9.845	7.483	3.817
Robustness analysis						
Zero borrowing limit	19.929	37.309	29.604	22.014	14.177	6.088
Additional taxation	37.690	81.307	60.284	39.938	24.333	10.341
Housing not in home prod	20.202	39.337	30.883	21.713	13.623	5.316
Alternative economies						
Home prod no house	15.580	28.060	22.481	16.848	11.434	5.211
House no home prod	16.389	24.265	21.137	17.380	13.046	6.602
No home input	12.749	25.783	19.697	13.609	8.700	3.572

rate are higher than the benchmark, but slightly less than the one-good economy. Market labor supply increases much more than in the benchmark but somewhat less than the one-good economy. Home hours are roughly unchanged. Consumption of both home input and market good increase significantly more than in the benchmark.

Finally, as seen in Table 12, the welfare gain of eliminating Social Security benefits drops to 15.58 percent, about 5 percentage points lower than the welfare gains in the benchmark economy but 6 percentage points higher than the one-good economy. The main reason for this result is that households no longer benefit from the relative change in the price of housing. Compared to the one-good economy, however, the home-production economy still provides insurance against income risk, and as a result, Social Security is less valued in this intermediate economy than in the one-good economy. Ranking households by their initial market labor productivity from lowest to highest, the welfare gains are much smaller than the welfare gains of households in the benchmark economy at the same productivity levels, but much larger than the welfare gains in the one-good economy. This highlights the role of home production as an insurance mechanism especially for those agents with lower initial productivity who on average have low lifetime productivity in the market.

7.2. With housing but no home hours

This economy has the same capital and capital/output ratio as the benchmark economy because housing is modeled separately and no longer is part of the aggregate capital stock. We then set ω_2 to zero, and keep ω_1 and ζ_1 the same as in the benchmark economy. We recalibrate the rest of the preference parameters to match the various data moments. Since home production is no longer constrained by the provision of home hours, we need a much larger weight (ω_3) on the market good to match the ratio of the home input to income. The values for the parameters ω_4 and ζ_4 are also a bit smaller than the values we calibrated in the benchmark economy. Table 10 presents these estimates.

Though home production is absent in this economy, adding a home-produced good still provides an additional margin of substitution beyond what is present in the one-good economy. Adding back home production would return us to the benchmark specification. As reported in Table 11, eliminating Social Security in this economy leads to an increase in aggregate savings that is close to that of the benchmark economy. Much of the increase in wealth, however, goes to housing leading to an increase of close to 24 percent in housing services, about 4 percentage points higher than the increase in the benchmark. Both the increase in productive capital and labor supply lie in between the increases in the benchmark and one-good economies. The end result is that total welfare increases by 16.39 percent. The 7 percentage point difference between the welfare gain in this economy and that in the one-good economy results from the changes in the relative price between housing services and other goods as in Chen (2010). Compared with Chen (2010), it is worth noting that our welfare gains in the one-good economy and in the model with housing are both smaller than in his analogous specifications. This result is due to endogenous labor supply in our model. Ranking households by their initial market labor productivity from lowest to highest, compared to the benchmark economy, the welfare gains are smaller for the low productivity households but higher for the high productivity households. This result occurs because high productivity households consume more housing and no longer suffer any disutility from supplying home hours. They thus benefit more from the decline in the interest rate in this intermediate economy. Compared to the one-good economy, these welfare gains are unambiguously larger at all productivity levels indicating that relative price changes benefit all households in the economy.

7.3. No home input in home production

In this subsection, we maintain housing as an input to home production but reclassify the home input into market consumption. As a result of the change, we can no longer target home input over income of the young and the old for our recalibration. We, therefore, target the housing/income ratio for the young and the old instead. As seen in Table 10, this change leads to a higher weight on the market good, a slightly smaller weight on total consumption, and a smaller elasticity of substitution between total consumption and leisure. The change in the parameters is due to the fact that this economy has more market goods and to match that feature a higher weight must be placed on the market good. In other words, the reclassification of the home input into the market good effectively reduces the role of home production in the economy and in so doing leads to less home produced goods that can substitute market goods. This in turn implies that the need for Social Security to ensure against old age risk and the desire to smooth consumption across households are larger than in the benchmark. Indeed, as reported in Table 11, after the policy change, the drop in the interest rate and increase in the wage rate are not as large as the changes we observe in the benchmark reform. Households, nevertheless, work more in the market and also save more in order to compensate for the loss of insurance from Social Security. Total welfare gains from removing Social Security, at 12.75 percent, are 8 percentage points lower than those in the benchmark reform, but close to 4 percentage points higher than those occur in the one-good economy. This experiment therefore reinforces the notion that home production and its relative size in the economy has important implications for households' ability to insure against income risks, and thus influences the value of Social Security.

Finally, an indication that home production provides insurance to households can be seen by looking at the Gini coefficients of consumption by age across four different models. This is shown in Fig. 2, where the four models correspond to the benchmark, the intermediate economy with home production but no housing, the intermediate economy when we remove home hours in home production, and the one-good economy.[30] As is evident, both with and without Social Security, the Gini coefficients are much lower for all ages when home production is part of the model environment. Importantly, the increase in the Gini coefficient when home production is eliminated occurs when we eliminate home hours as Gini's are roughly equivalent for the one-good and the intermediate economy with no home hours used in home production but with housing, and for the benchmark and the intermediate economy with home production but with housing. Note that in all four economies, after eliminating Social Security, the distribution of consumption becomes slightly less skewed, especially for the young. The lower skewness indicates that households are better able to smooth consumption. This improvement in consumption smoothing occurs because the reduction in taxes and the increase in the wage rate enable borrowing-constrained poor households to increase consumption without affecting rich households who save for retirement. See Yang (2013) for more discussion.

[30] In order not to crowd the graph, we do not include all economies. Similar observations can be observed in the other economies.

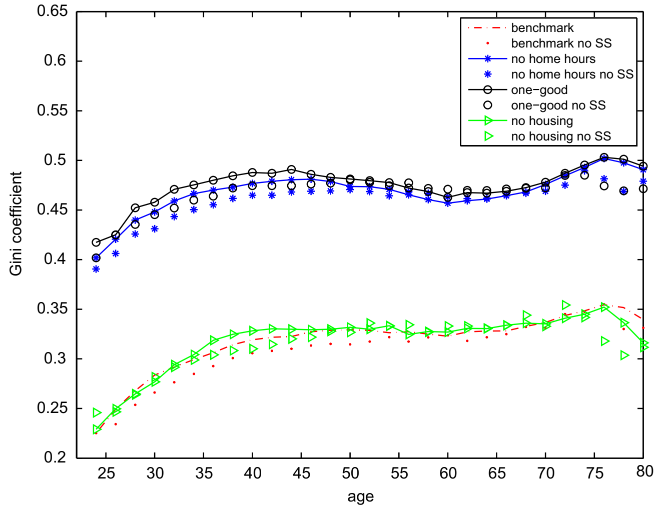

Fig. 2. Consumption Gini coefficients.

8. Transitional dynamics

In analyzing reforms to Social Security, it is important to also investigate transitional dynamics. Here we look at a reform that provides for a gradual transition out of Social Security. Our main purpose is to compare the implications of adding home production for the transition, rather than designing an optimal transition or a transition that would be approved by a median voter as in Cooley and Soares (1999).

The particular reform we look at grandfathers retirees and prorates benefits based on how much a person has contributed to Social Security before it is abolished. Basically, we apply the Social Security formula to each individual based on his contribution to date. Additionally, a proportional tax is levied on labor income in order to fund the existing claims and is gradually lowered according to a linear schedule. The tax rate becomes zero once all claims have been satisfied. Thus, there are no claims or taxes after 66 years, which is the maximum time span for anyone who contributed to still be alive. Initially, some of the Social Security payments are funded by government debt, but by the time all payments have been made the tax rate also becomes zero and the debt has been repaid.

As shown in Fig. 3, in both the benchmark home-production and one-good economies households initially work less as they intertemporally substitute effort into the future when tax rates are lower. As a result, asset holdings initially decline as well but to a lesser extent than the supply of labor. The greater relative decline in labor causes a rise in the capital labor ratio and results in a decline in the interest rate and a rise in wages. However, the increased need for precautionary saving quickly causes the capital decline to slow and for capital to eventually start increasing toward its new steady state value. The decline in the labor supply also dampens and hours worked then gradually increase toward the new steady state as well. Home hours, by comparison, increase initially and then decline as market hours start to recover due to the increase in after-tax wages. After about 10 periods, home hours rise again as households' consumption of housing services increases raising the demand for home hours. Overall, home hours fluctuate within a much narrower range than market hours. Taken together, the capital labor ratio initially increases from its period one value and then declines toward steady state. This behavior accounts for the hump shape profile in interest rates and U-shaped wages along the transition path.

Although the qualitative behavior of aggregate variables is similar along the two economies' transition paths, there are some important quantitative differences. First, a significant fraction of the increase in assets in the home-production economy is used to fund a greater housing stock, while by definition all of the increase in assets goes into capital in the one-good economy. Further, because the precautionary motive is greater in the one-good economy, saving increases by more, and the new steady-state interest rate is lower and the wage is higher. Finally, in the benchmark low productivity workers substitute market work with home work. As a result, labor supply in efficiency units is higher for the benchmark than for the one-good economy.

The welfare consequences along the transition are depicted in Fig. 4. In the one-good economy, all of the existing agents are worse off and the middle-aged are particularly hard hit. They have lost a sizable amount of future Social Security payments without having a substantial amount of time to accumulate additional assets. Also, the wage rate does not increase sufficiently over their life span to compensate for the loss in Social Security benefits. Those in retirement and close to retirement are little affected as their Social Security benefits are either unchanged or little changed. The small welfare decline is due to a fall in the interest rate. The current young lose a bit, because the tax rate they initially pay is being used to fund current retirees, and the young will not benefit from Social Security. Also, it takes more than one generation for the capital stock and the productive capacity of the economy to increase by a large enough extent to more than compensate for loss of the Social Security annuity.

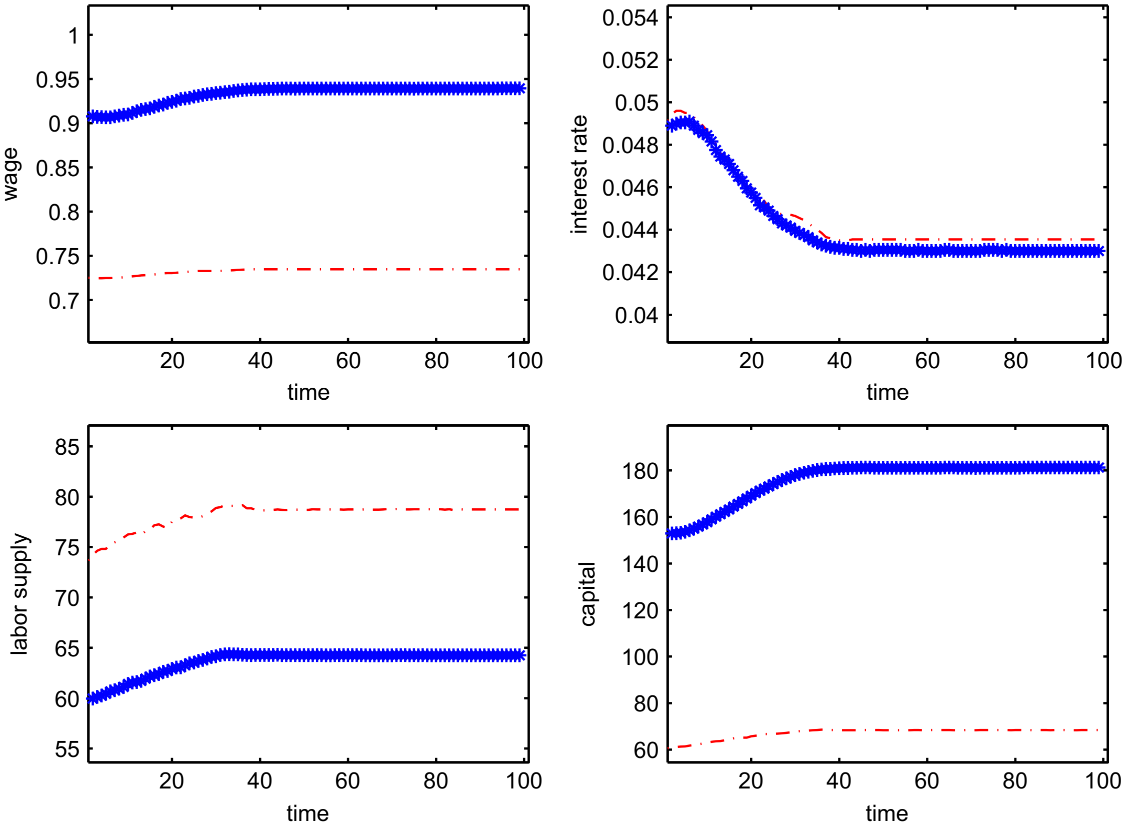

Fig. 3. Transitional dynamics (dashed line: benchmark economy; star: one-good economy).

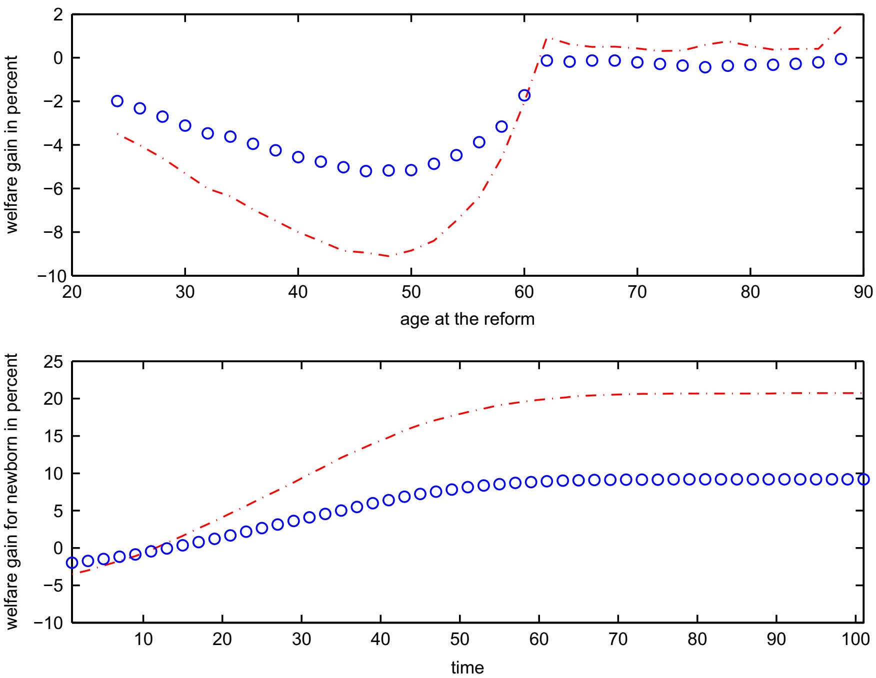

Fig. 4. Welfare along the transition path (dashed line: benchmark economy; circle: one-good economy).

In the home-production economy, the welfare profiles are similar, but the losses for all but the retirees are more pronounced. Retirees actually benefit, because the decline in the interest rate allows them to rent bigger houses and produce more at home. Further, the decline in the interest rate is not as great as in the one-good economy and retirees therefore do not lose as much interest income from their accumulated savings. On net, the gain, however, is small. The larger welfare loss for other current generation agents occurs in part because a higher tax rate on labor is needed to finance the remaining Social Security obligations. The higher tax rate arises from the fact that the labor supply elasticity in this economy is much larger than in the one-good economy, and the greater reduction in hours worked requires a higher tax rate in order to generate the necessary revenue. The larger elasticity of labor implies that taxes are more distortionary in the presence of home production. Additionally, households in the one-good economy have higher wages and, therefore, can accumulate precautionary savings and reduce the negative consequences of the borrowing constraint implying a lower proportional welfare loss. However, as the bottom panel in Fig. 4 shows, new born agents become better off sooner in the home production economy. As the after-tax wage rises along the transition path, the combination of a more elastic labor supply as well as the additional means of self insurance afforded by home production in the presence of a larger housing stock is the primary contributors to future generations benefiting from Social Security reform at a slightly faster pace.

9. Conclusion

We study the aggregate economic and welfare effects of Social Security reform in an environment with home production and multiple consumption goods. We show that abolishing Social Security improves steady-state welfare as well as differentially affects the demand for various goods depending on the degree of substitutability between home production and market work for each particular good. Importantly, the steady-state gains are more than twice as large as those in a standard one-good economy model that is used in the extensive literature devoted to the study of possible Social Security reforms.

Our results indicated that abstracting from the key role that home production plays over the life cycle may result in a significant understatement of the costs of Social Security. Further, the presence of home production can have consequences for the transitional dynamics associated with reforms of Social Security. For the particular reform we examine, current generations are made significantly worse off relative to steady-state in the home-production economy when compared to those in the one-good economy. However, future generations enjoy the benefits of the reform somewhat sooner. We trace some of these differential welfare effects to the additional margins of substitution afforded to agents when they have access to a home-production technology. To summarize, because the home-production economy is able to match life-cycle profiles and to jointly explain time use and the types of goods consumed over the life cycle, it may provide a better platform for analyzing the consequences of changes in government policies that impact household behavior.

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Appendix A. Supplementary data

Supplementary data associated with this paper can be found in the online version at http://dx.doi.org/10.1016/j.euroecorev.2014.11.006.

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