

Should unemployment insurance be asset tested?*

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Abstract

We study asset-tested unemployment insurance in an incomplete markets model with moral hazard during job search. Optimal asset testing is weak and yields negligible welfare gains. The optimal replacement rate of an unemployed worker with zero liquidity is 9 percentage points higher than that of the median worker. Welfare rises by 0.03 percent in consumption equivalent terms. We develop a general welfare decomposition for heterogeneous agent models with transitional dynamics. Asset testing creates welfare gains due to redistribution and additional consumption during the transition phase, and welfare losses due to reduced consumption smoothing, lower consumption, and higher effort levels.

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1 Introduction

The financial situation during unemployment is a key determinant of job search behavior. Empirical evidence shows that liquidity-constrained households have higher job finding rates. Moreover, their job finding rates and consumption expenditures are more elastic with respect to the generosity of unemployment insurance (UI).¹ A natural question is therefore whether an optimal UI system should be asset tested. The answer to this question has to trade off two counteracting effects. On the one hand, liquidity-constrained households have the least ability to smooth consumption and the highest marginal utility of consumption. Following this reasoning, redistribution to liquidity-constrained households is good for social welfare, and so UI should be asset tested (i.e., UI benefits should decrease with assets). On the other hand, asset testing undermines the incentive for asset accumulation. Fewer assets at the beginning of an unemployment spell imply a larger consumption drop and reduce the internalization of the costs of unemployment, as well as the smoothing of those costs across time.² This reasoning suggests that UI should not be asset tested. It is an open question which of the two effects dominates.

We answer this question in an incomplete markets model with moral hazard during job search calibrated to the U.S. economy. We find that asset testing is optimal but weak: the optimal replacement rate of an unemployed worker at the borrowing constraint is a mere 9 percentage points higher than that of the median worker. The welfare gains from introducing optimal asset testing are negligible: welfare rises by only 0.03 percent in consumption equivalent terms. We conclude that the absence of asset testing in the current U.S. unemployment insurance system is approximately optimal.

We decompose the welfare change from the reform to examine the countervailing effects of asset testing. We find that effects related to redistribution (inequality) and additional consumption during the transition phase yield welfare gains, whereas effects related to consumption smoothing (uncertainty) and level changes of consumption and effort yield welfare losses. We provide a simple two-period model to discuss the trade-off between redistribution and con-

¹Rendon (2006), Card, Chetty, and Weber (2007), and Lentz (2009) document that higher asset holdings lead to prolonged job search. Chetty (2008) shows that the elasticity of the job finding rate with respect to unemployment benefits decreases with liquid wealth. Browning and Crossley (2001) show that unemployment insurance improves consumption smoothing for poor agents, but not for rich ones.

²Feldstein and Altman (1998) argue that asset-based unemployment insurance systems reduce moral hazard, because agents internalize the costs of their unemployment spell. Shimer and Werning (2008) show that savings technologies emulate the optimal consumption dynamics during unemployment and reemployment in a framework with limited planner instruments.

sumption smoothing analytically. Moreover, we relate our results to previous findings on asset testing based on single-spell models of unemployment. These models emphasize the welfare gains from redistribution and are therefore severely biased toward asset testing.

Due to the complexity of the government’s problem in our setup, we refrain from a characterization of the second best allocation and follow the large strand of the literature that uses calibrated models to study the optimal policy for a restricted class of policy instruments (Ramsey optimal policy).³ We build an incomplete markets model in which workers are randomly separated into unemployment and exert unobservable effort to influence their chances of finding a job. Workers save in a risk-free asset and have access to a limited amount of unsecured credit. The asset distribution is thus endogenous and depends, in particular, on the structure of the UI system. For simplification, we assume that assets are observable for the UI agency without costs. Including such costs would further strengthen our conclusion that the absence of asset testing is approximately optimal.

Our quantitative analysis imposes strong discipline on the model’s parameters. We calibrate the model according to empirical evidence on U.S. job finding and separation rates, holdings of liquid assets, and the availability of unsecured credit. For the calibration of liquid assets, we construct alternative liquidity measures from the 2004 Survey of Consumer Finances (SCF). Our calibration focuses on the median household, but we provide a sensitivity check that targets further quantiles of the distribution.

Starting from the calibrated benchmark economy, we study the utilitarian welfare effects of UI reform. We first explore asset-independent UI systems. We find that the current U.S. system with a replacement rate of 50 percent is close to optimal if the level of the replacement rate is the only policy instrument. This result is in line with Chetty (2008), who analyzes unemployment insurance with a sufficient statistic approach.⁴ In a second step, we explore simple parametric functional forms of asset tests. We show that the optimal slope of UI benefits with respect to assets is negative but very close to zero. We show that this result is robust to alternative parameter values, alternative definitions of liquid assets, additional asset heterogeneity, simultaneous changes in tax rates and UI benefits, and the class of Epstein-Zin preferences.

³See Hansen and Imrohoroglu (1992), Wang and Williamson (2002), and Abdulkadiroglu, Kuruscu, and Sahin (2002), for example.

⁴Chetty derives a formula for the optimal benefit level based on a number of sufficient statistics with natural empirical counterparts. Since his approach does not rely on functional form assumptions, the fact that we find similar results provides support for our calibration strategy.

We extend previous work on the decomposition of the welfare effects from policy changes. Our decomposition applies to a large class of heterogeneous agent models with transitional dynamics.⁵ We decompose the welfare effects of asset testing into level changes of consumption and effort, changes in cross-sectional heterogeneity and uncertainty, and transitional effects. The decomposition finds two welfare-improving effects from introducing asset testing. First, asset testing redistributes resources from asset-rich to asset-poor unemployed households. This mitigates cross-sectional inequality within the group of unemployment workers but not across the groups of employed and unemployed workers. Total inequality therefore improves only marginally. Second, asset testing lowers the incentive for saving, and thus agents enjoy a transitional gain from asset decumulation during the transition phase after the policy reform. On the other hand, asset testing brings a number of negative consequences. First, asset testing reduces the incentive to save. This exacerbates the consumption drop from unemployment and increases the amount of uncertainty that agents face. Second, it raises job search efforts in order to escape from unemployment more quickly. Finally, the reduced incentive to save causes a negative income effect due to lower asset income.

We also provide a link to the literature on single-spell models of unemployment. Such models have been widely used for the analysis of optimal UI, including the role of asset testing. In single-spell models, workers are initially unemployed but remain employed once they have found a job. The initial asset distribution of the unemployed is exogenous. When we explore a single-spell version of our model, we see that the optimal slope of UI benefits with respect to assets becomes much more negative—about six times as large in absolute value. This shows that heterogeneity in asset holdings among unemployed workers creates a strong motive for asset testing. Once we endogenize asset heterogeneity in a model with repeated employment and unemployment spells, we obtain a strong countervailing force due to the reduced incentive to save. The policy implications of the model with endogenous asset accumulation therefore differ considerably from the single-spell analysis.

The paper proceeds as follows. The next section reviews the related literature. Section 3 highlights the trade-off between redistribution and savings incentives in a stylized two-period setup. Sections 4 and 5 describe our model and calibration strategy. Section 6 contains the

⁵Benabou (2002) and Floden (2001) provide similar formulas for steady state comparisons with multiplicative preferences.

main results. In addition to the analysis of optimal unemployment insurance, we provide a decomposition result and a link to the literature on single-spell models of unemployment. Several robustness checks and extensions of the model are provided in Section 7. Section 8 provides concluding remarks.

2 Related literature

To the best of our knowledge, this is the first paper to analyze asset-tested UI in a model with endogenous asset accumulation. Our approach is based on works by Hansen and Imrohoroglu (1992), Abdulkadiroglu, Kuruscu, and Sahin (2002), and Wang and Williamson (2002), who use calibrated incomplete markets models to study optimal UI systems without asset tests. We extend the analysis of those papers by allowing for asset-dependent benefits. Moreover, we model the transition phase that is induced by UI reforms.

The paper closest to ours is by Rendahl (2012). Rendahl studies asset-tested UI in a model with a single unemployed agent who experiences a single unemployment spell (single-spell model). In his model, the distribution of assets at job loss is exogenous and homogeneous by assumption, and hence the UI system has no effect on precautionary savings behavior. Rendahl argues that optimal unemployment benefits should fall sharply with assets—a result that we replicate when the asset distribution in our model is exogenous. However, single-spell models create a large bias in favor of asset-tested UI. Taking into account the endogeneity of precautionary savings, we show that asset-independent benefits are very close to optimal.

Our results also differ from the analysis by Lentz (2009), who studies individual unemployment insurance schemes in a heterogeneous population. Taking the distribution of types and assets as given, Lentz concludes that unemployment benefits should be a negative function of *initial* assets. Due to his timing convention, asset tests have no consequences for precautionary saving decisions, which as in Rendahl (2012) mutes the precautionary savings channel highlighted in our analysis. Unemployment benefits are indexed to initial assets and are unrelated to the later evolution of assets.

Our paper draws on the insight that moral hazard can be reduced by financing consumption during unemployment through individual assets. Asset testing crowds out the use of individual assets during unemployment, since agents have a reduced incentive to accumulate assets prior to

job loss. Feldstein and Altman (1998) propose a UI system based on mandatory unemployment savings accounts. Their proposal avoids the crowding-out problem to some extent, since asset accumulation in the unemployment savings account becomes compulsory. However, substitution effects may reduce the accumulation of other assets. Unemployment savings accounts have some additional drawbacks compared to systems with asset-tested UI benefits. For instance, unemployment savings accounts require a much more drastic reform. Moreover, such accounts are illiquid and cannot be used for shocks other than unemployment. For recent quantitative explorations of unemployment savings accounts, we refer the reader to the works by Pallage and Zimmermann (2010) and Setty (2012). For a system that integrates unemployment accounts and retirement benefits, see Stiglitz and Yun (2005).

Hubbard, Skinner, and Zeldes (1995) analyze the effect of asset-tested social insurance programs on life-cycle savings behavior. They argue that asset testing can explain why low-income households accumulate very little wealth. Their focus is on life-cycle savings, and they do not consider asset-tested unemployment insurance. The model and spirit of our paper are quite different, as we use a moral hazard framework and provide a *normative* analysis of asset testing for UI programs.

A very different case for asset-tested insurance can be found in the New Dynamic Public Finance literature. In that literature, the government has access to sophisticated history-dependent taxes and transfers. Individual saving decisions then merely hinder the government's ability to allocate resources in an efficient way, and it becomes optimal to use capital taxation, asset tests (Golosov and Tsyvinski, 2006), or other instruments to prevent the agent from saving. Our results follow a very different logic. The government's instruments are much more limited and close to existing UI policies. Individual savings decisions are useful in our model, because they complement the limited government instruments and lead to a stronger internalization (and smoothing) of unemployment costs than in models without saving. The argument that saving technologies can improve social welfare given limited UI instruments is not new, however. Shimer and Werning (2008) show in a single-spell model that asset decumulation during unemployment brings the economy close to the constrained efficient allocation when UI benefits and reemployment taxes are independent of time.

3 Redistribution versus savings incentives

Before setting up the general model, this section outlines the trade-off between redistribution and savings incentives in a stylized two-period model. We show that, on the one hand, asset testing reduces cross-sectional inequality. On the other hand, asset testing undermines the incentive to save. We show that the two effects have counteracting implications for welfare.

We consider a two-period model with two agents who differ in their initial assets a_0^i , with $a_0^h > a_0^l$. In the first period, both agents are employed, earn labor income w , and take an asset decision a_1^i . In the second period, both agents are unemployed and receive an asset-dependent UI benefit $b(a_1^i) = \bar{b} + \alpha(\bar{a} - a_1^i)$. Agents take the benefit system as given and choose assets optimally:

$$a_1^i = \arg \max u(a_0^i + w - a_1^i) + \beta u((1+r)a_1^i + b(a_1^i)), \quad i = l, h.$$

For simplicity, we choose logarithmic utility and set $\beta = 1, r = 0$. Our argument generalizes easily to the case of CRRA utility and $\beta(1+r) \neq 1$. Solving the agent's Euler equation, we obtain optimal savings as

$$a_1^i = \frac{1}{2}(a_0^i + w) - \frac{\bar{b} + \alpha\bar{a}}{2(1-\alpha)}, \quad i = l, h.$$

The parameter $\bar{a}$ of the benefit function is chosen such that the government's budget is fixed at level $2\bar{b}$ across all slopes α . Hence, the parameter α solely affects the degree of asset testing but not the average level of benefits.⁶ After some simple algebra, unemployment benefits at optimal savings levels can be represented as $b(a_1^h) = \bar{b} - \tau$, $b(a_1^l) = \bar{b} + \tau$, where $\tau = \alpha(a_0^h - a_0^l)/4$ represents a transfer from the rich to the poor agent. Note that the transfer τ and the slope of asset testing α are related one-to-one. Hence, we might as well interpret τ as the government's policy variable.

Denoting individual budgets as

$$M^l = a_0^l + w + \bar{b} + \tau, \quad M^h = a_0^h + w + \bar{b} - \tau,$$

⁶Straightforward algebra gives

$$\bar{a} = \frac{\frac{a_0^l + a_0^h}{2} + w - \frac{\bar{b}}{1-\alpha}}{2 + \frac{\alpha}{1-\alpha}}.$$

we can represent the allocation as

$$c_0^i = \frac{1}{2-\alpha} M^i, \quad c_1^i = \frac{1-\alpha}{2-\alpha} M^i, \quad i = l, h.$$

Note that the intertemporal consumption shares $(1-\alpha)/(2-\alpha)$ and $1/(2-\alpha)$ are the same for both agents. Social welfare, using a utilitarian welfare measure, can therefore be written as

$$W = \frac{1}{2} \sum_{i,t} \log(c_t^i) = \log(M^l) + \log(M^h) + \log\left(\frac{1-\alpha}{2-\alpha}\right) + \log\left(\frac{1}{2-\alpha}\right).$$

The first two terms on the right-hand side measure the redistributive role of asset testing. An increase in α raises the transfer τ and brings the individual budgets M^l, M^h closer together, which increases social welfare. The remaining two terms consider the intertemporal consumption shares. An increase in α reduces the incentive to save. This increases the relative consumption drop from unemployment and lowers social welfare:

$$\frac{d \left[\log\left(\frac{1-\alpha}{2-\alpha}\right) + \log\left(\frac{1}{2-\alpha}\right) \right]}{d\alpha} = \frac{2}{2-\alpha} - \frac{1}{1-\alpha} \leq 0.$$

To maximize social welfare, the optimal asset test trades off the beneficial effect on cross-sectional inequality against the harmful effect on the incentive to save (intertemporal inequality).

The model studied throughout the remainder of this paper adds a continuum of agents, an infinite horizon with repeated unemployment spells, uncertainty about job loss, and moral hazard during unemployment to this stylized setup. The trade-off between cross-sectional redistribution on the one hand and savings incentives on the other hand still remains valid. However, the possibilities for redistribution become more limited and the effects of savings incentives become richer. In addition to intertemporal smoothing, the savings technology increases the internalization of the costs of unemployment (Feldstein and Altman, 1998) and emulates a form of history dependence in the consumption of unemployed and reemployed workers (Shimer and Werning, 2008).

4 Model

There is a continuum of mass 1 of ex ante identical agents. At each date $t \in \{0, 1, \dots, \infty\}$, the agent's employment state θ_t is an element of the set $\Theta = \{E, U, S\}$, where E represents employment, U unemployment, and S social assistance. Transition probabilities between states depend on the (unobservable) effort exerted by the agent. If the agent exerts effort $e_t \in \mathbb{R}_+$ and is in state θ at time t , then her probability of being in state θ' in period $t + 1$ is denoted by

$$\text{Prob}(\theta_{t+1} = \theta' \mid \theta_t = \theta, e_t) = \pi_{\theta\theta'}(e_t).$$

If the agent is employed ($\theta_t = E$), she receives a wage w and pays a proportional employment tax at rate τ . In line with earlier contributions to this literature, we abstract from wage heterogeneity and assume that the wage w is identical across agents. The employment tax τ is used to finance transfers to unemployed agents. If the agent is unemployed ($\theta_t = U$), she receives unemployment benefits $b(a_t)$. Unemployment benefits depend only on asset holdings but not on any other aspect of the agent's history. Finally, in state $\theta_t = S$ the agent is unemployed, unemployment benefits have expired, and the agent receives social assistance transfers z . The agent's income (excluding interest income) in period t is hence given by

$$y(a_t, \theta_t) = \begin{cases} (1 - \tau)w & \text{if } \theta_t = E, \\ b(a_t) & \text{if } \theta_t = U, \\ z & \text{if } \theta_t = S. \end{cases}$$

Agents can save in a risk-free asset at interest rate r_s and have access to unsecured credit at interest rate $r_b \geq r_s$. We denote the interest rate schedule as a function of assets by $r(a)$. The borrowing limit is denoted $\underline{a}$.⁷ In each period, the agent derives utility $u(c_t)$ from consumption $c_t \geq 0$ and disutility $\phi(e_t)$ from effort $e_t \geq 0$, where $u : \mathbb{R}_+ \rightarrow \mathbb{R}$ is strictly increasing and strictly concave and $\phi : \mathbb{R}_+ \rightarrow \mathbb{R}$ is strictly increasing and (weakly) convex. The time discount

⁷We abstract from default in this model. A default option would offer poor households additional insurance, because filing for bankruptcy and wiping out debt is equivalent to transfers to poor households. Ruling out default therefore arguably biases the model in favor of asset testing, as asset testing is an alternative way of providing transfers to poor households. Furthermore, any change in UI benefits would affect default decisions of households and require assumptions on the reaction of interest rates on unsecured debt and default punishments. In particular, the government might want to jointly vary the bankruptcy code and UI benefits. Allowing for default would therefore add an additional layer of complication to the problem, but will likely not alter the conclusions about the main trade-off highlighted in the analysis.

factor is $\beta \in (0, 1)$.

Given the income process $y(a, \theta)$, interest rates r_s, r_b , borrowing limit $\underline{a} \leq 0$, and the above specification of uncertainty, the agent chooses a consumption sequence $\{c_t\}_{t=0}^\infty$, a sequence of asset holdings $\{a_{t+1}\}_{t=0}^\infty$, and a sequence of effort levels $\{e_t\}_{t=0}^\infty$ to maximize expected discounted life time utility:

$$\begin{aligned} \max_{\{c_t, a_{t+1}, e_t\}} \quad & \mathbb{E} \left[\sum_{t=0}^{\infty} \beta^t (u(c_t) - \phi(e_t)) \right] \\ \text{s.t.} \quad & c_t + a_{t+1} = (1 + r(a_t)) a_t + y(a_t, \theta_t) \\ & a_{t+1} \geq \underline{a}, \quad c_t \geq 0, \quad e_t \geq 0 \\ & a_0, \theta_0 \text{ given.} \end{aligned} \tag{1}$$

4.1 Steady state equilibrium

Recall $\Theta = \{E, U, S\}$ and denote the asset space by $A = [\underline{a}, \infty)$. The agent's problem has a recursive structure, and we restrict attention to recursive policies from now on. We adopt standard notation and denote the current period's variables without a time subscript and the next period's variables by a prime (e.g., θ and θ' for the employment state in the current and the next period). The agent's Bellman equation reads

$$\begin{aligned} v(a, \theta) = \max_{\{a', e\}} \quad & u((1 + r(a)) a + y(a, \theta) - a') - \phi(e) + \beta \sum_{\theta' \in \Theta} v(a', \theta') \pi_{\theta\theta'}(e) \\ \text{s.t.} \quad & e \geq 0, \quad a' \geq \underline{a}, \quad (1 + r(a)) a + y(a, \theta) - a' \geq 0. \end{aligned} \tag{2}$$

A *(recursive) steady state equilibrium* consists of a value function $v : A \times \Theta \rightarrow \mathbb{R}$, an asset policy function $a' : A \times \Theta \rightarrow A$, an effort policy function $e : A \times \Theta \rightarrow \mathbb{R}$, a government policy $(b(\cdot), z, \tau)$, and an invariant distribution μ on the state space $A \times \Theta$ such that:

1. v , a' , and e solve the agent's problem (1) given prices (w, r_s, r_b) and the government policy.
2. The government's budget constraint is satisfied:

$$\tau w \int_A d\mu(a, E) = \int_A b(a) d\mu(a, U) + z \int_A d\mu(a, S). \tag{3}$$

3. μ is an invariant distribution given the decision functions e, a' and employment transition

probabilities $\pi_{\theta\theta'}$.

4.2 Functional forms

The general setup of the model is not accessible for a quantitative analysis. We will therefore make some standard assumptions on functional forms.

Assumption 1. *The agent's period utility function is given by*

$$u(c) - \phi(e) = \begin{cases} (1 - \beta) \left(\frac{c^{1-\gamma}}{1-\gamma} - e \right), & \gamma \neq 1, \\ (1 - \beta) (\log(c) - e), & \gamma = 1. \end{cases}$$

The restriction to CRRA consumption utilities is standard. Moreover, note that the agent's decision problem depends on the link between effort disutilities $\phi(e)$ and probabilities $\pi_{\theta\theta'}(e)$ but not on the unit of measurement for e . Hence, letting the disutility of effort $\phi(e)$ be linear does not result in a loss of generality.

Since empirical knowledge on the extent to which workers can influence their layoff risk is very limited, we will model separations as exogenous.

Assumption 2. *Transition probabilities from employment to employment are independent of the agent's effort:*

$$\pi_{EE}(e) = \pi_{EE},$$

with $\pi_{EE} > 0$. Job finding probabilities depend on effort in the following way:

$$\pi_{\theta E}(e) = 1 - \exp(-\psi e), \quad \theta \in \{U, S\}.$$

The functional form for the job finding probability is standard and follows Hopenhayn and Nicolini (1997) and Wang and Williamson (2002). The job finding probability is increasing and concave in effort and bounded between 0 and 1.

To economize on the number of state variables, we assume that the duration of unemployment benefits is stochastic.⁸ An agent who received unemployment benefits at time $t - 1$ and

⁸By making the duration of unemployment benefits stochastic, we substantially reduce the computational complexity of the problem, but nonetheless capture the fact that benefits are paid for a limited time only. If the duration of unemployment benefits were deterministic, we would have to introduce the current duration of the unemployment spell as an additional state variable.

continues to be unemployed at time t will receive unemployment benefits with probability p and social assistance transfers with probability $1 - p$. By contrast, an unemployed agent who received social assistance transfers at time $t - 1$ and continues to be unemployed at time t will receive social assistance transfers (and no unemployment benefits) with certainty.

5 Calibration

We take a model period to be one month and normalize the monthly wage rate to $w = 1$. We choose a coefficient of relative risk aversion of $\gamma = 3$ and set the interest rate on savings r_s to match an annual return on assets of 3 percent. For the parameters related to unsecured credit, we use data on credit card borrowing from the Survey of Consumer Finances (SCF) 2004. We measure the credit limit in the data as a multiple of monthly after-tax labor income and choose the median of this statistic as our parameter for the borrowing constraint.⁹ We obtain $\underline{a} = -2.2$. The reported median annual interest rate on credit cards in the SCF 2004 is 11 percent.¹⁰ We set the monthly interest rate for borrowing r_b to match this number.

The benchmark UI policy consists of an asset-independent replacement rate of 50 percent, $b(a) = 0.5(1 - \tau)$, which approximately represents the average replacement rate in the United States.¹¹ Based on the design of the UI system in the United States, we choose $p = 5/6$, so that unemployed workers in expectation have access to unemployment benefits during the first six months of their spell. Social assistance benefits z are chosen according to the average transfer to unemployed workers in the United States once unemployment benefits have expired. This gives $z = 0.08(1 - \tau)$.¹² The employment tax rate is $\tau = 0.0259$ and is set to balance the

⁹We use the answer to the following question to determine the credit limit: “What is the maximum amount you could borrow on all of these accounts; that is, what is your total credit limit?” We categorize all households that do not indicate a limit as having no credit limit, and all households without a credit card as having a credit limit of zero.

¹⁰We use the answer to the following set of questions: “What interest rate do you pay on the card where you have the largest balance? What is the interest rate on the card you got most recently? What interest rate do you pay on this card?” Survey participants are asked one of those questions based on their previous answers during the interview. As emphasized in the documentation, the question aims at eliciting the interest rate that has to be paid on new balances.

¹¹According to the OECD, the net replacement rate during the first six months of unemployment in the United States in 2009 amounts to 0.49. This number is calculated for single persons with no children and averaged over three stylized pre-unemployment income levels. See www.oecd.org/dataoecd/17/21/49021188.xlsx for further details.

¹²The social assistance level of 0.08 is the net replacement rate for long-term unemployment (more than six months) in the United States in 2009, calculated for single persons with no children and averaged over three stylized pre-unemployment income levels. See www.oecd.org/dataoecd/17/19/49021050.xlsx for further details. Benefits include social assistance (SNAP) and housing benefits.

government's budget.

The parameters ψ and π_{EE} are chosen to replicate the average job finding and separation rates in the United States for the period from 1980 to 2004. Using data by Shimer (2012), we obtain a monthly transition rate from employment to unemployment of 2.03 percent and a monthly job finding rate of 30.69 percent. The target for β is the median ratio of liquid assets to monthly after-tax labor income of labor force participants in the United States. Based on the Survey of Consumer Finances 2004, we find this number to be 3.55. We discuss the asset data and our notion of liquidity in detail in Section 5.1. The calibration generates the following parameters: $\pi_{EE} = 0.9797$, $\psi = 0.0953$, $\beta = 0.9952$. The corresponding consumption and effort decisions are shown in Figure 1.

The job finding rates for different asset levels in Figure 1 are in line with two important empirical regularities. First, job finding rates are falling as a function of assets; see Rendon (2006), Card, Chetty, and Weber (2007), and Lentz (2009). Second, job finding rates increase once unemployment benefits have expired; compare Meyer (1990). Finally, we note that the elasticity of the job finding rate with respect to UI benefits ranges from 0.33 for wealthy agents to 0.54 for agents at the borrowing constraint (Figure 2). The elasticities in our model are slightly higher than estimates by Meyer and Mok (2007) and slightly lower than estimates by Chetty (2008). Overall, our results are within the range of empirically plausible elasticities (perhaps somewhat toward the lower end); see Krueger and Meyer (2002) for an overview of the empirical literature.

5.1 Empirical findings on asset holdings

Our data source to document the liquid wealth of households is the 2004 Survey of Consumer Finances (SCF). Unlike other survey data sets, the SCF is designed to also provide information on the wealthiest households in the United States population. To make the data comparable to the Current Population Survey (CPS), which is used for labor market transition rates, we follow Kaplan and Violante (2010) and drop the 5 percent of households with the highest net worth. We follow Bucks, Kennickell, and Moore (2006) for the definition of variables. We further restrict the sample to households that participate in the labor force and with average wage income above half the federal minimum wage. We provide further details in the appendix.

We construct three different measures of the liquid wealth of households. The strictest definition of liquid wealth (L1) contains transaction accounts (checking, saving, money market, call accounts) and tradable assets like mutual funds, stocks, and bonds. We subtract revolving debt. This liquidity measure corresponds to the definition of liquid assets in Kaplan and Violante (forthcoming). The second measure is our preferred measure and is used for the calibration of the benchmark model. It adds to L1 the value of cars net of debt. This liquidity measure is based on the idea that unemployment leads to a substantial reduction in household income, so that households might be willing to access additional funds for consumption smoothing during such a period.¹³ We call this measure L2. The broadest measure of liquidity (L3) adds to L2 certificates of deposit, retirement liquid assets, saving bonds, cash value of life insurance, other managed investment, and other financial assets. This measure includes all financial assets plus the net value of cars with revolving debt subtracted.

We express all financial statistics relative to monthly after-tax labor income. We determine after-tax income using the statutory United States income tax code of 2004.¹⁴ Table 1 shows the quantiles of the asset distributions. The final column shows the distribution from the benchmark calibration of our model that matches the median of the L2 measure. We provide a sensitivity analysis in which we match the median of L1 and L3, and one in which we match the lower and upper quartile in addition to the median of the L2 measure.

Quantile	L1	L2	L3	model
10	-1.06	0	0.38	1.26
25	0	1.32	2.65	2.39
50	0.68	3.55	8.14	3.55
75	3.44	8.12	21.70	4.44
90	12.61	18.82	48.69	5.04

Table 1: Percentiles of the distribution of different liquid wealth measures (relative to monthly after-tax labor income)

¹³Kaplan and Violante (forthcoming) look at a positive event and study the marginal propensity to consume out of a fiscal stimulus payment. In this case, the value of cars should not be part of the measure of liquidity.

¹⁴We use a simplified version of the United States tax code to derive after-tax income (see appendix for details). As sensitivity checks, we constructed after-tax labor income using the NBER TAXSIM calculator (Feenberg and Coutts, 1993) and the estimated tax code by Guner, Kaygusuz, and Ventura (forthcoming). The results are virtually identical.

6 Optimal unemployment insurance

We use the calibrated model as our benchmark for the analysis of optimal UI. The social welfare function is utilitarian. As a first step, we analyze the optimal replacement rate when UI benefits are independent of agents' asset holdings. In a second step, we analyze asset-dependent UI benefits.

6.1 Asset-independent unemployment insurance

We hold all other parameters fixed and vary only the replacement rate of the UI system (using a step size of 0.01) while adapting the employment tax rate to keep the government's budget balanced. Table 2 displays median asset holdings, unemployment rates, employment taxes, and welfare changes expressed as consumption equivalent variation with and without the transition to the new steady state.

Steady state welfare is strongly biased in favor of policies that increase the asset stock, as those policies generate more capital income. Since asset holdings change considerably between the different policies, steady state welfare is problematic for the current analysis, because it abstracts from the costs of transiting to the new system. In fact, according to this welfare measure, it would be optimal to abolish UI.

The second welfare measure includes the transition phase to the new steady state. This is our preferred welfare measure, as it includes the costs (benefits) of accumulating (decumulating) assets on the way toward the new steady state. When computing the transition, we assume that the UI reform is not anticipated and takes effect immediately at the time it is announced. Imbalances in the government budget during the transition phase are rebated to agents as an initial lump-sum tax or transfer.¹⁵

Based on welfare including the transition phase, the optimal replacement rate is 0.61. The welfare gain relative to the benchmark policy is negligible, as welfare rises by only 0.027 percent in consumption equivalent terms. The benchmark replacement rate of 0.5 is hence very close to optimal.

¹⁵In the experiment, surpluses in the government budget arising from the transition phase are rebated to the agent in a front-loaded way. This convention is beneficial for the agent in the case of budget surpluses but harmful in the case of deficits. However, the timing convention is not driving our results. First of all, the implied transfers are very small for most policies. Second, the results remain almost unchanged if we balance the budget effects of the transition phase by running a surplus (or deficit) in the new steady state, rather than by means of an initial transfer.

Table 2: Steady states for asset-independent replacement rates

replacement	assets	unemployment	tax	welfare change (steady state)	welfare change (incl transition)
0.10	5.10	5.6%	0.6%	0.334%	−0.484%
0.20	4.64	5.7%	1.0%	0.260%	−0.307%
0.30	4.22	5.8%	1.5%	0.185%	−0.168%
0.40	3.87	6.0%	2.0%	0.100%	−0.066%
0.50	3.55	6.2%	2.6%	0.000%	0.000%
0.60	3.26	6.4%	3.2%	−0.121%	0.026%
0.61	3.24	6.4%	3.2%	−0.135%	0.027%
0.70	3.02	6.7%	3.8%	−0.270%	0.010%
0.80	2.81	6.9%	4.5%	−0.455%	−0.057%
0.90	2.65	7.3%	5.2%	−0.686%	−0.183%

Notes: Results of varying the replacement rate starting from the benchmark economy. Column 1 presents the different replacement rates, column 2 the median asset holdings in the economy, column 3 the unemployment rate, column 4 the tax rate, and column 5 the steady state welfare change expressed as equivalent variation in consumption generated by moving from the benchmark economy to the economy with the new replacement rate. Column 6 includes the welfare effects of the transition phase.

6.2 Asset-dependent unemployment insurance

In the next step, we allow UI benefits $b(a)$ to depend on assets, holding the tax rate $\tau = 0.0259$ fixed at the benchmark level. Section 7.1 explores alternative tax rates. Appendix B studies nonlinear functional forms. Here, we consider schemes where the replacement rate depends on assets in a linear way,

$$\frac{b(a)}{1 - \tau} = \alpha_1 (a - \underline{a}) + \alpha_2. \quad (4)$$

We explore various slopes α_1 (using a step size of 0.005) and choose the level parameter α_2 to preserve budget balance. Note that α_2 corresponds to the replacement rate at the borrowing constraint. As before, we use utilitarian welfare including the transition phase as the relevant welfare measure. The optimal asset-dependent UI system is given by parameters $\alpha_1 = -0.02$ and $\alpha_2 = 0.594$ (Table 3). The welfare gain over the asset-independent benchmark system is very limited and amounts to 0.03 percent in consumption equivalent terms. Stronger forms of asset testing quickly lead to substantial welfare losses. Hence, asset testing does little to improve welfare but can easily reduce welfare, as Table 3 shows.

Under the optimal asset-tested system, one additional monthly labor income in assets reduces the replacement rate by 2 percentage points. The replacement rate equals 59 percent at the borrowing constraint and drops to 55 percent for agents with zero, and 50 percent for agents

Table 3: Steady states for asset-dependent replacement rates

α_1	replacement (borr constr)	replacement (median)	assets	unemployment	welfare change (incl transition)
-0.20	0.949	0.479	0.15	5.2%	-0.691%
-0.15	0.884	0.488	0.44	5.3%	-0.449%
-0.10	0.804	0.491	0.93	5.5%	-0.213%
-0.06	0.719	0.494	1.54	5.7%	-0.053%
-0.04	0.664	0.496	1.99	5.9%	0.004%
-0.02	0.594	0.498	2.61	6.0%	0.030%
0.00	0.500	0.500	3.55	6.2%	0.000%
0.02	0.348	0.499	5.35	6.5%	-0.157%

Notes: Results for asset-dependent replacement rates. Column 1 gives the slope of the replacement rate with respect to assets. Columns 2 and 3 present the replacement rate at the borrowing constraint and at median assets, respectively. The replacement rate at the borrowing constraint coincides with the level parameter α_2 . Column 4 presents the median asset holdings in the economy, column 5 the unemployment rate, and column 6 the welfare change expressed as equivalent variation in consumption (including the transition phase). The tax rate $\tau = 0.0259$ is fixed at the benchmark level.

with median asset holdings. Figure 3(a) plots the replacement rate under this system. Figures 3(b) and 3(c) display the corresponding consumption decisions and job finding probabilities.

Figure 4 displays the individual-specific welfare effects of the optimal asset-tested UI system. We note that the individual welfare effects are decreasing in asset holdings. Employed agents in the three poorest quartiles (assets below 4.5 months of labor income) gain from the policy reform, whereas those in the richest quartile lose. A very similar cutoff applies to unemployed agents, but welfare gains become significantly larger in magnitude. For unemployed agents at the borrowing constraint, the welfare gain reaches 1 percent of consumption. Finally, all recipients of social assistance benefits gain from the policy reform.

Asset-tested UI schemes with negative slopes α_1 generate slightly lower steady state unemployment rates than schemes with asset-independent or asset-increasing benefits. This is a direct consequence of how the policy experiment is designed. Recall that we fix the tax rate, which implies that the amount of government transfers is approximately the same for all policies. Since asset-tested UI schemes reduce the incentive for precautionary saving, the total amount of resources available during unemployment is lower for asset-tested schemes. As a result, job finding rates are higher. The fixed tax rate is not important for our result. Section 7.1 shows that the optimal rate of asset testing remains close to zero when we optimize additionally over the tax rate.

6.3 Welfare decomposition

Section 6.2 finds that the optimal slope of UI benefits with respect to assets is negative but close to zero. As we will see now, this result is due to a range of countervailing forces. Note that asset testing changes the levels of consumption and effort, the degree of cross-sectional inequality, and the amount of uncertainty that agents face. Moreover, there are transitional gains or losses from moving to the new steady state. This section provides a decomposition of the total welfare change into these effects. Our decomposition is based on ideas from Floden (2001) and Benabou (2002). However, their results do not apply to our setup, because welfare effects include a transition phase and preferences are additively separable between consumption and effort in our model.

Superscript A denotes the benchmark economy, and B the economy after the policy reform. Utilitarian welfare in economy $i \in \{A, B\}$ is given by

$$V^i = \sum_t \beta^t \int [u(c_t^i) - \phi(e_t^i)] d\mu_t^i.$$

We separate welfare into a consumption part and an effort part as follows:

$$\begin{aligned} V^{c,i} &= \sum_t \beta^t \int u(c_t^i) d\mu_t^i, \\ V^{e,i} &= \sum_t \beta^t \int \phi(e_t^i) d\mu_t^i. \end{aligned}$$

Due to the CRRA utility function, the consumption equivalent variation of the policy reform can be computed as

$$\omega = \left(\frac{V^B + V^{e,A}}{V^{c,A}} \right)^{1/(1-\gamma)} - 1.$$

We now provide a decomposition of the total welfare change ω into components due to level effects, changes in inequality and uncertainty, and effects due to the transition to the new steady state.

We first examine the steady state effects. In our framework, economy A is in its steady state, whereas economy B converges to its steady state after a transition phase. We denote the steady state distributions in the two economies by μ^A, μ^B . In what follows, the expectation operator denotes expectations with respect to the steady state distributions. For the steady

states, we define for each agent a certainty equivalent consumption level $\bar{c}^i$ depending on assets and employment (a_0, θ_0) as follows:

$$\frac{u(\bar{c}^i(a_0, \theta_0))}{1 - \beta} = \sum_t \beta^t \mathbb{E}[u(c_t^i) | a_0, \theta_0].$$

The average certainty equivalent $\bar{C}^i$ and the average consumption level C^i are

$$\bar{C}^i = \int \bar{c}^i d\mu^i, \quad C^i = \int c^i d\mu^i.$$

We define the cost of inequality p_{ineq}^i and uncertainty p_{unc}^i as follows:

$$\begin{aligned} u((1 - p_{\text{ineq}}^i) \bar{C}^i) &= \int u(\bar{c}^i) d\mu^i, \\ u((1 - p_{\text{unc}}^i) C^i) &= u(\bar{C}^i). \end{aligned}$$

The two costs represent the fractions of consumption that a utilitarian planner is willing to give up to eliminate inequality and uncertainty. The cost of inequality compares a single agent who consumes the average certainty equivalent to a cross section of agents who consume their individual certainty equivalents. The cost of uncertainty captures the difference between the average certainty equivalent and the average consumption level.

Using these concepts, we can express utilitarian consumption welfare in the steady state as

$$V_{\text{ss}}^{c,i} = (1 - p_{\text{ineq}}^i)^{1-\gamma} (1 - p_{\text{unc}}^i)^{1-\gamma} \frac{(C^i)^{1-\gamma}}{1 - \gamma}.$$

We are now ready for the decomposition result. We define the following five components:

$$\begin{aligned} \omega_{\text{ineq}} &= \frac{1 - p_{\text{ineq}}^B}{1 - p_{\text{ineq}}^A} - 1 \\ \omega_{\text{unc}} &= \frac{1 - p_{\text{unc}}^B}{1 - p_{\text{unc}}^A} - 1 \\ \omega_{\text{lev}} &= \frac{C^B}{C^A} - 1 \\ \omega_{\text{trans}} &= \left(1 + \frac{V_{\text{ss}}^B - V_{\text{ss}}^A}{V_{\text{ss}}^B + V^{e,A}} \right)^{1/(1-\gamma)} - 1 \\ \omega_{\text{eff}} &= \left(1 + \frac{V^{e,A} - V_{\text{ss}}^{e,B}}{V_{\text{ss}}^{c,B}} \right)^{1/(1-\gamma)} - 1 \end{aligned}$$

Proposition 1. *The consumption equivalent variation equals*

$$\omega = [1 + \omega_{\text{ineq}}] [1 + \omega_{\text{unc}}] [1 + \omega_{\text{lev}}] [1 + \omega_{\text{trans}}] [1 + \omega_{\text{eff}}] - 1.$$

The proof of Proposition 1 is relegated to Appendix A. Proposition 1 decomposes the total welfare change ω into three components regarding steady state consumption: changed consumption inequality ω_{ineq} , changed consumption uncertainty ω_{unc} , and a level change ω_{lev} . In addition, the component ω_{eff} picks up steady state changes in effort, and the component ω_{trans} captures transitional effects. Since the disutility of effort is linear in our model, ω_{eff} is a pure level effect and unrelated to uncertainty or inequality.

Table 4 decomposes the welfare consequences of asset-tested unemployment insurance. We see that the welfare gain of optimal asset testing ($\alpha_1 = -0.02$) is almost entirely due to a transitional effect (0.439 percent in consumption terms) resulting from asset decumulation after the policy reform. The welfare gain of reduced consumption inequality (0.002 percent) is positive but negligible. On the one hand, asset testing alleviates the consumption inequality among unemployed workers. On the other hand, asset testing reduces the incentive for private insurance and thereby exacerbates the inequality between employed and unemployed workers. Overall, consumption inequality thus improves only marginally.

Table 4: Welfare decomposition for asset-dependent replacement rates

α_1	ω_{ineq}	ω_{unc}	ω_{lev}	ω_{trans}	ω_{eff}	ω
-0.06	0.004	-0.256	-0.027	0.939	-0.706	-0.053
-0.04	0.003	-0.177	-0.042	0.730	-0.506	0.004
-0.02	0.002	-0.092	-0.042	0.439	-0.275	0.030
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.02	-0.005	0.105	0.186	-0.793	0.355	-0.157

Notes: All welfare effects are expressed in consumption equivalent terms (in percent).

The negative welfare consequences of asset testing take the form of increased uncertainty (-0.092 percent in consumption terms), reduced consumption levels (-0.042 percent), and increased effort levels (-0.275 percent). Uncertainty and effort increase for the very same reason: asset testing taxes the private insurance technology and increases the consumption drop from unemployment. This causes larger consumption uncertainty as well as higher job search efforts in order to escape from unemployment more quickly. The level effect of consumption,

finally, is due to lower asset income in the new steady state.

All in all, we see that the positive and negative consequences of asset testing nearly offset each other. Furthermore, the magnitudes of the various welfare effects are monotonic in the degree of asset testing and switch signs once we have positive slopes.¹⁶ The trade-off between the different welfare components therefore applies to asset testing in general and not just to the optimal policy.

6.4 Comparison to a single-spell model

Following Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997), we now explore a version of the model in which all agents begin their life unemployed and experience only a single unemployment spell. The ex ante asset distribution is exogenous and is set to the steady state asset distribution of unemployed agents of the benchmark model with a replacement rate of 0.5. Agents have the same preferences and search technology as before. However, once an unemployed agent finds a job, she keeps the job forever, and we set her consumption to net labor income $(1 - \tau)w$ plus asset-dependent interest income (possibly negative) for the rest of her life.

As in Section 6.2, we fix the tax rate at $\tau = 0.0259$ and explore various slopes for asset-tested UI benefits. We cannot balance the government's budget in steady state, because the model is nonstationary, and in the long run all agents will be employed with certainty. We therefore compute the present discounted value of government expenditures minus tax revenues in the single-spell model with a replacement rate of 0.5 and require all asset-tested UI schemes to generate the same present discounted value for the government. We choose the intercept of the benefit function to achieve this. In line with Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997), we define welfare as the utilitarian welfare of the group of initially unemployed workers.

The optimal asset-tested UI system is a corner solution given by parameters $\alpha_1 = -0.114$ and $\alpha_2 = 1.0$. The optimal system is tantamount to the strongest possible asset test subject to the restriction that replacement rates do not exceed one. Unemployment benefits decrease with assets about six times as quickly as in the optimal system from the benchmark model. Two main

¹⁶The only nonmonotonic part is the level effect for consumption. Asset testing reduces average consumption levels due to lower asset income but increases average consumption due to higher employment rates.

reasons are responsible for the strong bias of the single-spell model toward asset testing. First, the asset distribution at the time of job loss is fixed by construction. This avoids the adverse effect of asset testing on asset accumulation present in the benchmark model. Second, the single-spell model affects the incentive to dissave during unemployment. Since agents face no risk of becoming unemployed again, assets have no insurance value beyond the first unemployment spell. Therefore, asset decumulation during unemployment is very attractive in the single-spell model. This increases the heterogeneity of asset holdings within the group of unemployed agents and makes redistribution among unemployed agents more desirable.

7 Extensions and robustness

7.1 Alternative calibrations

This section explores the sensitivity of optimal asset testing with respect to some key parameters and alternative calibration targets. The remaining parameters are recalibrated to match the targets for monthly transition rates and median liquid asset holdings.

In the first experiment, we use alternative calibration targets for liquid asset holdings (L1 and L3 from Section 5.1). The first liquidity measure (L1) uses a very conservative definition of liquidity, whereas the second measure (L3) uses a very generous definition. We then explore alternative values for the coefficient of relative risk aversion, $\gamma \in \{2, 4\}$. Finally, we allow the government to jointly choose the tax rate and the parameters for asset tests. Table 5 lists the parameters of optimal asset tests for all experiments. We note that the optimal slope of UI benefits with respect to assets is close to zero in all cases. Optimal asset testing is most significant for the conservative liquidity definition L1, in which the median household has liquid assets of less than one monthly labor income. Even in this extreme case, the welfare gains of introducing asset testing remain small.

7.2 Epstein-Zin preferences

The CRRA utility specification from the benchmark model links the intertemporal elasticity of substitution invariably to the tolerance toward risk. To explore whether this limitation is important for our results, we study generalized recursive preferences that allow for a distinction between the intertemporal elasticity of substitution and the coefficient of relative risk aversion.

Table 5: Asset-dependent replacement rates for alternative calibrations

	α_1	replacement (borr constr)	replacement (median)	welfare change (incl transition)
less liquidity (L1)	-0.06	0.63	0.49	0.088%
more liquidity (L3)	0.00	0.50	0.50	0.000%
risk aversion $\gamma = 2$	-0.01	0.55	0.50	0.017%
risk aversion $\gamma = 4$	-0.03	0.64	0.50	0.044%
endogenous taxes ($\tau = 0.033$)	-0.02	0.71	0.62	0.059%
Epstein-Zin preferences	-0.01	0.55	0.50	0.027%

Notes: Results for replacement rates that are linear in assets. The first column describes the calibration. Column 2 gives the optimal slope of the replacement rate with respect to assets. Columns 3 and 4 present the replacement rate at the borrowing constraint and at median assets, respectively. Column 5 presents the welfare change expressed as equivalent variation in consumption (including the transition phase). For the case of generalized preferences, the equivalent variation is determined numerically.

One such recursive preference specification has been proposed by Epstein and Zin (1989). Most applications of these preferences consider consumption as the only argument to the utility function. Swanson (2013) discusses how a labor choice can be incorporated into this framework. We follow his formulation of preferences but replace the labor choice by an effort choice. The optimization problem for the case of generalized recursive preferences reads

$$v(a, \theta) = \max_{\{a', e\}} u(c) - \phi(e) + \beta \left(\mathbb{E} [v(a', \theta')^{1-\alpha}] \right)^{\frac{1}{1-\alpha}}. \quad (5)$$

Comparing equation (5) to the case of CRRA preferences in equation (2) shows that the only difference is a *twisted* expectation operator for next period's value function. Swanson (2013) shows that this formulation nests the preference specification of Epstein and Zin (1989). As is common with generalized recursive preferences, the case of a utility function with a negative image set requires a reformulation of the Bellman equation in (5). We therefore specify the Bellman equation as

$$v(a, \theta) = \max_{\{a', e\}} u(c) - \phi(e) - \beta \left(\mathbb{E} [(-v(a', \theta'))^{1-\alpha}] \right)^{\frac{1}{1-\alpha}}. \quad (6)$$

For $\alpha = 0$, we nest our benchmark case of CRRA preferences in which the coefficient of relative risk aversion coincides with the inverse of the intertemporal elasticity of substitution. For $\alpha < 0$, relative risk aversion exceeds the inverse of the intertemporal elasticity of substitution, and the reverse is true for $\alpha > 0$. The problem remains tractable and first-order conditions are

straightforward to derive.¹⁷

The estimates for the intertemporal elasticity of substitution generally differ across studies. Following estimations by Blundell, Browning, and Meghir (1994) based on micro data, we set the intertemporal elasticity of substitution to 0.75 by choosing $\gamma = 4/3$. We choose $\alpha = -8$ to match a coefficient of relative risk aversion of 4.¹⁸ As usual, we calibrate ψ and β to match the empirical job finding rate and median liquid assets. This results in $\beta = 0.9962$ and $\psi = 0.1149$. The tax rate of 0.0257 balances the government's budget given a UI replacement rate of 0.5. The final row of Table 5 shows that the optimal slope of the benefit function equals $\alpha_1 = -0.01$ and that the resulting welfare gains are small. Hence, generalized recursive preferences do not alter the result of an optimal slope close to zero.

7.3 Heterogeneous discount factors

In its basic version, the model generates less asset heterogeneity than we find in the data. This is a well-known problem of incomplete markets models. A larger degree of heterogeneity might change the case in favor of stronger asset tests. To check the sensitivity of our results, we follow the approach by Krusell and Smith (1998) and generate a larger variation in the asset distribution using heterogeneous time discount factors.

Throughout this section, we explore a version of the model in which agents have discount factors $\beta \in \{\beta_1, \beta_2, \beta_3\}$. The share of agents with discount factor β_i equals one-third for $i = 1, 2, 3$. Discount factors are permanent. We recalibrate the model to match the targets from Section 5 and the 25th and 75th percentiles of liquid asset holdings (L2). This generates parameters of $\psi = 0.098$, $\beta_1 = 0.9899$, $\beta_2 = 0.9955$, and $\beta_3 = 0.9973$. As before, we set $\gamma = 3$. The tax rate to obtain budget balance at a replacement rate of 0.5 is $\tau = 0.0258$.

With heterogeneous preferences, the definition of a welfare measure becomes less straightforward. For simplicity, we aggregate welfare using equal weights for all types. Since period utilities include the factor $(1 - \beta_i)$ by construction, it is easy to see that the first best allocation consists of full consumption insurance across all states and types. Hence, there is no motive to redistribute from patient to impatient agents (or vice versa) based on pure preference

¹⁷In comparison to CRRA preferences, the first-order conditions for the generalized case contain an additional multiplication by the expected value function for the next period. We adjust the numerical routines appropriately.

¹⁸See Swanson (2013) for details on how to derive the coefficient of relative risk aversion for this class of preferences.

heterogeneity.

The findings from Section 6 generalize to the model with heterogeneous discount factors and the resulting higher heterogeneity in assets. As before, we use utilitarian welfare including the transition phase as the relevant welfare measure. The optimal asset-tested UI policy is given by parameters $\alpha_1 = -0.03$, $\alpha_2 = 0.640$ and generates a welfare gain of 0.10 percent in consumption equivalent terms. Hence, compared to Section 6, the larger fraction of poor agents results in a slightly larger welfare gain of asset testing. However, the optimal asset test is still rather lenient: the replacement rate equals 64 percent at the borrowing constraint and drops to 52 percent for agents with median asset holdings.

The model with discount factor heterogeneity matches by construction the asset heterogeneity as measured by the interquartile range from the data. The Gini coefficient is a measure of inequality that puts considerably more emphasis on extreme observations. It is well known that standard incomplete markets models fall notoriously short of reproducing the empirical degree of inequality captured by the Gini coefficient. Our model considers liquid assets only, but inequality of this asset class still has a substantial Gini coefficient of 0.72 in the data.¹⁹ Our model generates a Gini coefficient of 0.53, also indicating substantial heterogeneity. The Gini coefficients in model and data match very closely once we trim the data for extreme observations. In line with our calibration, we remove all liquid asset observations that are smaller than -2.2 months of after-tax labor income (our borrowing limit). We also remove all observations where liquid assets exceed 24 months of after-tax labor income. If we compute the Gini coefficient for this sample, we find a number of 0.54, which matches almost exactly the Gini coefficient from the model.

8 Concluding remarks

This paper studies whether UI benefits should depend on individual asset holdings. We answer this question in a quantitative incomplete markets model where agents face moral hazard during job search, accumulate a risk-free asset for self-insurance, and have access to unsecured credit. We find that the optimal rate of asset testing is close to zero and has negligible effects on social welfare. We also find a replacement rate of 50 percent to be close to optimal, so we conclude that

¹⁹To abstract from heterogeneity in labor income, we report the Gini coefficient of liquid assets divided by after-tax labor income. If we look at the Gini coefficient of liquid assets, we find it to be 0.74.

the current U.S. unemployment insurance system is approximately optimal regarding its level as well as the absence of asset tests. We provide a welfare decomposition for policy experiments in heterogeneous agent models with transition dynamics that highlights the countervailing welfare effects from introducing asset testing.

A few final remarks seem appropriate. First, it is important to keep in mind that, in line with most contributions to this literature, there is no heterogeneity of agents with respect to skills/wages or age in our model. It is common practice in the United States (and in many other countries) to determine UI benefits using a replacement rate relative to the worker's previous wage. Our research design explores whether or not this replacement rate should be asset tested. Redistribution of wage inequality is orthogonal to that question and a task for income tax policy. Regarding life-cycle variation, our model provides a good description of the financial situation of prime-age workers.²⁰ Our model misses aspects of unemployment insurance related to young workers entering the labor market or workers close to retirement. Those workers face different labor market conditions and also have access to alternative insurance channels (active labor market policy, family insurance, early retirement, etc).²¹ This creates a rationale for age-dependent UI programs studied by Michelacci and Ruffo (2013).²² As for the redistribution of wage inequality, the question of optimal taxes and transfers over the life cycle is orthogonal to the issue of asset testing.

Second, we would like to remark that in practice, assets are observable for the UI agency at a cost only. Taking those costs into account would further strengthen our results, because asset tests then become even less attractive. Third, we would like to comment on the partial equilibrium nature of our model. Clearly, any policy that changes aggregate asset holdings will have some consequences for the equilibrium wage and interest rate. However, since our research question focuses on liquid assets held by typical labor force participants, and since wealth in the United States is heavily concentrated, the effects on asset accumulation in our model will have a very limited impact on the aggregate capital stock.²³ Finally, we acknowledge that agents may resort to illiquid assets for consumption smoothing during long unemployment

²⁰See Appendix C for evidence on age variation and the model's fit.

²¹Pavoni, Setty, and Violante (2013) study mandatory work and job search assistance programs in addition to standard unemployment insurance, Kaplan (2012) studies insurance by the family for young workers, and Jung and Kuhn (2012) show that transitions out of the labor force increase steeply after the age of 50.

²²Michelacci and Ruffo (2013) discuss optimal UI and tax design over the life cycle, but leave it as an open question whether asset tests offer an improvement over the current system.

²³For general equilibrium effects of unemployment insurance, see Young (2004).

spells. Therefore, a model that allows for liquid and illiquid assets would be a valuable extension for future research.²⁴

Appendix

A Proof of Proposition 1

Proof of Proposition 1. We write steady state consumption welfare as

$$V_{ss}^{c,i} = (1 - p_{\text{ineq}}^i)^{1-\gamma} (1 - p_{\text{unc}}^i)^{1-\gamma} \frac{(C^i)^{1-\gamma}}{1-\gamma}.$$

Then we obtain

$$\begin{aligned} (1 + \omega)^{1-\gamma} &= \frac{V^B + V^{e,A}}{V^{c,A}} = \frac{V_{ss}^{c,B}}{V^{c,A}} \frac{V^B + V^{e,A}}{V_{ss}^{c,B}} \\ &= \frac{(1 - p_{\text{ineq}}^B)^{1-\gamma} (1 - p_{\text{unc}}^B)^{1-\gamma} (C^B)^{1-\gamma} V^B + V^{e,A}}{(1 - p_{\text{ineq}}^A)^{1-\gamma} (1 - p_{\text{unc}}^A)^{1-\gamma} (C^A)^{1-\gamma} V_{ss}^{c,B}}. \end{aligned}$$

Using the identity $V^i = V^{c,i} - V^{e,i}$, we obtain

$$\begin{aligned} \frac{V^B + V^{e,A}}{V_{ss}^{c,B}} &= \frac{V_{ss}^B - V_{ss}^B + V^B + V^{e,A}}{V_{ss}^{c,B}} \frac{V_{ss}^{c,B} + V^{e,A} - V_{ss}^{e,B}}{V_{ss}^B + V^{e,A}} \\ &= \left(1 + \frac{V^B - V_{ss}^B}{V_{ss}^B + V^{e,A}}\right) \left(1 + \frac{V^{e,A} - V_{ss}^{e,B}}{V_{ss}^{c,B}}\right). \end{aligned}$$

Taken together, the last two equations generate the decomposition

$$\omega = [1 + \omega_{\text{ineq}}] [1 + \omega_{\text{unc}}] [1 + \omega_{\text{lev}}] [1 + \omega_{\text{trans}}] [1 + \omega_{\text{eff}}] - 1.$$

This completes the proof. □

²⁴Kaplan and Violante (forthcoming) explore the response to fiscal stimulus payments in a model with liquid and illiquid assets.

B Nonlinear asset tests

We now consider a more flexible functional form for UI benefits. We fix the replacement rate for borrowing-constrained agents at 0.594, in line with the optimal linear asset test, and consider the class of functions

$$\frac{b(a)}{1-\tau} = 0.594 \exp\left(-\frac{(a-\underline{a})^{\lambda_1}}{\lambda_2}\right),$$

where λ_1, λ_2 are positive parameters. The class is quite broad and contains convex functions, approximately linear ones, as well as functions that are concave at low asset levels and convex at high asset levels. Parameter λ_1 determines the shape of the function, and parameter λ_2 is chosen for budget balance. The parameters that maximize welfare (including the transition phase) are $\lambda_1 = 0.9$, $\lambda_2 = 23.86$. For these parameters, benefits are very close to linear in assets. The welfare gain relative to the asset-independent benchmark UI system coincides with that of the optimal linear asset test.

C Data and sample selection

We use data from the 2004 Survey of Consumer Finances (SCF). The SCF is a representative household survey that provides comprehensive information on the U.S. households' income and wealth situation. Income information in the SCF always refers to the previous calendar year, and we adjust all data to real 2004 dollars using the CPI index (CPI-U-RS). We restrict the sample to households with household heads between age 16 and 65 who participate in the labor force. This excludes households where the household head reports as current work status retired, disabled, student, and other not in the labor force.

The SCF aims at providing a comprehensive picture of wealth of U.S. households including the very wealthy households. To make the SCF data comparable to other survey data that usually do not cover very wealthy households, we follow Kaplan and Violante (2010) and drop the 5 percent of households with the highest net worth.²⁵ To construct wages, we use the information on hours of husband and wife and total family income from wages and salaries. We drop all households that report wages below half the federal minimum wage. Below, we describe in detail how we derive after-tax income by applying a stylized version of the year 2004

²⁵We follow Bucks, Kennickell, and Moore (2006) for the definition of net worth and other income and asset variables.

U.S. labor income tax code. To construct a measure of revolving debt, we follow Kaplan and Violante (forthcoming) based on SCF questions on credit card balances.

We closely follow Krebs, Kuhn, and Wright (2013) in computing labor taxes. We use nominal tax brackets for the year 2004 to compute average tax rates.²⁶ The rates vary according to the filing status of the household. We distinguish between *married couples filing jointly* and *single* households. For 2004, the U.S. income tax brackets and marginal tax rates are given in Table 6. The social security tax rate paid by employees was 7.65 percent in 2004. We assume that the 7.65 percent tax rate applies for all households.²⁷ In 2004 every household could deduct a \$1,000 child tax credit for each dependent child under age 17 from its tax obligations.²⁸ There is no specific information on age of children in the SCF. We apply the tax credit for all natural children, step children, and foster children of head or spouse. The child tax credit applies to income taxes and social security taxes, so that tax rates can be even lower than the 7.65 percent social security tax. The numbers for the personal exemption for married couples, single people, and per dependent for 2004 are \$6,100, \$3,050, and \$3,050, respectively. That is, in 2004, a married household filing jointly could claim \$6,100 plus an extra \$3,050 per dependent. As sensitivity checks, we constructed after-tax labor income using the NBER TAXSIM calculator (Feenberg and Coutts, 1993) and the estimated tax code by Guner, Kaygusuz, and Ventura (forthcoming). The resulting medians for the L2 liquidity measure of assets relative to monthly after-tax income are 3.59 and 3.55, so the results are virtually identical to our standard approach.

Marginal Tax Rate	Married Filing Jointly Tax Brackets		Single Tax Brackets	
	Over	Below	Over	Below
10.0%	\$0	\$14,300	\$0	\$7,150
15.0%	\$14,300	\$58,100	\$7,150	\$29,050
25.0%	\$58,100	\$117,250	\$29,050	\$70,350
28.0%	\$117,250	\$178,650	\$70,350	\$146,750
33.0%	\$178,650	\$319,100	\$146,750	\$319,100
35.0%	\$319,100	-	\$319,100	-

Table 6: Tax rates for 2004

We abstract from life-cycle variation in our analysis. The reason is that the data on liquid

²⁶See data from the Tax Foundation: <http://taxfoundation.org/article/us-federal-individual-income-tax-rates-history-1913-2011-nominal-and-inflation-adjusted-brackets>.

²⁷The annual limit for social security taxes in 2004 has been \$87,900 for each employee. For a single individual, this exceeds the 95th percentile of the income distribution, so we abstract from it for the current analysis.

²⁸See IRS for details on dependent status: <http://www.irs.gov/uac/Ten-Facts-about-the-Child-Tax-Credit>.

assets show only small variations during different phases of working life. For example, if we look at young households (household head younger than 35 years), liquid assets using our preferred definition L2 have a median of 2.74, compared to a median of 3.34 when the household head is 35–44 years old, or 4.28 when the household head is 45–54 years old. These levels of liquid assets are within the range of the upper and lower quartiles of our benchmark calibration (Table 1). We therefore argue that the benchmark model captures well the financial situation related to unemployment for prime-age workers. Similar results apply to the two other measures of liquidity we consider. For the conservative measure of liquidity (L1), median assets for the same age group vary between 0.42 and 0.92. For the broadest measure of liquidity (L3), median assets vary between 4.58 and 13.34. The calibrated model roughly covers these ranges of liquid assets within the range of the upper and lower quartiles. For the calibration that matches the median of L1 (L3), the lower quartile is 0.25 (5.90) and the upper quartile is 0.92 (10.36).

D Computation

This section sketches how we solve the agent’s problem, determine the stationary distribution, and find the optimal policy parameters of the UI system. Since we use standard numerical techniques, we will outline only the general steps of the computation.

We study benefit schedules that are differentiable in assets and assume that first-order conditions are sufficient for the solution of the agent’s problem. The agent’s first-order conditions are straightforward to derive. The agent’s effort decision is characterized by the following condition:

$$\phi'(e) = \beta\pi'_{\theta E}(e)v(a', E) + \beta\pi'_{\theta U}(e)v(a', U) + \beta\pi'_{\theta S}(e)v(a', S),$$

where $v(a, \theta)$ denotes the value function in employment state θ when the agent holds assets a . The value function is derived using standard value function iteration on the Bellman equation (2). The first-order condition for the optimal asset choice is also straightforward to derive. Due to asset testing, the condition involves a state dependent return $b'(a')$:

$$\frac{u'(c)}{\beta} = \pi_{\theta E}(e)(1 + \hat{r}(a'))u'(c'_E) + \pi_{\theta U}(e)(1 + \hat{r}(a') + b'(a'))u'(c'_U) + \pi_{\theta S}(e)(1 + \hat{r}(a'))u'(c'_S),$$

where c'_E, c'_U, c'_S denote the agent’s consumption in the next period in states E, U, S , respectively,

and $\hat{r}(a)$ denotes the interest rate schedule $r(a)$ that is smoothed around zero asset holdings:

$$\hat{r}(a) = \theta(a)r_s + (1 - \theta(a))r_b, \quad \theta(a) = (1 + \exp(-20a))^{-1}.$$

We restrict attention to recursive policy functions, so that finding the optimal policy function is equivalent to finding a fixed point to the first-order conditions. We verify numerically using grid search and value function iteration that using first-order conditions yields the agent's optimal decision. We determine the stationary distribution of the economy using a transition function on the same grid of asset states on which the policy functions are approximated. We interpolate transitions where necessary.

To compute the transition phase, we first solve for the steady state under the new policy using the method outlined above. Note that the agent's policy functions are stationary throughout the transition, because they only depend on individual states and the UI system, which is constant during the transition. The asset distribution, however, varies during the transition and thus the government's budget is not balanced in period-by-period terms. The present discounted value of budget surpluses or deficits is rebated as a lump-sum tax or transfer at the time of the policy change. We obtain very similar results if we balance the budget effects of the transition phase by running a surplus (or deficit) in the new steady state, rather than by means of an initial transfer.

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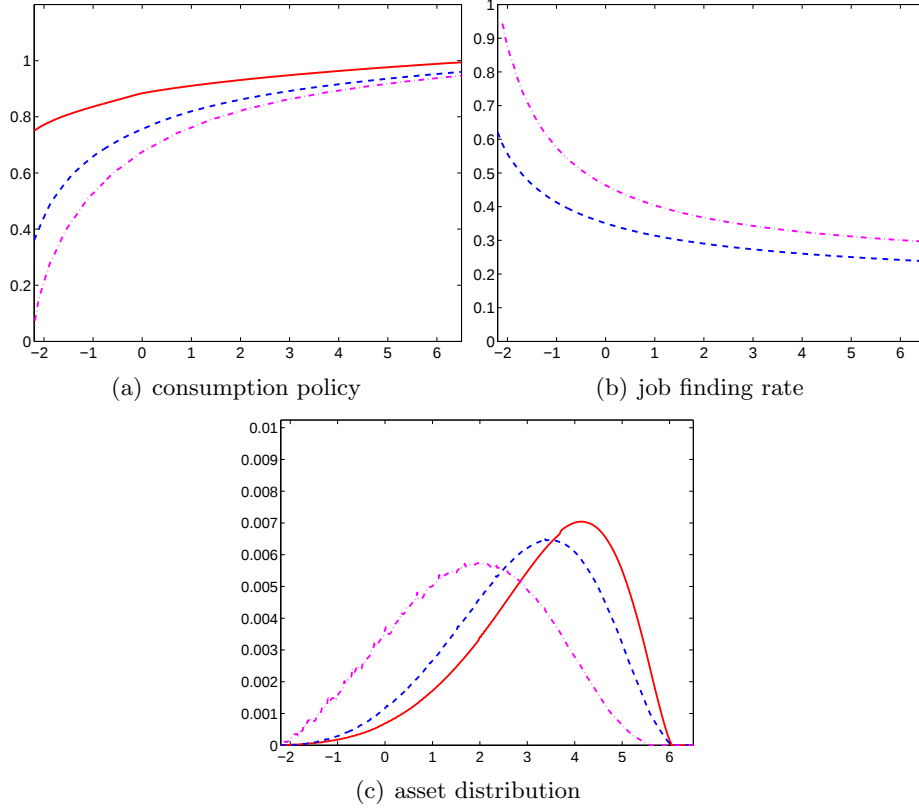
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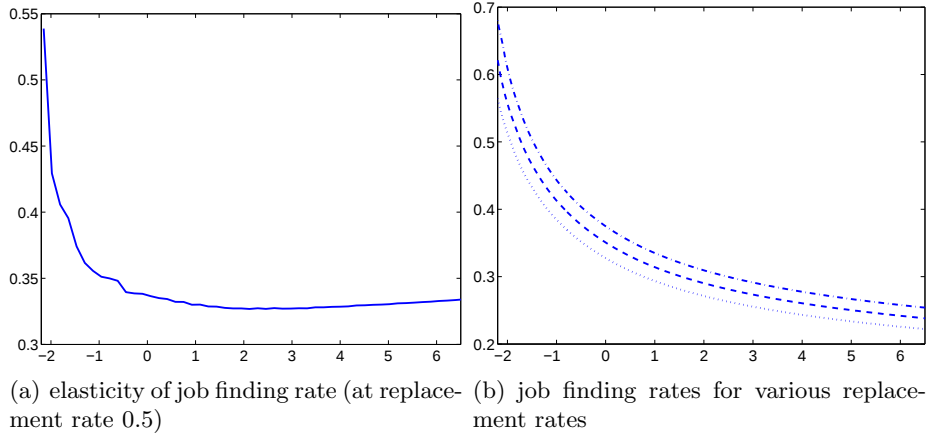
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Figure 1: Benchmark economy (replacement rate 0.5)



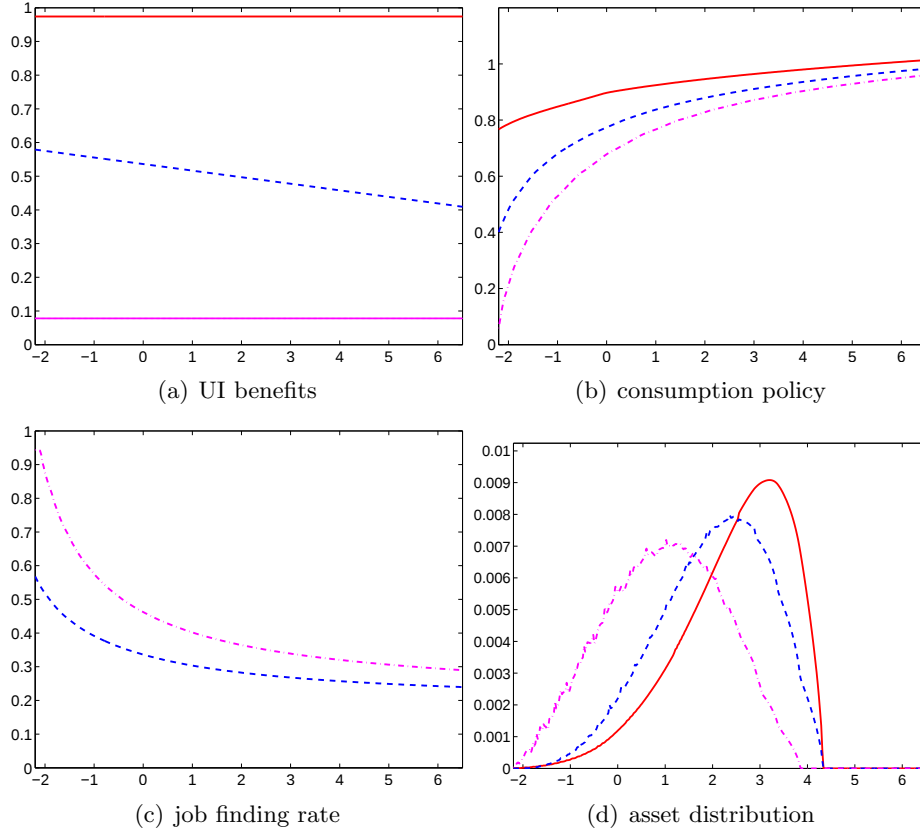
Notes: The upper left panel shows the consumption policy as a function of assets (months of labor income). The upper right panel shows the job finding rate as a function of assets. The lower panel displays the asset distribution. In all plots the red solid line represents employed workers, the blue dashed line represents unemployed workers, and the magenta dash-dotted line represents workers receiving social assistance.

Figure 2: Job finding rate



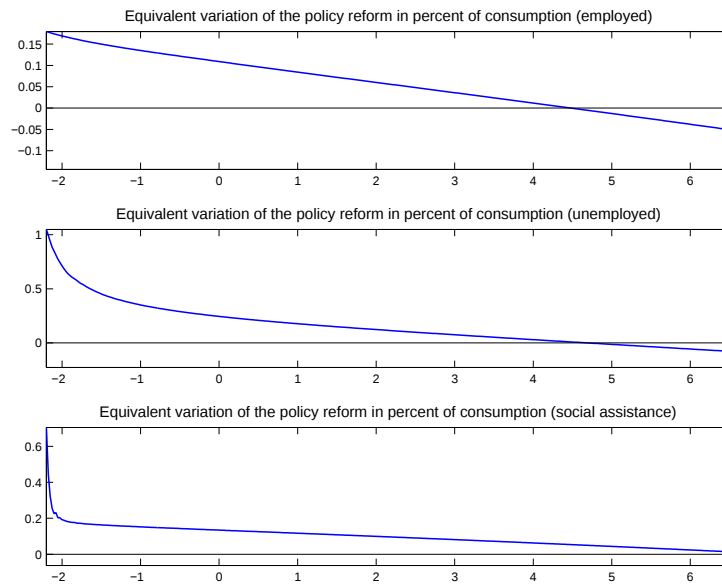
Notes: The left panel shows the elasticity of the job finding rate with respect to the replacement rate. The right panel shows the job finding rate for replacement rates of 0.4 (dash-dotted line), 0.6 (dotted line), and for the benchmark replacement rate of 0.5 (dashed line, same as in Figure 1(b)).

Figure 3: Optimal asset-tested UI system



Notes: The upper left panel shows the after-tax wage for employed workers, unemployment insurance benefits, and social assistance benefits as a function of assets (months of labor income). The upper right panel shows the consumption policy, and the lower left panel shows the job finding rate as a function of assets. The lower right panel displays the asset distribution. In all plots the red solid line represents employed workers, the blue dashed line represents unemployed workers, and the magenta dash-dotted line represents workers receiving social assistance.

Figure 4: Individual-specific welfare gains



Notes: This figure shows the individual-specific welfare gains (consumption equivalent variation in percent) of introducing the optimal asset-tested UI system. Welfare includes the transition phase.