Home Production and Retirement PRELIMINARY AND INCOMPLETE

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1 Introduction

The argument of this paper is that incorporating home production is important for understanding many aspects of behavior around the retirement stage of the life-cycle. In particular, I shall argue that home production can account for the following stylized facts regarding consumption, saving and wealth decumulation.

1. Individuals tend to retire completely from market work between ages 62 and 65, rather than continuing to work full time or switching to part-time work (see, for example, French 2002).

2. Retirement is associated with a discrete decline in consumption (see Banks, Blundell and Tanner 1998, Bernheim, Skinner and Weinberg 2001, or Lundberg, Shelly and Startz 2002). This drop constitutes a break in the generally smooth hump-shape for consumption over the life-cycle.

3. Households decumulate wealth relatively slowly in retirement, and are especially reluctant to run down housing wealth (see, for example Venti and Wise 2002).

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Without home production it is difficult to account for these features of life-cycle behavior. For example, a basic prediction of the simplest permanent income / life-cycle model is that households should smooth consumption through predictable changes in income. Presumably households do not systematically retire earlier than expected. Moreover, since asset holdings tend to peak at retirement age, it is unlikely that this the abrupt decline in consumption is attributable to borrowing constraints.

One way to think about the home production interpretation of life-cycle evidence is that the apparent puzzles simply reflect measurement problems. A standard one sector theoretical model generates predictions for the relationship between total earnings, income and consumption. However, the observed life-cycle profile for earnings corresponds to measured market earnings, and the empirical profile for consumption corresponds to measured consumption of marketed goods and services. In reality, true consumption is higher than measured consumption, since measured consumption largely ignores consumption of home produced goods. Similarly, true earnings are higher than measured, since some fraction of home produced goods is attributable to value-added by labor. The fact that income and consumption are mis-measured (relative to the one sector model) would not matter, except for the fact that retirement presents an opportunity for households to substitute working in the market for working at home.

In this paper I extend a standard life-cycle model to incorporate a home sector, so that within the model I can explicitly distinguish between market and non-market variables. The mechanism the model is designed to capture can be summarized as follows. For various reasons to do with the way annuities are provided in the United States, individuals have an incentive to drastically reduce market hours around age 65. Holding hours worked at home constant, less market work implies more leisure, and a fall in the marginal utility of leisure. This constitutes a decline in the opportunity cost of working at home. Thus households substitute working in the market for working at home. More home work implies more consumption of the home produced good and, if market and home consumption are substitutes, less consumption of the market produced good. Essentially the same idea has been used by other authors to shed light on other issues. Baxter and Jermann (1999) argue that introducing home production can help account for the apparent excess sensitivity of consumption to income. Rupert, Rogerson and Wright (2000) argue that adding home production makes a big difference when estimating the inter-temporal elasticity of substitution.

Banks et. al. (1998) and Bernheim et. al. (2001) conclude that the decline in consumption at retirement most likely reflects either myopia or irrationality. Other authors have posited time inconsistent preferences (Diamond and Koszegi) or exogenous changes in bargaining power within the household (Lundberg et. al.). Which explanation is correct matters. For example, if households are systematically disposed to save too little for retirement, privatizing social security might exacerbate poverty among the elderly. If, however, individuals are optimally counting on home production as an implicit source of post-retirement income, we should not be concerned that they appear to under-saving relative to a "maintain market consumption" benchmark. The home production hypothesis has several attractive features relative to alternative candidate explanations. First, the home production mechanism can be illustrated in a model in which households enjoy perfect foresight, and in which preferences are both time separable and age invariant. Second, the home production model generates data-testable predictions for the life-cycle dynamics of other observable characteristics beyond just consumption. Third, the home production framework is a useful theoretical framework for framing measurement issues that plague the literature on savings adequacy. For example, one recurrent issue is whether housing should be treated as part of wealth in assessing households' preparedness for retirement (see, for example, Engen, Gale and Uccello 1999). Once housing is modeled explicitly, its role becomes clear. Housing should be counted as wealth, but we should not expect households to downsize their housing much in retirement, since housing is a key input for home production.[1]

A simple over-lapping generations model economy is constructed in which the only significant innovation relative to previous work in the life-cycle tradition is that the economy features two production technologies: a technology for producing marketed goods, and a technology for producing non-marketed goods that are consumed at home. The model is calibrated, and is found to be quantitatively consistent with all three features of the data listed at the start of the introduction. Moreover, for a range of parameter values, the model is also consistent with the observed life-cycle profiles for hours worked at home and purchases of consumer durables. In addition to shedding light on some of facts that are difficult to reconcile within a one-sector life-cycle model, introducing home production has important implications for other issues. For example, in the benchmark model the annual flow of bequests is three times as large as in an economy which abstracts from home production but which is otherwise identical.

[1] Thus the extent to which housing can be used as collateral to finance borrowing becomes critical.

It is easy to think of opportunities to increase home produced consumption after retirement. Consider food. Households may eat more at home rather than going out to restaurants, may cook more proper meals from cheaper basic ingredients rather than heating up pre-prepared products, and may even cultivate some fruits and vegetables themselves rather than purchasing them on a market. Or consider home cleaning and yard maintenance. Retirees may prefer to do more of these tasks themselves rather than hiring outside help. Similarly retirees may rely less heavily on dry-cleaning services, tax-filing services, dog-walking services and so on. In a broader sense, households may increase output of shopping services in order to acquire market goods more cheaply, by driving to more stores to compare prices prior to purchasing. As a final example, households may increase repair and maintenance of consumer durables in order to economize on new investments, for example by cleaning cars more frequently or darning holes in clothes.

The first part of this paper documents time use and consumption patterns over the life cycle, and in particular around retirement. Most previous studies of consumption around retirement have focused on data from the PSID, which offers very limited information on consumption. One exception is Banks et. al. (1998) who find that (broadly-measured) consumption falls 12% between ages 61 and 66 in synthetic cohort data from the UK Family Expenditure Survey.[2] I look at different components of consumption in the Consumer Expenditure Survey, which is generally regarded as the best source for consumption data in the US. In the model, households divide market income between financial savings, purchases of consumer durables (including housing) and purchases of non-durables and services. I therefore construct empirical counterparts to these two components of consumption, in addition to looking at narrower spending categories.

In addition to looking at consumption, it is important to assess what direct evidence there is to support the hypothesis that households substitute from market to home production around retirement. I therefore look at time use data from the 1994 Maryland Time Use Survey, which contains detailed time use data for individuals between the ages of 18 and 94.

In the second part of the paper, the theoretical model is described, and the calibration and numerical solution methods used are discussed. Two parameterizations are considered: one which incorporates the home production

[2] Berheim, Skinner and Weinberg (2001) find a mean fall in PSID (food) consumption over a four year period around retirement of 14 percent. Lundberg, Shelly and Startz (2002) find that married households in the PSID reduce food consumption by 8 to 10 percent following retirement of household head.

sector and one which ignores it. The idea is to provide a new benchmark for optimal labor supply, consumption and savings across the life-cycle, and to measure the distance between this benchmark and the predictions of a traditional one-sector life-cycle model.

The main finding is that in the model with home production, rational households with perfect foresight optimally choose to reduce market consumption at retirement; under the baseline calibration, market consumption falls by 6.3 percent in the retirement year. This is not a prediction of the model without home production. A second finding is that in the home production economy, a given decline in the after-tax wage at the normal retirement age generates a decline in market hours that is much larger than in a standard one sector model. Lastly, individuals in the home production economy save less in the form of financial assets while working (implying a larger equilibrium interest rate) and only decumulate non-financial assets very slowly in retirement. Thus the model with home production represents an improvement over previous models in terms of accounting for observed life-cycle behavior.

2 The Time Use Data

The first data I examine are time use data. The time use study was conducted by the Survey Research Center of the University of Maryland for the Environmental Protection Agency. In a nationwide survey, interviewees were asked to report all activities undertaken "yesterday". The sampling period was from September 1992 to October 1994. The sample comprises 7392 adults aged 18 to 94, of which 3310 were men and 4082 women. I follow a standard classification scheme to allocate various activities between three broad categories: market work time, home work time, and personal time. Personal time is defined as time spent sleeping or napping, washing, dressing, eating, receiving medical care, and performing various other activities relating to personal care. Market work time is time spent working at first and second jobs, commuting to work, taking breaks while at work, and looking for work. Home work time comprises time spent at food preparation and cleanup, time spent cleaning inside or outside the home, time spent caring for clothes, plants and animals, time spent shopping, time spent on home and car repair, and all children-related activities. Thus home work time is conceptualized as time spent on activities at home to produce goods or services that could alternatively be purchased in the market sector. For example, shopping counts as time spent in home production (a personal shopper can in principle provide shopping services) while watching television does not (to enjoy a show, you have to watch it yourself). Disposable time is defined to be 1440 minutes (the number of minutes in a twenty four hour day) minus personal time minutes.

Note that the home work time definition is not necessarily consistent with the way home production is conceptualized in the theory literature, where home time is a complement to consumer durables in delivering utility. According to the theory view, enjoyment of a television show is a home produced good, and time spent watching TV should be counted as home work. Indeed, in one of the original macroeconomic applications of the home production concept (Greenwood and Hercowitz 1991), all disposable time not spent in market work is treated as time spent working at home. More broadly, one could argue that almost anything that delivers utility involves a combination of time, non-durable consumption goods and durables. However, articulating and calibrating an ideal utility function is beyond the scope of this paper. In order to facilitate comparison with the existing home production literature, a standard period utility function is used in the theoretical model developed in the next section. This function has three arguments, market non-durable consumption, pure leisure, and the home produced consumption good which is produced using as inputs home capital (housing and consumer durables) and hours worked at home. Given this particular utility function, there are several attractive features of the definition of home hours described above. First, home production activities for the most part are not enjoyable, and thus it is appropriate that home work time should detract from leisure. Second, in order to generate interaction between consumption of market and home produced goods, it will turn out to be important that the two types of consumption are substitutes, so that, for example, an increase in consumption of home produced goods reduces the marginal utility of market consumption. Restricting the definition of home work time to activities that have market substitutes makes higher elasticities more plausible.

On average, individuals in the sample spent 26.3 percent of their disposable time in market work related activities, and 19.3 percent of time in home production activities. Thus individuals spent the remaining 54.4 percent of disposable time in leisure-related activities. There are significant and well-known differences between men and women. On average men in the sample spend 32.4 percent of their time working in the market, and 13.3 percent working at home. Women spend 21.4 percent of their disposable time working in the market and 24.2 percent working at home. Thus average time spent enjoying leisure is identical across sexes.

The primary question of interest, however, is whether there is evidence of increased home production time post retirement. Table XX presents some simple statistics that address this issue.[3]

Table XX : Home Work Time / Disposable Time			
	Men	Women	All
Not retired	0.120	0.235	0.182
# observations	2791	3276	6067
Retired	0.205	0.271	0.245
# observations	514	801	1315
All	0.133	0.192	0.193
# observations	3305	4076	7381

Figures XX through XX describe how hours worked in the market and hours worked at home vary by age in the sample. Market hours begin to decline around age 50, and the decline accelerates between the ages of 60 and 65. The figures suggest that some of the extra time that becomes available as individuals reduce market hours is used to increase home production. In particular, individuals spend a larger fraction of disposable time working at home in their 60s and 70s than at younger ages.

In order to more sharply isolate the effects of changes in market hours and / or retirement status, I now consider some simple regressions. In each case the dependent variable is the fraction of disposable time devoted to home production activities. The primary independent variables of interest are the labor market status of the individual and the fraction of disposable time in market work. The other independent variables are designed to control for more or less exogenous characteristics of the individual. The first and second are age and age squared, which capture smoothly evolving age effects. The third control is a dummy to indicate whether the individual lives in a single detached house or townhouse; more home capital should indicate more home production opportunities. The fourth is a dummy which takes the value one if the respondent has one or more children aged five or younger; the presence of young children may indicate more home produced childcare. The fifth is

[3]Perhaps the best known paper on time use is the survey article by Juster and Stafford (1991). They report that in the U.S. in 1981, men spent 44.1 percent of disposable time in market work, and 13.8 percent of time in home production. The corresponding figures for women are 24.8 percent and 31.6 percent. However, their sample is limited to men and women between the ages of 25 and 64. Thus it is not surprising that market work occupies a larger fraction of time than in the Maryland Survey.

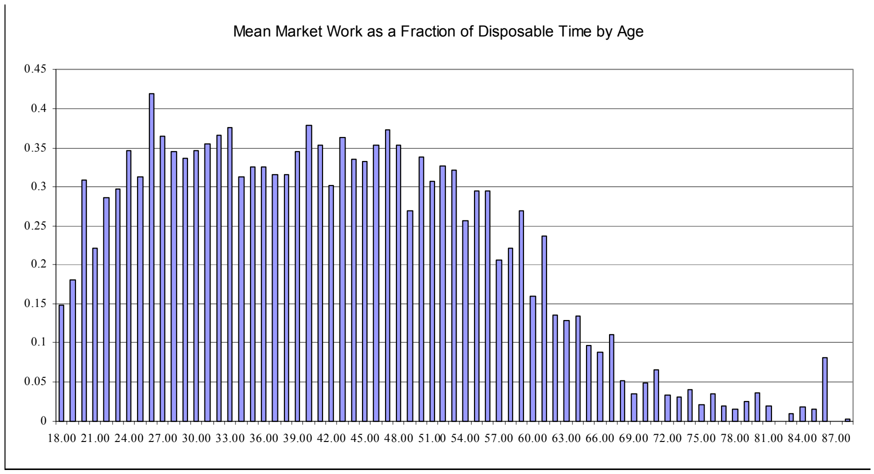


Figure 1:

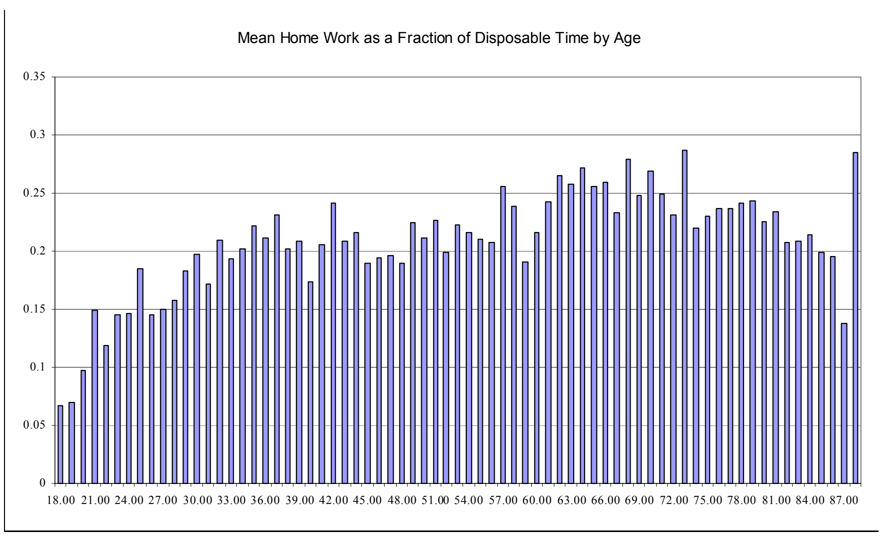


Figure 2:

a dummy which takes the value one if the respondent is female. The last variable captures the number of adults in the household.

Clearly hours worked in the market will be strongly correlated with indicators of employment status, such as indicators of whether the respondent is retired or otherwise unemployed. They will also likely to depend on whether the day for which the subject is asked to describe time use was a weekday or a weekend day. I therefore report the results of three alternative regressions. In the first, I include only dummies for whether the respondent is retired, unemployed (for reasons other than being retired or a student) and whether the reference day was a weekend. In the second, the dummies are dropped and hours worked as a fraction of disposable time is introduced. In the third, both the employment status / weekend dummies and hours worked are included.

The results are in table XX. First, all variables have the expected sign and are strongly significant (except for the number of adults in the household). Consider for example, specification (3). Other things equal women spend an additional 8.4 percentage points of their disposable time in home production activities, and individuals with young children devote 5.6 percentage points more disposable time to home work than those without. People living in houses do more home work. The effect of age is non-linear; holding everything else constant, the age profile for home hours is hump-shaped. All these coefficients are very similar across the three specifications.

Table XX : Dependent Variable: Home Production / Disposable Time			
	(1)	(2)	(3)
Retired	0.138	**	0.025
t-statistics	*11.148*		*2.159*
Unemployed	0.142	**	0.027
	19.867		*3.768*
Work hours / disposable time	**	-0.325	-0.333
		-45.939	*-39.903*
Weekend	0.038	**	-0.045
	6.584		*-8.010*
Age	0.009	0.014	0.014
	10.313	*18.050*	*18.313*
Age^2	-0.0001	-0.0001	-0.0001
	-9.106	*-16.495*	*-16.431*
House-occupier	0.034	0.021	0.023
	5.423	*3.713*	*4.029*
Child < 5	0.048	0.057	0.056
	7.809	*10.239*	*10.137*
Female	0.116	0.089	0.084
	22.723	*18.969*	*17.824*
Number of adults	-0.0004	-0.0004	-0.0004
	-0.682	*-0.758*	*-0.706*
Intercept	-0.128	-0.073	-0.074
	-6.869	*-4.379*	*-4.346*
R^2 (weighted)	0.379	0.483	0.489

Regression (1) predicts that being retired increases the fraction of disposable time spent in home production by 13.8 percentage points, controlling for age and the other household characteristics listed. Being unemployed has a similar effect. There is evidence that individuals do more home production on weekends, but the additional effect is small relative to the effect of employment status. The coefficient on market hours in regression (2) indicates that for every additional minute spent in market work, individuals reduce home work by about one third of a minute. In the final regression, which includes both employment status / weekend dummies and market hours, the market hours variable has the greater explanatory power. The effect of being retired or unemployed on home hours is larger than can be accounted for just by the fact that such households work fewer market hours; even controlling for market hours, such households do more home work.

In addition to the results reported, I also experimented with separate regressions for men and women. Qualitatively all the results are similar. Quantitatively there are some differences. In particular home hours for women respond more strongly in general to changes in market hours. In specification (3) the respective coefficients are -0.41 and -0.25. However, the coefficient on retirement is stronger for men, and works in the opposite direction. Thus comparing a man and a woman, both of whom move from working 25 percent of disposable time in the market to doing zero market work, the prediction is that the man will devote an additional 17 percentage points of disposable time to home work, while the woman will devote an additional 11 percentage points of time to home work.

3 The Consumption Data

TO BE COMPLETED

4 The Model

The goal of the theoretical part of the paper is to understand the implications of introducing home production into an otherwise standard over-lapping generations model economy. The model is deliberately simple, and abstracts from several factors that are likely important in understanding behavior over the life-cycle in order to sharpen the focus on the role of home production. I shall think of the agent as an individual rather than a household. This allows me to abstract from changing household size over the life-cycle, and from issues relating to how decisions are made within the household. I assume that mortality risk is the only source of uncertainty for individuals. By abstracting from uninsurable idiosyncratic earnings risk, I ensure that all agents of a given age are identical. I focus on steady states with no growth in population or average productivity; thus there are no time subscripts in what follows.

Each period a new generation of mass one and age $t = B$ enters the economy; agents of age less than B are assumed to be economically inactive. The conditional probability that an agent will survive from age t to age $t+1$ is s_t. Agents live at most to terminal age T, thus $s_T = 0$. The unconditional probability of living to at least age t is $s^{t-1} = \prod_{t=B}^{t-1} s_t$. Thus the mass of agents of age t is $\pi_t = \pi_{t-1} s_{t-1}$.

In each period of their life, agents are endowed with one unit of disposable time. This time is divided between working in the market sector, working at home, and enjoying leisure. Time spent working in the market at age t is denoted n_t^m, while time spent working at home is n_t^h. At each age, households derive utility from consumption of market produced goods, c_t^m, from consumption of home produced goods, c_t^h, and from leisure, $1-n_t^m-n_t^h$. Preferences take the standard additively separable form, with discount factor β. Thus expected discounted utility is given by

$$\sum_{t=B}^{T} \beta^{t-B} s^{t-1} u(c_t^m, c_t^h, (1 - n_t^m - n_t^h)) \tag{1}$$

Note that the period utility function is not indexed by age. Note also that individuals are not altruistic; they do not care about any other current or future generation's welfare, and they derive no utility from making bequests.

Individual labor productivity varies both by age and by sector. Productivity at age t is denoted ε_t^m and ε_t^h respectively. Each period individuals decide (i) how to divide their time, (ii) how to divide market income between market consumption and savings, and (iii) how to divide savings between market capital (financial assets) and home capital (housing and consumer durables). Market capital k_t^m depreciates at rate δ_k, and may be rented to firms at rate r. Home capital k_t^h depreciates at rate δ_h, and is combined with time spent working at home to produce the home consumption good.

Each period the individual faces the following set of constraints

$$y_t = (1 - \tau_t^n) w \varepsilon_t^m n_t^m + (1 - \tau^k)(r - \delta^m) k_t^m + p_t \tag{2}$$

$$c_t^m + i_t^m + i_t^h \leq y_t \tag{3}$$

$$k_{t+1}^m = b_{t+1}^m + i_t^m + (1 - \delta^m) k_t^m \tag{4}$$

$$k_{t+1}^h = b_{t+1}^h + i_t^h + (1 - \delta^h) k_t^h \tag{5}$$

$$c_t^h = \left(k_t^h\right)^{\theta_h} \left(\varepsilon_t^h n_t^h\right)^{1-\theta_h} \tag{6}$$

$$k_t^m \geq -\phi k_t^h, \qquad \phi \in [0, 1) \qquad t \geq 2 \tag{7}$$

$$k_t^h, n_t^m, n_t^h \geq 0 \tag{8}$$

Equation 2 lists the potential sources of an individual's money income. The first term is labor income, which is the product of the wage per unit of effective time w and effective hours worked $\varepsilon_t^m n_t^m$. Labor income is taxed at the flat rate τ_t^n, where the tax rate potentially varies with age. Asset income is taxed at a flat (age-invariant) rate τ^k, but is subject to a depreciation allowance. Lastly, households may receive annuity income p_t. This is described in more detail below. Equation 3 says that market income at age t is divided between market consumption, savings in the form of market capital, i_t^m and savings in the form of home capital i_t^h. Note that market consumption and both types of capital have the same price since they are all perfect substitutes in market sector production. Equations 4 and 5 describe the laws of motion for market and home capital. Stocks of capital are reduced by depreciation and increased by saving and by bequests. At the start of age t individuals receive inheritances in the form of market capital in the amount b_t^m and inheritances in the form of home capital in the amount b_t^h.

The technology for producing the home consumption good (equation) is Cobb-Douglas with home capital's share θ^h. Note that the home sector is entirely shielded from taxation: the home capital stock, the returns to factors employed at home, and home consumption are all untaxed.

Equation 7 describes the borrowing constraint. In equilibrium individuals will never choose zero home capital (or hours) since this will imply zero home production and an infinite marginal utility of home consumption. However, households may want to borrow in the form of market capital, and they are allowed to do so up to a fraction of the value of their home capital which serves as collateral. This assumption is meant to capture the idea that it is possible to borrow to buy a house, or to take out a reverse mortgage, but there are financial penalties to borrowing more than a certain fraction of the value of the property. Note that constraints jointly imply that total wealth must be non-negative at each age:

$$k_t^h \geq 0 \Rightarrow k_t^m + k_t^h \geq k_t^m + \phi k_t^h \geq 0.$$

Individuals in the model face mortality risk. Given the option to purchase annuities at actuarially fair rates, households would choose to annuitize all of their market wealth. Similarly, since households cannot borrow against the full value of their home capital, elderly households with high mortality rates would opt to rent rather than buy if there was a fair rental market for housing. In the United States, a large fraction of wealth is not annuitized, and home ownership rates typically increase with age. I therefore assume that rental markets for housing do not exist, and that the size of annuity payments in retirement is not a choice variable for households. In the U.S., funded private pension schemes operate alongside the mostly pay-as-you-go social security program. For expositional simplicity, I assume that the government manages all annuities, and that it operates a mix of a funded and an unfunded program. An individual of age a receives an annuity payment of size p if $a \geq R$, where R is the normal retirement age. Note that the size and age at which the individual collects the annuity does not depend on the number of hours the individual works in the market at any particular age. Since households are not perfectly annuitized, they will potentially leave accidental bequests. I assume that all the assets or debts of households that die at age t are inherited by households aged $t - G$ (where G denotes the generation length) or by the generation of age B if $t \leq G$.

$$\begin{aligned} b^m_{t-G} &= \frac{\left[i^m_{t-1} + (1-\delta^m)k^m_{t-1}\right]\pi_{t-1}(1-s_{t-1})}{\pi_{t-G}} \qquad t > G \\ b^m_B &= \sum_{t=B+1}^{G} \left[i^m_{t-1} + (1-\delta^m)k^m_{t-1}\right]\pi_{t-1}(1-s_{t-1}) \end{aligned}$$

$$\begin{aligned} b^h_{t-G} &= \frac{\left[i^h_{t-1} + (1-\delta^h)k^h_{t-1}\right]\pi_{t-1}(1-s_{t-1})}{\pi_{t-G}} \qquad t > G \\ b^h_B &= \sum_{t=B+1}^{G} \left[i^h_{t-1} + (1-\delta^h)k^h_{t-1}\right]\pi_{t-1}(1-s_{t-1}) \end{aligned}$$

At age B households choose sequences $\left\{c^m_t, c^h_t, n^m_t, n^h_t, i^m_t, i^h_t\right\}_{t=B}^{T}$ to maximize expected discounted utility (equation 1) subject to constraints 2 through 8 taking as given sequences for bequests, tax rates, survival probabilities, and factor prices.

Household savings in financial assets determine the quantity of capital that is used by competitive profit-maximizing firms in the market sector. These firms produce the non-durable market consumption good, a non-valued government consumption good, and new home and market capital. Firms rent labor and capital from households and produce according to a Cobb-Douglas technology, where θ_m is the share of capital in the market sector. Their static profit maximization problem is

$$\max_{K_m, N_m} \left\{K_m^{\theta_m} N_m^{1-\theta_m} - wN_m - rK_m\right\}$$

The government in this economy collects taxes, manages the pension system, and purchases market output for non-valued government consumption G. The government cannot issue debt. However, the government does own some market capital, K_g, which constitutes the assets which back the funded component of the pension system.

4.1 Economy without Home Production

In order to assess the role of home production, I compare the benchmark economy described above to an alternative in which there is no home production sector. In this economy, leisure and market work are the only possible uses of time, and market consumption and leisure are the only arguments in the period utility function. The only discretionary savings vehicle is market capital, and the no-borrowing constraint takes the form that asset holdings must be non-negative at each date. In every other respect, the economies with and without home production are identical.

4.2 Steady State

Let upper case variables denote aggregate quantities. A steady state for this economy is a list N_m, K_m, K_g, G, P, w, p, r, τ^k, $\{\tau_a^n\}$, s.t. when households and firms maximize utility and firms maximize profits:

1. Individual and aggregate variables are consistent

$$\begin{aligned} N_m &= \sum_{t=B}^{T} \pi_t \varepsilon_t^m n_t^m \\ K_m &= K_g + \sum_{t=B}^{T} \pi_t k_t^m \\ P &= \sum_{t=R}^{T} \pi_t p \end{aligned}$$

2. Factor prices are marginal productivities

$$\begin{aligned} r &= \theta_m K_m^{\theta_m - 1} N_m^{1-\theta_m} \\ w &= (1-\theta_m) K_m^{\theta_m} N_m^{-\theta_m} \end{aligned}$$

3. The goods market clears

$$C_m + \delta^m K_m + \delta^h K_h + G = K_m^{\theta_m} N_m^{1-\theta_m}$$

4. The government budget is balanced

$$G + P = \tau^n w N_m + \tau^k (r - \delta^m) K_m + (r - \delta^m) K_g$$

$$u(c_t^m, c_t^h, 1 - n_t^m - n_t^h) = \frac{\left(C_t^{\mu} \left(1 - n_t^m - n_t^h\right)^{1-\mu} \right)^{1-\gamma}}{1-\gamma}$$

5 Calibration

I now discuss calibration of the benchmark home production economy. The period length is one year. Households are born at age $B = 21$ and live to a maximum age $T = 100$. The age at which individuals start to receive annuity payments is $R = 65$. Survival probabilities are taken from the U.S. Decennial Life Tables for 1989-9 published by the CDC/NCHS, and are for the total population. When an individual dies, any assets and debts are divided equally among all individuals aged $GL = 25$ years younger.

The period utility function is restricted to the following functional form

$$u(c_t^m, c_t^h, 1 - n_t^m - n_t^h) = \frac{\left(C_t^{\mu}\left(1 - n_t^m - n_t^h\right)^{1-\mu}\right)^{1-\gamma}}{1-\gamma}$$

where

$$C_t = \left(\lambda\left(c_t^m\right)^{-\rho} + (1-\lambda)\left(c_t^h\right)^{-\rho}\right)^{-\frac{1}{\rho}}$$

Note that the elasticity of substitution between market and home consumption, denoted σ, is $1/(1+\rho)$. Higher elasticities encourage more substitution between sectors, and thus more potential interaction between activity in the market and non-market sectors. Baxter and Jermann (2000) discuss the range of previous estimates for σ, and settle on a benchmark value of 3. In the baseline calibration I set $\sigma = 2$. I consider alternative values as part of a sensitivity analysis.

The discount factor β is set to 0.96. For partial equilibrium models in which the interest rate is exogenous, the choice for the time preference rate is a key parameter. Engen, Gale and Uccello devote four pages to discussing the choice for this parameter, and in discussing their paper, Carroll argues that their choice constitutes "the single most important parametric assumption in the paper". When the interest rate is endogenous, the discount factor is much less important, since what drives the patterns for life-cycle consumption and wealth accumulation is the difference between the equilibrium interest rate and the rate of time preference, and the equilibrium interest will rise or fall depending on whether individuals are more or less impatient. Thus the general equilibrium framework provides some very useful discipline. I return to this issue when interpreting the models' predictions for behavior over the life-cycle.

In the baseline calibration I set γ, the coefficient of relative risk aversion, equal to 1. Since the choice for γ affects the degree of substitutability between the consumption aggregate and leisure, I also experiment with a higher values for γ. The share parameters μ and λ are then set so that the model reproduces (i) the average fraction of disposable time spent in market work (0.263) and (ii) the average fraction of time spent enjoying leisure (0.544), where the empirical counterparts for these numbers are taken from the Maryland Time Use Survey (see section XX). Thus the model also reproduces the average fraction of time spent working at home (0.193).

The empirical counterpart of market capital is the sum of non-residential structures, producer durables and government non-defense capital. Home capital is the stock of housing plus consumer durables. The depreciation rate for market capital is set to 6.0 percent, which is the average annual depreciation rate for appropriately measured capital between 1980 and 2000.[4] The depreciation rate for home capital over the same period is 5.6 percent. This figure masks considerable variation across the different components of home capital; housing depreciates at only about 1.5 percent per year, while the average depreciation rate for consumer durables is 20.5 percent.

Capital's share in the market sector θ^m is set to 0.27. Labor's share $(1-\theta^m)$ is estimated in the standard way, by dividing compensation of employees by value added less indirect business taxes and proprietors' income. The sample period is 1980 to 1998. I exclude the Finance, Insurance and Real Estate (FIRE) industry from each component, since much of FIRE value added is imputed income from owner-occupied housing, and this is part of home capital in the model. Since FIRE has a very high capital share (0.72), excluding FIRE reduces θ^m. (see Davis and Heathcote 2001 for more details). Capital's share in home sector θ^h is set to match the empirical ratio of market to home capital. The average value for this ratio over the 1980 to 2000 period was 1.25 (the ratio of market capital to GDP was 1.79).

The borrowing constraint parameter ϕ is set to 0.63, implying that individuals can borrow up to 63 percent of the combined value of housing and consumer durables. In reality, it is relatively easy to borrow against housing, though there are large incentives to make a down-payment of at least 20 percent when buying a house. It is more difficult and more costly to borrow against consumer durables. The baseline value for ϕ is simply the average value over the 1980 - 2000 period of 80 percent of the value for residential capital divided by total home capital. In the sensitivity analy-

[4]Depreciation rates are computed by dividing BEA estimates of depreciation at current cost by the BEA estimates of the corresponding measure of the capital stock at current cost. For example the depreciation rate for home capital is the sum of depreciation of consumer durables and private plus government residential assets divided by the total value of all these assets. All these data are available at http://www.bea.doc.gov/bea/dn/facd/xls/summary.xls

sis, I also experiment with loosening the collateral requirement, by setting $\phi = 0.8$.

The annuity payment p received by individuals of at least age R, and the quantity of capital in the funded pension system, K_g, are set to reproduce (i) the social security replacement rate, and (ii) the ratio of annuitized to bequeathable wealth at retirement. According to the Office of the Chief Actuary (www.ssa.gov/OACT/), a worker who has enjoyed average earnings over his worker life, and who retires at age 65 in 2000, can expect benefits of \$987 per month. According to the same source, average wage income in 2000 was \$32,154. Thus suggests a social security replacement rate (relative to average life-time pre-tax labor income) of 37 percent. The corresponding figure for 1990 is 41 percent. I target a replacement rate in the model of 40 percent, the empirical average over the 1987 to 2000 period. In 1990, according to Auerbach, Gokhale, Kotlikoff, Sabelhaus and Weil 1995, close to 50% of the total wealth of both men and women in the 60-69 age range was annuitized, either within the social security system or privately. Given the social security replacement rate, targeting a ratio of annuitized to bequeathable wealth of 50 percent at age 64 implies a 13 percent private pension replacement rate. Thus the total public plus private pension replacement rate is 53 percent. This is similar to values used in other studies.[5]

The tax rate on capital income, τ^k is set to 0.4, which is an estimate for the 1990 - 1996 period from Domeij and Heathcote (2001). The same authors report an average tax rate on labor of 27 percent. Coile and Gruber (2001) use data from the Health and Retirement study to estimate, for the median worker at different ages, the implicit labor income tax rates associated with the social security tax and benefit rules in the 1990s. Their estimated tax rate (which excludes the effects of ordinary income taxes) rises from 2.7 percent at age 64 to 14.5 percent at age 65, and peaks at 33.4 percent at age 68. One important reason for the increase in the effective tax rate on labor income is that the delayed retirement credit received by individuals who delay retirement beyond normal retirement age is actuarially unfair. I assume that all the myriad incentive effects associated with the way annuities are provided in the US can be captured by a discrete jump in the tax rate on labor income at normal retirement age R. In light of the estimates of Coile and Gruber and others (see, for example, figure 3 in Mulligan 1999),

[5]For example, Engen et. al. (1999) estimate replacement rates of 50 percent for households with less than sixteen years of education, and 43 percent for households with sixteen years of education or more. The corresponding estimates by Laibson, Reppetto and Tobacman (1998) are $41 - 45$ percent and 55 percent (for college graduates).

I set $\tau_t^n = 0.27$ for $t < R$, and $\tau_t^n = 0.42$ for $t \geq R$.[6]

The only remaining parameter values are those defining the labor productivity profiles in the market and home sectors. I base these on hourly wage data from the 1990 US Census. The market labor efficiency profile is based on wages of all persons age 18 and over in the civilian labor force with positive earnings in 1989. Wages for men and women are weighted by their relative proportions in the labor force at different ages. Deciding on a labor efficiency profile for the home sector is somewhat less straightforward, since wages are not observed here. Nonetheless it is possible to look at age-wage profiles for individuals in market activities that look similar to different components of home work. Figure XX below reports wage profiles for child care, cleaning, and maintenance type activities. Comparing these various wage profiles to profiles for men and women with different education levels, the profile with the most similar shape is that for women with less than ninth grade education. I therefore base the efficiency profile for the home sector on the age wage profile for this group. The actual efficiency profiles used in the model differ from the empirical wage profiles in several respects. First, I assume that average population efficiency is equal across sectors. Workers in market-type occupations on average earn much higher wages than those in home-type occupations, but this presumably reflects the fact that workers whose comparative advantage is in market-type work tend to have higher productivity in all types of work than workers whose comparative advantage is home-type work. Second, I assume that at older ages, productivity declines in both sectors at a similar rate, and use cubic splines to extrapolate the productivity profiles assuming efficiency in the last year of life is around half its average level over the life-cycle. The actual productivity profiles used are described in figure XX. To assess the importance of productivity differentials across sectors, I also consider a version of the model in which labor efficiency at home is equal to labor efficiency in the market at every age.

Parameter values are reported in table XX. The first two columns report parameter values that are calibrated outside the model. The columns on the right hand side of the table reports the parameters that are set so that the model endogenously reproduces certain features of the US economy. All the parameter values in the left hand column of table XX are identical for the

[6] French (2002) builds a heterogeneous agent model in which he carefully models all the details of the social security system, alongside private pensions. He finds that declining wages coupled with increasing effective tax rates account for most of the observed decline by age in labor force participation in the US, while declining health and liquidity constraints are relatively unimportant.

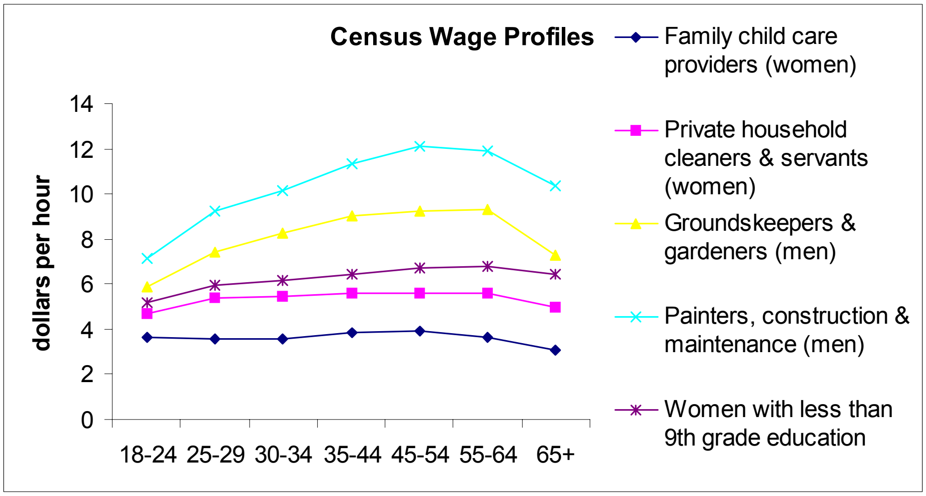


Figure 3:

economies with and without home production.[7] The endogenous parameter values are, for the most part, chosen in the same fashion in both cases. In particular, in the economy without home production, consumption's share in utility μ is chosen to match the fraction of time spent in market work. There are several possible alternative approaches to calibrating the public and private pension schemes in the economy without home production. The one that seems to allow the fairest comparison across the two economies is to set the size of the pension p and the trust fund parameter ψ such that the two economies feature the same equilibrium social security replacement rate and the same private pension replacement rate.

It is interesting to note that the share of consumption in utility μ is 0.54 in the version of the model with home production, which is much larger than the value of 0.344 that generates the same value for market hours in the economy without home production. Also the estimated relative weight on the home consumption good is large; λ is not far from the value 0.5 which would indicate equal weight on both types of consumption in utility. These findings underscore the potential importance of the home sector, and the motivation for incorporating it explicitly in macro models.

The implied share for capital in the home sector is 0.309, which is similar to capital's share in the market sector. The parameter ψ, which defines the

[7] Of course, σ, δ^h and ϕ are not relevant for the economy without home production.

ratio of capital managed within the funded pension system to non-annuitized market capital, is 0.257. Thus in the model roughly one fifth of private wealth (excluding housing and durables) is annuitized. In the economy without home production, the implied size of the funded pension system is much smaller.

Table XX : Parameter Values				
Exogenous parameters		Endogenous parameters		
			HP	No HP
β	0.96	μ	0.540	0.344
γ	1	λ	0.578	1.00
$\sigma = 1/(1+\rho)$	2			
θ^m	0.27	θ^h	0.309	
δ^m	0.060			
δ^h	0.056			
τ^n	$0.27 - 0.42$	p	0.169	0.160
τ^k	0.4	ψ	0.257	0.241
ϕ	0.63			

6 Steady State

Table XX describes some properties of the steady state of the models. The net annual after-tax interest rate in the model with home production is 6.0 percent, which is comparable to the historical return on equities in the US. The calibration procedure did not explicitly target the ratio of market capital to output. It is thus reassuring that both models come close to reproducing the empirical value of 1.79. Note, however, that in models without home production, a broader concept of capital is typically used to define the empirical capital to output ratio, and a ratio of 1.75 would be considered too low.

A second dimension along which it is possible to compare the model and the data is the ratio of the annual flow of inheritances (or bequests) to output. Two open and related issues in the economics of the family are (i) the extent to which parents are altruistic towards their children, and (ii) the extent to which observed bequests are altruistic as opposed to accidental. In the model developed here, all bequests are accidental by construction.

Inheritances are equal to bequests (since there are no alternative uses for bequests and no estate taxes). Recall also that the model is calibrated to reproduce the observed degree of annuitization, which is an important determinant of the size of accidental bequests. Hendricks (2001) surveys the literature on inter-generational transfers, and concludes that the annual flow of inheritances in the US is between 1.2 and 2.0 percent of GDP. In the home production model economy, the corresponding figure is 3.2 percent. Thus the model over-explains observed inheritances, suggesting that there is not much room for altruism as an additional reason for bequests.[8] The annual flow of bequests in the version of the model without home production is less than half as large, at 1.4 percent of GDP. I conclude that it is important to incorporate the home sector when studying inter-generational transfers. This becomes even more apparent when one considers the composition of bequests in the home production economy. Less than one third of bequests are in the form of market capital, while over two thirds are in the form of home capital. This is consistent with the fact that most of the non-annuitized wealth of the elderly in the U.S. is in the form of the primary residence (see Fernandez-Villaverde and Krueger 2001).

Table XX : Properties of steady state

	Data	HP	No HP
net after-tax interest rate ($\widetilde{r}$)		6.0	5.8
K^m/K^h	1.25	1.25	
N^m/N^h	1.36	1.36	
N^m/disposable time	0.263	0.263	0.263
K^m/Y	1.79	1.69	1.72
private + public pension repl. rate		0.53	0.53
public pension replacement rate	0.40	0.40	0.40
fraction of wealth annuitized at age 64	0.50	0.50	0.64
$(B^m + B^h)/Y$	$0.012 - 0.02$	0.032	0.014
B^m/Y		0.010	0.014

[8] It is probably worth extending to model to incorporate heterogeneity in income, wealth, annuitization rates and family composition to explore whether this finding extends to a richer environment.

7 Life-cycle Behavior

Figures XX through XX describe individuals' behavior over the life-cycle in the economies with and without home production.

7.1 No Home Production

Consider first the economy without home production. Figure XX indicates that a very small fraction of households survives to age 100. The profile for labor productivity is such that wages peak around age 50. Figure XX describes hours, income and consumption. Both income and consumption are roughly hump-shaped in the model, as in the data. Market hours peak before earnings, at age 40. Earnings peak slightly later, at age 44, and income later still, at age 48. Consumption peaks last, at age 64. There is no discrete drop in consumption at retirement. However, the slope of the age profile for consumption is not continuous; consumption grows particularly fast at young ages, and the rate of decline in consumption at old age groups drops around age 81.

There is much debate as to whether the empirical hump shaped profile for consumption and the tendency for income and consumption to co-move over the life cycle are consistent with the standard life-cycle framework (see, for example, Fernandez-Villaverde and Krueger 2001 or Browning and Crossley 2001). The simple model considered here suggests that a simple life-cycle model with uninsurable mortality risk is roughly consistent with these two stylized facts. However, empirically consumption and income peak more or less together; relative to the data, consumption peaks too late in the model. I return to this issue later.

Figure XX describes profiles for asset accumulation. It is clear that the no-borrowing constraint is binding until age 32; this accounts for the rapid growth rate of consumption until this age. As an individuals ages, his survival probability declines, which in the absence of perfect annuity markets, effectively makes him more impatient. The optimal growth rate of consumption slows, and eventually turns negative. At age 82 liquid assets are exhausted. From this point on it is optimal for the individual to consume their entire (pension plus labor) income in each period rather than continuing to reduce consumption at a faster and faster rate. This property of the optimal consumption profile with lifetime uncertainty is emphasized by Davies (1981).

Total non-annuitized wealth peaks eight years prior to retirement, at age 57. This is not consistent with empirical evidence, which indicates that wealth reaches a maximum right around retirement age. The reason for this counter-factual prediction is closely related to the pronounced hump-shape in hours and thus earnings and income which peak relatively early on in the working stage of the individual's life-cycle. Early on, the individual works relatively hard, as a consequence of the fact that the borrowing constraint is binding at the start of the life-cycle. Working hard is a substitute for borrowing that facilitates a degree of consumption smoothing. Once the borrowing constraint ceases to bind, the profile for hours up until normal retirement age roughly mirrors the hump-shaped profile for labor productivity. To understand why labor supply peaks before wages, consider the equilibrium (non-borrowing-constrained) relationship in the model between growth in leisure, consumption and after tax wages, $\widetilde{w}_t = we_t(1 - \tau_t^n)$, for the baseline calibration case in which period utility is log separable in consumption and leisure.

$$\frac{1 - n_{t+1}}{1 - n_t} = \frac{c_{t+1}}{c_t} \frac{\widetilde{w}_t}{\widetilde{w}_{t+1}} \tag{9}$$

Holding consumption constant, rising wages translate to declining leisure and increasing work hours. Given that the individual can borrow and lend freely, it makes sense to concentrate labor effort in the middle of the working life when wages are highest. However, the growth rate of consumption also influences the hours choice. The fact that consumption rises right until age 64 in the model works to increase leisure throughout the normal working life. In particular, consumption is increasing at age 50 when wages peak; thus hours must already be declining at this age. At age 65, the tax rate on labor income increases, and individuals respond by cutting back on their hours of work. However, the decline in labor earnings is more than offset by pension payments which kick in at this age. Thus total income and savings both counter-factually increase at 65. A decade later hours increase somewhat again, reflecting rapidly declining consumption (see equation 9).

To summarize, three of the failings of this model relative to the data are related. Consumption peaks too late. This drives hours to start to decline too soon.[9] The fact that consumption is too high late in the working stage of the life-cycle while hours and labor earnings are too low combine to imply that savings declines too rapidly at when the individual is in his 50s, and wealth peaks too early. In a model with an exogenous interest rate, it is possible to adjust the gap between the interest rate and the household's

[9] In the data, average hours increase rapidly until individuals reach the late 20s, after which hours are relatively flat till until age 50 before declining gradually until age 60 and rapidly in the 60 to 65 age range (see section XX).

rate of time preference to target any desired peak age for consumption. In the economy described here, the interest rate is endogenous, which effectively pins down the interest rate / time preference rate differential. In this context, the obvious candidate for forcing consumption to peak earlier is to change the structure of preferences. One possibility that has been explored in the literature is to allow the discount rate to vary with age, in such a way that consumption is more highly valued in the middle of the working stage of the life cycle (see, for example, Attanasio et. al. 1999). An alternative is to change the period utility function, so that equation XX no longer holds. There are many alternative possible specifications for preferences; the home production economy is one.

7.2 Economy with Home Production

Broadly speaking, much of the intuition for the life-cycle behavior observed in the economy without home production carries over to the benchmark model with home production. There are some important differences, however, especially around retirement.

In the first years of the life-cycle, individuals rapidly accumulate home capital. This is financed largely by borrowing (taking out mortgages), and the constraint on financial wealth is binding (see figure XX). The very youngest individuals do not have sufficient total wealth to finance much mortgage borrowing. Without much home capital, it is optimal for these households to concentrate work effort in the market sector. As time passes, individuals pay off their financial debts (mortgages) and start to accumulate financial wealth. Total financial wealth (financial assets minus mortgage debts) becomes positive by age 38 and peaks at age 58. At this point, financial wealth starts to decline, though the agent continues to gradually accumulate additional home capital until retirement at age 65. The pre-retirement profiles for market hours, earnings, income and consumption are generally similar to those in the corresponding economy without home production. There is, however, little correlation between market hours and consumption on the one hand, and home hours and consumption on the other.

At age 65 the individual chooses to stop working in the market altogether. Recall that the same increase in the labor tax rate in the economy without home production induces a decline in market hours, but not total retirement. The reason for the difference is that in the home production economy, there is an additional untaxed use for time beyond simple leisure, namely working at home. When individuals reduce market work, the marginal utility of leisure which is effectively the price of time declines. Thus it is optimal to increase home hours by 37 percent between ages 64 and 65 (see table XX). This translates into more home production and a 27 percent increase in consumption of the home-produced good. As in the one-sector model, the optimal time path for market consumption requires equating the marginal utility of market consumption date by date (adjusting, of course, for differences between the market interest rate and the survival-probability adjusted rate of time preference). If market and home consumption are substitutes, as they are under the baseline calibration, then the increase in home consumption immediately following retirement reduces the marginal utility of market consumption. Thus equating the marginal utility of market consumption through time requires reducing consumption by 6.3 percent between ages 64 and 65. In the economy without home production, by contrast, unless utility is non-separable in consumption and leisure, the optimal consumption profile exhibits no discontinuity around retirement.

Another difference relative to the economy without home production is that income declines smoothly into retirement; the home production economy does not predict a counter-factual increase in income when the individual begins to collect pension benefits. Savings, on the other hand do increase slightly at age 65, since even though the income profile is continuous around retirement, there is now a discrete drop in consumption, which implies higher savings. One might expect that since households plan on increasing home production in retirement, the model would predict a large spike in purchases of consumer durables in the year immediately prior to (semi) retirement. The model does in fact predict an increase in saving in the form of home capital at this age, but this increase is relatively small and the profile for home capital is still relatively smooth.[10] The reason a large spike in durables purchases is not observed is that conflicting incentives are at work. On the one hand, more home hours post-retirement increase the marginal product of home capital. On the other hand, the reason for extra home hours are worked in the first place is that when the individual reduces market hours, time effectively becomes a cheaper input. Thus the individual wants to increase production of the home produced primarily by increasing hours worked at home, rather than by increasing the stock of home capital.

During retirement financial wealth is gradually run down but there is no decumulation of home capital while the borrowing constraint is still nonbinding. Around age 77, financial wealth is exhausted, and individuals start

[10] For a higher co-efficient of relative risk aversion, the spike in durables purchases disappears altogether (see the next section).

to borrow against the value of their property in order to continue buying market consumption goods. Since the retirement stage of the life-cycle emphasizes home production, and home production requires home capital, households do not want to decumulate housing wealth or consumer durables rapidly. This is why the fraction of household wealth in the form of home equity increases during retirement. When the individual reaches his early 80s, the borrowing constraint starts to bind - for the second time in the life-cycle. Note, however, that total non-annuitized wealth declines more slowly than in the no-home-production economy. In particular, total wealth remains strictly positive right through the life-cycle, while it is optimally exhausted by age 82 in the one sector version of the model. The reason for the difference is that the individual requires a stock of home capital to continue home production, and it is not possible to borrow against the full value of this home capital. This suggests that the home production economy can help account for the observed slow decline in total wealth in retirement. Once production at home has taken place in the last period of life, all home capital is sold off, and the revenue from this is used to pay off financial debts.

7.3 Sensitivity Analysis

Thus the profile for market consumption around retirement will depend crucially on the degree of substitutability between home and market consumption goods. If these are good substitutes, the increase in home production at retirement will imply a fall in market consumption. On the other hand, if the marginal utility from market consumption is independent of the level of home consumption, the model will not capture the consumption dip observed empirically.

TO BE COMPLETED

Table XX : Parameter values - sensitivity analysis

Calibration	μ	λ	θ^h	p	ψ
Baseline	0.540	0.578	0.309	0.169	0.257
No HP baseline	0.344	1.00		0.160	0.241
Higher risk aversion: $\gamma = 2$	0.543	0.580	0.308	0.159	0.208
No HP $\gamma = 2$	0.345	1.00		0.149	0.194
Easier credit: $\phi = 0.8$	0.540	0.579	0.307	0.171	0.269
60% wealth annuitized	0.543	0.580	0.310	0.206	0.616
$e^h = e^m$	0.539	0.577	0.306	0.168	0.256
$N^m/N^h = 1$	0.599	0.545	0.248	0.169	0.252

Table XX : Properties of steady state - sensitivity analysis

	$\widetilde{r}$	K^m/Y	B^{m+h}/Y	B^m/Y	AW/TW	P/LI
Baseline	6.0	1.69	0.032	0.010	0.5	0.53
No HP baseline	5.8	1.72	0.014	0.014	0.64	0.53
CRRA $= \gamma = 2$	6.9	1.54	0.036	0.015	0.5	0.52
No HP $\gamma = 2$	6.6	1.58	0.015	0.015	0.65	0.52
$\phi = 0.8$	6.0	1.68	0.031	0.009	0.5	0.54
60% annuitized	6.0	1.68	0.026	0.005	0.6	0.64
$e^h = e^m$	6.0	1.69	0.032	0.010	0.5	0.53
$N^m/N^h = 1$	6.0	1.69	0.032	0.010	0.5	0.53

Table XX : Percentage change in variable in retirement year

	c^m	c^h	n^m	n^h	k^m	k^h
Baseline	-6.3	27.4	-100.0	36.7	-11.5	8.9
No HP baseline	0.0		-60.5		-9.4	
CRRA $= \gamma = 2$	-13.0	20.6	-71.5	29.8	-8.0	2.1
No HP $\gamma = 2$	-4.6		-40.5		-10.6	
$\phi = 0.8$	-6.1	26.9	-100.0	35.8	-11.7	8.8
60% annuitized	-6.2	27.3	-100.0	36.6	-19.1	9.0
$e^h = e^m$	-6.2	26.6	-100.0	35.5	-11.6	8.6
$N^m/N^h = 1$	-7.6	28.3	-100.0	35.5	-11.6	8.6

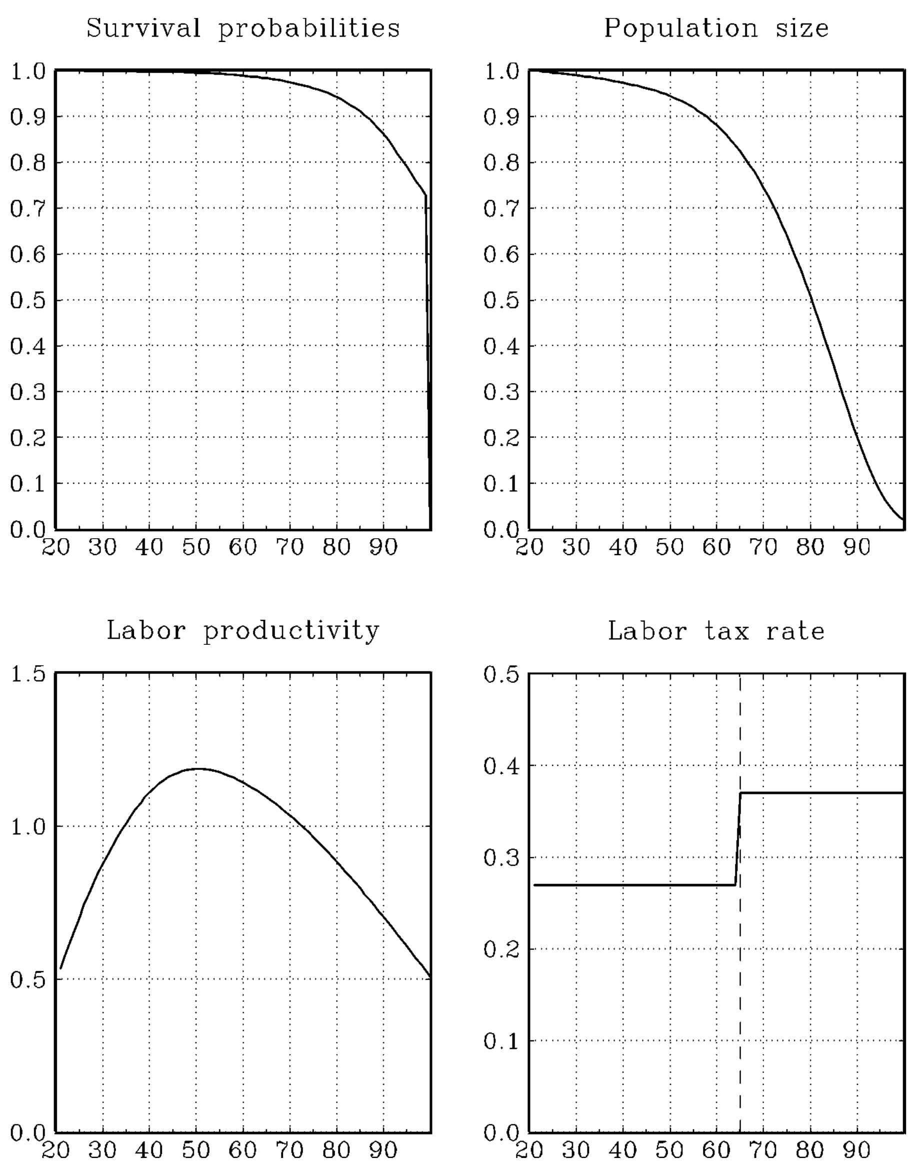
8 Conclusions

TO BE COMPLETED

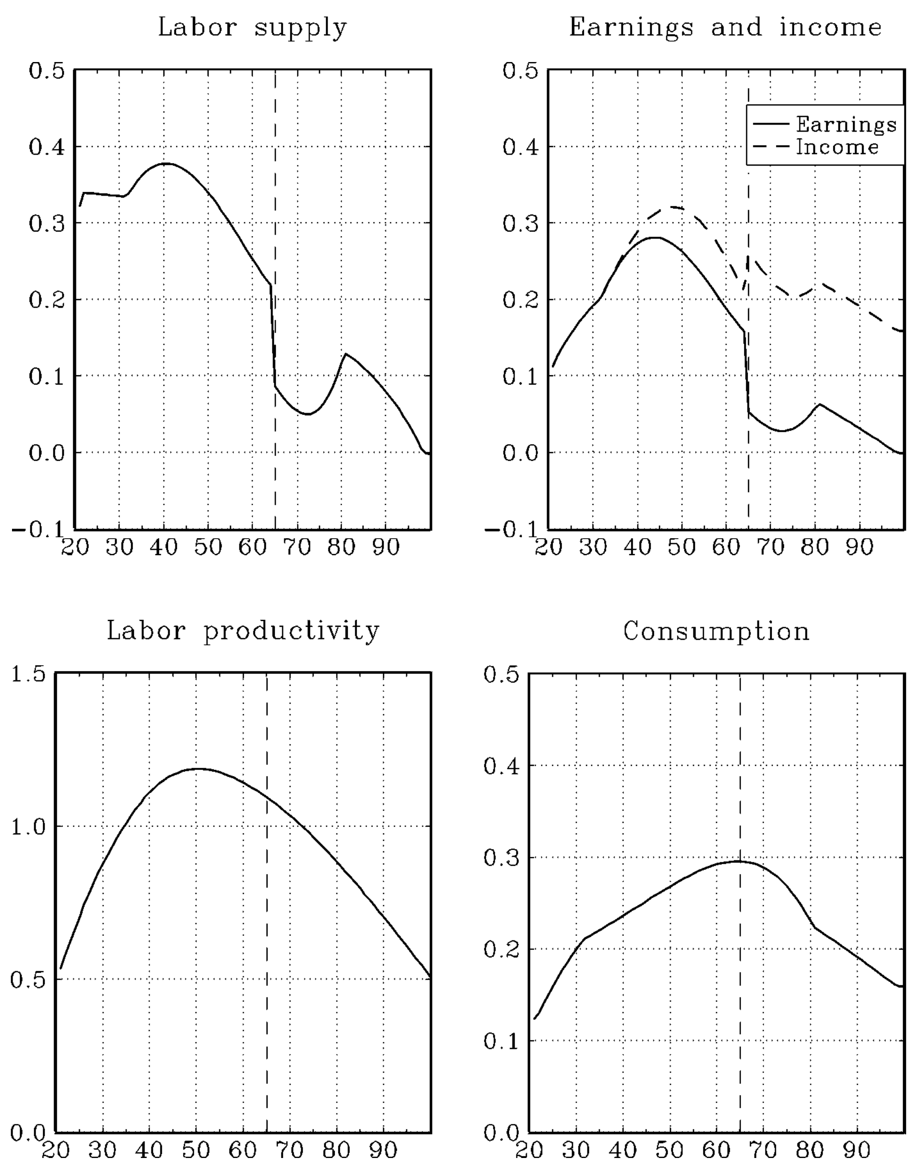
Introducing home production changes the

1. Life-cycle market consumption profile: larger drop at retirement
2. Life-cycle hours worked profile: break at retirement more decisive
3. Life-cycle wealth profile: much more total wealth accumulated, slightly less capital
4. Ratio of bequests to GDP: more than twice as large
5. Home hours in model consistent with empirical life-cycle profile

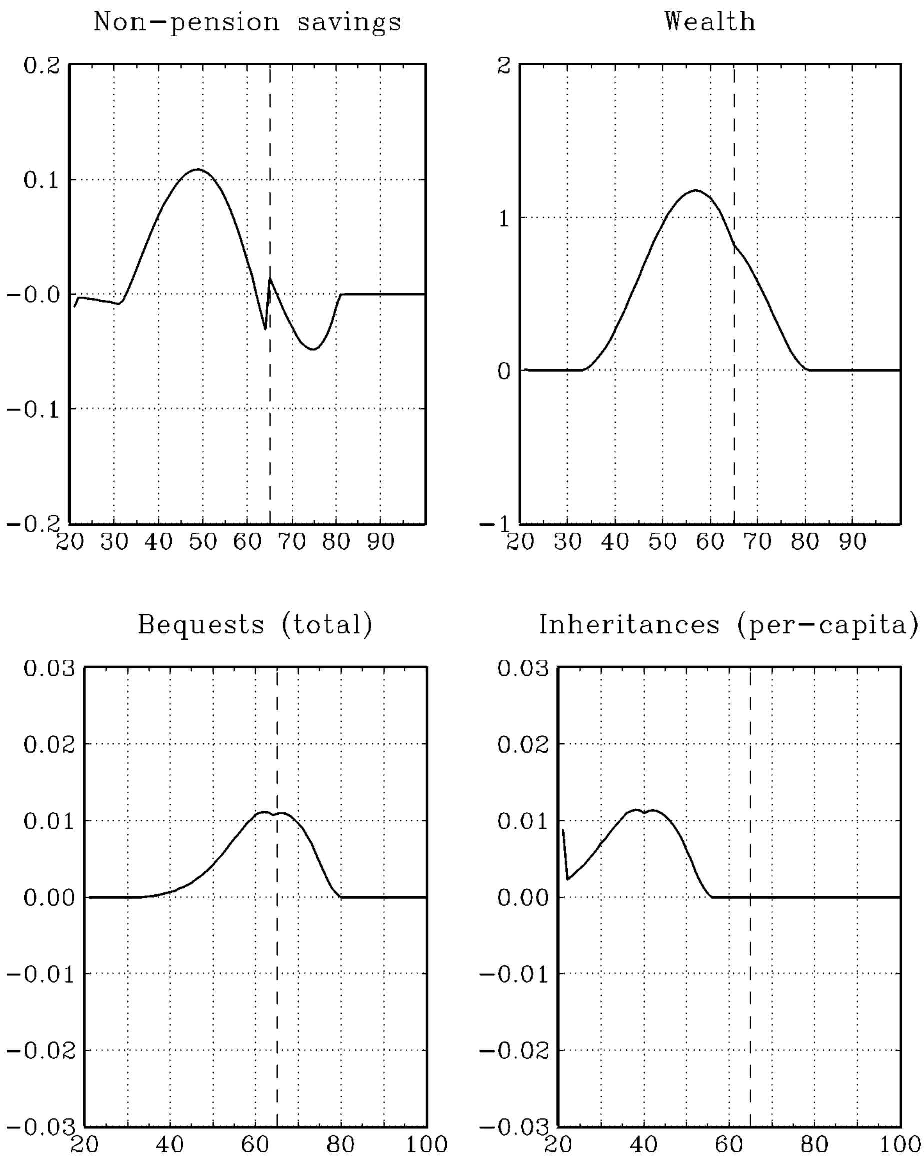
Economy without Home Production



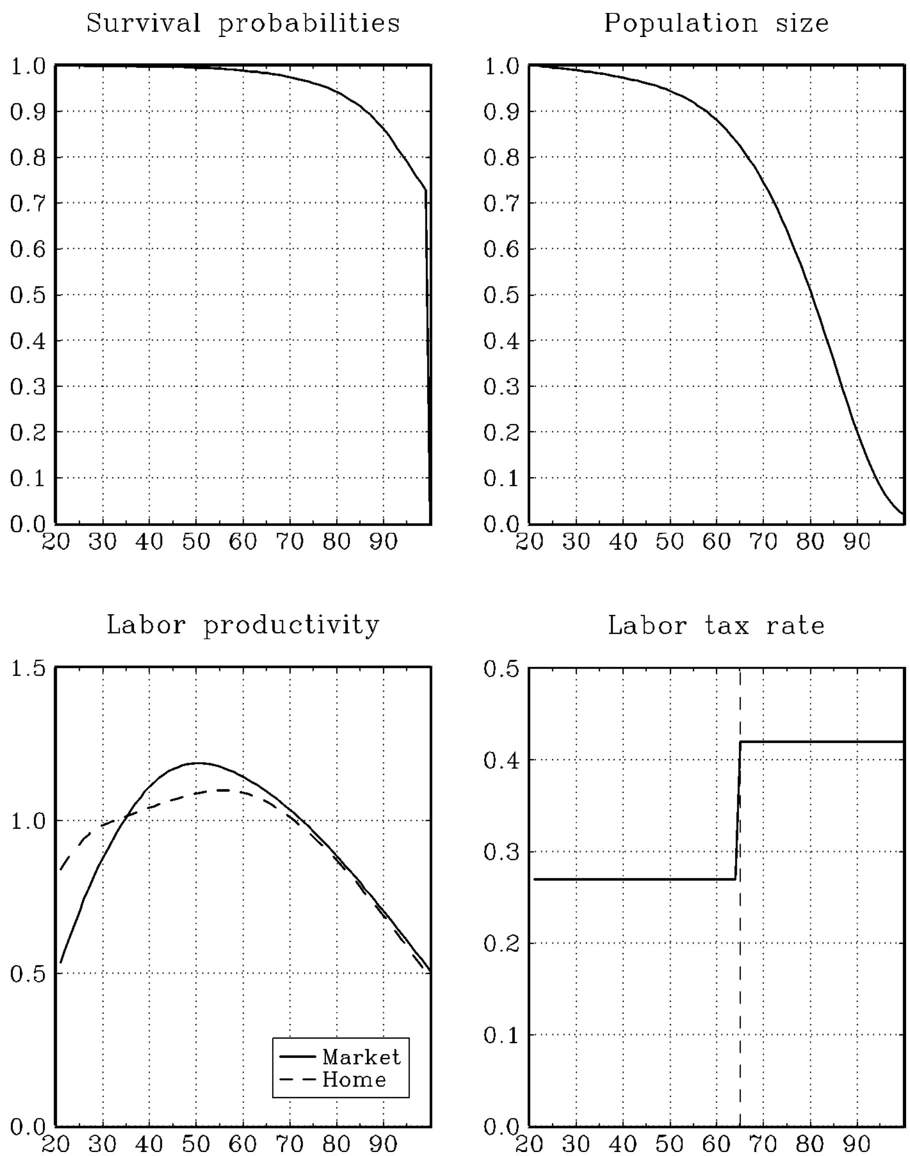
Economy without Home Production



Economy without Home Production



Economy with Home Production



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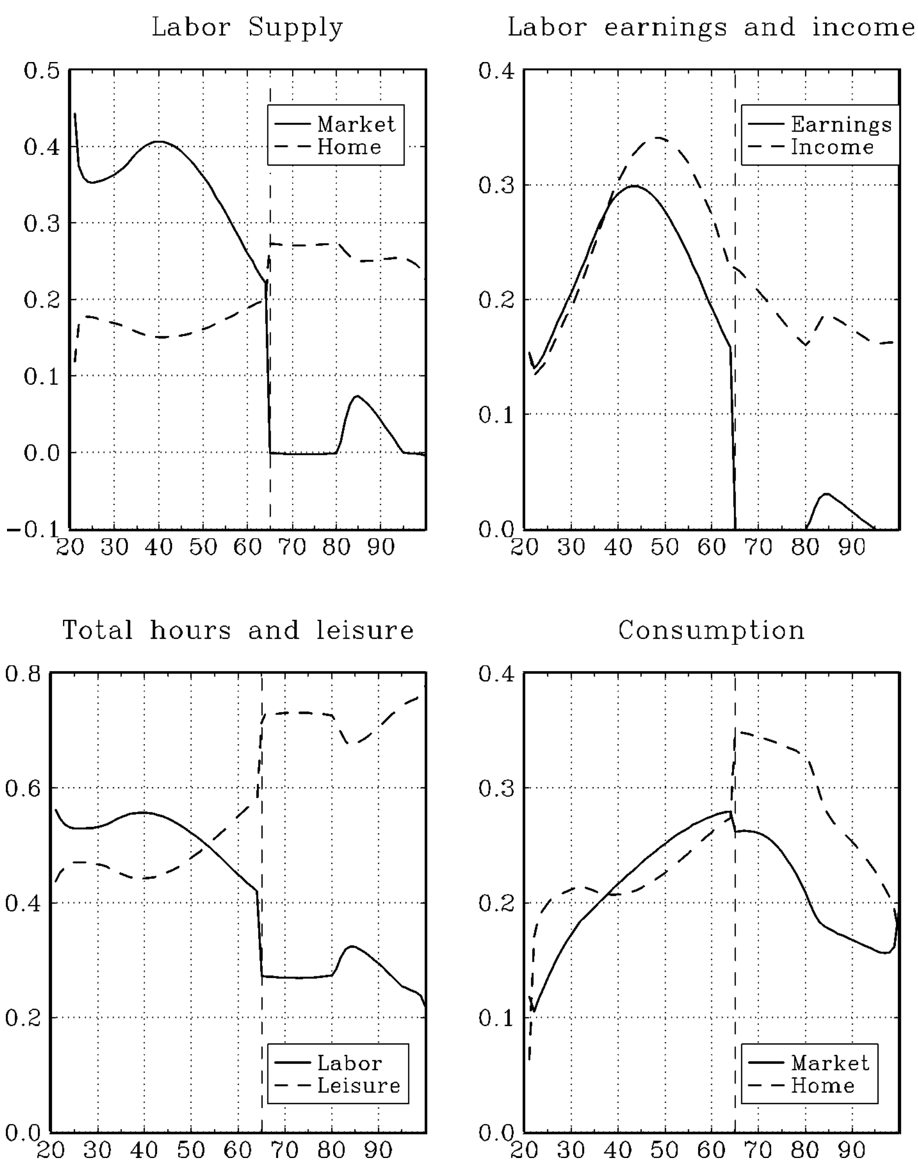
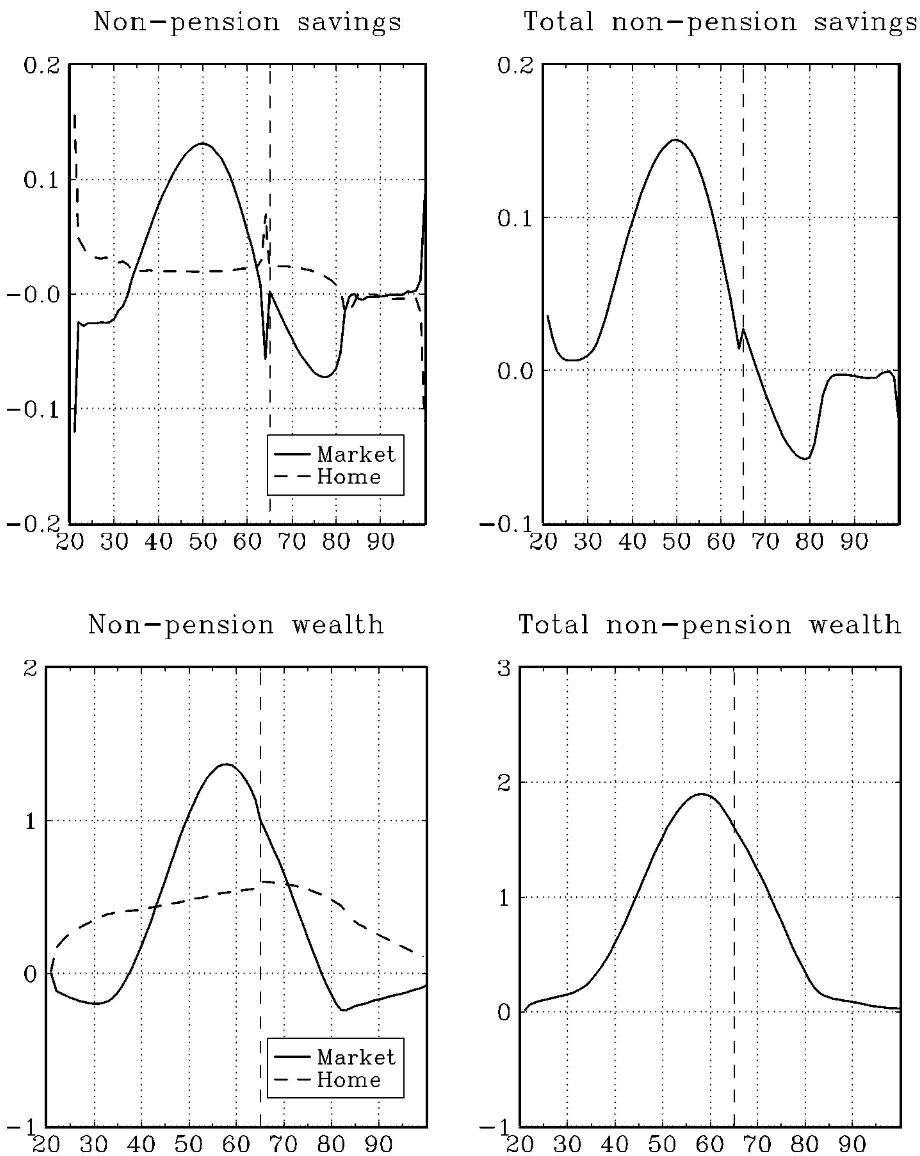


Economy with Home Production



Economy with Home Production