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Abstract:

This paper employs a dynamic general equilibrium model to design and evaluate long-term unemployment insurance plans (plans that depend on workers' unemployment history) in economies with and without hidden savings. We show that optimal benefit schemes and welfare implications differ considerably in these two economies. Switching to long-term plans can improve welfare significantly in the absence of hidden savings. However, welfare gains are much lower when we consider hidden savings. Therefore, we argue that switching to long-term plans should not be a primary concern from a policy point of view.

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1 Introduction

An important adverse effect of unemployment insurance is the disincentive to find/maintain a job.[1] Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997) suggest that a possible remedy is switching to long-term contracts where benefit payments depend on workers' unemployment history. In particular, Hopenhayn and Nicolini (1997) show, by simulating a search-theoretic model, that switching from the current US unemployment insurance system to the optimal one may reduce the cost of the system by 30%. The optimal plan they propose provides a declining benefit path to create intertemporal incentives. It punishes workers (agents) for continued unemployment and creates incentives to find a job. A maintained assumption in these papers is that consumer/workers cannot save or, alternatively, that any savings they undertake are perfectly monitored and thus completely controlled by the insurance provider. The main contribution of our paper is to study long-term unemployment insurance plans by relaxing the assumption that agents' savings can be perfectly monitored. Thus, we consider "hidden savings." We believe that introducing hidden savings is important for at least two reasons. First, it is not realistic that perfect monitoring is available at zero cost. Second, and more importantly, if savings cannot be monitored, the incentives of consumer/workers change significantly. Suppose that we apply the unemployment insurance system suggested by Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997) to our economy where agents have hidden savings. Then the agents would be tempted to cheat: they would try to get a higher net present value transfer from the unemployment insurance system and would deal with any implied increase in risk by self-insuring using their hidden savings. Thus, in an economy with hidden savings—where agents can self-insure—the government-provided insurance may be less important and may change in nature.

We find that indeed it is important to consider hidden savings in the analysis. The nature of the optimal unemployment insurance plans differs significantly from the ones suggested by Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997): the benefit path is not necessarily declining. We also find that the role of history dependence of unemployment insurance plans is not as important quantitatively as the earlier studies suggest. Our analysis, in fact, also suggests that unemployment plans that are designed ignoring agents' ability to save secretly could cause an increase in unemployment and be harmful to the economy.

The model we study is different from the ones analyzed in the cited papers in several aspects. First of all, we do not look at fully optimal dynamic contracts since they are difficult to characterize when agents have hidden savings. However, we consider a broad

[1] Hamermesh (1977), Moffit (1985) and Meyer (1990) estimate that a 10% rise in the replacement ratio might cause a one-half to a one week increase in the length of unemployment spell. Meyer (1990) predicts that 10% increase in benefits lead to an 8.8% decrease in the probability of leaving unemployment.

set of history-dependent unemployment insurance plans. Secondly, we focus on the moral hazard problem based on unobservability of job refusals as opposed to the job-search effort as in Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997). Thirdly, we insist on budget balance of the unemployment insurance system. That is, there is a feedback of the benefit part of the system to the tax on the labor income of employed agents. Therefore, we choose a dynamic general equilibrium model for our analysis.

We study an extension of the model with incomplete markets analyzed in Hansen and Imrohoroglu (1992). To understand the role of hidden savings, we also consider a variant of our model in which we shut down the savings channel. The economy consists of ex-ante identical agents who derive utility from consumption and leisure. Agents are subject to unemployment risk: at the beginning of each period, they are offered an employment opportunity with a certain probability. They can partially insure themselves against the possibility of income loss by saving through non-interest-bearing assets. Agents also have access to an unemployment insurance system financed by the government through proportional taxes. The system distinguishes agents according to their unemployment history: agents are offered different benefit levels depending on how long they have been unemployed. We introduce moral hazard to the model by assuming that government monitoring of insurance claimants is imperfect, i.e., the government monitors only a certain fraction of the claimants. Therefore, agents who are not qualified (who refuse job opportunities) can collect benefits with a positive probability. We refer to imperfect government monitoring as moral hazard. Because ineligible agents are more likely to take advantage of the unemployment insurance system when the government monitors a small fraction of claimants.

In this framework, our objective is to compute the unemployment insurance (UI) plans that maximize the steady state equilibrium welfare. One should consider all possible employment histories to find "the" optimal UI plan in the context of dynamic contracting literature. However, due to the computational complexity of this problem, we restrict our attention to a certain degree of history dependence. The unemployment insurance plans that we consider focus only on the most recent unemployment spell and distinguish agents with respect to the number of periods they have been unemployed consecutively up to "T" periods. We allow the benefit levels to be flexible for T periods and thereafter the benefit level is held constant. We increase T up to a point beyond which increasing T does not improve welfare significantly. We refer to the plan that maximizes steady state average utility as the optimal UI plan. We use a variant of the evolutionary algorithms suggested by Gomme (1997) to compute the optimal UI plans. This algorithm reduces computation time drastically and makes it possible to solve otherwise infeasible optimization problems.

In this study, we analyze unemployment insurance in two different economic environments. In the first one, agents have hidden savings and in the second, they do not. Our analysis suggests that optimal benefit paths differ remarkably in these two economies. In general, the optimal benefit levels are significantly higher and the optimal unemployment insurance plan implies a declining benefit path when there are no savings. However, when agents have hidden savings the optimal benefit path is not necessarily declining. Depending on the degree of moral hazard, the benefit path can be non-monotonic or even increasing. Yet, the optimal unemployment insurance plan implies a declining consumption path as Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997) argue. We also show that welfare implications of long-term plans are different in these two economies. Our experiments suggest that long-term plans can improve welfare significantly in economies without savings. For example, the welfare gain of switching to long-term plans is 2.0133% of consumption.[2] Yet, the welfare gains are much lower if we consider savings in the analysis. The welfare gain varies between 0.0325% and 0.1840% depending on the degree of moral hazard.

An important result of our analysis is that the welfare gains of switching to unemployment insurance plans that depend on the unemployment history are quite small when agents have hidden savings. Even if the government can monitor a large fraction of unemployment claimants, the welfare gains are as low as 0.06%. We show that our conclusion is not affected by plausible variations in parameters. Given our results and the fact that long-term unemployment insurance plans are hard to administer in practice, we argue that switching to long-term plans perhaps should not be a primary concern from a policy point of view.

Finally, our findings reveal that unemployment insurance plans, designed ignoring agents' ability to save privately, could be harmful to the economy. When we apply the optimal plan from the economy without savings to our economy with hidden savings, a quite drastic increase in unemployment results. This is because this plan critically uses history dependence; in particular, it applies high benefit rates in the first few periods upon job loss. Thus, any recently separated workers with access to hidden savings would choose to turn down new job offers, collect the high benefit, and use hidden savings to smooth consumption. This example also reveals the importance of taking into account the general equilibrium effects in the design of unemployment insurance plans: the lower the employment rate is, the higher the tax rate on labor income of the employed should be in order to balance the budget of the unemployment insurance system. This feedback—which indeed is present in real life—exacerbates the negative effects of improperly designed unemployment insurance systems on the economy.

Hansen and Imrohoroglu (1992) is the first study that analyzes the welfare effects of unemployment insurance system in a general equilibrium environment with moral hazard and savings. They concentrate on constant benefit schemes and argue that it is almost

[2]Welfare gains are computed as a percentage of consumption.

impossible to insure agents for high degrees of moral hazard. We generalize their result by showing that more complicated unemployment insurance plans do not provide much better insurance when agents have hidden savings.

Long-term unemployment insurance plans in environments where agents have hidden savings are also studied by Wang and Williamson (1999). They evaluate alternative unemployment insurance schemes in a dynamic economy with unobservable job-search and job-retention effort. Their main concern is to study welfare implications of long-term plans and experience rating. They, too, report small welfare gains from switching to long-term plans. It is noteworthy that they reach a similar conclusion to ours by using a different framework. However, they do not specifically analyze how savings affect the nature and the role of long-term unemployment insurance plans.

The plan of the paper is as follows. In Section 2, we describe the economy. Section 3 discusses the calibration. Section 4 explains the algorithm used in the numerical solution. Section 5 discusses calculation of welfare gains. In Section 6, we present our results. Section 7 provides an example regarding the importance of hidden savings. Section 8 presents our conclusions.

2 The Economic Environment

2.1 The Model Economy with Savings

We use a dynamic general equilibrium model with hidden savings to analyze different unemployment insurance plans. The economy consists of ex-ante identical infinitely-lived agents who derive utility from consumption and leisure. Individuals maximize the expected value of their discounted utility:

$$E\sum_{j=0}^{\infty}\beta^{j}U(c_j, l_j), \tag{1}$$

where β is the discount factor, $U(.,.)$ is the momentary utility function, c_j is the consumption and l_j is the leisure. Each agent has 1 unit of time in each period that can be allocated between work and leisure. An agent either chooses to work a fixed amount of $\hat{h} \in [0, 1)$ hours and produces y units of consumption goods or does not work at all.

In this model, agents can save through non-interest bearing assets but they cannot borrow. Assets evolve according to the following equation:

$$m' = m + y^d - c, \tag{2}$$

where m is the asset holdings in the current period, c is the consumption in the current period, m' is the asset holdings in the next period, and y^d is the disposable income at the current period.

Agents are offered employment opportunities according to a stochastic process. Let s denote the employment opportunity state of an individual. If $s = e$, the agent has a job offer and he chooses to accept or reject the offer. If $s = u$, he becomes unemployed.

Let η denote the employment status of the agent. If he chooses to work $\eta = 1$, otherwise $\eta = 0$. We can summarize the employment status of the agent as follows:

$$\begin{array}{lll} \text{Job Offer } (s = e) & \longrightarrow & \begin{array}{lll} \text{Accept} & \rightarrow & \text{Work for } \hat{h} \text{ hours } (\eta = 1) \\ \text{Reject} & \rightarrow & \text{Unemployed } (\eta = 0) \end{array} \\ \text{No Job Offer } (s = u) & \longrightarrow & \text{Unemployed } (\eta = 0). \end{array} \tag{3}$$

It is assumed that s follows a two-state Markov chain. The transition probabilities are given by the 2×2 transition matrix $\chi = \{\chi(i, j)\}$ where $i, j \in \{e, u\}$. For instance, given that the agent did not have an employment opportunity in the last period, the probability of getting a job offer in the current period is $Prob\{s' = e|s = u\} = \chi(u, e)$.

The unemployment history of an agent is denoted by t, the number of periods he has been unemployed consecutively in the last unemployment spell. For example, if the agent has been unemployed for 3 periods, then $t = 3$.

Our insurance plan is characterized by a replacement ratio of the following form:

$$\theta(t) = \begin{cases} \theta_t & t \in \{0, ..., T-1\} \\ \theta_{T-1} & t \geq T \end{cases} \tag{4}$$

This UI plan distinguishes agents according to their unemployment history up to $t = T$. For an unemployed agent, the replacement ratio is θ_0 in the first period of unemployment and θ_{t-1} in the t^{th} period up to the T^{th} period. Thereafter, it will be constant at θ_{T-1}. When $T = 1$, replacement ratio is constant. This case corresponds to the UI plans analyzed in Hansen and Imrohoroglu (1992).

In our framework, agents who refuse job opportunities can collect UI benefits with positive probability, $\pi(t)$. The degree of moral hazard is controlled by changing $\pi(t)$. Note that $\pi(t) = 0$ corresponds to perfect monitoring; i.e., no moral hazard and $\pi(t) = 1$ corresponds to no-monitoring, i.e., extreme moral hazard. We differentiate between the individuals who have worked last period and who have not by letting

$$\pi(t) = \begin{cases} \pi_0 & \text{for } t = 0 \\ \pi_1 & \text{for } t > 0 \end{cases} \tag{5}$$

and assigning different values for π_0 and π_1.

We can summarize the unemployment insurance system as follows:

- If the agent has no job offer ($s = u$), then he collects benefits. The amount of benefit is determined by the long-term UI plan according to (4). The current employment status is $\eta = 0$ and the unemployment history becomes $t' = t + 1$.
- If the agent has a job offer ($s = e$) and he accepts it, then he does not receive any benefits. Then $\eta = 1$ and $t' = 0$.
- If the agent has a job offer ($s = e$) but he does not accept it, then he receives the UI benefit with probability $\pi(t)$. For this case, $\eta = 0$ and $t' = t + 1$.

Let μ be the indicator that shows whether an agent receives UI benefit. If the agent receives benefits $\mu = 1$, otherwise $\mu = 0$. Government uses proportional income tax to finance UI benefits. Let τ be the proportional income tax rate. The state of the agent can be summarized as follows:

$$\begin{array}{llll} s = u, \eta = 0 & \rightarrow & t' = t + 1, & \mu = 1 \text{ and } y^d = (1-\tau)\theta(t)y; \\ s = e, \eta = 1 & \rightarrow & t' = 0, & \mu = 0 \text{ and } y^d = (1-\tau)y; \\ s = e, \eta = 0 & \rightarrow & t' = t + 1, & \mu = 1 \text{ and } y^d = (1-\tau)\theta(t)y \text{ with probability } \pi(t), \\ & & & \mu = 0 \text{ and } y^d = 0 \text{ with probability } 1 - \pi(t); \end{array} \tag{6}$$

The timing in the model is:

- At the beginning of each period, the employment opportunity state s is known to agents. Given the employment opportunity s, asset holdings m, and employment history t, they choose η.
- Agents who do not receive employment opportunities collect benefits with certainty and choose consumption and next period's asset holdings. At the same time, agents who work choose consumption and next period's asset holdings.
- Agents who reject employment opportunities first learn whether they receive benefits then they choose consumption and next period's asset holdings according to equation (2).

The maximization problem can be written as a dynamic programming problem. Note that the state variables are current asset holdings m, employment opportunity s, and employment history t. The dynamic programming problem is:

$$V(m, u, t) = \max_{m'} \left\{ U(m + (1-\tau)\theta(t)y - m', 1) + \beta \sum_{s'} \chi(u, s') V(m', s', t+1) \right\}$$

$$V(m,e,t) = \max\Bigg\{ \max_{m'}\{U(m+(1-\tau)y-m', 1-\hat{h}) + \beta \sum_{s'} \chi(e,s')V(m',s',0)\},$$
$$\pi(t)\left[\max_{m'}\{U(m+(1-\tau)\theta(t)y-m',1) + \beta\sum_{s'}\chi(e,s')V(m',s',t+1)\}\right]$$
$$+(1-\pi(t))\left[\max_{m'}\{U(m-m',1)+\beta\sum_{s'}\chi(e,s')V(m',s',t+1)\}\right]\Bigg\} \qquad (7)$$

subject to $m' \geq 0$.

Definition: The stationary equilibrium for this economy is the set of decision rules $c(x)$, $m'(x)$, $\eta(m,s,t)$ where $x=(m,s,t,\mu)$, a time-invariant measure $\lambda(x)$ of individuals at state x and a tax rate τ such that

1. Given the tax rate τ, individuals solve the maximization problem in (7);
2. The goods market clears:

$$\sum_x \lambda(x)c(x) = \sum_x \lambda(x)\eta(x)y. \qquad (8)$$

3. Government finances UI benefits by taxing income. So, the total amount of UI benefits should be equal to the taxes paid by the employed individuals. The government budget constraint is satisfied:

$$\sum_{m,t}\lambda(m,e,t,0)\eta(m,e,t)\,\tau y = \sum_{m,t}\left[\lambda(m,u,t,1)+\lambda(m,e,t,1)\right](1-\tau)\theta(t)\,y. \qquad (9)$$

4. The invariant measure $\lambda(x)$ solves the following equation:
$\lambda(m',s',t',\mu') =$

$$\begin{cases} 0 & s'=u, \mu'=0 \\ \sum_s\sum_\mu\sum_{(m,t)\in\Omega}\chi(s,s')\lambda(x) & s'=u,\mu'=1 \\ \sum_s\sum_\mu\sum_{(m,t)\in\Omega}\chi(s,s')\lambda(x)\left[\eta'(m',s',t')+(1-\pi(t'))(1-\eta'(m',s',t'))\right] & s'=e,\mu'=0 \\ \sum_s\sum_\mu\sum_{(m,t)\in\Omega}\chi(s,s')\lambda(x)\left[\pi(t')(1-\eta'(m',s',t'))\right] & s'=e,\mu'=1 \end{cases} \qquad (10)$$

where $\Omega(m',s,t',\mu) = \{(m,t): m'=m'(m,s,t,\mu) \text{ and } t'=(t+1)(1-\eta(m,s,t))\}$.

The first part of equation (10) corresponds to the fraction of agents who have no job offer and no unemployment benefit. Since every individual who does not get any job offer receives UI benefits, the fraction of such agents is zero. The second part corresponds to the fraction of agents who have no job offer and receive benefits. Since anybody without a job offer receives UI benefit with certainty, this part is equal to the total fraction of individuals who have no job offer. The third part corresponds to the fraction of individuals who have a job offer but do not receive UI benefits. These are the individuals who decided to work or who rejected the job offer and did not receive benefits.[3] The fourth part corresponds to the fraction of individuals who rejected job offers and receive benefits.

2.2 The Model Economy without Savings

The economy without savings is a special case of the one that we analyzed in the previous subsection. We restrict asset holdings to be zero in all periods, i.e., $m = m' = 0$. Since agents do not have any savings, the only source of consumption for the unemployed is UI benefits.

3 Calibration

- The utility function used in the computations has the following form:

$$U(c,l) = \frac{(c^{1-\sigma} l^{\sigma})^{1-\rho} - 1}{1-\rho}. \tag{11}$$

- The time period in the model is 6 weeks and output is normalized to 1. Following Kydland and Prescott (1982) β is set to 0.995.

- $\hat{h}$ is set to 0.45 assuming that individuals have 98 hours in a week (when sleep, eating, etc. are deducted) and they spend approximately 45 hours of this time at work.

- σ is set to 0.67 in our benchmark parameterization following Kydland and Prescott (1982). However, Acemoglu and Shimer (2000) suggests smaller values for σ. So we check the robustness of our results by changing σ to 0.5.

- Degree of risk aversion ρ is set to 2.5 following Mehra and Prescott (1985) in the benchmark case. We also examine how our results are affected when $\rho = 10$.

- Following Hansen and Imrohoroglu (1992), the transition matrix χ is formed such that the employment opportunity is offered 94% of the time and the average duration of not having an employment opportunity is 12 weeks. These requirements imply that the transition matrix is:

$$\begin{bmatrix} \chi(e,e) & \chi(e,u) \\ \chi(u,e) & \chi(u,u) \end{bmatrix} = \begin{bmatrix} 0.9681 & 0.0319 \\ 0.5000 & 0.5000 \end{bmatrix} \tag{12}$$

- We set $\pi_1 = 1$ and consider different levels of monitoring of quitters and change π_0 from 0 to 1.

[3] Recall that the individuals who refuse job offers do not receive any benefits with probability $1 - \pi(t')$.

4 Computation

We want to compute average utility for different $\Theta^T = \{\theta(0), \theta(1), \theta(2), \cdots, \theta(T-1), \theta(T), \cdots\}$ sequences to find the optimal benefit scheme.

The computational procedure for a given Θ^T is as follows:

1. Start with a guess for tax rate τ and solve the dynamic programming problem by value function iteration:
   (a) Form a discrete state space for (m, s, t). m is allowed to take values between 0 and 8 and a grid of 301 points is used. Since s can take only 2 values and t can take T values, the dimension of the state space is $301 \times 2 \times T$.
   (b) Start with an initial guess $V^0(.,.,.)$ for $V(.,.,.)$.
   (c) Calculate $V^{n+1}(.,.,.)$ by value function iteration.
   (d) Repeat (c) until value function converges.
2. Calculate $\lambda(x)$ by iterating on equation (9):
   (a) Start with an initial guess for $\lambda(x)$.
   (b) Calculate an updated $\lambda(x)$ by using equation (9).
   (c) Repeat this procedure until convergence.
3. Calculate the budget constraint by using equation (7). If there is a surplus (deficit) decrease (increase) the tax rate.
4. Steps 1-4 are repeated until the equilibrium is found.

The above procedure calculates the decision rules and tax rate for a given Θ^T sequence. Our goal is to find the optimal UI plan. Calculation of the optimal UI plan requires the repetition of above procedure for all possible Θ^T sequences. In our computations, θ is allowed to take values between 0 and 1 and a grid of 21 points is used. For $T = 1$, number of all possible UI plans is just 21, but as T increases, number of possible UI plans increases dramatically. For example for $T = 4$, we need to repeat the solution procedure $21^4 = 194,481$ times. The dramatic increase in the computation time with increasing T makes the direct solution impossible. Following Gomme (1997), we use an evolutionary algorithm to find the optimal θ^T sequence:

1. Construct a population of twenty Θ^T sequences as first guesses.
2. For each Θ^T sequence in the population, calculate the average utility in the equilibrium by using the above algorithm.

3. Sort the population from the best to the worst according to the corresponding values of average utility.

4. Replace the worst half of the population by the first half of the population by adding some random noise.

5. Repeat 2-5 with the new population until all of the top ten Θ^T sequences are the same.

The noise added in step 4 helps the evolutionary algorithm to escape from local minima and at the same time explore the space of all possible Θ^T sequences.

5 Social Planner's Problem and Calculation of Welfare Gains

In the following sections, we are going to evaluate equilibrium allocations under different UI plans. For this purpose, we solve a social planner's problem and evaluate the gap between the social planner's allocation and the equilibrium allocation under a certain plan. The social planner's allocation is given by the solution to the following problem:

$$\max \sum_{t=0}^{\infty} \beta^t [N_t U(c_{1t}, 1-\hat{h}) + (1-N_t) U(c_{2t}, 1)] \tag{13}$$

subject to

$$N_t c_{1t} + (1-N_t) c_{2t} \leq N_t y, \;\; N_t \leq \bar{N}$$

where N_t is the employment rate, c_{1t} is the consumption of an employed individual, and c_{2t} is the consumption of an unemployed individual. $\bar{N}$ is the upper bound on employment rate which was set to 0.94. This problem is static in its nature and has a simple closed form solution as shown in Hansen and Imrohoroglu (1992). Let (c_1^*, c_2^*) be the solution to the problem above. To compute the welfare cost of an equilibrium allocation, we calculate the average utility, V, under that particular allocation. Then we compute the value of ϕ such that the allocation $(\phi\, c_1^*, \phi\, c_2^*)$ gives the utility V; the welfare cost is given by $1-\phi$.

6 Design and Evaluation of Optimal UI Plans

In this section we examine optimal UI plans in two different economic environments. These two sample economies are identical except for the distinction that in the first one, agents cannot save and in the second one, they can. We compute optimal unemployment insurance plans for different levels of government monitoring. We distinguish between agents according to the number of periods they have been unemployed up to T periods, and find the optimal benefit schemes by varying T from 1 to 4. We evaluate potential welfare gains of going from

$T = 1$ to $T = 4$. Recall that $T = 1$ corresponds to the case where the benefits are constant throughout the unemployment spell (short-term unemployment insurance plans), and $T > 1$ corresponds to the case with a changing benefit level throughout the unemployment spell (long-term plans).[4]

In the following section, we present results for $\pi_1 = 1$. This situation where it is not possible to monitor searchers seems to be empirically plausible given the fact that search activity is hard to monitor. Although we concentrate on this case, our main results remain robust for a wide range of π_1. In fact, even if the government can monitor 50% of searchers ($\pi_1 = 0.5$), our results do not change significantly. In practice, it seems easier to detect quitters than to detect searchers. Therefore, we concentrate on cases where $\pi_0 < \pi_1$.

6.1 Benchmark Economy:

In our benchmark economy, we set $\sigma = 0.67$, $\rho = 2.5$ and $\pi_1 = 1$. To understand to what extent welfare gains from long-term UI plans depend on the degree of moral hazard in the economy, we consider different levels of the monitoring of quitters by changing π_0 from 0 to 1. We first present the results for the economy without savings since it is simpler. This analysis helps us understand how allocations and welfare implications compare across economies with and without savings.

6.1.1 Optimal Unemployment Insurance Plans without Savings

In this subsection, we evaluate long-term UI plans when agents cannot save. In this case, the only source of consumption for the unemployed is the UI benefits. This makes it possible for the government to perfectly monitor the consumption of agents. This is the situation analyzed in Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997).

In our experiments, we change π_0 from 0 to 1 and find that the optimal benefit path is the same for all values of π_0 such that $\pi_0 < 1$. This result is not surprising since UI benefits are the only source of consumption for the unemployed agents and if denied benefits, they have nothing to consume.[5] Even if a small fraction of agents are monitored, agents will never want to quit their jobs to collect benefits.

Table 1 presents summary statistics for $\pi_0 < 1$. When the benefits are constant ($T = 1$), optimal benefit level is 0.25. However, as we switch to long-term plans ($T = 2$) it is possible to provide higher benefit levels: 0.65 in the first period of unemployment and 0.30 thereafter.

[4] We have tried increasing T to 5 and seen that distinguishing agents beyond the 4th period of unemployment does not improve welfare significantly. Given this and the computational complexity of solving the problem for higher values of T, we carry out our analysis up to $T = 4$.

[5] Zero consumption gives a utility of $-\infty$.

T	Optimal UI Plans	Tax Rate (τ)	Employment Rate	Standard Deviation of Consumption	Average Utility	Welfare Cost (%)
1	0.25 0.25 0.25 0.25	0.0157	0.9400	0.1753	-0.5652	2.4987
2	0.65 0.30 0.30 0.30	0.0294	0.9400	0.1279	-0.5551	0.8635
3	0.65 0.65 0.30 0.30	0.0445	0.9253	0.1127	-0.5531	0.5349
4	0.65 0.65 0.65 0.30	0.0612	0.9044	0.1098	-0.5528	0.4854

Table 1: The optimal UI plans and summary statistics for the benchmark parameterization and $\pi_0 \in [0, 1)$, $\pi_1 = 1$.

Since most of the agents experience unemployment for less than two periods, offering a high replacement ratio in the early periods improves welfare considerably: going from $T = 1$ to $T = 2$ results in a welfare gain of 1.6352%. Overall, the benefit of going from $T = 1$ to $T = 4$ is 2.0133%. As can be seen in Table 1, the optimal plan increases welfare by smoothing consumption and providing more leisure.

T	Optimal UI Plans	Tax Rate (τ)	Employment Rate	Standard Deviation of Consumption	Average Utility	Welfare Cost (%)
1	0.25 0.25 0.25 0.25	0.0157	0.9400	0.1753	-0.5652	2.4987
2	0.25 0.25 0.25 0.25	0.0157	0.9400	0.1753	-0.5652	2.4987
3	0.30 0.25 0.20 0.20	0.0165	0.9400	0.1725	-0.5646	2.4027
4	0.30 0.25 0.20 0.20	0.0165	0.9400	0.1725	-0.5646	2.4027

Table 2: The optimal UI plans and summary statistics for the benchmark parameterization and for $\pi_0 = \pi_1 = 1$.

Now, we want to analyze $\pi_0 = 1$ case. Table 2 shows that the welfare gains from switching to long-term UI plans are small: going from $T = 1$ to $T = 4$ improves welfare by only 0.0960%. In this case, it is not optimal to offer high benefits in the early periods of unemployment since high benefits would induce agents to quit their jobs. Agents can take advantage of the UI system by quitting their jobs and collecting benefits for a few periods while enjoying leisure. They can return back to work when benefits become lower. Since quitters have high reemployment probabilities and can easily find jobs, they are more likely to take advantage of the UI system when high benefits are offered in the first periods. Since most of the welfare gain from switching to long-term plans comes from offering high benefits in the early periods of the unemployment, it is not possible to improve welfare significantly.

T	Optimal UI Plans	Tax Rate (τ)	Employment Rate	Standard Deviation of Consumption	Average Asset Holdings	Average Utility	Welfare Cost (%)
No UI	0.00 0.00 0.00 0.00	0.0000	0.9400	0.1202	3.2411	-0.5540	0.6830
1	0.05 0.05 0.05 0.05	0.0040	0.9220	0.1206	2.2323	-0.5539	0.6665
2	0.90 0.05 0.05 0.05	0.0297	0.9349	0.1136	1.3764	-0.5529	0.5019
3	0.90 0.00 0.05 0.05	0.0287	0.9400	0.1117	1.4334	-0.5528	0.4854
4	0.95 0.00 0.00 0.10	0.0302	0.9399	0.1121	1.2050	-0.5526	0.4825

Table 3: The optimal UI plans and summary statistics for the benchmark parameterization and for $\pi_0 = 0$, $\pi_1 = 1$.

6.1.2 Optimal Unemployment Insurance Plans with Hidden Savings

Now we consider hidden savings. Similar to the previous case we again change π_0 from 0 to 1. Table 3 reports the results for perfect government monitoring, i.e., $\pi_0 = 0$.[6] In this case, nobody quits his job to collect benefits since quitters will definitely be disqualified. When benefits are constant, optimal replacement ratio is only 0.05. Agents insure themselves mainly by saving and the welfare gain from the unemployment insurance system is almost zero. Then we increase T to 2. The optimal plan offers 0.9 in the first period of unemployment and 0.05 thereafter. The welfare benefit of going from $T = 1$ to $T = 2$ is equal to 0.1646%. Agents hold substantially lower assets and enjoy smoother consumption. High benefit levels in the first period of unemployment give incentive for searchers to accept job offers; because, if they are laid off, they can enjoy both leisure and high benefits in the first period of unemployment. This is why a smaller number of agents turn down job offers and employment rate will be higher. Changing T from 2 to 4 increases welfare by less than 0.02%.

When $T > 2$, the optimal benefit scheme is not monotonic. The benefit level starts with a high rate, then decreases to zero, and continues at a low rate indefinitely. This interesting result deserves some explanation. The insurance administrator recognizes that agents in the first period of unemployment are really the ones who did not get any job offer, so he does not have to be concerned about the incentive problem for these agents. Therefore, it is possible to provide insurance to agents by offering high benefit levels. In the latter periods, the government cannot monitor the unemployed. Since agents have hidden savings, they are tempted to cheat to get the highest net present value transfer from the unemployment insurance system. This makes it difficult for the government to provide insurance. Thus, it

[6] Although perfect monitoring is almost impossible in real life, we would like to analyze this case to provide better understanding of long-term plans for different levels of monitoring.

π_0	T	Optimal UI Plans	Welfare Cost (%)	Welfare Gain (%)
0.00	T=1	0.05 0.05 0.05 0.05	0.6665	0.6665 - 0.4825 =
	T=4	0.95 0.00 0.00 0.10	0.4825	0.1840
0.10	T=1	0.05 0.05 0.05 0.05	0.6665	0.6665 - 0.5546 =
	T=4	0.25 0.00 0.00 0.10	0.5546	0.1119
0.25	T=1	0.05 0.05 0.05 0.05	0.6830	0.6830 - 0.6199 =
	T=4	0.10 0.00 0.00 0.10	0.6199	0.0631
0.50	T=1	0.00 0.00 0.00 0.00	0.6830	0.6830 - 0.6340 =
	T=4	0.00 0.00 0.05 0.05	0.6340	0.0490
1.00	T=1	0.00 0.00 0.00 0.00	0.6830	0.6830 - 0.6340 =
	T=4	0.00 0.00 0.05 0.05	0.6340	0.0490

Table 4: The optimal UI plans and the welfare gains for benchmark parameterization and $\pi_1 = 1$, $\pi_0 \in \{0, 0.1, 0.25, 0.5, 1\}$.

is optimal not to offer any benefits until agents consume most of their savings. So, benefits drop to zero for two periods. As savings get smaller, consumption will depend more on UI benefits. Now, positive benefits are required to insure unemployed agents.

Our analysis reveals the importance of agents' ability to save in evaluating long-term UI plans. When we abstracted from this feature—agents cannot save—we have found that switching to long-term UI plans could increase welfare by 2.0133%. However, when we introduce hidden savings, the corresponding gain becomes as low as 0.1840%.

Next we evaluate the optimal UI plans for different levels of π_0. Table 4 reports the optimal plans for $T = 1$ and $T = 4$ and the welfare gains of going from $T = 1$ to $T = 4$. For various values of π_0, benefit schemes are very similar except for the first-period benefit level. For higher values of π_0, replacement ratio in the first period becomes smaller. Even if π_0 is increased from 0 to 0.1, the replacement ratio drops from 0.90 to 0.25. This is because, when quitters can qualify for unemployment insurance with a positive probability, agents are tempted to quit their jobs to collect benefits if high benefits are offered in the first period of unemployment spell. If they manage to go undetected, they collect UI benefits and enjoy leisure. If not, they can consume out of their savings while they search for a job. Since they have high reemployment probability, the possibility of being detected is not such a bad outcome.[7] That is why it is not possible to offer high benefits in the first period without creating incentive to quit when government monitoring of quitters is imperfect.

Non-monotonic or increasing benefit schemes look quite different than declining benefit paths suggested by Shavell and Weiss (1979), and Hopenhayn and Nicolini (1997). How-

[7] Recall that quitters will be given employment opportunity with 0.9681 probability.

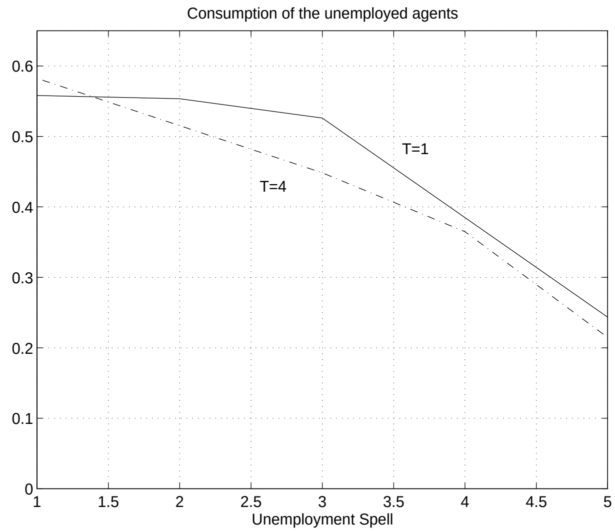

Figure 1: Consumption of the unemployed agents under different UI plans for benchmark parameterization and $\pi_0 = 0$, $\pi_1 = 1$.

ever, the intuition behind these seemingly different results are similar. Despite the non-monotonicity of the benefit scheme, the implied consumption path is declining throughout the unemployment spell as Figure 1 suggests. To create incentives for agents to accept job offers, the optimal UI plan should punish agents for continued unemployment by providing a declining consumption path throughout the unemployment spell. The optimal benefit and the consumption path are quite different in our model because agents have hidden savings. Our results indicate how introducing hidden savings can lead to different policy implications.

As Table 4 shows, the welfare gains of switching to long-term UI plans depend on the degree of moral hazard for quitters. For $\pi_0 = 0$ welfare benefit of going from $T = 1$ to $T = 4$ is 0.1840%. However, when π_0 is increased to 0.1 and 0.25, the welfare gains are 0.1119% and 0.0631% respectively. As we increase π_0 above 0.5, the corresponding gain drops to 0.049%. Even if the government can monitor quitters quite effectively as in $\pi_0 = 0.25$ case (75% of ineligible agents are detected), the welfare gain of switching to long-term UI plans is quite small. Since potential welfare benefits are small even for low degrees of moral hazard and implementing long-term UI plans is costly in practice, we argue that switching to long-term UI plans is not that attractive from a policy point of view.

6.2 Robustness

The equilibrium properties of the model can change when we consider different parameter values. In particular, the coefficient of relative risk aversion and the weight of leisure in the utility function are most likely to affect the optimal benefit path.[8]

6.2.1 The Value of Leisure:

First we would like to start with a discussion of how leisure's weight in the utility function changes our results. Following Acemoglu and Shimer (2000), who suggest a lower value of leisure in their study, we set σ to 0.5. In this case, agents value leisure less compared to our benchmark parameterization and, thus, the importance of moral hazard decreases. Therefore, for a given value of π_0 agents are less likely to take advantage of imperfect government monitoring, and it is possible to offer higher benefit levels without creating disincentives to become and remain unemployed.

T	Optimal UI Plans	Average Utility	Welfare Cost (%)
1	0.50 0.50 0.50 0.50	-0.4068	0.7266
4	0.75 0.55 0.55 0.55	-0.4028	0.2312

Table 5: The optimal UI plans and the welfare gains for $\sigma = 0.5$, $\pi_0 \in [0, 1)$ and $\pi_1 = 1$.

Table 5 shows optimal UI plans and the welfare gains in the economy without savings. When benefits are constant, optimal replacement ratio is 0.5. Since it is possible to insure agents quite well even with constant benefit schemes by offering high benefits, the welfare gains of switching to long-term plans are relatively small compared to $\sigma = 0.67$ case. Note that when $\sigma = 0.67$, the welfare gain of going from $T = 1$ to $T = 4$ was 2.0133%. When $\sigma = 0.5$, the corresponding welfare gain is 0.4954%.

T	Optimal UI Plans	Average Utility	Welfare Cost (%)
No UI	0.00 0.00 0.00 0.00	-0.4075	0.8157
1	0.45 0.45 0.45 0.45	-0.4039	0.2684
4	1.00 0.40 0.45 0.50	-0.4019	0.1166

Table 6: The optimal UI plans and summary statistics for $\sigma = 0.5$, $\pi_0 \in [0, 0.5]$, and $\pi_1 = 1$.

Next we want to evaluate optimal plans when $\sigma = 0.5$ in the presence of hidden savings. Table 6 displays the results for this case. Similar to the exercise without savings, constant benefit schemes insure agents quite well. In this case, adding a UI system with constant replacement ratio reduces the welfare cost from 0.8157% to 0.2684%. This implies a welfare

[8] Remember that the utility function takes the form $U(c, l) = \frac{(c^{1-\sigma} l^{\sigma})^{1-\rho} - 1}{1-\rho}$

gain of 0.5473%. On the other hand, going from $T = 1$ to $T = 4$ increases welfare by only 0.1518%. Compared to the welfare gain of introducing a UI system to the economy, the gain of switching to the long-term UI plan is much smaller.

This exercise shows that when disincentive effects due to moral hazard are less important, it is possible to provide insurance with constant benefit schemes. Therefore, the welfare gains of switching to long-term UI plans are relatively small as we have discussed above.

6.2.2 Risk Aversion:

Next, we want to describe the behavior of the economy when higher degree of risk aversion is assumed. When risk aversion is higher, agents prefer smoother consumption of the composite commodity, $c^{1-\sigma}l^{\sigma}$.

Table 7 displays the results for $\rho = 10$ in the economy without savings. Compared to our benchmark case, replacement rates are lower in general and benefit schemes are flatter. Since more risk-averse agents prefer smoother consumption of the composite commodity, benefit levels should be lower to provide a smoother utility. If replacement rate were higher, the utility of an unemployed agent would be much higher than that of an employed agent.[9]

T	Optimal UI Plans	Average Utility	Welfare Cost (%)
1	0.25 0.25 0.25 0.25	-4.3442	1.5808
4	0.40 0.30 0.30 0.25	-4.1899	0.4061

Table 7: The optimal UI plans and the welfare gains for $\rho = 10$, $\pi_0 = 0$ and $\pi_1 = 1$.

Finally, we want to describe the behavior of the economy with hidden savings for $\rho = 10$. Table 8 displays the results. Compared to $\rho = 2.5$ case, benefit levels are generally higher and benefit paths are flatter. These results follow from the fact that more risk-averse agents prefer smoother consumption of the composite commodity, $c^{1-\sigma}l^{\sigma}$. When the replacement ratio is constant, the optimal level is 0.2. Recall that, when $\rho = 2.5$, the corresponding replacement ratio was 0.05, implying a much smaller composite commodity for the unemployed. Then the only way to smooth the consumption of the composite commodity is to increase the consumption of goods (c) since leisure for the unemployed is already high. That is why benefit levels are higher when agents are more risk averse. The reason why long-term plans are flatter compared to the benchmark case is also very similar: since every unemployed agent

[9]When $\rho = 2.5$ replacement ratio in the first few periods of unemployment was 0.65. Then, the amount of composite commodity consumed by the unemployed agent will be $0.65^{0.33}1^{0.67} = 0.8675$. For the employed agent the consumption is around 0.94 and leisure is 0.55. Then the composite commodity of the employed agent is $0.94^{0.33}0.55^{0.67} = 0.6564$. Note that instantaneous utility of the unemployed agent is higher.

enjoys the same amount of leisure, the only way to provide a smoother utility flow over the unemployment spell is to provide a lower benefit level in the first period of unemployment and higher benefit levels in the later periods.[10]

For $\rho = 10$, when we introduce an unemployment insurance system with a constant benefit level, the welfare cost reduces from 0.5168% to 0.2255%. This implies a welfare gain of 0.2913%. However, using long-term plans do not improve welfare significantly: as we go from $T = 1$ to $T = 4$ the improvement in welfare is only 0.0629%.[11]

T	Optimal UI Plans	Average Utility	Welfare Cost (%)
No UI	0.00 0.00 0.00 0.00	-4.2041	0.5168
1	0.20 0.20 0.20 0.20	-4.1668	0.2255
4	0.65 0.20 0.15 0.20	-4.1591	0.1626

Table 8: The optimal UI plans and summary statistics for $\rho = 10$, $\pi_0 = 0$, and $\pi_1 = 1$.

7 Role of Savings:

Our experiments show that policy implications change considerably when hidden savings are taken into account. UI plans designed without considering savings can cause high unemployment and be quite harmful if applied to an economy with hidden savings. This section illustrates this argument quantitatively. We compare the employment rates for the economy with hidden savings when a) the optimal UI plans suggested by the same economy are applied; b) the optimal UI plans suggested by the economy without savings are applied. Table 9 shows that if UI plans are designed without considering hidden savings, they might be quite harmful to the economy. For example, for $T = 1$ the employment rate decreases from 92% to 52% and the welfare cost increases from 0.0665% to 10.4504%. It is remarkable that the long-term UI plans suggested by the economy without savings cause even higher unemployment rates and higher welfare cost. For example, for $T = 4$ employment rate decreases from 94% to 24.3% and the welfare cost increases from 0.4825% to 42.0459%. This is because this plan critically uses history dependence; in particular, it applies high benefit rates in the first few periods upon job loss. Thus, any recently separated workers with access to hidden

[10]When $\rho = 2.5$, the optimal benefit scheme for $T = 4$ is (0.95,0,0,0.10) and when $\rho = 10$, the optimal benefit scheme is (0.65,0.20,0.15,0.20).

[11]When we tried higher values of π_0 we have seen that the the optimal benefit level for $T = 1$ does not change significantly. For instance, when $\pi_0 = 0.5$ the constant benefit scheme still offers 0.20. So, the welfare benefit of introducing an UI plan is 0.2913%. However, higher levels of moral hazard decreases the welfare benefit of switching to long-term plans. Thus, the welfare gains will be less than 0.0629%.

savings would choose to turn down new job offers, collect the high benefit, and use hidden savings to smooth consumption.

	Optimal UI Plan 1	Optimal UI Plan 2
T=1	0.05 0.05 0.05 0.05	0.25 0.25 0.25 0.25
Employment Rate	0.9220	0.5204
Tax Rate	0.0040	0.1633
Welfare Cost (%)	0.6665	10.4504
T=2	0.90 0.05 0.05 0.05	0.65 0.30 0.30 0.30
Employment Rate	0.9349	0.3736
Tax Rate	0.0297	0.2946
Welfare Cost (%)	0.5019	20.2501
T=3	0.90 0.00 0.05 0.05	0.65 0.65 0.30 0.30
Employment Rate	0.9400	0.3261
Tax Rate	0.0287	0.3971
Welfare Cost (%)	0.4854	28.8593
T=4	0.95 0.00 0.00 0.10	0.65 0.65 0.65 0.30
Employment Rate	0.9399	0.2431
Tax Rate	0.0302	0.5773
Welfare Cost (%)	0.4825	42.0459

Table 9: The optimal UI plans derived in economies with and without savings and their effects on the economy with savings for benchmark parameterization and $\pi_0 = 0$, $\pi_1 = 1$.

This exercise clearly reveals the importance of general equilibrium effects in the design of unemployment insurance plans. In the absence of such effects, the tax rate on labor income would be independent of the unemployment rate. Thus, the value of being employed would be immune to the disincentive effects created by the unemployment insurance plans designed ignoring agents' ability to save. However, when we incorporate general equilibrium effects to the analysis, we observe that the lower the employment rate is, the higher the tax rate on labor income of the employed should be. This is to balance the budget of the UI system. This feedback—which indeed is present in real life—exacerbates the negative effects of improperly designed UI systems on the economy.

8 Conclusion

We have studied short-term and long-term unemployment insurance plans in economies with and without savings. We find that welfare implications change notably when we consider savings. Although long-term plans can improve welfare significantly in economies without savings, our experiments suggest that welfare gains are much lower when hidden savings are taken into account.

Potential welfare gains of long-term plans depend on the degree of moral hazard. However, for a wide range of moral hazard values, we find that welfare gains of long-term unemployment insurance plans are close to zero. Our conclusion is not affected by plausible variations in parameters including the coefficient of relative risk aversion and the weight of leisure in the utility function.

We recognize that our results are not strictly comparable to those of the dynamic contracting literature since our plans do not keep track of the entire unemployment history of workers. One might argue that contracts that depend only on the most recent unemployment spell and distinguish agents up to four periods can be considered short-term contracts. However, we have shown that these contracts, in fact, improve welfare considerably in economies without savings. This result suggests that the small welfare gains we obtain with hidden savings are not a consequence of limited history dependence but rather a consequence of hidden savings. Given these results, as well as the fact that long-term unemployment insurance plans are hard to administer in practice, switching to long-term plans may not be a desirable policy.

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