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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. Asset testing has two counteracting effects on welfare. On the one hand, it improves consumption insurance by introducing state contingent transfers to agents most in need. On the other hand, it worsens the moral hazard problem, since workers have a reduced incentive to save and fewer private resources are used for consumption smoothing during unemployment. Our results show that in a realistically calibrated model of the U.S. economy the two effects nearly offset each other—the optimal rate of asset-testing is approximately zero. This finding is robust to several alternative specifications of the model, including a case with heterogeneous time-discount factors. We conclude that the current U.S. unemployment insurance system is approximately optimal.

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1 Introduction

The financial situation during unemployment is a key determinant of job search behavior. According to recent empirical evidence, 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 of consumption. They should therefore receive higher transfers, so UI should be asset-tested. On the other hand, asset-testing undermines the incentive for precautionary saving. Less precautionary saving shifts costs of unemployment from the individual to society. The moral hazard problem associated with job search aggravates and so 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 that we calibrate to the U.S. economy. We find unemployment insurance without asset-testing to be approximately optimal. The contemporaneous need for transfers to liquidity constrained households and the endogeneity of asset accumulation are both quantitatively relevant for the role of asset-testing. If the asset distribution of job losers, i.e. asset accumulation, is exogenous, we find strong asset-testing to be optimal. If asset accumulation is endogenous, the crowding out effect on precautionary savings leads to an optimal UI system that is approximately independent of the agents' asset holdings. At the optimal UI system, the replacement rate of unemployed agents with zero assets is a mere 5 percentage points higher than that of the median unemployed. The effect on social welfare is negligible: asset-testing raises welfare by less than 0.1 percent in consumption equivalent terms. Hence, the absence of asset-testing in the current U.S. unemployment insurance system is approximately optimal according to our model.

Due to the complexity of the government's problem in this 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 (Ram-

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[1]Silvio (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.

sey optimal policy).[2] We build an incomplete markets model in which workers are randomly separated and exert unobservable effort to influence their chances of finding a job. Workers accumulate or decumulate a risk-free asset during employment and unemployment subject to an exogenous borrowing limit. 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 optimal rate of asset-testing is approximately zero.

Our analysis puts strong discipline on the model's parameters. We calibrate the model according to empirical evidence on U.S. job finding and separation rates, as well as liquid asset holdings of labor force participants. The elasticity of the job finding rate with respect to the replacement rate in our model is well in line with empirical evidence. Moreover, the heterogeneity of this elasticity with respect to asset holdings matches the difference of empirical estimates along the asset distribution. This shows that our model matches the importance of liquidity relative to the data.

Starting from the calibrated benchmark economy, we proceed in two steps. We first show that for constant (asset-independent) replacement rates a 50 % replacement rate is approximately optimal. This is in line with results by Chetty (2008), who—using a different model and approach—finds that the current U.S. system is close to optimal in terms of the replacement rate. In the second step, we go beyond asset-independent UI and 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. To shed further light on this result, we build a second model with a fixed asset distribution of job losers (single-spell model). The optimal slope of UI benefits with respect to assets becomes in this case much more negative—about 8 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, this creates a strong countervailing force. Intuitively, asset-testing works like a tax on savings and punishes precautionary savings behavior. Asset-testing reduces therefore the extent to which workers internalize the costs of unemployment. The reason is that fewer private resources are used for consumption smoothing

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

during unemployment, and this worsens the moral hazard problem of the unemployed. An alternative, but closely related, explanation of our result is that asset tests hardly improve the credit market imperfections caused by borrowing constraints. The reason is that the same two counteracting forces offset each other: asset tests alleviate liquidity problems of poor unemployed workers, but reduce the level of precautionary asset holdings overall.

Welfare effects arising from transiting to an economy with asset testing are important and our analysis takes these effects into account. We show that our results are robust to alternative parameter values and simultaneous changes in tax rates and UI benefits. They are also robust to additional asset heterogeneity generated by heterogeneous time discount factors.

The paper proceeds as follows. The next section reviews the related literature. Sections 3 and 4 describe our model and calibration strategy. Section 5 contains the main results. In addition, we provide a link to the literature on single spell models of unemployment, and explain why such models are severely biased towards asset-testing. Several robustness checks and extensions of the model are provided in Section 6. Section 7 concludes.

2   Related literature

To the best of our knowledge, this is the first paper analyzing 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 only 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, since agents lose the incentive to accumulate assets in the first place. This explains why strong asset-testing diminishes social welfare in our model. 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. First, unemployment savings accounts require a much more drastic reform. Second, such accounts are illiquid and cannot be used for shocks other than unemployment. Finally, mandatory savings with fixed contribution rates can be problematic when individuals have heterogeneous rates of time preference, while we show that the results derived in the present paper are robust to such form of heterogeneity. For recent quantitative explorations of unemployment savings accounts, we refer the reader to the works by Pallage and Zimmermann (2010) and Setty (2012).

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 is 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; compare Golosov and Tsyvinski (2006). 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 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 Model

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

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

In each period, the agent derives utility $u(c_t)$ from consumption c_t and disutility $\phi(e_t)$ from effort e_t, where $u : \mathbb{R}_+ \to \mathbb{R}$ is strictly increasing and strictly concave and $\phi : \mathbb{R}_+ \to \mathbb{R}$ is strictly increasing and (weakly) convex. Given prices (r, w), discount factor $\beta \in (0, 1)$, utility functions u and ϕ, 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:

$$\max_{\{c_t, a_{t+1}, e_t\}} \quad \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t \left(u(c_t) - \phi(e_t)\right)\right] \tag{1}$$

$$\text{s.t.} \quad c_t + a_{t+1} = (1+r)a_t + y(a_t, \theta_t; w, \tau)$$

$$a_{t+1} \geq \underline{a}, \ c_t \geq 0, \ e_t \geq 0$$

$$a_0, \theta_0 \text{ given}$$

where $y(a_t, \theta_t; w, \tau)$ denotes the agent's income in period t, r is the return on assets between periods t and $t+1$, and $\underline{a} \leq 0$ represents a borrowing constraint.

If the agent is employed ($\theta_t = E$), she receives a wage w and pays proportional income taxes at rate τ. If she 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. The agent's income (excluding interest income) in period t is hence given by

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

In steady state, the government runs a balanced budget in each period, i.e., the government policy must satisfy

$$\tau w \int_{a_t} d\mu_t(a_t, E) = \int_{a_t} b(a_t) d\mu_t(a_t, U) \quad \forall t \tag{2}$$

where μ_t denotes the distribution of agents over asset holdings $A = [\underline{a}, \infty)$ and employment states $\Theta = \{E, U\}$ at time t.

3.1   Steady state equilibrium

Recall $\Theta = \{E, U\}$ 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 current period's variables without time subscript and 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

$$
\begin{aligned}
v(a, \theta) \quad = \quad & \max_{\{a', e\}} u((1+r)a + y(a, \theta; w, \tau) - a') - \phi(e) + \beta \sum_{\theta' \in \Theta} v(a', \theta') \pi_{\theta\theta'}(e) \qquad (3) \\
& \text{s.t. } e \geq 0, a' \geq \underline{a}, (1+r)a + y(a, \theta; w, \tau) - a' \geq 0.
\end{aligned}
$$

A *(recursive) steady state equilibrium* consists of a value function $v : A \times \Theta \to \mathbb{R}$, an asset policy function $a' : A \times \Theta \to \mathbb{R}_+$, an effort policy function $e : A \times \Theta \to \mathbb{R}$, a government policy $(b(\cdot), \tau)$ 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) and the government policy.

2. The government's budget constraint (2) is satisfied.

3. μ is an invariant distribution given decision functions e, a' and employment transition probabilities $\pi_{\theta\theta'}$.

3.2 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*

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

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, it is without loss of generality to let the disutility of effort $\phi(e)$ be linear.

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 (EE) are independent of the agent's effort:*

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

with $\pi_{EE} > 0$. *Transition probabilities from unemployment to employment (UE) depend on effort in the following way:*

$$\pi_{UE}(e) = 1 - \exp(-\psi e).$$

The functional form for the job finding probability π_{UE} 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.

The following assumption allows us to solve the agent's decision problem using first-order conditions.[3]

Assumption 3. *Unemployment benefits $b(a)$ are differentiable on $[\underline{a}, \infty)$.*

4   Calibration

We take a model period to be one month and normalize the monthly wage rate to $w = 1$. Following Kaplan and Violante (2010), we choose a coefficient of relative risk aversion of $\gamma = 2$ and set the interest rate to match an annual return on assets of 3%. The borrowing limit is $\underline{a} = 0$. The parameters ψ and π_{EE} are chosen to replicate the average job finding and separation rate in the United States for the period from 1980 to 2005.[4] The target for β is the median ratio of financial assets to monthly after-tax labor income of labor force participants in the United States. Based on the Survey of Consumer Finances 2001, we find this number to be 2.42. We discuss the asset data in detail in Section 4.1.

The benchmark UI policy consists of an asset-independent replacement rate of 0.5, $b(a) = 0.5(1-\tau)w$, which approximately represents the average replacement rate currently effective in the United States.[5] The tax rate is $\tau = 0.0279$ and is set to balance the government's budget.

The calibration generates the following parameters: $\pi_{EE} = 0.9847$, $\psi = 0.1113$, $\beta = 0.9952$. With these parameters, the steady state equilibrium matches the calibration targets as shown in Table 1. The corresponding consumption and effort decisions are shown in Figure 1.

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[3]We numerically verify that the solution to the agent's first-order conditions is indeed a solution to the agent's decision problem by re-optimizing the agent's decision using grid search and value function iteration.

[4]The rates are derived using monthly worker flows from the Current Population Survey (CPS) for all workers between age 16 and 65 for the years 1980 to 2005. See appendix for further details.

[5]According to the OECD, the net replacement rate during the first six months of unemployment in the U.S. 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.

Table 1: Calibration

	model	target
job finding rate	26.67%	26.66%
separation rate	1.53%	1.53%
median asset-to-income ratio	2.42	2.42

Notes: Calibration result. The first column gives the data target, the second column the model predicted value of the data target, and the third column the empirical value of the calibration target. Job finding and separation rates are derived from the CPS using data on worker flows between 1980 and 2005. The median asset-to-income ratio is derived from the 2001 SCF and reports the median of the financial assets to after tax labor income ratio.

Since at least Baily (1978), it is well-known that a key determinant of optimal UI is the elasticity of the job finding rate with respect to UI benefits. This is a moment that we do not target in the calibration. At the benchmark UI system, the elasticity of the job finding rate with respect to the replacement rate is 0.612 in our model.[6] This number is close to recent empirical results by Chetty (2008), whose point estimate of the elasticity is 0.527. The point estimates by Meyer (1990) range from 0.533 to 0.878. Most results surveyed by Krueger and Meyer (2002) are of similar magnitude.

In our model, as in the data, the elasticity of the job finding rate varies with the agent's liquidity situation. Intuitively, agents with few assets respond more strongly to changes in UI benefits, because benefits finance a larger share of their consumption. For agents with zero assets, the elasticity of the job finding rate with respect to the replacement rate is 0.965. This number is comparable to estimates by Chetty (2008). For agents in the lowest quartile of liquid assets, he finds elasticities ranging from 0.642 to 0.978 depending on the empirical specification.

4.1 Empirical findings on asset holdings

Our data source to document the liquid wealth of households is the 2001 Survey of Consumer Finances (SCF). The SCF is a triannual survey of income and wealth of U.S. households. Unlike other survey data sets, the SCF is designed to also provide information on the wealthiest households in the U.S. population. To make the data comparable to data from the CPS used to calibrate transition rates, we follow Kaplan and Violante (2010) and drop the 5 percent households with the highest net worth.[7] We restrict the sample further to households that

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[6]More precisely, a ten percent reduction in the replacement rate (from 0.5 to 0.45) increases the job finding rate by 6.12 percent in our model (from 0.2667 to 0.2830).

[7]We follow Aizcorbe, Kennickell, and Moore (2003) for the definition of net worth.

participate in the labor force and with average wage income above half the federal minimum wage. We follow Aizcorbe, Kennickell, and Moore (2003) for the definition of variables. To abstract from savings directly related to life-cycle considerations, we use financial assets net of liquid retirement assets as our for liquid wealth.[8]

We use a simplified version of the U.S. tax code to derive after-tax income. The average tax rate in our sample is 19.5 percent.[9] We divide financial asset holdings by after-tax labor incomes. Table 2 shows the quantiles of the distribution of financial assets to monthly labor income from the SCF sample and compares this to the data for employed workers from Table 2 in Gruber (2001).[10] Gruber's analysis is similar to ours, but based on the Survey of Income and Program Participation (SIPP) for 1984–92. Our data is both in level and dispersion very close to his findings. In the appendix we provide further details and discussion.

Table 2: Financial assets to labor income

Quantile	SCF 2001	SIPP 1984–92 (Gruber 2001)
10	0.08	0.07
25	0.52	0.55
50	2.42	2.35
75	9.65	8.90
90	29.08	27.22

In absolute terms, the median level of financial assets in our sample is roughly 7,000 Dollars. The first quartile ends at roughly 1,250 Dollars and the fourth quartile starts at roughly 33,000 Dollars.

5   Optimal unemployment insurance

We use the calibrated model as our benchmark for the analysis of optimal UI. As a first step, we analyze the optimal replacement rate when UI benefits are independent of agents' asset holdings. As a second step, we allow UI benefits to dependent on individual asset holdings.

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[8]We provide some additional discussion in the conclusions.

[9]The Congressional Budget Office reports average labor income taxes for 2000 of 19.7 percent (average individual income tax rate of 11.8 percent and average social insurance rate of 7.9 percent.)   See http://www.cbo.gov/sites/default/files/cbofiles/attachments/Average_rates_3.pdf.

[10]Gruber reports ratios relative to weekly earnings. We transform his numbers to correspond to monthly frequency.

5.1 Asset-independent unemployment insurance

We hold all model parameters fixed and vary the replacement rate of the UI system, while adapting the tax rate to keep the government's budget balanced. Table 3 displays mean asset holdings, unemployment rates, taxes, steady state welfare, and welfare including the transition costs 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 mean assets 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 give up UI entirely.

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 towards the 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 of the government budget during the transition phase are rebated to agents as an initial lump sum tax or transfer.[11]

Based on welfare including transition costs, the optimal replacement rate is 0.47. The welfare gain relative to the benchmark policy is negligible, welfare rises by only 0.01 percent in consumption equivalent terms. The benchmark replacement rate of 0.5 is hence very close to optimal.

5.2 Asset-tested unemployment insurance

In the next step, we allow UI benefits $b(a)$ to depend on assets, holding the tax rate $\tau = 0.0279$ fixed at the benchmark level. For now, we restrict ourselves to schemes where the replacement rate depends on assets in a linear way,

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

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[11]In the experiment, surpluses of 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 case of budget surpluses, but harmful in case of deficits. However, the timing convention is not driving our results. First of all, the implied transfers are rather 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 3: Steady states for asset-independent replacement rates

replacement	assets	unemployment	tax	welfare change (steady state)	welfare change (incl transition)
80%	0.56	12.0%	9.9%	-4.71%	-3.79%
70%	1.07	7.8%	5.6%	-1.48%	-0.90%
60%	1.64	6.3%	3.9%	-0.47%	-0.19%
50%	2.25	5.4%	2.8%	0.00%	0.00%
47%	2.44	5.2%	2.5%	0.10%	0.01%
40%	2.89	4.9%	2.0%	0.27%	-0.03%
30%	3.56	4.5%	1.4%	0.44%	-0.18%
20%	4.27	4.2%	0.9%	0.56%	-0.40%
1%	5.63	3.8%	0.0%	0.68%	-1.13%

Notes: Results of varying the replacement rate starting from the benchmark economy. Column 1 gives the different replacement rates, column 2 the average 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.

We explore various slopes α_1 and choose the intercept α_2 to preserve budget balance. Section 6 explores nonlinear functional forms and alternative tax rates.

As before, we use welfare including transition costs as the relevant welfare measure. The optimal linear asset-tested UI system is given by parameters $\alpha_1 = -0.03$ and $\alpha_2 = 0.534$, see Table 4. The welfare gain over the asset-independent benchmark system is very limited and amounts to 0.04 percent in consumption equivalent terms. Stronger forms of asset-testing quickly lead to welfare losses. Hence, asset-testing does little to improve welfare, but can easily reduce welfare substantially as Table 4 shows.

Table 4: Steady states for linearly asset-tested replacement rates

α_1	α_2	assets	unemployment	welfare change (incl transition)
-0.30	0.561	0.34	5.2%	-0.27%
-0.20	0.561	0.50	5.2%	-0.16%
-0.10	0.556	0.82	5.2%	-0.02%
-0.03	0.534	1.46	5.3%	0.04%
0.00	0.500	2.25	5.4%	0.00%
0.02	0.428	3.81	5.5%	-0.17%

Notes: Results for replacement rates that are linear in assets. Column 1 gives the slope of the replacement rate with respect to assets, column 2 the intercept, column 3 the average asset holdings in the economy, column 4 the unemployment rate, and column 5 the welfare change expressed as equivalent variation in consumption (including the transition phase). The tax rate $\tau = 0.0279$ is fixed at the benchmark level.

Under the optimal linear asset-tested system, agents with zero assets face a replacement rate of 0.53. For the median job loser, having assets of roughly 1.6 months of after-tax income, the replacement rate equals 0.48 during the first month of unemployment. Figure 2(a) shows the shape of UI benefits under this system. Figures 2(b) and 2(c) display the corresponding consumption decisions and job finding probabilities.

Figure 3 displays the individual specific welfare effects from the introduction of the optimal linear asset-tested UI system. As we know from Table 3, this reform generates a utilitarian welfare gain corresponding to 0.04 percent of consumption. Figure 3 shows that the individual welfare effects are decreasing in initial asset holdings. Yet, all agents in the economy, including those that are initially unemployed and have high asset holdings, experience a welfare gain.

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 6.2 shows that the optimal rate of asset-testing remains close to zero when we optimize additionally over the tax rate.

5.3 Discussion and comparison to a single-spell model

Section 5.2 has shown that the optimal slope of UI benefits with respect to assets is negative, but close to zero. Two countervailing forces are responsible for this finding. On the one hand, asset-testing undermines the incentives for precautionary saving prior to job loss. On the other hand, asset-testing allocates the UI transfers to the most needy agents. These two effects are similarly important for social welfare and nearly offset each other.

As argued by Feldstein and Altman (1998), consumption smoothing based on private resources reduces moral hazard, because agents internalize the costs of unemployment. Asset-testing imposes an implicit tax on savings, and implies that agents will have fewer assets when they become unemployed, compare Table 4. Hence, with asset-testing there is a harmful shift

14

from private to public insurance of unemployment. Based on this reasoning, asset tests are detrimental to welfare. However, asset tests also have a beneficial effect. Asset tests allocate more resources to agents with low liquidity. These agents have insufficient funds for consumption smoothing and high marginal utility.

In the next step, we isolate the liquidity motive by exploring a version of the model with an exogenously fixed asset distribution. Following Shavell and Weiss (1979) and Hopenhayn and Nicolini (1997), all agents begin their life unemployed and experience only a single unemployment spell (single-spell model). 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 interest income ra for the rest of her life. The ex-ante asset distribution is set to the steady state asset distribution of unemployed agents of the benchmark model with a replacement rate of 0.5.

As in Section 5.2, we fix the tax rate at $\tau = 0.0279$ and explore various slopes for linear asset-tested UI benefits of type (4). We cannot balance the government's budget in steady state, because the model in non-stationary 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.

Table 5 presents policy parameters, mean assets of job finders, mean unemployment durations, and welfare for various asset-tested UI schemes. 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 slope of the benefit function with respect to assets is -0.25. This is 8 times as large as the optimal slope in the model with endogenous asset accumulation from Section 5.2. Not surprisingly, the welfare effects of the various policies are relatively small, as unemployment is a one-time event.

The single spell model has a double bias towards strong asset-testing. The first bias is rather obvious: targeting benefits to poor agents does not change the asset distribution of job losers, because the distribution is fixed by construction. The second bias lies in the incentive to dissave during unemployment. Since agents face no risk of becoming unemployed again, assets

15

Table 5: Linear asset-tested replacement rates in the single spell model

α_1	α_2	assets of job finders	unemployment duration	welfare change
-0.50	0.670	0.14	3.45	0.059%
-0.40	0.655	0.23	3.38	0.072%
-0.30	0.635	0.32	3.31	0.080%
-0.25	0.622	0.38	3.27	0.082%
-0.20	0.607	0.46	3.24	0.080%
-0.10	0.566	0.63	3.19	0.061%
0.00	0.500	0.87	3.15	0.000%
0.05	0.453	1.03	3.15	-0.060%

Notes: Results for replacement rates that are linear in assets (single spell model). Column 1 gives the slope of the replacement rate with respect to assets, column 2 the intercept, column 3 the average asset holdings upon transition to employment, column 4 the average unemployment duration in months, and column 5 the welfare change expressed as equivalent variation in consumption. The tax rate $\tau = 0.0279$ is fixed at the benchmark level.

have no insurance value beyond the first unemployment spell. Therefore, asset decumulation during unemployment is very attractive in the single spell model. Figure 4 shows that optimal consumption of unemployed workers in the single-spell model is always larger than that of unemployment workers in the benchmark model. In other words, agents dissave more during unemployment in the single-spell model. Note that the UI system is the same in both models and pays an asset-independent replacement rate of 50%. By construction, the initial asset distribution of unemployed agents in the single-spell model coincides with the asset distribution of unemployed agents in the benchmark model. The stronger incentive to dissave causes mean assets upon transition to employment to fall from 1.12 in the benchmark model to 0.87 in the single-spell model. Hence, the single-spell model generates a larger number of poor agents that benefit from strong asset-testing.

6 Extensions and robustness

6.1 Nonlinear asset tests

We now consider a more flexible functional form for UI benefits. Since benefit schemes that increase with assets lead to welfare losses in the linear case, we restrict ourselves to a class of

decreasing functions,

$$\frac{b(a)}{(1-\tau)w} = 0.534 \exp\left(-(a/\lambda_2)^{\lambda_1}\right),\tag{5}$$

where λ_1, λ_2 are positive parameters. Note that the replacement rate of agents with zero assets is the same as under the optimal linear asset test from Table 4 ($\alpha_2 = 0.534$).The class of functions in (5) 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 $\lambda_1 = 1.3$ and $\lambda_2 = 9.164$. For these parameters, benefits are very close to linear in assets. The welfare gain relative to the asset-independent benchmark UI system is 0.04 percent in consumption equivalent terms. This number coincides with the welfare gain of the optimal linear asset test.

6.2   Asset tests and endogenous taxes

Section 5 explored optimal asset-tested UI when the tax rate is fixed at the benchmark level. We now allow the government to jointly choose the tax rate and the parameters for linear asset tests. The government policy that maximizes transition welfare is given by parameters $\tau = 0.025$, $\alpha_1 = -0.03$, $\alpha_2 = 0.504$. This UI system is slightly less generous than the one from Section 5.2. Average steady state asset holdings are given by 1.62 and the steady state unemployment rate is 5.1 percent. The welfare gain relative to the asset-independent benchmark UI system is 0.06 percent in consumption equivalent terms.

6.3   Alternative calibrations

This section explores asset-tested UI for alternative values of some key parameters. The remaining parameters are recalibrated according to the targets from Table 1.

For the first experiment, we note that the current unemployment insurance system in the U.S. pays benefits only during the first 6 months of unemployment. When those months expire, agents receive social assistance benefits at a significantly lower level. To account for this fact, we introduce an additional employment state S representing social assistance. In social assistance, agents receive benefits z at the level of the average public transfer received by a single adult with

no children in the 60th month of unemployment in the U.S., which gives $z = 0.08(1 - \tau)w$.[12] To economize on the number of state variables, we assume that the duration of unemployment benefits is stochastic.[13] An agent who received unemployment benefits at time $t - 1$ and continues to be unemployed at time t will receive unemployment benefits with probability $p = 5/6$ 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. In expectation, unemployed agents therefore have access to unemployment benefits during the first 6 months of their spell.

In the second experiment, we allow for more generous borrowing by setting the borrowing limit to $\underline{a} = -2$. The third and fourth experiment explore alternative values for the coefficient of relative risk aversion, $\gamma \in \{1, 3\}$. Table 6 lists the parameters of optimal linear 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.

Table 6: Linearly asset-tested replacement rates for alternative calibrations

	α_1	α_2	welfare change (incl transition)
social assistance system	-0.04	0.574	0.04%
borrowing constraint $\underline{a} = -2$	-0.01	0.530	0.02%
risk aversion $\gamma = 1$	-0.01	0.513	0.01%
risk aversion $\gamma = 3$	-0.05	0.552	0.09%

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, column 3 the intercept, and column 4 the welfare change expressed as equivalent variation in consumption (including the transition phase).

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[12]The social assistance level of 0.08 is the net replacement rate in the 60th month of unemployment in the U.S. 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.

[13]By 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.

6.4 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 4 and the 25th and 75th percentile in the asset distribution of labor force participants. The last two moments are extracted from the Survey of Consumer Finances 2001, see Section 4.1. This generates parameters of $\pi_{EE} = 0.9847$, $\psi = 0.12$, $\beta_1 = 0.9836$, $\beta_2 = 0.9954$, $\beta_3 = 0.9975$. As before, we set $\gamma = 2$ and choose the tax rate $\tau = 0.0278$ to obtain budget balance.

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 heterogeneity.

Qualitatively, the findings from Section 5 generalize to the model with heterogeneous discount factors and the resulting higher heterogeneity in assets. As before, we use utilitarian welfare including transition costs as the relevant welfare measure. The optimal linearly asset-tested UI policy is given by parameters $\alpha_1 = -0.08$, $\alpha_2 = 0.556$ and generates a welfare gain of 0.29 percent in consumption equivalent terms. Hence, compared to Section 5, the larger fraction of poor agents results in a larger welfare gain of asset-testing. However, the optimal asset test is still rather lenient: the replacement rate of agents with zero assets is 55.6 percent, which is just 2 percentage points higher than in the model with homogeneous discount factors. Median steady state assets of employed workers for the asset-tested UI system are equal to 0.92, hence the replacement rate of the median job loser equals 48.2 percent during the first month of unemployment.

7 Concluding remarks

This paper studies the question 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 and accumulate a risk-free asset for self-insurance. 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% to be close to optimal, so we conclude that the current U.S. unemployment insurance system is approximately optimal regarding its level as well as the absence of asset tests.

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 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 approximation of workers aged between 30 and 50.[14] Our stylized model has admittedly less explanatory power for workers at ages below 30 or above 50. Those workers face different labor market conditions and also have access to alternative insurance channels (active labor market policy, family insurance, early retirement, etc).[15] This creates a rationale for age-dependent UI programs studied by Michelacci and Ruffo (2013).[16] 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.

Secondly, 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 become even less attractive then. Finally, 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

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[14] The measure of financial assets that we use still has some age variation but asset holdings at ages 30 and 50 are only about one monthly income away from our calibration target. Our calibration describes therefore closely the financial situation of prime age households that are attached to the labor force.

[15] Pavoni, 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.

[16] Michelacci 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.

question focuses on financial 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.

Appendix

A   Data and sample selection

We use data from the 2001 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 2000 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.[17] 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 the very wealthy households, we follow Kaplan and Violante (2010) and drop the 5% households with the highest net worth.[18] We also drop all households that report wages below half the federal minimum wage.[19] We use all income from wages and salaries as labor income. Below, we describe in detail how we derive after-tax income by applying a stylized version of the year 2000 U.S. labor income tax code. We use the definition of financial assets from Aizcorbe, Kennickell, and Moore (2003) and subtract retirement liquid assets. Financial assets include money in checking, saving, money market and call accounts, ceritificate of deposit, further money invested in mutual funds, stocks, bonds, cash value of life insurance contracts, other managed investment, and other financial assets. We divide financial assets by monthly after-tax labor income at the household level.[20]

In the main part of the paper, we discuss the life-cycle variation of financial assets of prime age households. When we compute median financial assets to after-tax labor income ratios, we

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[17]This excludes households where the household head reports as current work status retired, disabled, student, and other not in the labor force.

[18]We follow Aizcorbe, Kennickell, and Moore (2003) for the definition of net worth and other income and asset variables.

[19]To construct wages, we use the information on hours of husband and wife and total family income from wages and salaries.

[20]The SCF only provides information on annual income. To derive monthly labor income, we divide annual labor income by 12.

find this ratio for households at age 30 to be 1.81, at age 40 to be 2.02, and at age 50 to be 3.60. Our calibration target is 2.42 and matches almost exactly the value of assets held by 41-year old households. We compute age-dependent medians by constructing 5-year windows centered at each household age.

B   Taxes

We closely follow Krebs, Kuhn, and Wright (2013) in computing labor taxes. We use nominal tax brackets for the year 2000 to compute average tax rates.[21] The rates vary according to the filing status of the household. We distinguish between *married couples filing jointly* and *single* households. For 2000, the U.S. income tax brackets and marginal tax rates are given in Table 7.

Marginal Tax Rate	Married Filing Jointly Tax Brackets		Single Tax Brackets	
	Over	Below	Over	Below
15.0%	$0	$43,850	$0	$26,250
28.0%	$43,850	$105,950	$26,250	$63,550
31.0%	$105,950	$161,450	$63,550	$132,600
36.0%	$161,450	$288,350	$132,600	$288,350
39.6%	$288,350	–	$288,350	–

Table 7: Tax rates for 2000

The social security tax rate paid by employees was 7.65% in 2000. We assume that the 7.65% tax rate applies for all households.[22] In 2000 every household could deduct a 500 Dollar child tax credit for each dependent child under age 17 from its tax obligations.[23] 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% social security tax. The numbers for the personal exemption for married couples, single people, and per dependent for 2000 are $5600, $2800, and $2800, respectively. That is, in 2000, a married

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[21]Using data from The Tax Foundation: http://taxfoundation.org/article/us-federal-individual-income-tax-rates-history-1913-2011-nominal-and-inflation-adjusted-brackets

[22]The annual limit for social security taxes in 2000 has been 76,500 Dollars for each employee. For single individual this exceeds the 95 percentile of the income distribution so that we abstract from it for the current analysis.

[23]See IRS for details on dependent status http://www.irs.gov/uac/Ten-Facts-about-the-Child-Tax-Credit.

household filing jointly could claim $5600 plus an extra $2800 per dependent.

C   Transition rates

The job finding rate and the separation rate are derived using data on worker flows from the Current Population Survey (CPS). The CPS is the official data source for labor market statistics in the United States like for example the unemployment rate. We follow standard procedures as for example described in Jung and Kuhn (2012) to merge the basic monthly files to panels. All CPS data has been downloaded from the NBER webpage. We construct monthly worker flows and use worker flows between unemployment and employment (UE) for the job finding rate and employment to unemployment flows (EU) for the separation rate. Further details are available upon request.

D   Computation

This section sketches how we solve the agent's problem and find the stationary distribution and 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 (Assumption 3) and assume that first-order conditions are sufficient for the solution of the agent's problem. We verify numerically that this is indeed the case by re-optimizing the agent's decision using grid search and value function iteration. The agent's first-order conditions are straightforward to derive. The agent's effort decision is characterized by the following condition:

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

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 equation (3). 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,

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

23

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

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 start with an initial guess for policy functions $c(a, \theta)$ and $e(a, \theta)$ that we specify on an equally spaced grid of asset states and use linear interpolation in between. We use the first-order conditions to update the initial guess and iterate until convergence. We also update the value function in equation (3) during the updating procedure for the policy functions.

To derive the stationary distribution of the economy, we approximate a transition function on the same grid of asset states and use the eigenvector to the largest eigenvalue. Given a stationary distribution over asset and employment states, it is straightforward to compute the government budget. We use bisection on a grid of tax rates or benefit function parameters to obtain budget balance.

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 a 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 compute the consumption equivalent variation induced by a policy reform as follows. Denote consumption, effort, and the distribution of agents in the benchmark economy by c, e, μ, and denote the corresponding objects in the economy after the policy reform by $\tilde{c}, \tilde{e}, \tilde{\mu}$. We define the following values:

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

$$
\tilde{V} := \sum_t \beta^t \int [u(\tilde{c}_t) - \phi(\tilde{e}_t)] \, d\tilde{\mu}_t.
$$

For CRRA utility, $u(c) = (1 - \beta)c^{1-\gamma}/(1 - \gamma)$, with $\gamma \neq 1$, the consumption equivalent variation Δ is defined as

$$
\Delta = \left(\frac{\tilde{V}}{V} \right)^{1/(1-\gamma)} - 1
$$

If consumption utility is logarithmic, $u(c) = (1-\beta)\log(c)$, the consumption equivalent variation Δ is given by $\Delta = \exp(\tilde{V} - V) - 1$.

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Figure 1: Benchmark economy (replacement rate 0.5)

(a) consumption policy

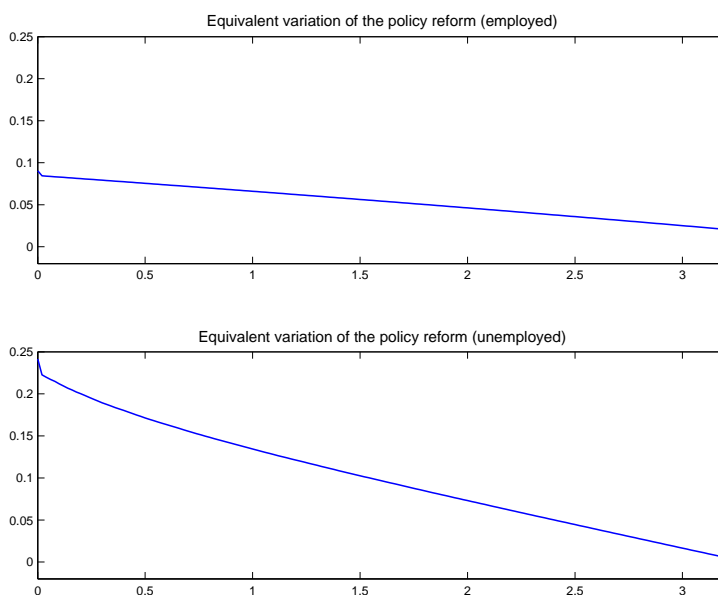(b) job finding probability

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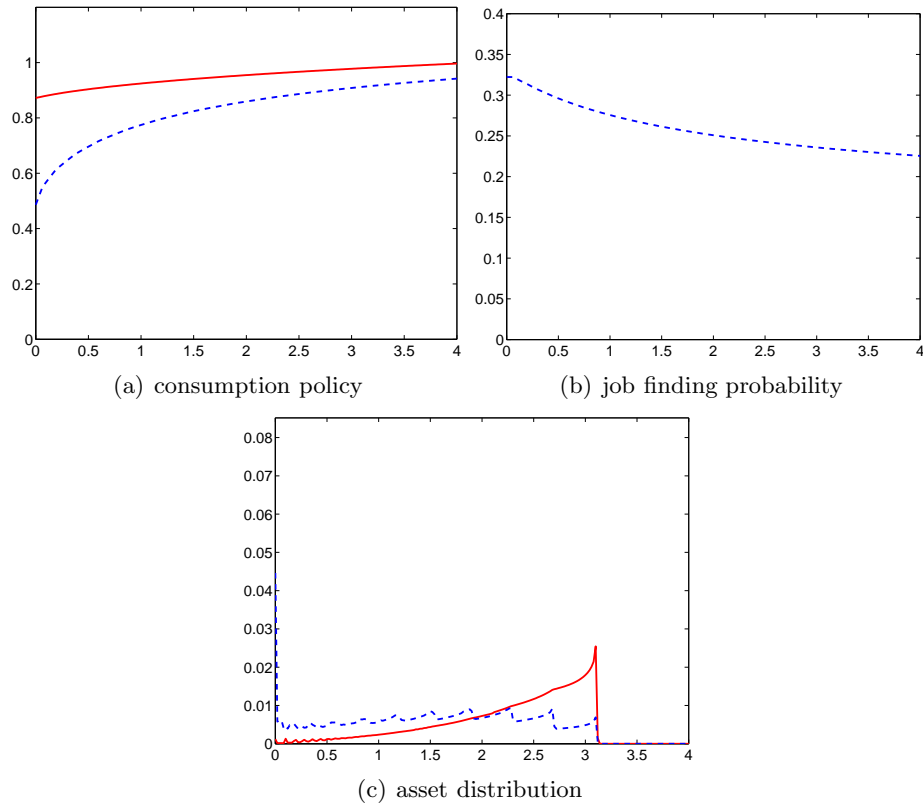
Notes: The upper left panel shows the consumption policy as a function of assets (months of labor income). The upper right panel shows the job finding rate as a function of assets. The lower panel displays the asset distribution. In all plots the red solid line represents employed workers, while the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

Figure 2: Optimal linear asset-dependent UI system

(a) UI benefits

(b) consumption policy

(c) job finding probability

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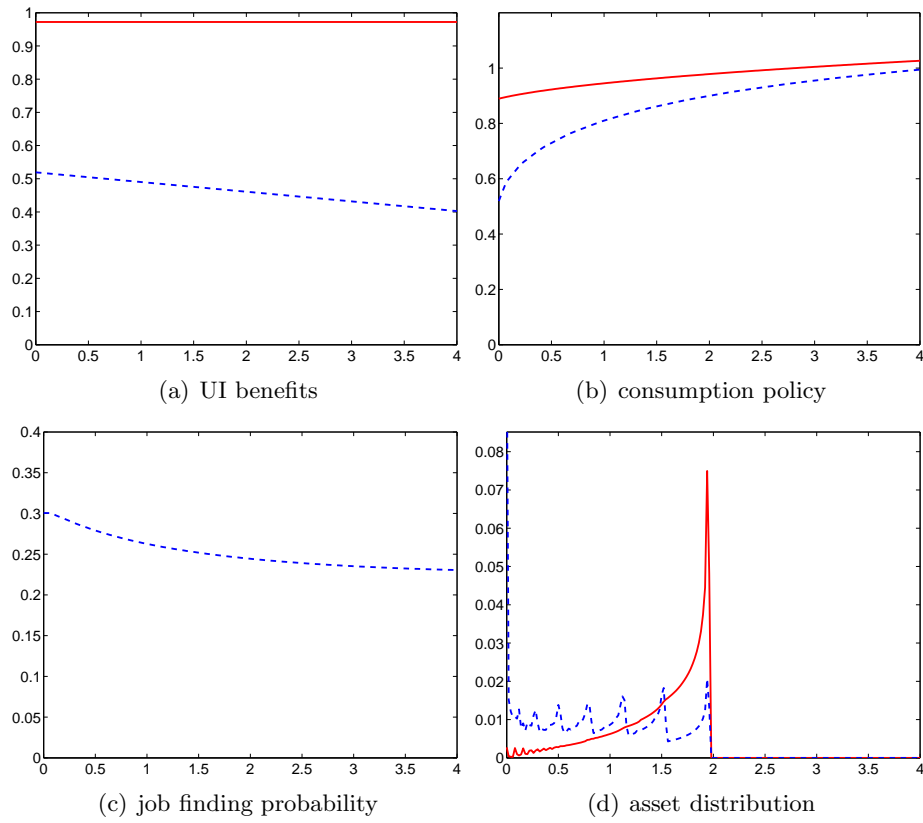
Notes: The left panel shows the after-tax wage for the employed and unemployment insurance benefits as a function of assets (months of labor income). The upper right panel shows the consumption policy and the lower left panel shows the job finding rate as a function of assets. The lower right panel displays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

Figure 3: Individual specific welfare gains

Equivalent variation of the policy reform (employed)

Equivalent variation of the policy reform (unemployed)

Notes: This figure shows the individual specific welfare gains (in percent of consumption equivalent variation) of introducing linearly asset-tested unemployment benefits with a slope of $\alpha_1 = -0.03$ and an intercept of $\alpha_2 = 0.534$, compare Section 5.2. Welfare includes the transition phase.

Figure 4: Consumption policy of unemployed workers
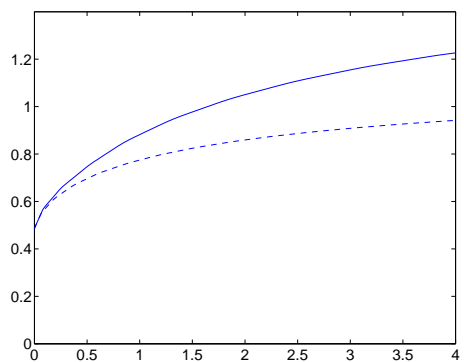
Notes: This figure shows the consumption policy of unemployed workers in the single-spell model (solid line) and the multiple-spell benchmark model (dashed line). The replacement rate during unemployment is 0.5 and independent of assets.