Unemployment Insurance and Home Production*

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Abstract

In this paper, we incorporate home production into a quantitative model of unemployment, and show that realistic levels of home production have a significant impact on the optimal unemployment insurance rate. Using data from the American Time Use Survey (ATUS), we first show that unemployed workers spend an additional 10 hours per week in home production compared to employed workers, which is roughly a 50% increase. We use the Panel Study of Income Dynamics (PSID) data on housework to confirm that this difference is robust to controlling for unobserved heterogeneity between employed and unemployed adults. Motivated by this fact, we augment an incomplete markets model of unemployment with a home production technology, which allows unemployed workers to use their extra non-market time as partial insurance against the drop in income due to unemployment. In the benchmark model, we find that the optimal replacement rate in the presence of home production is roughly 40% of wages, which is 40% lower than the no-home production models optimal replacement rate of 65%. The 40% optimal rate is also close to the estimated rate in practice. The fact that home production makes a significant difference in the optimal unemployment insurance is robust to a variety of parameterizations and alternative model environments.

J.E.L. Classification: D12, D13, E24, H55, I38, J22, J65.

Keywords: Unemployment insurance, home production, incomplete markets, self-insurance, welfare analysis.

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1 Introduction

In this paper, we incorporate home production into a quantitative model of unemployment, and show that realistic levels of home production have a significant impact on the optimal unemployment insurance rate. In general, incomplete market models- including the quantitative models of unemployment insurance- ignore the partial insurance role[1] of home production and how it varies with employment status.[2] However, home production is quantitatively important in time-use surveys. In particular, unemployed allocate their non-market time differently, and this is important for policy analysis. Our paper closes this gap between home production literature and unemployment insurance literature.

If there were complete private insurance against unemployment shocks, then government-provided unemployment insurance would be unnecessary. Therefore, it is important to account for the amount of self insurance of unemployed workers when designing unemployment insurance programs. In this paper, we consider home production as a self-insurance mechanism, and study the role of home production on the optimal unemployment insurance policy. The results suggest that the optimal replacement rate is substantially lower when we allow agents to self-insure through home production.

Using data from the American Time Use Survey (ATUS), we first show that unemployed workers spend an additional 10 hours per week in home production compared to employed workers, which is roughly a 50% increase. We use the Panel Study of Income Dynamics (PSID) data on housework to confirm that this difference is robust to controlling for unobserved heterogeneity between employed and unemployed adults. Motivated by this fact, we augment an incomplete markets model of unemployment with a home production technology, which allows unemployed workers to use their extra non-market time as partial insurance against the drop in income due to unemployment. In the

[1] See Heathcote et al (2009) for a survey on the partial insurance mechanisms in incomplete markets.

[2] See for instance: Hansen and Imrohoroglu (1992), Hopenhayn and Nicolini (1997), Acemoglu and Shimer (2000).

benchmark model, we find that the optimal replacement rate in the presence of home production is roughly 40% of wages, which is 40% lower than the no-home production models optimal replacement rate of 65%. The 40% optimal rate is also close to the estimated rate in practice. The fact that home production makes a significant difference in the optimal unemployment insurance is robust to a variety of parameterizations and alternative model environments.

We use a dynamic general equilibrium model, which is an extension of Hansen and Imrohoroglu (1992) with home production, in order to quantify the effect of home production on the optimal unemployment insurance policy. In the model, individuals receive idiosyncratic employment shocks. Government provides unemployment insurance financed through proportional income taxation. Along with government-provided unemployment insurance, individuals can have partial self insurance through two channels. The first channel is accumulation of wealth through a non-interest bearing asset. Individuals thereby can accumulate precautionary wealth against the risk of income loss and enjoy their wealth during unemployment spells.[3] The second channel is home production, which allows us to distinguish actual consumption from expenditure on market goods. The home production approach assumes that individuals produce consumption goods and services by combining time and market goods. For instance, food can be either consumed as a market good and service at a restaurant or it can be prepared via time-intensive cooking and cleaning at home. If it is purchased from a market, the market goods component of the production is relatively larger and the time component is relatively smaller. If the food is prepared at home using time and raw inputs, then the market goods component is relatively smaller and the time input is relatively larger. The weight of these components is a choice of the individual and it depends on the relative

[3]The empirical studies on the wealth of unemployed find wealth/income ratios varying between 0 to 0.56 depending on sample restriction and wealth definition. (Carroll et al (2001), Engen and Gruber (2002), Gruber (2001))

cost of time and market goods.

The relative price of time and market goods is surely affected by unemployment shocks (more time and less market goods are available in unemployment spells). On the one hand, unemployment status has a big effect on expenditures since agents have an income loss during unemployment spells. On the other hand, unemployment status has a smaller effect on actual consumption due to the increase in spare time. The important question is whether individuals use a significant fraction of that spare time in home production, which depends on the relative elasticities of available insurance mechanisms such as precautionary savings or home production. In the empirical results, we show that home production is quantitatively important in time-use surveys, and the unemployed allocate their non-market time differently.[4] Therefore, we consider home production as a self insurance mechanism in an incomplete market environment, where individuals face uninsurable unemployment shocks.

In order to see the role of home production in optimal unemployment insurance policy, we solve the model twice, once with and once without home production. We define optimal replacement rate as the one which maximizes the steady state equilibrium welfare. We calculate the optimal replacement rates in several model environments. We also allow for the possibility of moral hazard in the society. Moral hazard refers to imperfect government monitoring of job offers. In this case, individuals can turn down some job offers and still collect unemployment benefits with some probability. In general, we find that the optimal replacement rates are significantly smaller when we allow agents to self-insure through home production. Along with the 40% difference between home production and no-home production case in the benchmark model, we find that alternative parameterizations may result up to 80% difference in optimal replacement rates due to

[4]Also, Burda and Hamermesh (2009) provide empirical evidence for Australia, Germany, Italy, and the United States that unemployed workers increase their home production significantly as a response to unemployment. Aguiar and Hurst (2009) document an unconditional difference of 9 hours per week between unemployed and employed men in the United States.

home production. The consumption smoothing mechanism through home production affects optimal replacement rates significantly. In equilibrium, unemployed agents spend less on market goods and services, however they spend more time on home production compared to employed agents. The gap between consumption levels of employed and unemployed agents, and consumption inequality in population get smaller as a result of consumption smoothing mechanism through home production option.

Design of optimal unemployment insurance programs has been studied extensively in the literature. Hansen and Imrohoroglu (1992), Wang and Williamson (1996), Acemoglu and Shimer (2000), and Abdulkadiroglu et al (2002) work on the welfare analysis of unemployment insurance programs using dynamic general equilibrium models. They assume that there is no insurance mechanism other than government-provided unemployment insurance, or self-insurance through wealth accumulation. This paper is different than the aforementioned studies in several dimensions. First, we fill the gap of a quantitative analysis of unemployment insurance in an environment where individuals are allowed to do home production as an additional smoothing mechanism.[5] Second, we provide robust empirical evidence of the fact that unemployment status has a significant effect on home production. Incorporating our empirical analysis on home production with the empirical literature on the wealth of the unemployed, we calibrate the self insurance of unemployed individuals in the model. Therefore, we make a quantitatively reliable optimal unemployment insurance analysis.

In related work, Shavell and Weiss (1979), Hopenhayn and Nicolini (1997), and Alvarez and Sanchez (2008) focus on the profile of replacement rate over the unemployment periods using dynamic contract theory in a partial equilibrium environment. Under cer-

[5]Home production approach has been employed in other studies, too. For example, Aguiar and Hurst (2005) bring explanation to retirement puzzle using home production approach, where home production has a consumption smoothing role. Chang and Hornstein (2007) employs home production in a business cycle model to better understand the aggregate fluctuations in labor supply and small correlation between employment and wages. Benhabib et al (1991), Greenwood and Hercowitz (1991), Canova and Ubide (1998), and Chang (2000) are other examples.

tain assumptions, their common finding is that replacement rates should be decreasing with the duration of unemployment spell. The rate of decrease in replacement rates depends on the particular environment in each study. However, there are also opposite results in recent studies. For example, Werning (2002) and Shimer and Werning (2008) claim that the optimal profile of unemployment insurance payments could be constant over unemployment spell. Hagedorn et al (2005) claim that the profile of payments should depend on worker types. In this paper, we assume that replacement rate is constant over time, and focus on the role of self-insurance mechanisms on the optimal replacement rate.

There is also an empirical literature on the unemployment insurance programs. Hamermesh (1982) studies the effect of unemployment insurance on the liquidity constraints during unemployment spells. Engen and Gruber (2001) show empirical evidence on the negative relationship between unemployment insurance and precautionary wealth accumulation. Gruber (2001b), and Carroll et al (2003) estimate the amount of precautionary wealth of individuals due to unemployment risk. These empirical studies give motivation to account for self insurance mechanisms while designing optimal unemployment insurance policies.

The remaining sections of the paper is organized as follows: in section 2, we document the empirical motivation regarding consumption smoothing mechanism through home production. In section 3, we describe the model. Section 4 discusses the calibration strategy. In section 5, we present quantitative results regarding the effect of home production on optimal unemployment insurance policy. Finally, we conclude in section 6.

2 Empirical Motivation

In this section, we document empirical evidence on the relationship between home production and unemployment. We use a group of cross sectional time-use data sets including American Time Use Survey (ATUS), Americans' Use of Time (AUT), Time Use in Economics and Social Accounts (TUESA), National Human Activity Pattern Survey (NHAPS), and a panel data set, Panel Study of Income Dynamics (PSID)[6] to estimate the change in home production with respect to unemployment status. We use both cross sectional and panel data sets, because of the trade off between them. On the one hand, the cross sectional time-use data sets are very rich in terms of individuals' time use information. Home production and its components are measured very well in this data set. However, cross sectional nature of the data is a disadvantage when we estimate the effect of unemployment status on home production. Cross sectional data does not allow us to capture individual fixed effects in estimations. On the other hand, PSID is a panel data which allows us to control for individual fixed effects in estimations. However, it has a disadvantage on measurement of home production, which we will discuss later in this section.

In the empirical analysis using cross sectional time-use surveys, we use the same data sets as Aguiar and Hurst (2007b), which includes 1965 and 1985 AUT, 1975 TUESA, 1992-1994 NHAPS, and 2003 ATUS. We define home production as the total time spent on meal preparation and clean up, indoor cleaning and laundry, outdoor cleaning, repairs and maintenance, child care, gardening and pet care, and other housework. We restrict the sample to the individuals between 15 years old and 59 years old. We exclude retired, students and disabled from the sample in order to see the effect of unemployment status on home production. The unit of time is hours per week. We use the following equation:

[6] Please see data appendix for details of the data sets and sample construction.

Table 1: Summary Statistics.

Variable	AUT (1965&1985)	TUESA (1975)	NHEPS (1992-1994)	ATUS (2003)	PSID (1979-1986)
Percent Married	67	78	-	56	70
Percent With Children	50	59	-	58	49
Percent Unemployed	4	7	5	7	5
Percent Male	54	59	50	48	51
Percent High school or less	60	66	39	39	56
Percent Age 15-34	45	48	45	36	53
Percent Age 35-49	38	33	39	44	31
Percent Age 50-59	17	18	16	20	16
Percent White	92	92	89	88	80
Sample size	3,948	1,243	4,658	13,075	11,797
Average Home Production (Hours per week)					
All Sample	18.7	17.1	17.8	19.9	-
Employed	18.3	16.5	17.3	19.5	-
Unemployed	31.9	26.4	27.9	24.7	-
Married	19.3	17.4	-	23.4	-
Unmarried	17.3	16.1	-	15.6	-
Male	12.6	11.8	13.0	15.5	-
Female	26.8	25.5	22.7	24.9	-
White	17.4	17.5	18.1	20.3	-
Black	17.9	13.2	14.7	17.2	-
Average Housework (Hours per week)					
All Sample	7.5	6.8	6.6	6.3	12.9
Employed	7.3	6.4	6.3	6.1	12.7
Unemployed	14.4	13.2	12.5	8.9	16.1
Married	7.3	6.7	-	7.4	13.8
Unmarried	7.9	7.5	-	5.0	10.7
Male	2.4	1.7	2.6	3.1	8.09
Female	14.2	14.7	10.8	10.0	17.8
White	6.8	7.0	6.7	6.4	12.7
Black	10.0	5.6	5.7	5.7	13.6

Notes: We use the following abbreviations in the table; AUT: Americans' Use of Time, TUESA: Time Use in Economics and Social Accounts, NHEPS: National Human Activity Pattern Survey, ATUS: American Time Use Survey, PSID: Panel Study of Income Dynamics. The first set of rows represents summary demographics in the data sets. The second and third set of rows are average home production and average housework for some sub-samples. In all data sets, the samples are restricted to individual between 15 and 59 years old, those with employed or unemployed (actively looking for job) status. We define housework as the total time spent on food preparation and kitchen clean up, laundry, and indoor and outdoor house cleaning. We define home production as the total time spent on housework plus house and vehicle repair, child care, and gardening and pet care.

$$HP_i = \beta_0 + X_i\beta + U_i\phi + \epsilon_i \quad (1)$$

In equation (1), HP_i is individual i's hours per week spent on home production, X_i is a set of variables including gender, race, number of children, marital status, educational attainment, age, year, and education-age interaction. U_i equals 1 if the individual is unemployed, 0 otherwise. We are particularly interested in the estimated coefficient of ϕ. It is estimated as 9.8 with a standard error of 0.7. It means that home production increases about 9.8 hours per week due to unemployment status. It corresponds to a 50% increase as we run the same regression with log home production. We also find that whites, females and older workers spend more time on home production. Married households and those with more number of children also do more home production. We report the results in Table 2. We also repeat the same exercise with restriction to married and unmarried households separately. We find that unemployment status has a greater effect on home production decisions of married households.

Since time-use surveys provide cross sectional data, we are unable to capture unobserved fixed effects in our estimations. Therefore the estimated coefficient of, ϕ, might not consistently represent the effect of unemployment status on home production. The difference between home production levels of employed and unemployed individuals could be due to some unobserved differences between them. Therefore, we use the PSID, which is a panel data set, in order to check if there is any bias in cross section estimations. The drawback of using the PSID is that it does not include detailed questions on non-market time use, therefore there could be a measurement error in home production. In the PSID, there is a question about how much "housework" individuals do. We consider it as a narrow definition of home production, because we do not know if individuals include time spent on child care, repairs and maintenance, and gardening and pet care when they respond to this question. Formally we define housework as the total time

Table 2: Unemployment and Home Production in Time-Use Surveys

	Dependent Variable			
	Full Sample		High School or Less Educated	
	Home Prod.	Log Home Prod.	Home Prod.	Log Home Prod.
Unemployment	9.770	0.514	8.926	0.460
	(0.651)	(0.041)	(0.905)	(0.060)
White	3.414	0.104	3.822	0.128
	(0.466)	(0.030)	(0.647)	(0.044)
Male	-13.950	-0.700	-15.608	-0.788
	(0.278)	(0.017)	(0.411)	(0.027)
Number of Children	1.673	0.086	1.276	0.067
	(0.105)	(0.007)	(0.144)	(0.010)
Married	3.400	0.185	3.247	0.175
	(0.331)	(0.021)	(0.492)	(0.032)
Sample Size	15,622	13,582	6,806	5,713

Notes: Time units are represented by hours per week. Data: Americans' Use of Time (1965 & 1985), Time Use in Economics and Social Accounts (1975), National Human Activity Pattern Survey (1992-1994), American Time Use Survey (2003). Sample is restricted to individuals with ages between 15-59, and those in labor force. Year dummies, square and cube of education and age, and education-age interaction are included in estimations in addition to the reported variables.

spent on food preparation and kitchen clean up, laundry, and indoor and outdoor house cleaning. In the PSID, we have to restrict to the years between 1979 and 1986, because the variables we are interested in (home production and employment status) are jointly available at individual level for only between 1979 and 1986. In order to be consistent with the time-use surveys' sample, we make the following restrictions on the sample: we restrict the sample to individuals between 15 and 59 years of age, with black or white ethnicity, and with either employed or unemployed status.

In order to see if the cross sectional estimations are biased or not, we estimate the effect of unemployment status on housework twice, once with a fixed effect regression, and once with cross section regression in PSID. And then, we also estimate the same coefficient with cross section regression in ATUS.[7] We use equation (2) to capture unobserved fixed effects. The estimated coefficient for unemployment dummy in this equation is 4.6. It implies that housework increases by 4.6 (with a standard error of 0.5) hours per week due to unemployment status. And then, we use equation (1) to estimate the same coefficient (cross section). This coefficient is estimated as 4.4 (with a standard error of 0.1) and 4.8 (with a standard error of 0.4) in PSID and ATUS respectively. The estimated coefficients in the three cases are within one standard error of each other. Therefore, we conclude that the individual fixed effects are not important and do not have a significant role in the cross sectional estimations. We report the results of fixed effect and cross sectional regressions using PSID and ATUS in Table (4) and (3).

$$HP_{it} = \beta_0 + X_{it}\beta + U_{it}\phi + \epsilon_i + \nu_{it} \tag{2}$$

As a result of our estimations using two data sets, and Burda and Hamermesh (2009) estimations, we conclude that the effect of unemployment status on home production

[7]Note that "housework"- the narrow definition of home production- is available in both data sets.

Table 3: Unemployment and Housework in Time-Use Surveys

	Dependent Variable			
	Full Sample		High School or Less Educated	
	Housework	Log Housework	Housework	Log Housework
Unemployment	4.802	0.415	5.050	0.447
	(0.356)	(0.047)	(0.530)	(0.070)
White	1.019	0.030	1.304	0.033
	(0.152)	(0.036)	(0.379)	(0.053)
Male	-11.447	-1.059	-13.238	-1.190
	(0.152)	(0.021)	(0.241)	(0.034)
Number of Children	0.327	0.057	0.264	0.055
	(0.058)	(0.008)	(0.084)	(0.012)
Married	1.029	0.093	1.217	0.101
	(0.180)	(0.023)	(0.288)	(0.036)
Sample Size	15,622	9,571	6,806	3,867

Notes: Time units are represented by hours per week. Data: Americans' Use of Time (1965 & 1985), Time Use in Economics and Social Accounts (1975), National Human Activity Pattern Survey (1992-1994), American Time Use Survey (2003). Sample is restricted to individuals with ages between 15-59, and those in labor force. Year dummies, square and cube of education and age, and education-age interaction are included in estimations in addition to the reported variables.

Table 4: Unemployment and Housework in PSID

	Dependent Variable			
	Panel (Fixed Effects)		Cross Section	
	Housework	Log Housework	Housework	Log Housework
Unemployment	4.584	0.306	4.406	0.286
	(0.532)	(0.036)	(0.108)	(0.008)
White	-	-	0.415	0.018
	-	-	(0.061)	(0.005)
Male	-	-	-9.920	-0.920
	-	-	(0.049)	(0.004)
Family Size	0.048	0.012	0.136	0.019
	(0.167)	(0.011)	(0.017)	(0.001)
Married	1.229	0.150	3.439	0.285
	(0.511)	(0.035)	(0.581)	(0.004)
Sample Size	11,304	11,304	11,304	11,304

Notes: Time units are represented by hours per week. Data: PSID (1979, 1980, 1981, 1983, 1984, 1985, 1986). Sample is restricted to individuals with ages between 15-59, and those in labor force. Race dummies, year dummies, and square and cube of education and age, and interaction between them are included in estimations in addition to the reported variables.

should be in between 4.6 to 10 hours per week.[8] In the model, where we analyze the role of home production on optimal unemployment insurance policy, we are going to consider this range as a plausible range for the effect of unemployment status on home production.

3 Model

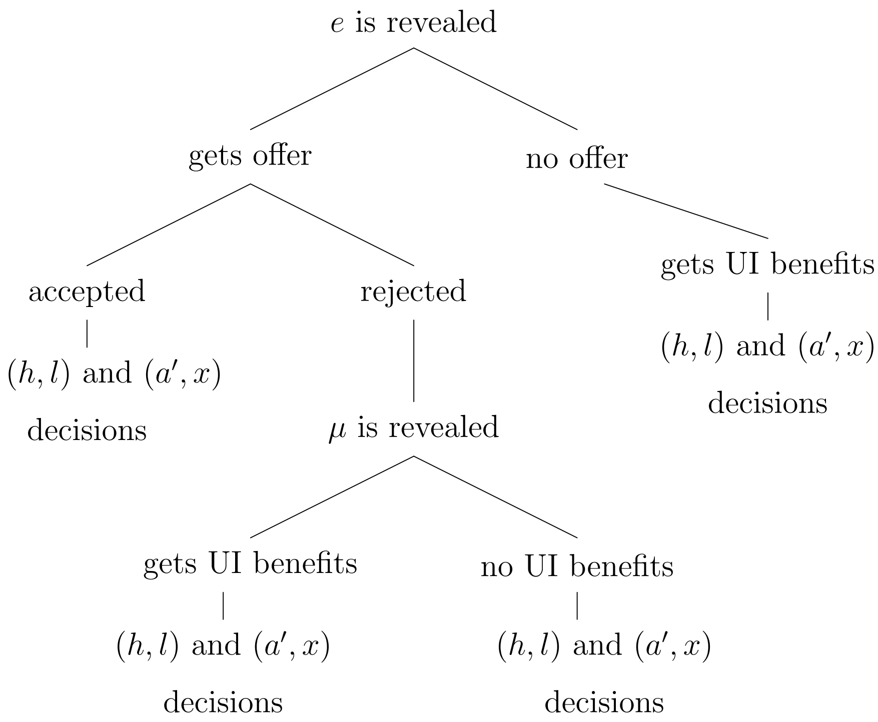
Motivated by the empirical facts presented in the previous section, we augment an incomplete markets model of unemployment with a home production technology, which allows unemployed workers to use their extra non-market time as partial insurance against the drop in income due to unemployment. We use a dynamic general equilibrium environment with home production to understand the role of home production on optimal unemployment insurance policy. The environment is incomplete due to uninsurable employment opportunity shocks. The unemployment insurance is financed by proportional income tax. There is a continuum of ex ante identical individuals and heterogeneity arises due to idiosyncratic employment opportunities. We explain each component of the model in detail in the following subsections.

3.1 Employment Process

Individuals receive shocks to employment opportunity states every period. It follows a two-state Markov chain. The transition probabilities are defined as $\chi(i,j) = P(e' = j|e = i)$, where $i, j \in \{0,1\}$. For example, given that the individual did not get an offer in the last period, the probability of getting an offer in the current period is equal to $P(e' = 1|e = 0) = \chi(0,1)$. Each employed individual earns the same wage rate denoted

[8] Burda and Hamermesh (2009) report that effect of unemployment status is about 90 minutes per day (10.5 hours per week) using 2003-2006 samples of ATUS data set.

Figure 1: Timing of the Events



Notes: In this scheme, e represent employment opportunities. Indicator of unemployment insurance qualification is denoted with μ. We denote home production, leisure, expenditure, and saving decisions with h, l, x, and a', respectively.

with y.

3.2 Household Decisions

Individuals enjoy utility from consumption and leisure. They have two continuous decisions at every period, one is the saving/spending, and the other one is the time allocation decision. Individuals can choose the amount of time spent on home production, and leisure given employment status. The time constraint is looser and liquidity constraint[9] is tighter when the individual is unemployed. Given that the individual has a job offer, he or she also makes an accept/reject decision.

They maximize their life-time utility:

$$E \sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$$

where $u(\cdot)$ is period utility function, β is time discount factor, c_t is consumption and l_t is leisure.

Individuals have a time constraint at each period, which depends on employment shock at current period:

$$h_t + l_t + n(e) = 1 \tag{3}$$

where h_t is time spent on home production, l_t is leisure and $n(e)$ is labor supply conditional on employment status. Individuals have employment decision only at extensive margin. If individual is unemployed, then $n(0) = 0$, if he or she is employed, then $n(1) = \bar{n}$. Therefore, not-employed individuals have more flexible time constraints for allocation of time when compared to employed individuals. In particular employed indi-

[9] We refer to the constraint on resources to obtain market goods and services as liquidity constraint.

viduals face the following time constraint:

$$h_t + l_t + \bar{n} = 1 \tag{4}$$

and, unemployed individuals face the following time constraint:

$$h_t + l_t = 1 \tag{5}$$

3.3 Storage Technology

Individuals can accumulate wealth through a non-interest bearing asset and the assets evolve according to the following equation:

$$x_t + a_{t+1} = a_t + y_t^d(e) \tag{6}$$

where x_t is expenditure on market goods and services, and a_{t+1} is amount of wealth carried to the next period. Disposable income (y_t^d) depends on employment opportunity and qualification on unemployment insurance, and we are going to explain it later on. If individuals are not working, they can consume their stock of wealth and they can also possibly consume unemployment benefits. We are going to explain the qualification process of employment benefits later on.

3.4 Home Production

Individuals produce consumption goods and services using market goods and services and time according to a production function:

$$c_t = f(h_t, x_t) \tag{7}$$

where, c_t is the amount of consumption goods and services, h_t is time spent on home production and x_t is expenditure on market goods and services. In this paper, we assume that every individual has the same home production technology with function $f(\cdot)$. We are going to explain this function in detail later on, when we explain functional specifications.

The individual's two constraints (3) and (6) are important in our analysis. Employed individuals have less time remaining for leisure and home production, so time resource is more scarce for them. On the other hand, unemployed individuals have less resources for market goods and services. Due to this difference, they will allocate their time and goods differently.

3.5 Timing of Events

At each period the state for the individual is determined by current employment opportunity (e), previous employment status (η), and current asset level (a). Given the current state, the individual makes employment decision, saving/spending decision, and time allocation decision. First, the employment opportunity shock is received. If there is an employment opportunity, then individual makes employment decision, accept or reject the opportunity. If individual rejects the opportunity, then he or she finds out if he qualifies for the unemployment benefits. Then the individual makes saving/spending decision and time allocations decision according to the realization of unemployment benefits. On the other hand, if there is no employment opportunity, then the individual makes saving/spending and time allocation decisions directly. We summarize the timing of events in Figure 1.

3.6 Moral Hazard

In the model, we allow for moral hazard in the society. Moral hazard is caused by imperfect government monitoring of job offers. In this case, individuals can turn down job offers and still collect unemployment benefits with some probability. The probability of obtaining benefits conditional on rejecting an offer is denoted with $\pi(\eta)$, where η represents last period employment status. We allow $\pi(.)$ to depend on η, because effectiveness of government monitoring might be different for employed and unemployed individuals in the last period. Note that positive values of either $\pi(0)$ or $\pi(1)$ refers to moral hazard in the society.

3.7 Unemployment Insurance System

We define the unemployment benefits system as follows: If individual has no employment opportunity, then he or she qualifies for unemployment benefits directly. If individual has an employment opportunity and accepts it, then he or she does not qualify for the unemployment benefits. If individual has an employment opportunity and rejects it, then he or she qualifies for the unemployment benefits with probability $\pi(\eta)$ depending on his or her last period employment status.

In the scheme below, e is the indicator of employment opportunity with $e \in \{0, 1\}$. If e is equal to 1, individual has an employment opportunity, if e is equal to 0, individual has no employment opportunity. We denote unemployment insurance qualification indicator with $\mu \in \{0, 1\}$. If it is equal to 1, the individual is qualified for unemployment benefits, otherwise he or she is not qualified. Last period's employment status is denoted with $\eta \in \{0, 1\}$. If $\eta = 1$, then the individual was employed in the last period, otherwise he or she was not employed in the last period. We summarize the unemployment benefit system as follows:

$$
\begin{aligned}
\text{gets no offer } (e=0) \Rightarrow \quad & \mu = 1 \\
\text{gets offer } (e=1),\ \text{accepts } (\eta'=1) \Rightarrow \quad & \mu = 0 \\
\text{gets offer } (e=1), (\eta=0),\ \text{rejects } (\eta'=0) \Rightarrow \quad & \mu = 1 \text{ with prob. } \pi(0) \text{ and} \\
& \mu = 0 \text{ with probability } 1-\pi(0) \\
\text{gets offer } (e=1), (\eta=1),\ \text{rejects } (\eta'=0) \Rightarrow \quad & \mu = 1 \text{ with prob. } \pi(1) \text{ and} \\
& \mu = 0 \text{ with probability } 1-\pi(1)
\end{aligned}
$$

Note that government monitoring is an exogenous process with $\pi(.)$. The government does not make a decision on the degree of monitoring job offers. Optimal government monitoring is not analyzed in this paper.

3.8 Taxation and Disposable Income

The government collects a proportional income tax (τ) to finance the unemployment benefits. The rate of tax is adjusted to balance government balance. Individuals who qualify for unemployment benefits receive a certain fraction (θ) of their lost income. As we noted before, the disposable income (y_t) of individual depends on the current and previous employment status. When the individuals qualify for unemployment insurance, they receive a benefit equal to $\theta(1-\tau)y$, and we denote it with b. We summarize the disposable income at different states as follows:

$$\text{gets no offer } (e=0) \Rightarrow \quad y_t^d = b \tag{8}$$

$$\text{gets offer } (e=1),\ \text{accepts } (\eta'=1) \Rightarrow \quad y_t^d = (1-\tau)y \tag{9}$$

$$\text{gets offer}(e=1),\ \text{rejects } (\eta'=0),\ \text{gets benefit } (\mu=1) \Rightarrow \quad y_t^d = b \tag{10}$$

$$\text{gets offer } (e=1),\ \text{rejects } (\eta'=0),\ \text{no benefit } (\mu=0) \Rightarrow \quad y_t^d = 0 \tag{11}$$

In the above scheme, y_t^d represents disposable income in period t. We denote the wage of an employed worker with y, which is normalized to 1. If individual has no employment opportunity, he or she enjoys the after tax unemployment insurance benefits. If individual has an employment opportunity and accepts it, then he or she enjoys the after tax wage. If individual has an employment opportunity and rejects it, and qualifies for benefits, then he or she enjoys after tax unemployment benefits. If he or she does not qualify for the benefits when he rejects the employment opportunity, then he has 0 disposable income in that period.

3.9 Recursive Formulations

The individuals make their decisions depending on three state variables; current asset levels (a), existence of job offer at current period (e), and previous period's employment status (η). We denote the value function of an individual with state variables a, e, and η with $V(a, e, \eta)$.

The problem of an individual with no employment opportunity can be summarized with the following recursive formulation:

$$V(a,0,\eta) = \max_{a',x,h,l}\{u(c,l) + \delta \sum_{e'} \chi(0,e')V(a',e',0)\} \tag{12}$$
$$\text{s.t.}$$
$$\text{constraints (5), (6), (7), (8).}$$

On the left hand side of equation (12), a represents current asset level and η represents last period employment status. Note that η has no role in value function of individuals with no employment opportunity[10], because they are directly qualified for unemployment insurance. Also, note that the employment opportunity indicator (e) is 0, in this case. On the right hand side, the inputs of period utility is consumption and leisure. Consumption is represented as a function ($f(.)$) of time spent on home production and expenditures on market goods. Time left for leisure equals $1 - h$, because labor supply (n) is zero. In the next period's value function, η is equal to zero, because the individual is not working at the current period. Since the individual qualifies for the unemployment insurance, disposable income equals a certain fraction (θ) of lost after tax earnings ($(1-\tau)y$).

The problem of an individual with an employment opportunity can be summarized with the following recursive formulation:

$$V(a,1,\eta) = \max\{V_A(a,1,\eta), V_R(a,1,\eta)\} \tag{13}$$

$$\text{where, } V_R(a,1,\eta) = \pi(\eta)V_B(a,1,\eta) + (1-\pi(\eta))V_N(a,1,\eta) \tag{14}$$

where, V_f is value of an offer, V_A is value of accepting the offer, V_R is value of rejecting the offer, V_B is value of qualifying for unemployment insurance after rejecting the offer, V_N is value of not qualifying for unemployment insurance after rejecting the

[10] We write it as an input in order to be consistent with the general notation of the model.

offer. Recall that $\pi(\eta)$ represents the probability of obtaining unemployment benefits for those who reject employment opportunities. Therefore, value of rejecting an offer is equal to $\pi(\eta)$ times value of obtaining unemployment benefits, and $(1-\pi(\eta))$ times value of not obtaining benefits upon turning back job offers.

Value of accepting an offer can be summarized as follows:

$$\begin{aligned} V_A(a,1,\eta) = \quad & \max_{a',x,h,l}\{u(c,l)+\delta\sum_{e'}\chi(1,e')V(a',e',1)\} \\ & \text{s.t.} \\ & \text{constraints (4), (6), (7), (9).} \end{aligned} \tag{15}$$

Value of qualifying for unemployment insurance after rejecting an offer is equal to:

$$\begin{aligned} V_B(a,1,\eta) = \quad & \max_{a',x,h,l}\{u(c,l)+\delta\sum_{e'}\chi(1,e')V(a',e',0)\} \\ & \text{s.t.} \\ & \text{constraints (5), (6), (7), (10).} \end{aligned} \tag{16}$$

Value of not qualifying for benefits after rejecting an offer is defined as:

$$\begin{aligned} V_N(a,1,\eta) = \quad & \max_{a',x,h,l}\{u(c,l)+\delta\sum_{e'}\chi(1,e')V(a',e',0)\} \\ & \text{s.t.} \\ & \text{constraints (5), (6), (7), (11).} \end{aligned} \tag{17}$$

3.10 Equilibrium

In this economy, a *stationary competitive equilibrium* is defined as:

- a set of decision rules of expenditure $x(\omega)$, stock of wealth $a'(\omega)$, home production

$h(\omega)$, leisure $l(\omega)$, employment $\eta'(a,e,\eta)$, where $\omega = (a,e,\eta,\mu)$,

- a tax rate τ,
- an invariant measure $\lambda(\omega)$,
- such that:
- the decision rules solve the individuals' problem defined in equations (12), (14), (15), (16), (17),
- the goods market clear:

$$\sum_{\omega} \lambda(\omega)x(\omega) = \sum_{\omega} \lambda(\omega)\eta'(\omega)y$$

- the government budget is balanced:

$$\sum_{a} \{[\lambda(a,1,\eta,1) + \lambda(a,0,\eta,1)](1-\tau)\theta y - \lambda(a,1,\eta,0)\eta'(a,1,\eta,0)y\tau\} = 0$$

- and the invariant measure $\lambda(\omega)$ solves:

$$\lambda(\omega') = \begin{cases} 0;\ \text{if } e' = 0, \mu' = 0 \\ \sum_{\mu}\sum_{\eta}\sum_{e}\sum_{a\in\Omega} \chi(e,e')\lambda(\omega);\ \text{if } e' = 0, \mu' = 1 \\ \sum_{\mu}\sum_{\eta}\sum_{e}\sum_{a\in\Omega} \chi(e,e')\lambda(\omega)\times \\ \{\eta'(\omega') + [1-\pi(\eta'(\omega'))][1-\eta'(\omega')]\};\ \text{if } e' = 1, \mu' = 0 \\ \sum_{\mu}\sum_{\eta}\sum_{e}\sum_{a\in\Omega} \chi(e,e')\lambda(\omega)\times \\ \pi(\eta'(\omega'))[1-\eta'(\omega')];\ \text{if } e' = 1, \mu' = 1 \end{cases}$$

where $\Omega = \{a : a' = a'(a,e,\eta,\mu)\}$.

Note that, in equilibrium, decision rules solve the individuals' optimization problems. Total unemployment insurance payments for unemployed workers must be equal to the taxes paid by employed workers. The invariant distribution ensures that distribution of agents doesn't change across time. In the invariant distribution, the first line means that the fraction of population who do get offers, and also do not obtain unemployment benefits is zero. The second line means that all agents who do not get an offer qualify for unemployment insurance benefits for sure. The third line represents the fraction of population who gets and offer and does not qualify for benefits. The last line is the fraction of population who get an offer and also qualify for the benefits.

4 Calibration

In the unemployment insurance literature, most of the studies have quarterly or six-week periods.[11] We define each period as six weeks to be in line with the existing literature. The employment opportunities follow a two state Markov process. We follow Hansen and Imrohoroglu (1992) in transition matrix of employment opportunities with the following probabilities, which matches average rate and duration of unemployment in the United States:

$$\begin{bmatrix} .9681 & .0319 \\ .5 & .5 \end{bmatrix}$$

With the above transition matrix, agents receive employment opportunities 94% of the time, and the average duration of time without employment opportunities is 12 weeks.

We have a constant labor supply of employed workers denoted with $\bar{n}$, which equals

[11] There are exceptions that use weekly periods. For example: Acemoglu and Shimer (2000), Shimer and Werning (2008).

0.45. We take this constant labor supply same with the closely related studies in the literature, Hansen and Imrohoroglu (1992), Abdulkadiroglu et al (2002), and Pallage and Zimmermann (2005), which match the average working hours in the United States.[12]

We calibrate β to match the average wealth over income ratio for unemployed agents. We follow the empirical studies to target a plausible ex-ante wealth over income ratio for unemployed agents. The empirical findings on this ratio varies in the range of 0 and 0.56 depending on the definition of wealth. We use a value of 0.9995 for β, which gives a wealth over income ratio around 0.15 for unemployed individuals and around 0.40 for employed individuals.

The utility function is Constant Relative Risk Aversion (CRRA) in composition of consumption and leisure with a risk aversion parameter of σ, and the composition of consumption and leisure is formed as a Cobb-Douglas form:

$$u(c,l) = \frac{(c^{1-\rho}\, l^{\rho})^{1-\sigma} - 1}{1-\sigma}$$

We choose a benchmark value for σ in order to have comparable results with aforementioned related studies in the unemployment insurance literature. Although the acceptable range for σ is 1.5 to 10 in the business cycle literature, unemployment insurance studies usually take it in between 0.5 to 4.[13] In the benchmark case, we pick 2.50 for σ, and we repeat the exercises with a lower and a higher risk aversion parameter (2 and 3.50) to find out the effect of risk aversion on the optimal unemployment insurance policy. The share of leisure in utility function is denoted with ρ, and the value for this parameter is 0.67 in the benchmark case. We follow Kydland and Prescott (1982) and

[12]In the business cycle literature, Kydland and Prescott (1991) reports the same value for $\bar{n}$.

[13]For example: The value of σ is 1 in Shavell and Weiss (1979), 0.5 Hopenhayn and Nicolini (1997), 2.5 in Hansen and Imrohoroglu (1992), 2 in Alvarez-Parra and Sanchez (2009), and 4 in Acemoglu and Shimer (2000).

Table 5: Parameters of the Benchmark Economy.

Parameter		Value
β	Time discount factor	0.995
σ	Relative risk aversion	2.50
ρ	Weight of leisure in utility	0.67
n	Constant labor supply	0.45
θ	Current Unemployment benefit	0.40
$\chi(0,0)$	Employment Opportunities Transition	0.50
$\chi(1,1)$	Employment Opportunities Transition	0.9681
ψ	Weight of time input in home production (HP)	0.31
$1/(1-\nu)$	Elasticity of substitution between time and market goods in HP	1.45
γ	Degree of homogeneity in HP	1

(1991) for the benchmark value of ρ, which is standard in the business cycle literature.[14]

Home production function takes a Constant Elasticity of Substitution (CES) form with an elasticity of substitution between time and goods, $1/(1-\nu)$:

$$f(h,x) = (\psi h^{\nu} + x^{\nu})^{\gamma/\nu}$$

The parameters of the home production function are estimated in Aguiar and Hurst (2007).[15] They have multiple estimations for ψ and $1/(1-\nu)$. In the benchmark case, we choose $\psi = 0.31$ and $1/(1-\nu) = 1.45$, since they give the most plausible values for the effect of unemployment status on home production, and we also repeat computations with other parameters.

Note that ψ and ν are key parameters in our analysis since they determine the amount of self-insurance through home production. The parameter ψ affects the average time spent on home production, and at the current value of this parameter in the model, average time spent on home production is 5% of total time. This is about 10% in

[14]Also, Jacobs (2007) estimates a range of 0.63 to 0.68 for the value of ρ using PSID data set.

[15]For a detailed discussion of the data sets and estimations, please see Aguiar and Hurst (2007).

empirical data. Therefore, we are putting a lower bound to the role of home production in this sense. The parameter ν affects the difference between home production levels of unemployed and employed. The current value of ν in the model gives us a difference of 4.5 hours per week. This is about 10 hours in empirical data. Again, we are putting a lower bound to the role of home production in this sense. The parameters ψ and ν can be calibrated to exactly match the empirical data on home production, however we preferred to use the estimated parameters from Aguiar and Hurst (2007). Using the estimated parameters, we hit a lower bound to the role of home production, and we avoid overstating the main result of the paper.

To calibrate the current replacement rate (θ) in the model, we need to decide on the current empirical replacement rate. There are empirical studies on the average replacement rate in the United States. Gruber (1997) finds an average of 40% replacement rate. Clark and Summers (1982) estimate the average replacement rate around 65%. Keeping in mind that replacement rates decreased over time in the United States, and that Gruber's work is more recent, we pick the current level of replacement rate as 40% in the benchmark case. The parameters are reported in Table 5.

We choose parameters $\pi(0)$ and $\pi(1)$ to determine the degree of moral hazard in the society. Higher values for these parameters mean higher moral hazard. Pallage and Zimmermann (2005) assume that $\pi(0) > 0$ and $\pi(1) = 0$, and predict a value about 0.2 for $\pi(0)$ in the United States using a quantitative dynamic general equilibrium model. We do quantitative analysis in several different cases for parameters $\pi(0)$ and $\pi(1)$, and we pick values close to the reported ones in Pallage and Zimmermann (2005). We analyze the role of home production on optimal unemployment insurance policy for those different cases.

5 Quantitative Results

We solve the model computationally and simulate 50000 periods to calculate the moments. In the quantitative exercises, we aim to find the role of home production in optimal unemployment insurance. We divide [0,1] interval into grids. The replacement rate takes values from these grids. We compute the equilibrium for each possible value of replacement rate. We pick the one which maximizes average utility in the society as optimal replacement rate. In order to see the role of home production in optimal unemployment insurance, we solve the model twice; once with home production, and once with no-home production. We also repeat the same exercises with allowing for moral hazard in the society. Following this way, we understand how moral hazard affects the role of home production on unemployment insurance policy.

In general, our results imply that optimal unemployment insurance levels are smaller, when we allow for self insurance through home production and stock of wealth. In the following subsections, we quantify the role of home production on optimal unemployment insurance policy in different environments.

5.1 Benchmark Model

We are going to use the benchmark economy as an example to illustrate how agents behave. The average wealth over income ratio 0.11 for unemployed individuals, and 0.36 for employed individuals in this economy. We define unemployment as the fraction of population who do not get offers and would accept it if they had one plus those who qualify for the unemployment insurance although they are not eligible.[16] Unemployment level is 5.5% in the benchmark case. The average unemployment duration is about 10 weeks. The standard deviation of log consumption is 0.14, and standard deviation of log

[16] In the definition of unemployment, we include the fraction of population who refuse offers but still qualifies for unemployment insurance, because they report themselves as unemployed.

Table 6: Optimal Replacement Rates (Summary of the Quantitative Results)

σ	$1/(1-\nu)$	ψ	$\pi(0)$	$\pi(1)$	Optimal θ, HP	Optimal θ, no HP	% Difference
2.50	1.45	0.31	0.00	0.00	0.40	0.65	40
2.50	1.45	0.31	0.10	0.00	0.25	0.65	60
2.50	1.45	0.31	0.10	0.10	0.10	0.20	50
2.50	1.45	0.31	0.20	0.00	0.05	0.25	80
2.50	1.45	0.31	0.20	0.10	0.05	0.20	75
2.50	1.78	0.31	0.00	0.00	0.50	0.65	25
2.50	1.45	0.22	0.00	0.00	0.50	0.65	25
2.00	1.45	0.31	0.00	0.00	0.50	0.70	30

Notes: This table shows the summary of our quantitative results on the optimal unemployment insurance policy. The optimal replacement rates for different set of parameters are reported. In the last column, we report percentage differences between optimal replacement rates with and without home production option.

expenditure is 0.22. Note that, the dispersion in consumption is smaller than the dispersion in expenditure due the smoothing role of home production in this economy. The agents who receive employment opportunities decide on employment status depending on their asset levels. They reject offers, if they have asset levels more than or equal to 0.52. Unemployed individuals spend about 40 minutes per day (4.66 hours per week) more than the employed individuals. The results are reported in Table (7).

5.2 Role of Home Production

In this subsection, our purpose is to quantify the role of home production on the optimal unemployment insurance. In order to do that, we perform a series of quantitative exercises. First, we quantify the role of home production on optimal unemployment insurance in a society with no moral hazard ($\pi(0) = \pi(1) = 0$). We solve the model for two cases: (i) individuals are not allowed to do home production, that is $\psi = 0$, (ii) they are allowed to do home production.

In the first case, we basically assume that the consumption is equal to the expenditure on market goods and services. In this case, we compute the optimal replacement rate about 0.65. Employed individuals spend all the time remained after inelastic labor supply on leisure. And, unemployed individuals enjoy leisure with all of their time. Note that, consumption is assumed to be equal to expenditures on market goods and services in this case. Therefore, standard deviation of consumption is equal to standard deviation of expenditure in this case.

And then, we keep all the parameters the same, and we solve for the second case, where individuals are allowed to do home production. Note that we have the wealth over income ratio of unemployed agents same as it was in the model with no-home production in order to identify the role of home production. In this case, we find that it is optimal to give around 0.40 replacement rate to the unemployed agents. At this equilibrium, unemployed agents spend about 420 minutes (7 hours) per week for home production. On the other hand, employed agents spend about 140 minutes (2.3 hours) per week for home production. The individuals reduce the cost of unemployment by changing their time allocation in unemployment spells, and that makes the optimal replacement rate smaller compared to the no home production case. Due to the home production, the optimal level of unemployment insurance decreases by 0.25 which corresponds to about 40%. Since consumption is a function of time and market goods, it deviates from expenditures in this case. Standard deviation of consumption is about two thirds of standard deviation of expenditures in this case. Therefore, home production option decreases the consumption inequality in the society.

5.3 Role of Elasticity of Substitution Between Time and Goods

In order to see how the role of home production depends on the elasticity of substitution between time and goods, we solve the model with a higher elasticity of substitution [17] between time and goods, $1/(1-\nu) = 1.78$. For this value of elasticity, the optimal replacement rate in the model with home production is 0.50. It is 0.65 in the model with no-home production. Therefore, the optimal replacement rate decreases by roughly 25% in this case. The difference between average home production levels of unemployed and employed individuals is about 150 minutes (2.5 hours) per week. Standard deviation of log consumption increases as a result of the decrease in home production levels of unemployed, in this case.

5.4 Alternative Home Production Technology

Note that the role of technology in home production is also important in our analysis. Therefore, we solve the model with a smaller technology parameter (weight of time in production). With a technology parameter of $\psi = 0.22$ instead of $\psi = 0.31$ (benchmark), the optimal replacement rate in the model with home production is 0.50. It is 0.65 in the model with no-home production. That means home production decreases the optimal replacement rate by roughly 25%. The difference between average home production levels of unemployed and employed individuals is about 150 minutes (2.5 hours) per week in this case. Since the role of home production decreases in this case, the standard deviation in log consumption is higher when compared to home production technology.

[17] We take the estimated parameters from Aguiar and Hurst (2007). The estimated values for $1/(1-\nu)$ are 1.45, 1.78, and 2.13. We use the first two in our quantitative analysis.

5.5 Role of Moral Hazard

Now, we quantify the role of home production in a society with moral hazard. We introduce some moral hazard with $\pi(0) = 0.1$. This means the agents who were not employed in the last period can qualify for the unemployment insurance with probability 0.1 despite having job offers in the current period. In this society with moral hazard, the optimal replacement rate is 0.20, if agents are allowed to do home production, otherwise the optimal replacement rate is 0.40, that means the difference between the two cases is about 50%. Therefore, our result regarding the difference in optimal replacement rates is robust in a society with moral hazard. When agents are allowed to do home production, consumption inequality is smaller relative to expenditure inequality. However, inequality in both variables are higher compared to the case with no moral hazard. Therefore, smoothing role of home production gets smaller, when there is moral hazard in the society.

And then, we introduce moral hazard to an additional fraction of population who are not eligible for unemployment insurance. Specifically, we allow the agents who quit their jobs can cheat the system with probability 0.1 ($\pi(1) = 0.1$). In this society, optimal replacement rate is 0.20 when agents are not allowed for home production. It is 0.10 when agents are allowed to do home production, that makes a 50% difference. These results imply, in general, moral hazard has a negative effect on the optimal replacement rate, and it increases the role of home production (in % terms) on the optimal replacement rate. We also solve the model with other moral hazard levels, the results are reported in Table 6.

5.6 Unemployment Insurance and Stock of Wealth

The model implies a negative relationship between stock of wealth and replacement rate. Due to the partial replacement for lost earnings, unemployment shocks have smaller costs, and individuals accumulate less precautionary wealth. Engen and Gruber (2002) provides empirical evidence on this relationship between precautionary wealth accumulation of individuals and unemployment insurance.

We summarize our results in Table (6). In general, the optimal replacement rates are smaller, when we account for self insurance through home production. This is due to the consumption smoothing role of home production during unemployment spells. We perform quantitative exercises in several different environments, and the effect of home production is robust in all the environments. The results also imply that current average replacement rate in the United States (about 40%) is optimal only if there is no moral hazard in the society.

6 Discussions and Conclusion

In this paper, we first document the effect of unemployment status on home production behavior of individuals. We find that on average, home production increases about 10 hours per week due to unemployment status. Since, consumption is a function of time and market goods, higher home production allows individuals to enjoy higher consumption levels at a given amount of expenditures on market goods and services. We make a quantitative analysis of optimal unemployment insurance, where we incorporate the self insurance through home production and stock of wealth. In the benchmark model, we find that the optimal replacement rate in the presence of home production is roughly 40% of wages, which is 40% lower than the no-home production model's optimal replacement rate of 65%. Presence of home production decreases the optimal replacement rate in the range of 20% and 80% depending on alternative model environments. The reason behind this result is the nature of unemployment shock. Individuals get tighter constraints while purchasing market goods and services, and looser time constraints during unemployment spells, and they respond by increasing their home production against unemployment shocks. Since consumption is a function of time and market goods, in the presence of home production, unemployed individuals enjoy smoother consumption levels compared to the no-home production case.

We would also like to discuss the caveats in the model and the current calibration. At the current calibration, the role of home production on the optimal unemployment insurance policy might be understated due to two reasons. One reason is that the average time spent on home production in the model is smaller when we compare to data. Another reason is that we hit the bottom level in data when we target the effect of unemployment status on home production. The estimations imply that the effect of unemployment status varies in the range of 4.6 to 10 hours per week. We hit 4.7 hours per week in the benchmark case.

On the other hand, the role of home production might be overstated due to the asset market structure in the model. We have only one type of asset, and we allow for only saving (no borrowing).[18]

[18]Although this asset structure is pretty standard in the UI literature, we would like to indicate that the optimal replacement rates would tend to be smaller with a richer asset market structure or a borrowing option.

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8 Data Appendix

For the cross sectional analysis, we use the same data sets as Aguiar and Hurst (2007b), which includes 1965-1966 Americans' Use of Time, 1975-1976 Time Use in Economics and Social Accounts, 1985 Americans' Use of Time, 1992-1994 National Human Activity Pattern Survey, and 2003 American Time Use Survey. We obtained the data sets at http://troi.cc.rochester.edu/~maguiar/timeuse_data/datapage.html. We focus on the activities related to home production. First, we define housework[19] as the total time spent on food preparation and kitchen clean up, laundry, and indoor and outdoor house cleaning. We define home production as the total time spent on housework plus house and vehicle repair, child care, and gardening and pet care. We restrict the sample to the individuals between 15 years old and 59 years old. We also restrict to the individuals with employed or unemployed status in order to see the effect of unemployment status on time allocation.

For the panel data analysis, we use PSID data set. PSID provides data sets at two different scales, one at individual level and one at family level. The individual level data sets include information about family members separately, however family level data sets include information at family level. Therefore, we use individual level data sets. We restrict to the years between 1979 and 1986, because the variables we are interested in are jointly available at individual level for only between 1979 and 1986. We restrict to the individuals between 15 years old and 59 years old. We restrict to the individuals with employed or unemployed status in order to estimate the effect of unemployment status on time allocation. We also restrict to the white and black individuals to be consistent with the cross sectional analysis.[20] Since PSID focuses on income dynamics, it does not include detailed information on non-market time use, specifically home production. The

[19]We define this variable consistently with its counterpart in PSID data set.

[20]In the cross sectional data sets we use, there is only two ethnicity, black and white.

only variable about home production includes time spent on housework. We focus on the effect of unemployment status on this variable when we use PSID.

With Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = \pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0548	1.9613	0.0211	0.0674	2.6135	1.7091	0.1764	0.2571	-0.424
0.1	0.008	0.0548	1.9656	0.0211	0.0676	1.3745	0.6579	0.1709	0.251	-0.4234
0.2	0.015	0.0543	1.9575	0.0211	0.0665	0.8505	0.3176	0.166	0.2452	-0.423
0.3	0.023	0.054	1.953	0.0211	0.0665	0.5104	0.1501	0.1559	0.2346	-0.4225
0.35	0.026	0.0543	1.9588	0.0211	0.0668	0.3975	0.1081	0.1508	0.2293	-0.4223
0.4	0.03	0.0543	1.9674	0.0211	0.0632	0.3607	0.1098	0.1427	0.2189	-0.422
0.45	0.034	0.0538	1.9729	0.0211	0.0632	0.3138	0.1099	0.1337	0.2098	-0.4222
0.5	0.038	0.0522	1.8413	0.0211	0.0632	0.3156	0.1422	0.1274	0.2031	-0.4221
0.55	0.042	0.0538	1.782	0.0211	0.0632	0.3117	0.1546	0.1228	0.1983	-0.4223
0.6	0.046	0.0542	1.7439	0.0211	0.0632	0.3076	0.2198	0.1439	0.2228	-0.4223
0.65	0.05	0.0543	1.5359	0.0211	0.0632	0.3038	0.2573	0.1492	0.2299	-0.4226
0.7	0.054	0.0579	1.6215	0.0211	0.0632	0.3068	0.3181	0.1465	0.2271	-0.4227
0.8	0.062	0.0639	1.6534	0.0211	0.0632	0.3029	0.3667	0.1465	0.2281	-0.423
0.9	0.07	0.0698	1.7525	0.0211	0.0632	0.3029	0.4582	0.1423	0.2238	-0.4234

Table 7: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.31$ and $1/(1-\nu) = 1.45$, there is no moral hazard ($\pi(0) = \pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.40.

Without Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = \pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0597	1.9651	0.00	0.00	3.1836	2.1971	0.1834	0.1834	-0.5532
0.1	0.006	0.0597	1.9651	0.00	0.00	1.8556	1.0669	0.1781	0.1781	-0.5524
0.2	0.013	0.0597	1.9651	0.00	0.00	1.2337	0.6158	0.1678	0.1678	-0.5516
0.3	0.019	0.0597	1.9651	0.00	0.00	0.7222	0.3036	0.1631	0.1631	-0.5511
0.4	0.025	0.0597	1.9651	0.00	0.00	0.4057	0.1282	0.1482	0.1482	-0.5503
0.55	0.034	0.0597	1.9651	0.00	0.00	0.0403	0.0001	0.1331	0.1331	-0.5496
0.6	0.037	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.1211	0.1211	-0.5493
0.65	0.04	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.1021	0.1021	-0.5491
0.7	0.043	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.0845	0.0845	-0.5491
0.75	0.046	0.0598	1.9632	0.00	0.00	0.0026	0.082	0.0837	0.0837	-0.5492
0.8	0.049	0.0598	1.9191	0.00	0.00	0.0173	0.2253	0.1003	0.1003	-0.5493
0.85	0.052	0.0606	1.8861	0.00	0.00	0.021	0.2793	0.101	0.101	-0.5495
0.9	0.055	0.061	1.7904	0.00	0.00	0.0265	0.3249	0.108	0.108	-0.5497

Table 8: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are not allowed to do home production, there is no moral hazard ($\pi(0) = \pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.65.

With Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = 0.1$ $\pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0548	1.9613	0.0211	0.0674	2.6135	1.7091	0.1764	0.2571	-0.424
0.05	0.004	0.1249	1.2848	0.0211	0.0674	1.7399	1.1065	0.1756	0.2568	-0.4237
0.1	0.008	0.125	1.2654	0.0211	0.0674	1.437	0.8308	0.1701	0.2502	-0.4234
0.15	0.013	0.1269	1.253	0.0211	0.0669	1.1399	0.5705	0.168	0.2479	-0.4233
0.2	0.018	0.1603	1.9244	0.0211	0.0668	1.0272	0.4889	0.1616	0.2413	-0.4232
0.25	0.023	0.1664	1.9288	0.0211	0.0669	0.8692	0.3508	0.1563	0.2362	-0.4231
0.3	0.029	0.1729	1.916	0.0211	0.0665	0.7819	0.288	0.1552	0.2363	-0.4232
0.35	0.035	0.185	1.939	0.0211	0.0656	0.75	0.2955	0.1563	0.2396	-0.4235
0.4	0.04	0.1937	2.0686	0.0211	0.0632	0.7529	0.309	0.1511	0.2334	-0.4238
0.5	0.054	0.2132	2.1542	0.0211	0.0632	0.7739	0.326	0.1438	0.2282	-0.425
0.6	0.069	0.2497	2.8869	0.0211	0.0632	0.9365	0.5478	0.1578	0.2461	-0.4271
0.7	0.083	0.2656	3.0689	0.0211	0.0632	0.9282	0.5942	0.1581	0.2476	-0.4288
0.8	0.1	0.2899	3.4168	0.0211	0.0632	0.9255	0.6764	0.1668	0.2595	-0.4315
0.9	0.124	0.3343	4.3529	0.0211	0.0632	1.0039	0.8638	0.1723	0.2681	-0.4372

Table 9: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.31$ and $1/(1-\nu) = 1.45$, there is some moral hazard ($\pi(0) = 0.1$, $\pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.25.

Without Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = 0.1$, $\pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0597	1.9651	0.00	0.00	3.1836	2.1971	0.1834	0.1834	-0.5532
0.1	0.006	0.0597	1.9651	0.00	0.00	1.8556	1.0669	0.1781	0.1781	-0.5524
0.2	0.013	0.0597	1.9651	0.00	0.00	1.2337	0.6158	0.1678	0.1678	-0.5516
0.3	0.019	0.0597	1.9651	0.00	0.00	0.7222	0.3036	0.1631	0.1631	-0.5511
0.4	0.025	0.0597	1.9651	0.00	0.00	0.4057	0.1282	0.1482	0.1482	-0.5503
0.55	0.034	0.0597	1.9651	0.00	0.00	0.0403	0.0001	0.1331	0.1331	-0.5496
0.6	0.037	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.1211	0.1211	-0.5493
0.65	0.04	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.1021	0.1021	-0.5491
0.7	0.043	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.0845	0.0845	-0.5491
0.75	0.048	0.0691	1.7719	0.00	0.00	0.1157	0.2158	0.1287	0.1287	-0.5502
0.8	0.053	0.0784	1.6959	0.00	0.00	0.2089	0.3126	0.1439	0.1439	-0.5511
0.85	0.06	0.0939	1.981	0.00	0.00	0.3181	0.472	0.1609	0.1609	-0.5524
0.9	0.071	0.1256	2.2032	0.00	0.00	0.6376	0.5795	0.1685	0.1685	-0.5558

Table 10: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are not allowed to do home production, there is some moral hazard ($\pi(0) = 0.1$, $\pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.65.

With Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = 0.1$, $\pi(1) = 0.1$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0685	1.6621	0.0211	0.0666	2.6135	1.8493	0.1764	0.2571	-0.424
0.05	0.005	0.0677	1.6734	0.0211	0.0669	1.7192	1.0308	0.174	0.255	-0.4237
0.1	0.009	0.0699	1.6402	0.0211	0.067	1.3476	0.7577	0.1706	0.2511	-0.4235
0.15	0.016	0.0715	1.595	0.0211	0.0661	1.0814	0.5746	0.1633	0.2452	-0.4239
0.2	0.022	0.072	1.565	0.0211	0.0657	0.8632	0.4316	0.154	0.2358	-0.4241
0.3	0.034	0.0762	1.5342	0.0211	0.0668	0.4841	0.2241	0.1607	0.2469	-0.4247
0.4	0.046	0.0752	1.5295	0.0211	0.0632	0.3288	0.1723	0.1515	0.2357	-0.4247
0.5	0.059	0.101	1.9253	0.0211	0.0632	0.3217	0.1963	0.1419	0.2267	-0.4253
0.6	0.072	0.1024	1.8597	0.0211	0.0632	0.3256	0.2955	0.1377	0.2229	-0.4267
0.7	0.093	0.1146	1.8917	0.0211	0.0632	0.3361	0.3943	0.1511	0.2413	-0.4316
0.8	0.11	0.1315	2.1104	0.0211	0.0632	0.3389	0.5207	0.1461	0.2369	-0.4341
0.9	0.139	0.1555	2.387	0.0211	0.0632	0.3157	0.6063	0.1512	0.2458	-0.4427

Table 11: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.31$ and $1/(1-\nu) = 1.45$, there is some moral hazard ($\pi(0) = 0.1$, $\pi(1) = 0.1$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.10.

Without Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = 0.1$, $\pi(1) = 0.1$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0597	1.9651	0.00	0.00	3.1836	2.1971	0.1834	0.1834	-0.5532
0.05	0.003	0.0597	1.9651	0.00	0.00	2.2384	1.3487	0.1819	0.1819	-0.5528
0.1	0.006	0.0597	1.9651	0.00	0.00	1.8556	1.0669	0.1781	0.1781	-0.5524
0.15	0.009	0.0597	1.9651	0.00	0.00	1.4841	0.787	0.1749	0.1749	-0.5521
0.2	0.013	0.0597	1.9651	0.00	0.00	1.2337	0.6158	0.1678	0.1678	-0.5516
0.25	0.017	0.0625	1.8591	0.00	0.00	0.9883	0.4879	0.1699	0.1699	-0.5523
0.3	0.021	0.0623	1.8607	0.00	0.00	0.7534	0.3347	0.1676	0.1676	-0.5522
0.35	0.024	0.0627	1.8529	0.00	0.00	0.5828	0.254	0.1634	0.1634	-0.552
0.4	0.028	0.063	1.8298	0.00	0.00	0.4257	0.1721	0.1673	0.1673	-0.5521
0.5	0.036	0.0641	1.8051	0.00	0.00	0.3019	0.1542	0.1512	0.1512	-0.5519
0.6	0.046	0.0725	1.9669	0.00	0.00	0.2761	0.2041	0.1419	0.1419	-0.5532
0.7	0.057	0.0767	1.8393	0.00	0.00	0.2717	0.2992	0.162	0.162	-0.5556
0.8	0.07	0.0852	1.7835	0.00	0.00	0.3299	0.4153	0.1623	0.1623	-0.5592
0.9	0.081	0.0903	1.7804	0.00	0.00	0.33	0.4987	0.1605	0.1605	-0.5606

Table 12: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are not allowed to do home production, there is some moral hazard ($\pi(0) = 0.1$, $\pi(1) = 0.1$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.20.

With Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.78$, $\pi(0) = \pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0573	1.9745	0.0211	0.0495	2.7815	1.8533	0.176	0.2168	-0.52
0.1	0.007	0.057	1.9689	0.0211	0.0477	1.5097	0.7678	0.1844	0.224	-0.5195
0.2	0.014	0.0564	1.9686	0.0211	0.0477	0.9898	0.4245	0.1766	0.2144	-0.5189
0.3	0.021	0.056	1.9622	0.0211	0.0453	0.5885	0.1969	0.1722	0.2079	-0.5185
0.4	0.028	0.0566	1.9605	0.0211	0.0472	0.3321	0.0891	0.1634	0.1991	-0.5181
0.45	0.032	0.0561	1.9492	0.0211	0.0422	0.3179	0.1072	0.1537	0.1862	-0.5178
0.5	0.035	0.0561	1.9574	0.0211	0.0422	0.3203	0.1512	0.1448	0.1766	-0.5176
0.55	0.038	0.0567	1.9143	0.0211	0.0422	0.3197	0.1833	0.1393	0.1707	-0.5176
0.6	0.042	0.0566	1.8705	0.0211	0.0422	0.3217	0.223	0.1358	0.167	-0.5176
0.7	0.049	0.0578	1.6243	0.0211	0.0422	0.3204	0.3109	0.1441	0.1768	-0.518
0.8	0.056	0.0608	1.5941	0.0211	0.0422	0.321	0.3843	0.142	0.1749	-0.5183
0.9	0.064	0.0666	1.6705	0.0211	0.0422	0.3202	0.4461	0.1399	0.1729	-0.5186

Table 13: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.31$ and $1/(1-\nu) = 1.78$, there is no moral hazard ($\pi(0) = \pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.50.

With Home Production, $\sigma = 2.50$, $\psi = 0.22$, $1/(1-\nu) = 1.45$, $\pi(0) = \pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0567	1.9688	0.0211	0.0445	2.8395	1.9062	0.1858	0.224	-0.473
0.1	0.007	0.0569	1.9634	0.0211	0.0447	1.5501	0.8021	0.1846	0.2228	-0.4724
0.2	0.014	0.0563	1.9562	0.0211	0.0438	1.0015	0.4341	0.1771	0.2138	-0.4719
0.3	0.021	0.0561	1.9547	0.0211	0.0439	0.5976	0.21	0.1712	0.2075	-0.4714
0.4	0.028	0.0566	1.9626	0.0211	0.0422	0.3299	0.0891	0.1646	0.1996	-0.471
0.45	0.032	0.0561	1.9492	0.0211	0.0422	0.3179	0.1072	0.1521	0.1862	-0.4707
0.5	0.035	0.0558	1.9456	0.0211	0.0422	0.3208	0.1556	0.143	0.1764	-0.4705
0.55	0.038	0.0563	1.911	0.0211	0.0422	0.3199	0.185	0.1375	0.1707	-0.4705
0.6	0.042	0.0566	1.8705	0.0211	0.0422	0.3217	0.223	0.1341	0.167	-0.4705
0.7	0.049	0.0575	1.5942	0.0211	0.0422	0.3206	0.3197	0.1432	0.1777	-0.4708
0.8	0.056	0.0608	1.5941	0.0211	0.0422	0.321	0.3843	0.1403	0.1749	-0.471
0.9	0.065	0.0657	1.6702	0.0211	0.0422	0.2902	0.4351	0.1543	0.1911	-0.472

Table 14: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.22$ and $1/(1-\nu) = 1.45$, there is no moral hazard ($\pi(0) = \pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.50.

With Home Production, $\sigma = 2.00$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = \pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0.00	0.000	0.0546	1.9669	0.0211	0.0674	2.6516	1.6784	0.1494	0.2273	-0.3840
0.10	0.008	0.0529	1.9783	0.0211	0.0675	1.4067	0.6220	0.1425	0.2194	-0.3835
0.20	0.016	0.0538	1.9557	0.0211	0.0663	0.9219	0.3245	0.1337	0.2090	-0.3831
0.30	0.024	0.0528	1.9577	0.0211	0.0669	0.5670	0.1481	0.1238	0.1989	-0.3827
0.40	0.031	0.0529	1.9651	0.0211	0.0632	0.3999	0.0999	0.1086	0.1811	-0.3822
0.45	0.035	0.0524	1.9103	0.0211	0.0632	0.3992	0.1088	0.0979	0.1702	-0.3820
0.50	0.039	0.0527	1.9205	0.0211	0.0632	0.4010	0.1476	0.0884	0.1603	-0.3819
0.55	0.044	0.0521	1.7213	0.0211	0.0632	0.3376	0.1002	0.1038	0.1799	-0.3827
0.60	0.049	0.0527	1.7363	0.0211	0.0632	0.3389	0.1964	0.1035	0.1801	-0.3828
0.70	0.057	0.0533	1.6087	0.0211	0.0632	0.3441	0.3010	0.0989	0.1753	-0.3830
0.80	0.065	0.0575	1.5809	0.0211	0.0632	0.3404	0.3508	0.0953	0.1719	-0.3833
0.90	0.073	0.0647	1.7289	0.0211	0.0632	0.3451	0.4499	0.0919	0.1683	-0.3836

Table 15: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.31$ and $1/(1-\nu) = 1.45$, there is no moral hazard ($\pi(0) = \pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.00. In this case, optimal replacement rate is 0.50.

Without Home Production, $\sigma = 2.00$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = \pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0588	1.9581	0.00	0.00	3.2313	2.1788	0.1769	0.1769	-0.4946
0.1	0.007	0.0587	1.9711	0.00	0.00	1.8964	1.0345	0.1691	0.1691	-0.494
0.2	0.013	0.0587	1.9619	0.00	0.00	1.2953	0.6119	0.1618	0.1618	-0.4935
0.3	0.02	0.0583	1.9584	0.00	0.00	0.8767	0.3585	0.1499	0.1499	-0.4929
0.4	0.026	0.0586	1.9678	0.00	0.00	0.525	0.1811	0.141	0.141	-0.4925
0.5	0.032	0.058	1.9741	0.00	0.00	0.3507	0.1165	0.125	0.125	-0.492
0.55	0.036	0.0585	1.9624	0.00	0.00	0.3349	0.1233	0.1119	0.1119	-0.4918
0.6	0.039	0.0577	1.9586	0.00	0.00	0.3187	0.1417	0.1103	0.1103	-0.4918
0.65	0.04	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.1021	0.1021	-0.4913
0.7	0.043	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.0845	0.0845	-0.4911
0.75	0.046	0.0597	1.9651	0.00	0.00	0.0001	0.0001	0.0682	0.0682	-0.4911
0.8	0.05	0.0597	1.9104	0.00	0.00	0.0925	0.2131	0.0963	0.0963	-0.4914
0.85	0.053	0.0589	1.8469	0.00	0.00	0.0879	0.2683	0.0955	0.0955	-0.4914
0.9	0.056	0.0597	1.7897	0.00	0.00	0.0783	0.3118	0.0975	0.0975	-0.4915

Table 16: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are not allowed to do home production, there is some moral hazard ($\pi(0) = \pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.00. In this case, optimal replacement rate is 0.70.

With Home Production, $\sigma = 3.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = \pi(1) = 0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0.00	0.000	0.0575	1.9679	0.0211	0.0672	2.6217	1.8269	0.1938	0.2681	-0.5165
0.10	0.007	0.0571	1.9744	0.0211	0.0683	1.3151	0.7011	0.1926	0.2679	-0.5158
0.20	0.014	0.0576	1.9699	0.0211	0.0664	0.7706	0.3397	0.1884	0.2622	-0.5150
0.30	0.021	0.0571	1.9535	0.0211	0.0673	0.3649	0.1210	0.1851	0.2598	-0.5146
0.40	0.027	0.0564	1.9776	0.0211	0.0632	0.2246	0.0857	0.1724	0.2437	-0.5138
0.45	0.031	0.0568	1.9600	0.0211	0.0632	0.2264	0.1262	0.1635	0.2338	-0.5136
0.50	0.034	0.0571	1.8820	0.0211	0.0632	0.2279	0.1685	0.1600	0.2304	-0.5137
0.55	0.038	0.0571	1.7695	0.0211	0.0632	0.2298	0.2123	0.1596	0.2305	-0.5138
0.60	0.041	0.0579	1.6239	0.0211	0.0632	0.2281	0.2623	0.1680	0.2413	-0.5141
0.70	0.049	0.0623	1.6417	0.0211	0.0632	0.2126	0.3406	0.1862	0.2649	-0.5148
0.80	0.056	0.0694	1.7650	0.0211	0.0632	0.2115	0.4137	0.1856	0.2652	-0.5152
0.90	0.064	0.0780	1.8554	0.0211	0.0632	0.2085	0.4936	0.1874	0.2685	-0.5157

Table 17: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.31$ and $1/(1-\nu) = 1.45$, there is no moral hazard ($\pi(0) = \pi(1) = 0$) in the society, and risk aversion parameter of individuals is 3.50. In this case, optimal replacement rate is 0.45.

With Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = 0.20$, $\pi(1) = 0.0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0.00	0.000	0.0548	1.9613	0.0211	0.0674	2.6135	1.7091	0.1764	0.2571	-0.4240
0.05	0.005	0.1257	1.2806	0.0211	0.0669	1.7393	1.1086	0.1757	0.2570	-0.4237
0.10	0.010	0.1574	1.9322	0.0211	0.0673	1.4645	0.8891	0.1712	0.2529	-0.4237
0.15	0.017	0.1790	1.9503	0.0211	0.0664	1.2561	0.6823	0.1591	0.2415	-0.4241
0.20	0.025	0.2069	2.5317	0.0211	0.0661	1.1488	0.6144	0.1675	0.2533	-0.4247
0.30	0.040	0.2240	2.7277	0.0211	0.0648	1.0679	0.5725	0.1581	0.2442	-0.4249
0.40	0.059	0.2555	3.0521	0.0211	0.0632	0.9614	0.5448	0.1574	0.2450	-0.4275
0.50	0.089	0.3130	3.8839	0.0211	0.0632	1.1057	0.7233	0.1496	0.2408	-0.4337
0.60	0.124	0.3694	4.9838	0.0211	0.0632	1.2391	0.9232	0.1658	0.2631	-0.4430
0.70	0.157	0.4044	5.6549	0.0211	0.0632	1.2403	0.9895	0.1621	0.2618	-0.4507
0.80	0.213	0.4723	7.0965	0.0211	0.0691	1.2283	1.0980	0.1613	0.2777	-0.4710
0.90	0.276	0.5309	8.0172	0.0211	0.0843	1.0560	1.0691	0.1487	0.2751	-0.4980

Table 18: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.31$ and $1/(1-\nu) = 1.45$, there is no moral hazard ($\pi(0) = 0.20$, $\pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.05.

Without Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = 0.20$ $\pi(1) = 0.0$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0597	1.9651	0.00	0.00	3.1836	2.1971	0.1834	0.1834	-0.5532
0.05	0.003	0.0597	1.9651	0.00	0.00	2.2384	1.3487	0.1819	0.1819	-0.5528
0.1	0.006	0.0597	1.9651	0.00	0.00	1.8556	1.0669	0.1781	0.1781	-0.5524
0.15	0.009	0.0597	1.9651	0.00	0.00	1.4841	0.787	0.1749	0.1749	-0.5521
0.2	0.013	0.0597	1.9651	0.00	0.00	1.2337	0.6158	0.1678	0.1678	-0.5516
0.25	0.016	0.0598	1.9658	0.00	0.00	0.967	0.4623	0.1668	0.1668	-0.5513
0.3	0.021	0.0773	1.6169	0.00	0.00	0.8667	0.3721	0.1726	0.1726	-0.5522
0.4	0.03	0.0911	1.9458	0.00	0.00	0.7384	0.3679	0.1645	0.1645	-0.5524
0.5	0.041	0.1064	2.0549	0.00	0.00	0.6523	0.3706	0.167	0.167	-0.5534
0.6	0.06	0.1586	2.7183	0.00	0.00	0.9587	0.6357	0.1726	0.1726	-0.559
0.7	0.081	0.1971	3.3167	0.00	0.00	1.0393	0.8464	0.1968	0.1968	-0.565
0.8	0.109	0.2527	4.0242	0.00	0.00	1.1477	0.9492	0.2052	0.2052	-0.5759
0.9	0.139	0.2958	4.6952	0.00	0.00	1.1287	1.0307	0.2175	0.2175	-0.5873

Table 19: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are not allowed to do home production, there is some moral hazard ($\pi(0) = 0.20$, $\pi(1) = 0$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.25.

With Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = 0.20$, $\pi(1) = 0.10$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0.00	0.000	0.0685	1.6621	0.0211	0.0666	2.6135	1.8493	0.1764	0.2571	-0.4240
0.05	0.005	0.1335	1.3549	0.0211	0.0665	1.7442	1.1523	0.1751	0.2564	-0.4237
0.10	0.011	0.1444	1.3210	0.0211	0.0669	1.3970	0.8391	0.1673	0.2489	-0.4239
0.15	0.019	0.1890	1.9926	0.0211	0.0662	1.2321	0.6915	0.1584	0.2413	-0.4243
0.20	0.026	0.2002	2.0341	0.0211	0.0659	1.0026	0.5063	0.1689	0.2551	-0.4248
0.30	0.042	0.2140	2.0805	0.0211	0.0653	0.8236	0.3775	0.1582	0.2448	-0.4251
0.40	0.063	0.2516	2.4190	0.0211	0.0632	0.7446	0.3815	0.1610	0.2500	-0.4284
0.50	0.091	0.3060	3.3380	0.0211	0.0632	0.9270	0.5790	0.1440	0.2345	-0.4336
0.60	0.125	0.3508	3.5832	0.0211	0.0632	0.8989	0.6348	0.1603	0.2566	-0.4427
0.70	0.163	0.4028	4.6759	0.0211	0.0648	0.9676	0.7855	0.1627	0.2626	-0.4527
0.80	0.223	0.4762	5.8790	0.0211	0.0843	0.8788	0.8418	0.1527	0.2766	-0.4765
0.90	0.279	0.5221	6.3980	0.0211	0.0843	0.7770	0.8378	0.1462	0.2720	-0.4985

Table 20: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are allowed to do home production with parameters $\psi = 0.31$ and $1/(1-\nu) = 1.45$, there is no moral hazard ($\pi(0) = 0.20$, $\pi(1) = 10$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.05.

Without Home Production, $\sigma = 2.50$, $\psi = 0.31$, $1/(1-\nu) = 1.45$, $\pi(0) = 0.20$, $\pi(1) = 0.10$

Replacement Rate (θ)	Tax	Unemp. Rate	Mean Unemp. Duration	Mean HP Employed	Mean HP Unemp.	Mean Asset Employed	Mean Asset Unemployed	Std. Dev Log Cons.	Std. Dev. Log Exp	Average Utility
0	0	0.0597	1.9651	0.00	0.00	3.1836	2.1971	0.1834	0.1834	-0.5532
0.05	0.003	0.0597	1.9651	0.00	0.00	2.2384	1.3487	0.1819	0.1819	-0.5528
0.1	0.006	0.0597	1.9651	0.00	0.00	1.8556	1.0669	0.1781	0.1781	-0.5524
0.15	0.009	0.0597	1.9651	0.00	0.00	1.4841	0.787	0.1749	0.1749	-0.5521
0.2	0.013	0.0597	1.9651	0.00	0.00	1.2337	0.6158	0.1678	0.1678	-0.5516
0.25	0.018	0.078	1.6018	0.00	0.00	1.0234	0.5087	0.1768	0.1768	-0.5524
0.3	0.022	0.0794	1.554	0.00	0.00	0.8147	0.3538	0.1738	0.1738	-0.5524
0.4	0.031	0.0927	1.658	0.00	0.00	0.592	0.2543	0.1685	0.1685	-0.5527
0.5	0.044	0.1163	1.6228	0.00	0.00	0.5502	0.2388	0.1658	0.1658	-0.5554
0.6	0.063	0.1613	2.3138	0.00	0.00	0.7485	0.4767	0.1749	0.1749	-0.5605
0.7	0.083	0.1899	2.4415	0.00	0.00	0.733	0.5278	0.187	0.187	-0.5666
0.8	0.113	0.2514	3.3805	0.00	0.00	0.9451	0.7678	0.2036	0.2036	-0.5776
0.9	0.143	0.2961	4.1091	0.00	0.00	0.9311	0.8811	0.2134	0.2134	-0.589

Table 21: This table shows some moments in stationary competitive equilibrium at different replacement rates, when individuals are not allowed to do home production, there is some moral hazard ($\pi(0) = 0.20$, $\pi(1) = 10$) in the society, and risk aversion parameter of individuals is 2.50. In this case, optimal replacement rate is 0.20.