Unemployment Insurance and Unemployment Accounts: The Best of Both Worlds

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Abstract

Unemployment accounts are mandatory individual savings accounts that can be used only during unemployment or retirement. Unlike unemployment insurance, unemployment accounts solve the moral hazard problem but provide no public insurance to workers. I study a hybrid system that borrows from concepts of both unemployment insurance and unemployment accounts, in which workers are mandated to save when employed and can withdraw from the account when unemployed. Once the account is exhausted, the unemployed worker receives unemployment benefits. This hybrid policy provides insurance to workers more efficiently than an unemployment insurance system because it provides government benefits selectively. As a consequence, young workers can reduce their precautionary savings and better smooth their consumption over the life cycle. Calibrating the model to the US economy, I find that, relative to an optimal unemployment insurance system, the optimal hybrid policy leads to a welfare gain of 2.4%, measured as consumption equivalent variation.

JEL Classification: E24; E61; J64; J65

Keywords: Unemployment Accounts; Unemployment Insurance; Job-search; Moral hazard; Mechanism Design; Optimal Policy.

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1 Introduction

Unemployment accounts are mandatory individual savings accounts that governments can use as an alternative to unemployment insurance. Unemployment accounts operate as follows. Each employee is mandated to save a fraction of her labor income in an individual savings account. The worker is entitled to withdraw payments from this account only during unemployment; such payments amount to a fraction of her last labor income (a "replacement rate"). At retirement, the worker receives the remaining balance.

A system of unemployment accounts was implemented in Chile in 2002, and scholars such as Sehnbruch (2004), Feldstein (2005), and Feldstein and Altman (2007) have debated whether such a system should be implemented in the United States and elsewhere. Their papers assert that this system reduces the moral hazard problem inherent in any government support program because unemployed workers who withdraw from their own accounts reduce their available balance at retirement. Therefore, it has been argued, they internalize the cost of receiving funds during unemployment. At the same time, however, this system misses the goal of insuring workers as it excludes any form of redistribution.[1]

Several arguments can be suggested in favor of this system. If workers are myopic, mandatory savings ensure adequate self-insurance. Political economy concerns such as a government that is compelled to bail out poor unemployed workers could also justify this system. But apart from such considerations, this system is dominated by laissez faire as without any intervention, rational workers could mimic the forced savings and possibly do better.

The typical government policy for supporting unemployed workers is unemployment insurance. This policy is based on government benefits that are financed by a payroll tax and provided for a limited duration. Unemployment insurance poses a key trade-off between damaging workers' employment incentives and providing workers with insurance. On one hand, benefits increase the value of unemployment relative to that of employment, leading to a higher unemployment rate. On the other hand, the redistributive features of this policy may improve workers' welfare. A broad literature addresses the design of this policy given that trade-off.[2]

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[1]The Chilean system includes a small transfer to workers who have exhausted their accounts. In Feldstein and Altman (2007), workers who exhaust their accounts borrow from a government unemployment insurance fund.

[2]See, for example, Hansen and Imrohoroglu (1992) and Hopenhayn and Nicolini (1997) for workers' labor market incentives, and Fredriksson and Holmlund (2001) and Krusell, Mukoyama, and Şahin (2010) for an analysis of the incentives through vacancy posting.

Figure 1: The Unemployment Insurance Accounts (UIA) System
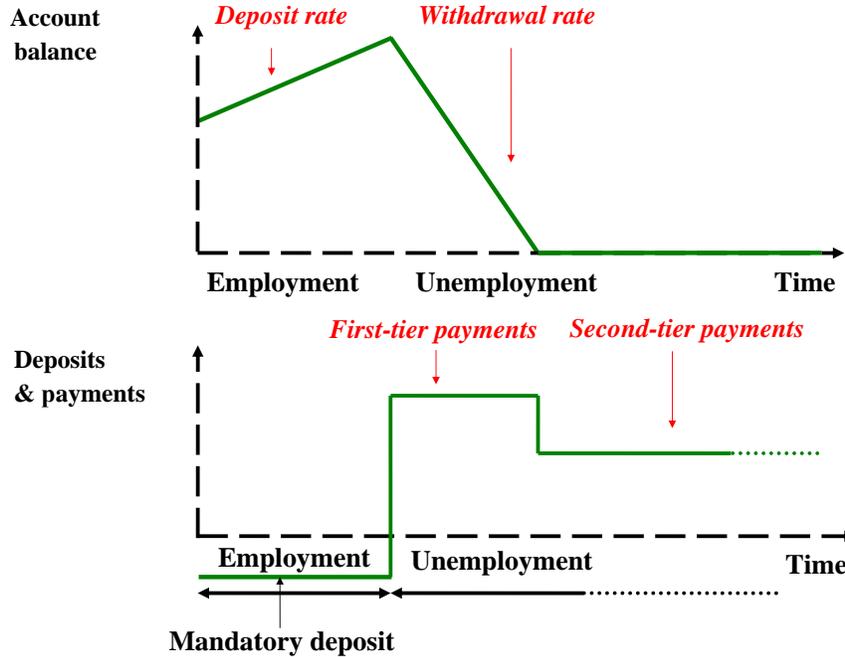
In this paper, I study a hybrid policy that combines elements from both unemployment insurance, in that it provides insurance, and unemployment accounts, in that it mitigates the moral hazard problem. According to this policy, a worker is required to make deposits into an individual account during employment. Upon unemployment, the worker withdraws payments from that account at a certain rate, as in unemployment accounts. Once the account is exhausted, the unemployed worker receives unemployment benefits according to a replacement rate, as in unemployment insurance. I call this policy unemployment insurance accounts (UIA) as it provides insurance that depends on the account's balance.

Figure 1 shows a graphic representation of the UIA system for a worker who starts off employed, becomes unemployed, and remains unemployed indefinitely. The top panel of the figure shows the balance of the unemployment account. The balance increases during employment and then declines during unemployment. Once the balance is exhausted, the account remains at its lower bound of zero. The bottom panel shows the deposits and payments for that worker. During employment, the worker pays her mandated contribution into the unemployment account. Upon unemployment, the worker withdraws payments from the account at a prespecified replacement rate until the account is exhausted. From that point on, she receives unemployment benefits ac-

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Figure 2: The Two-Tier Unemployment Insurance System (UI2)
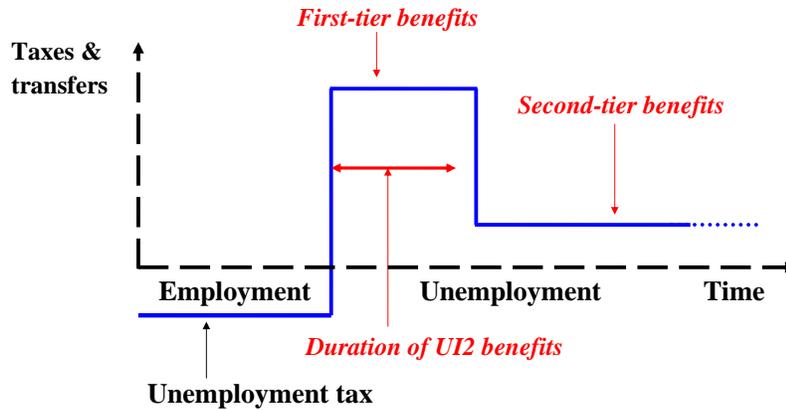
cording to some replacement rate.

I compare UIA to a variant of an unemployment insurance policy that also makes use of two tiers of payments. Figure 2 shows a graphic representation of the two-tier unemployment insurance policy (henceforth, UI2) for the same worker cited above. During employment, the worker pays an unemployment tax. Upon unemployment, she receives first-tier benefits proportional to her last labor income for some duration. Then she receives second-tier benefits according to the second replacement rate. Notice that this structure allows for decreasing benefits by setting a high first-tier replacement rate followed by a lower second-tier one.

There are two key differences between UI2 and UIA. First, in contrast to UIA, which uses a combination of private and public resources, UI2 uses public resources exclusively. Second, while the duration of first-tier benefits in UI2 is the same for all unemployed workers, the duration of first-tier payments in UIA (withdrawals) depends on the account balance at the beginning of the unemployment spell.

In Section 2, I use a structural model to study the implications of a shift from UI2 to UIA and to quantify the associated welfare effects. This is a life-cycle model that is based on incomplete markets and heterogeneous agents that expose workers to income fluctuations and unemployment shocks. Workers in the model differ from each other along several key dimensions: age, unemployment risk, income, and wealth. Unemployment in the model is driven both by *exogenous* factors (layoffs for employed workers and job-search frictions for unemployed workers) and *endogenous* decisions (quits for employed workers and job-offer rejections for unemployed workers).

The government can implement either UI2 or UIA. Given the unemployment policy, workers allocate their resources optimally between consumption and savings. In addition, workers with em-

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ployment opportunities choose between employment and unemployment. To maximize workers' welfare, the government takes into account these endogenous decisions when setting the parameters of the unemployment system. I refer to the combination of instruments that delivers the highest welfare level in each type of system–UI2 and UIA–as optimal UI2 and optimal UIA, respectively.

In Section 3, I calibrate the model to the US economy. Several parameters are calibrated externally to the model, while key parameters–those affecting the consumption-savings and employment decisions of the workers–are calibrated to match data moments in the US economy. The unemployment insurance policy in this exercise is the actual unemployment insurance policy in the US economy.

In Section 4, I describe the optimal UI2 and UIA policies on the basis of the calibrated model. The optimal UI2 provides a first-tier replacement rate of 40% for a duration of five months. The second-tier benefit is 10%. The optimal UIA is based on a saving rate of 2% and a withdrawal rate of 30%. The second-tier replacement rate is 30%.

A key difference between the two optimal policies is the level of second-tier benefits. Those benefits are especially important because they are indefinite and can therefore provide valuable insurance against long unemployment spells. Compared with a generous second-tier replacement rate of 30% under the optimal UIA, the optimal UI2 provides only a 10% rate. Yet, the optimal UIA is associated with only a 0.3% tax rate devoted to government benefits, compared with a 1.9% tax rate in the optimal UI2.

Providing generous benefits at a low cost is possible because the incentive-insurance trade-off in UIA differs from that of UI2. UI2 benefits cannot be provided selectively, so if this policy were to allow 30% second-tier benefits, it would create a serious moral hazard problem that would result in a considerable increase in both the unemployment rate and the government taxes required to provide benefits.

Generous second-tier benefits imply lower employment incentives in UIA as well. But by adjusting the deposit and withdrawal rate correctly, the system can provide generous insurance to workers selectively. Since workers with positive mandatory accounts realize that withdrawing from their accounts reduces their own resources, they adapt their employment choices accordingly.

The generous indefinite payment in UIA has important implications for workers' consumption-savings decisions. In particular, young workers who are well insured against repeated or extended unemployment spells dramatically lower their precautionary savings. Compared with a worker under the optimal UI2, a worker under the optimal UIA consumes, on average, $160 (or 11%) more each month through ages 25–30, the same at age 37, and $180 on average (or 7%) less

each month through ages 60–65. This change in consumption-savings decisions over the life cycle implies stronger consumption smoothing under UIA. Quantitatively, a shift from the optimal UI2 to the optimal UIA leads to a welfare gain of 2.4%, measured as a consumption equivalent variation at time zero.

The importance of consumption smoothing for young workers is also emphasized in Michelacci and Ruffo (2015). They show that a life-cycle profile of benefits that favors the young improves average welfare because young workers have low consumption and a low hazard rate. The mechanism of UIA is different from laid out by Michelacci and Ruffo because it favors not only the young but also middle-aged workers with bad experiences in the labor market.

To put the welfare gain of the shift from UI2 to UIA in context, I compare the optimal UI2 to two other policies within the UI2 set. The first is the actual unemployment insurance policy in the United States, providing only a first-tier replacement rate of 50% for six months. The second is a laissez-faire policy–a degenerated UI2 providing neither first-tier nor second-tier benefits. Compared with the laissez-faire policy, the optimal UI2 increases both the unemployment rate and the tax level, and it leads to a welfare gain of 2.3%. This gain is the value of providing insurance through UI2 in this model. Thus, according to the model, choosing the correct policy–UI2 or UIA–is as important as providing insurance to workers in the economy. Compared with the *actual* unemployment insurance policy, the optimal UI2 improves welfare by only 0.2%. This gain is the value of fine-tuning the actual unemployment insurance policy.

Section 4 concludes with several robustness exercises for the model's parameters. The welfare gain from optimal UI2 to optimal UIA is insensitive to most of those parameters. Two exceptions are aparent in exercises with regard to the asset distribution. In the first, young workers have no initial assets, so effective insurance becomes even more important as young workers need to save more than they do in the benchmark. Accordingly, the welfare gain of shifting from optimal UI2 to optimal UIA increases to 3.7%. In the second exercise, in order to target a lower wealth-income ratio than in the benchmark, I lower the (endogenous) assets of workers in all ages by lowering the discount factor. This brings the model's left tail of the wealth distribution closer to that of the data. Here, again, the importance of effective insurance increases, and the welfare gain increases as well to 3.7%.

The thought experiment in this paper is that of a shift from a steady state UI2 to a steady state UIA, without studying the transition. An alternative view, supported by a robustness test, is that of implementing UIA for a new cohort. Notice that under this "cohort" interpretation the transition does not come up.

Section 5 concludes the paper with a few directions for future research and several comments regarding the limitations of the model and their importance for the results.

1.1 Literature Review

The literature on unemployment accounts includes several papers that compare variants of that policy to unemployment insurance. In a closely related paper, Pallage and Zimmermann (2010) use a full-blown dynamic general equilibrium model with heterogeneity in employment and wealth to compare the following two policies. The first, *unemployment insurance*, provides an indefinite replacement rate during unemployment. The second, *unemployment accounts*, is based on their *unemployment insurance* policy but also determines a mandatory deposit during employment and a maximum withdrawal rate during unemployment. There are several key differences in the modeling choices between their paper and mine. First, the Pallage and Zimmermann model does not distinguish between voluntary and mandatory savings accounts. Therefore, workers' savings decisions have implications for both self and public insurance. In this environment few workers let their savings accounts deplete, so the resultant policy resembles self-insurance. Second, their model does not have heterogeneity in aspects that are key for my mechanism to operate, such as the life-cycle feature and heterogeneity in initial assets. Finally, their model is not calibrated to the US economy, which is important for quantifying the associated welfare gain. At the same time, they find that the benefits upon exhaustion of the mandatory account can be significantly higher than those under an unemployment insurance system. Therefore, their paper is complementary to mine.

Brown, Orszag, and Snower (2008) compare an unemployment insurance system with no savings to an unemployment accounts system. Their unemployment accounts policy excludes government benefits. Instead, the government redistributes resources among the accounts. The authors show that this policy maintains employment incentives and still provides significant insurance to workers. My paper differs from theirs in both the modeling choices and the policy design. The similarity comes from the importance of combining unemployment accounts with some source of redistribution.

Feldstein and Altman (2007) perform an accounting exercise, that is based on the Panel Study of Income Dynamics (PSID). They show that a saving rate of 4% of labor income is sufficient to finance the unemployment benefits for the vast majority of workers, leading to negative balances for only 5% of workers at retirement or death or upon exiting the panel. In addition, they show that the cost of forgiving the negative balances (which is the only usage of the unemployment tax)

equals roughly half the cost of the unemployment insurance system. Their paper does not model the agent's behavior in the economy, and therefore it does not attempt to conduct a normative analysis.

As in my paper, a few recent papers condition unemployment benefits on observable characteristics other than unemployment duration. As mentioned above, Michelacci and Ruffo (2015) use age to determine the level of benefits. Rendahl (2012) and Koehne and Kuhn (2015) study asset-dependent unemployment insurance. In those papers there is a tension between using assets to provide more benefits to poorer workers and the adverse effect of conditioning benefits on assets. In comparison, optimal UIA provides benefits selectively to workers with low *mandatory* accounts. Since rich workers have a wealth effect, they turn down bad job offers that poorer workers take. This leads to a key difference between asset-based unemployment insurance and UIA: under UIA there is a selection in the provision of benefits to *richer*, not poorer, workers. This selection, however, is not strong. More important is the selective redistribution from workers who are infrequently unemployed to those who are more frequently unemployed, leading to a more efficient insurance against unemployment.

2 The Model

This section is composed of four parts. First, I describe the economic environment of the model. Second, I introduce the government's role and explain in detail the two unemployment policies (UI2 and UIA) and the Social Security policy. Third, I present the workers' optimization problems under each unemployment policy. In the fourth and last subsection, I describe the optimal unemployment policy for each system–that is, the choice of the system's instruments that maximizes workers' welfare.

The model is especially rich in two aspects. First, workers are heterogeneous in several dimensions: age, unemployment risk, wealth, and income. This richness is important for analyzing the welfare gain or loss of various demographic groups. Second, the model includes a detailed productivity process and Social Security transfers. These details are important for matching the net resources that workers accrue over the life cycle and across labor market states.

2.1 The Economy

The model operates in discrete time. It assumes a stationary economy–that is, no aggregate shocks.

Demographics: Workers are born on date 1 and live up to T periods. Throughout the life cycle, they face an age-dependent unconditional survival rate Φ_t. The life cycle $[1, T]$ is split into two periods. During age $[1, T_R - 1]$, workers are in the labor force and can be either employed or unemployed. I exclude labor-force entry and exit considerations since unemployment payments are conditional on a worker being attached to the labor force. During age $[T_R, T]$, workers are retired. I refer to the time span $[1, T_R - 1]$ as the *working age* and to the time span $[T_R, T]$ as the *retirement age.*

Preferences: Workers' period utility is $u(c) - \zeta q$, where c is consumption, ζ is disutility from work, and q is an employment indicator that equals 1 if the worker is employed and 0 if the worker is unemployed or retired. Workers discount the future at rate β. Therefore, workers maximize

$$U = E_0 \left\{ \sum_{t=1}^{T} \Phi_t \beta^{t-1} \left[u(c_t) - \zeta q_t \right] \right\}.$$

Labor Market and Timing: Figure 3 shows the labor market structure and the timing of the model for employed and unemployed workers. An employed worker is laid off and becomes unemployed with probability ψ_t, which depends on her age t. A worker who is not laid off decides whether to retain or quit the job.

The process for an unemployed worker is similar. At the beginning of the period, an unemployed worker receives a job offer with age-dependent probability π_t, in absence of which she remains unemployed. A worker who receives a job offer decides whether to accept that offer and become employed or to reject it and remain unemployed. I discuss the observability of quits and job-offer rejections later on, when I describe the government.

The design of transitions between employment and unemployment allows for both exogenous factors and endogenous decisions. Employed workers lose their jobs because of either an exogenous separation or an endogenous quit. Unemployed workers remain unemployed because of either an exogenous absence of a job offer or an endogenous rejection of one. The presence of endogenous decisions is a key component in the model, as it implies that unemployment is determined within the model and depends on the unemployment policy.

Labor Productivity Process: Workers face an individual labor productivity process that accounts for a life-cycle trend and persistent income shocks. The log labor income of an employed individual

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Figure 3: The Labor Market and the Timing of the Model
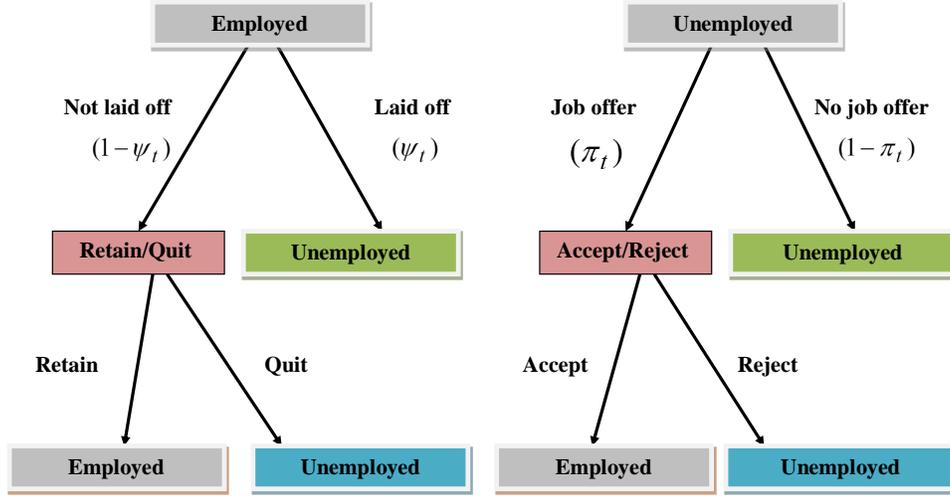
i at age t is

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\begin{aligned}
y_{i,t} &= k_t + z_{i,t} \\
z_{i,t} &= \rho z_{i,t-1} + \eta_{i,t}.
\end{aligned}
$$

The first component, k_t, is a life-cycle trend that accounts for the return to experience over the life cycle and supports the hump shape of labor income towards retirement. The second component, $z_{i,t}$, is an AR(1) process with persistence ρ and innovations $\eta_{i,t} \sim N\left(-\sigma_\eta^2/2, \sigma_\eta^2\right)$ during both employment and unemployment. The initial persistent shock is distributed $z_{i,1} \sim N\left(-\sigma_{z_1}^2/2, \sigma_{z_1}^2\right)$, thus allowing for initial heterogeneity in labor income already on date 1.

Initial Wealth and Savings: Workers are born on date 1 with an initial wealth of $a_{i,1}$. The log of initial wealth is distributed $N\left(-\sigma_{a_1}^2/2, \sigma_{a_1}^2\right)$. The distribution of initial assets will enable an investigation of how the policy affects young workers differently depending on their initial assets. Workers can save and borrow up to $\underline{a}$, and the periodic interest rate on assets is r.

2.2 The Government

The government implements an unemployment policy (either UI2 or UIA) for insuring workers against unemployment. It also administers a Social Security system for retired workers.

The UI2 System: UI2 relies on three instruments (see Figure 2). The first instrument is the

duration of the first-tier benefits, denoted by D_{UI2}. The second instrument is the replacement rate, Q_{UI2}^1, during D_{UI2}. The third instrument is the replacement rate once the duration of the first-tier benefits is completed, denoted by Q_{UI2}^2. Second-tier benefits for unemployed workers have no time limit. All benefits are taxable.

As in the actual unemployment insurance policy in the United States, UI2 benefits are provided only to workers who were laid off; those who quit are ineligible for benefits. The underlying assumption for this restriction is that the government observes quits. This assumption is supported by a component of the actual unemployment insurance system in the United States called "experience ratings", which indexes the firm's unemployment tax rate to its layoff experience. Thus, a firm that reports a quit as a layoff would, in general, face a higher unemployment tax rate. This component guarantees that the firm has the incentive to report the truth.

Compared with quits, rejections of job offers are hard to detect as they involve a third party that has no incentive to report them truthfully.[3] I therefore assume that job-offer rejections are perfectly unobservable.[4]

The UIA System: UIA relies on three instruments (see Figure 1). The first instrument is the mandatory saving rate during employment, denoted by M_{UIA}. This instrument, which is a fraction of labor income, determines the *inflow* into the account. The second instrument is the replacement rate provided by withdrawals from the account, denoted by Q_{UIA}^1. This instrument determines the account's *outflow*. The third instrument is the replacement rate once the mandatory account is exhausted, denoted by Q_{UIA}^2. As in UI2, these second-tier benefits have no time limit. Upon retirement, the balance of the mandatory account becomes available to the worker.

I assume that the mandatory account bears the same periodic interest rate, r, as private savings.[5] While the return on the two assets is the same, the mandatory account's liquidity is lower because

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[3]Although some monitoring of such rejections takes place in the United States, Setty (2014) shows that the average monthly monitoring probability in that country is 0.20. This is an upper bound for the probability of observing rejections because some rejections are undetected.

[4]The key result of this paper depends on some source of moral hazard that would allow voluntarily unemployed workers to receive government benefits in either UI2 or UIA. The exact source of moral hazard does not seem to be crucial for the results.

[5]The return on mandatory savings could be different from that on regular savings for at least three reasons: higher regulation on the investment (to avoid moral hazard, among other rationales), a higher interest rate given the central management of the funds, and an overhead cost. I exclude these considerations, which are beyond the scope of this study.

the account can be accessed only in unemployment and retirement.[6] Therefore, the worker would always prefer to deposit the minimum amount into the account and withdraw the maximum amount from it. The mandatory account has an upper bound of $\overline{a_m}$ and a lower bound of 0.[7] As in UI2, only laid-off workers are eligible to withdraw from the unemployment account and to receive second-tier benefits.

Social Security: In addition to the unemployment policy, the government administers a retirement-payments policy to retired workers. This policy follows the two main principles of the Social Security retirement plan in the United States: payments are based on lifetime labor income and are progressive.

The government finances its two activities, the unemployment system and Social Security, by collecting a labor income tax for either UI2 or UIA, denoted by τ^{UI2} and τ^{UIA}, respectively. The two alternative taxes are used to balance the government's budget.

Information Structure: Mandatory savings are regulated by the government, and hence both the government and the workers can observe them. The government, however, cannot observe private individual savings.

2.3 The Worker's Problems

UI2: The worker's state under UI2 is determined by five components: age (t), private savings (a), persistent component of labor income (z), unemployment duration (d), and eligibility for unemployment benefits (e).

Workers in the model face two types of decisions. The first is an *intertemporal* decision regarding consumption and savings, based on the workers' employment state (employed or unemployed). The second is an *intratemporal* decision of employment. This decision is relevant only for workers with an employment opportunity (employed workers who are not laid off and unemployed workers with a job offer).

The value functions for employed and unemployed workers under UI2 are $W^{UI2}(t, a, z)$ and $V^{UI2}(t, a, z, d, e)$, respectively. These values are the outcome of a maximization over consumption and savings. Note that the value for the employed worker does not include unemployment duration and eligibility–factors that are relevant only for the unemployed.

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[6]Notice that workers are born with only (the same) voluntary wealth under both UI2 and UIA policies. Thus, there is not an *already saved buffer* of mandatory assets. This justifies applying the same return to both assets.

[7]The upper bound saves on the state space. It is calibrated to a high level that does not affect any of the results.

The values for workers with job opportunities are assigned as follows. The value for a worker who was unemployed in the previous period and has a job offer is $J_u^{UI2}(t, a, z, d, e)$. The value for a worker who was employed in the previous period and was not laid off is $J_w^{UI2}(t, a, z)$. These values are the outcome of the following employment decisions:

$$J_u^{UI2}(t, a, z, d, e) = \max_{\{accept, reject\}} \left\{ W^{UI2}(t, a, z), V^{UI2}(t, a, z, d, e) \right\} \tag{1}$$

$$J_w^{UI2}(t, a, z) = \max_{\{retain, quit\}} \left\{ W^{UI2}(t, a, z), V^{UI2}(t, a, z, 1, 0) \right\} \tag{2}$$

The value for an unemployed worker who holds a job offer, $J_u^{UI2}(\cdot)$, is determined as a choice between becoming employed (accept) and remaining unemployed (reject). Since rejections are unobserved by the government, the eligibility state, e, is carried with its current value. Similarly, the value for an employed worker who does not face a layoff shock, $J_w^{UI2}(\cdot)$, is determined as a choice between remaining employed (retain) and becoming unemployed (quit). Since quits are observed by the government, the worker's eligibility state, e, upon becoming unemployed is 0.

Using the values that are based on the employment decisions, $J_u^{UI2}(\cdot)$ and $J_w^{UI2}(\cdot)$, we can now define the value for employed and unemployed workers. The value for an *unemployed* worker under UI2 is

$$V^{UI2}(t, a, z, d, e) = \max_{c, a'} \{ u(c) + \beta \phi_t \mathbb{E}_t \{ \pi_t J_u^{UI2}(t+1, a', z', d+1, e)$$
$$+ (1 - \pi_t) V^{UI2}(t+1, a', z', d+1, e) \} \}$$

$$s.t.$$

$$a' = a(1+r) - c + x$$

$$a' \geqslant \underline{a}$$

$$x = \begin{cases} Q_{UI2}^1 \exp(k_{t-d} + z)(1 - \tau^{UI2}) & if \ e = 1 \ and \ d \leq D_{UI2} \\ Q_{UI2}^2 \exp(k_{t-d} + z)(1 - \tau^{UI2}) & if \ e = 1 \ and \ d > D_{UI2} \\ 0 & if \ e = 0 \end{cases} \tag{3}$$

The worker in this problem decides on current consumption, c, and future assets, a', in order to maximize her expected discounted utility. The discounted future value is multiplied by the age-dependent conditional survival rate, ϕ_t. The future value itself is a weighted sum of the values of receiving and not receiving a job offer with the respective probabilities of π_t and $(1 - \pi_t)$.

The first constraint is a standard budget constraint, where x is the government transfer. A worker who is eligible for unemployment benefits and whose unemployment duration is within the time limit of UI2 benefits receives the first-tier replacement rate of her previous labor income, Q^1_{UI2}. An eligible worker with $d > D_{UI2}$ receives the second replacement rate, Q^2_{UI2}.[8] Finally, the ineligible worker's transfer is 0.

The value for an *employed* worker under UI2 is

$$W^{UI2}(t, a, z) = \max_{c, a'} \{ u(c) - \zeta + \beta \phi_t \mathbb{E}_t \{ (1 - \psi_t) J^{UI2}_w (t + 1, a', z')$$
$$+ \psi_t V^{UI2}(t + 1, a', z', 1, 1) \} \}$$
$$s.t.$$
$$a' = a(1 + r) - c + \exp(k_t + z)(1 - \tau^{UI2}) \tag{4}$$
$$a' \geqslant \underline{a}.$$

Note that the eligibility state upon being laid off is equal to 1. Also note that the value for the worker includes disutility from work $(-\zeta)$.

In the last period before retirement, the values collapse into the value of retirement as follows. The continuation value becomes $V^{Retirement}(t, a, z)$, as described at the end of this subsection.. All state variables other than $\{t, a, z\}$ drop as they are irrelevant for retirement.

UIA: The structure of the value functions for the worker under UIA is similar to that for the worker under UI2. The worker's state under UIA is defined by six components: age (t), private savings (a), mandatory savings (a_m), the persistent component of labor income (z), eligibility for withdrawals (e), and unemployment duration (d). The worker's state here differs from the worker's state under UI2 because of the additional mandatory savings (a_m). Notice that unemployment duration (d) is included in the model in order to recover the deterministic life-cycle component of income k_t at the start of the unemployment spell.

The intratemporal value functions under UIA are

$$J^{UIA}_u(t, a, a_m, z, d, e) = \max_{\{accept, reject\}} \{ W^{UIA}(t, a, a_m, z), V^{UIA}(t, a, a_m, z, d, e) \}$$
$$J^{UIA}_w(t, a, a_m, z) = \max_{\{retain, quit\}} \{ W^{UIA}(t, a, a_m, z), V^{UIA}(t, a, a_m, z, 1, 0) \}.$$

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[8]Since z changes over the unemployment spell and the replacement rate is taken with respect to the current z, the replacement rate is an approximation. Simulations show that about 95% of workers have replacement rates that are within 5% away from the theoretical replacement rate–e.g., within $[0.38, 0.42]$ when the replacement rate is 0.40.

The value for an *unemployed* worker under UIA can be written as follows, where m is the withdrawal from the mandatory account and b is the government transfer:

$$V^{UIA}\left(t, a, a_m, z, d, e\right) = \max_{c, a'}\{u\left(c\right) + \beta\phi_t\mathbb{E}_t\{\pi_t J_u^{UIA}\left(t+1, a', a'_m, z', d+1, e\right)$$
$$+ \left(1 - \pi_t\right) V^{UIA}\left(t+1, a', a'_m, z', d+1, e\right)\}\}$$

s.t.

$$a' = a\left(1+r\right) + m + b - c$$

$$a'_m = a_m\left(1+r\right) - m$$

$$m = \left\{ \begin{array}{l} \min\left\{Q_{UIA}^1\exp\left(k_{t-d} + z\right)\left(1 - \tau^{UIA}\right), a_m\right\} \text{ if } e = 1 \\ 0 \text{ otherwise} \end{array} \right\}$$

$$b = \left\{ \begin{array}{l} Q_{UIA}^2\exp\left(k_{t-d} + z\right)\left(1 - \tau^{UIA}\right) - m \text{ if } e = 1 \text{ \& } a_m < Q_{UIA}^1\exp\left(k_{t-d} + z\right)\left(1 - \tau^{UIA}\right) \\ 0 \text{ otherwise} \end{array} \right\}$$

$$a' \geqslant \underline{a}. \tag{5}$$

The objective function that determines $V^{UIA}\left(\cdot\right)$ is similar to the one in the value for an unemployed worker under UI2, with the necessary adjustments. Future private savings in the first constraint are determined by the sum of current private savings, including the interest rate, the withdrawal from the account, and the second-tier benefits minus consumption.

The withdrawal for an eligible worker (m) is equal to the replacement rate of her previous labor income if the account has a sufficient balance. Otherwise, it is the balance of the account. The mandatory account's balance in the second constraint is updated according to the withdrawal. The second-tier benefits (b) are based on the second replacement rate and are provided to workers who have exhausted their mandatory account. Workers with account balances that are lower than the second-tier benefits receive the difference in benefits.

The value for an *employed* worker under UIA is:

$$W^{UIA}(t, a, a_m, z) = \max_{c,a'}\{u(c) - \zeta + \beta\phi_t\mathbb{E}_t\{(1 - \psi_t)J_w^{UIA}(t+1, a', a'_m, z')$$

$$+\psi_t V^{UIA}(t+1, a', a'_m, z', 1, 1)\}\}$$

$$s.t.:$$

$$a' = a(1+r) + \exp(k_t + z)(1 - \tau^{UIA}) - c - (a'_m - a_m(1+r))$$

$$a'_m = \min\{\overline{a_m}, a_m(1+r) + \exp(k_t + z)(1 - \tau^{UIA})M_{UIA}\}$$

$$a' \geqslant \underline{a}. \tag{6}$$

The first constraint–the budget constraint of the worker–includes the deposit to the mandatory account $(a'_m - a_m(1+r))$. This deposit is equal to the deposit rate times the net labor income as long as the account's balance is lower than $\overline{a_m}$. Otherwise, it is the deposit that sets the mandatory account's balance at its upper bound. Note that the labor income used for replenishing the mandatory account is taxed (as is that used for the voluntary account).

Similar to UI2, in the last period before retirement, $T_r - 1$, the continuation value becomes $V^{Retirement}(t, a, z)$, as described below. All state variables other than $\{t, a, z\}$ drop. In addition, the future assets level a' is $a' + a_m$ as the mandatory assets become liquid to the worker; that is, the two assets are merged at retirement into this single voluntary asset.

The retirement problems are identical under UI2 and UIA and entail only a consumption-savings decision. These problems can be written as a special case of either UI2 or UIA. The worker's state in these problems is (t, a, z_{T_R}), where t is age as before and a is total assets.

The model's retirement income mimics the actual retirement income in the United States, under the Social Security formula. This requires the worker's lifetime income, which is not part of the state of the worker. I therefore approximate the retirement income, denoted g, by simulating the proper retirement income outside the model and regressing it on the worker's last observed labor income, $y_{i,T_r-1}(= k_{T_R} + z_i)$, which is a function of z, as follows:

$$g(z) = \gamma_0 + \gamma_1 y_{i,T_r-1} + \epsilon_i. \tag{7}$$

This results in estimators $\hat{\gamma}_0$, and $\hat{\gamma}_1$. Section 3 gives the details of this exercise and reports the quality of this approximation. The value of a retired worker is then

$$V^{Retirement}\left(t, a, z\right) = \max_{c, a'}\{u\left(c\right) + \beta\phi_t\{V^{Retirement}\left(t+1, a', z\right)\}\}$$

$$s.t.$$

$$a' = a\left(1+r\right) - c + g(z)$$

$$a' \geqslant \underline{a}$$

$$g(z) = \hat{\gamma}_0 + \hat{\gamma}_1 \exp\left(k_{T_R} + z\right). \tag{8}$$

2.4 Optimal Unemployment Policies

The optimal UI2 is a triplet $\{D_{UI2}^*, Q_{UI2}^{1\,*}, Q_{UI2}^{2\,*}\}$ that maximizes expected welfare subject to a balanced budget:

$$\max_{D_{UI2}, Q_{UI2}^1, Q_{UI2}^2} \left\{\mathbb{E}_0\left\{\xi_0 W^{UI2}\left(t=0, a, z\right) + \left(1 - \xi_0\right) V^{UI2}\left(t=0, a, z, d=1, e=1\right)\right\}\right\}$$

$$s.t.$$

$$\tau^{UI2} \sum_{i|d(i)=0} \sum_{t=1}^{T_R-1} \Phi_t \exp\left(k_t + z_{it}\right) = Q_{UI2}^1 \left(1 - \tau^{UI2}\right) \sum_{i|1 \leq d(i) \leq D_{UI2}} \sum_{t=1}^{T_R-1} \Phi_t e_{it} \exp\left(k_{t-d} + z_{it}\right)$$

$$+ Q_{UI2}^2 \left(1 - \tau^{UI2}\right) \sum_{i|d>D_{UI2}} \sum_{t=1}^{T_R-1} \Phi_t e_{it} \exp\left(k_{t-d} + z_{it}\right) + \sum_i \sum_{t=T_R}^{T} \Phi_t g\left(z_i\right), \tag{9}$$

In this problem, the expectation operator is taken with respect to initial wealth and the initial persistent component of income, taking into account the cohort size at each age. ξ is the initial measure of employed workers, and $g\left(z\right)$ is the determination of Social Security benefits based on the persistent component of labor income as defined in Equation 8.[9]

The optimal UIA is a triplet $\{M_{UIA}^*, Q_{UIA}^{1\,*}, Q_{UIA}^{2\,*}\}$ that maximizes expected welfare subject to a balanced budget:

$$\max_{M_{UIA}, Q_{UIA}^1, Q_{UIA}^2} \left\{\mathbb{E}_0\left\{\xi_0 W^{UIA}\left(t=0, a, a_m{=}0, z\right) + \left(1 - \xi_0\right) V^{UIA}\left(t=0, a, a_m{=}0, z, d=1, e=1\right)\right\}\right\}$$

$$s.t.$$

$$\tau^{UIA} \sum_{i|d(i)=0} \sum_{t=1}^{T_R-1} \Phi_t \exp\left(k_t + z_{it}\right) = \left(1 - \tau^{UIA}\right) \sum_{i|d(i)>0} \sum_{t=1}^{T_R-1} \Phi_t e_{it} b_{it} + \sum_i \sum_{t=T_R}^{T} \Phi_t g\left(z_i\right), \tag{10}$$

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[9]For the sake of light notation, I slightly abuse the notation. First, while formally the measure of workers is a continuum, I present workers as a discrete set. Second, I use the statement $d(i) = 0$ as a condition of employment.

where b is defined in (5).

In order to compare the welfare of optimal UIA to that of optimal UI2–or the welfare of any two (steady state) policies of interest, such as optimal UI2 and the actual unemployment policy in the United States–I need to define a welfare metric. I apply the *constant consumption equivalent variation*, defined as the variable ω, which solves

$$\mathbb{E}_0 \left\{ \sum_{t=1}^{T} \Phi_t \beta^{t-1} \left[u \left((1+\omega) c_t \right) - \zeta q_t \right] \right\} = \mathbb{E}_0 \left\{ \sum_{t=1}^{T} \Phi_t \beta^{t-1} \left[u \left(\widetilde{c}_t \right) - \zeta \widetilde{q}_t \right] \right\},$$

where $\{\widetilde{c}_t, \widetilde{q}_t\}$ are the optimal consumption and employment levels under the studied policy (e.g., the optimal UIA), and $\{c_t, q_t\}$ are those under the benchmark policy (e.g., the optimal UI2). This ω is the percentage increase in consumption that must be provided to each worker at each date in her lifetime in the studied policy to make her exactly as well off as she is under the benchmark policy, controlling for differences in employment across the two policies.

The expectation operator is taken with respect to the distribution of initial assets $a_{i,1}$ and persistent shocks at time zero with measures $\{\xi_0, 1 - \xi_0\}$ for employed and unemployed workers at time zero.

3 Calibration

The calibration is carried out in two stages. I first set the parameters that are calibrated externally to the model. Those parameters mimic the economic environment that workers face. I then determine the parameters that affect the consumption-savings and employment decisions of the workers in the economy–specifically, the discount rate, disutility from work, and the age profile of job offers. These key parameters are calibrated to match data moments in the US economy given the actual unemployment insurance policy in the steady-state US economy.

3.1 Externally Calibrated Parameters

Table 1 summarizes the values for the externally calibrated parameters in the model.
Life Cycle: The unit of time is one month. This frequency, which is relatively high for a life-cycle model, supports a careful distribution of unemployment shocks. Workers join the labor force at age 25 and remain within it through age 65. The entry age of 25 is chosen to reflect the assumption that most people have made their human capital decisions, which are outside of the model, by that age.

The retirement age of 65 is set to reflect the US retirement age range of 65 to 67 (depending on the year of birth) and the early retirement option at age 62. The maximum age, T, is calibrated to 100 years of age. The survival rates are taken from the US Census (2005). The life cycle therefore consists of a working-age span of 40 years (or 480 months) and a retirement-age span of 35 years (or 420 months).

Preferences: Utility from consumption is logarithmic. The level of disutility from work, ζ, is discussed in the next subsection.

Labor Productivity: Median monthly labor income is equal to \$3,010, based on the 2007 Current Population Survey (CPS) data. The initial employment level is set according to the unemployment rate at age 25 using CPS data for 1990–2005. The age profile (k_t) is estimated using mean labor income with cohort effects from the PSID as in Huggett, Ventura, and Yaron (2006). The income process is based on Heathcote, Perri, and Violante (2010), in which the persistence of the income shock, ρ, is equal to 1.00, and the (annual) variance of the income shock, σ_η^2, is equal to 0.007. As Heathcote, Perri, and Violante (2010) argue, this variance implies a realistic life-cycle increase in the variance of income. The initial variance of the persistent shock is $\sigma_{z_1}^2 = 0.242$ (Storesletten, Telmer, and Yaron, 2000). Notice that a permanent shock, together with initial variance in this shock, means that the initial difference in z acts as a *fixed effect* over the complete life cycle.

Actual Unemployment Insurance Policy in the United States: The unemployment policy in the calibration is the actual unemployment insurance policy in the United States. Although this policy varies across states, its instruments and their levels are fairly consistent. On average, unemployment insurance benefits in that country are based on a replacement rate of 50% for a duration of 26 weeks in nonrecessions.[10]

Savings: The initial wealth distribution is set to match two key moments in the asset distribution of workers between the ages of 25 and 34 in the US Census's Survey of Income and Program Participation (SIPP) data (see Anderson, 1999). The first moment is the median net worth of \$5,600. The second is the mean-median ratio of 4.2. This asset distribution implies a high Gini wealth coefficient of 0.78 at age 25. The borrowing limit is set to 0. The annual interest rate is set to 4%, following Cooley (1995).

Social Security Payments: As in the United States, Social Security payments for a retired worker in the model are based on the worker's lifetime labor income. As mentioned above, this object is not part of the worker's state. I therefore approximate the retirement payment for each worker

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[10]Department of Labor, U.S. Employment and Training Administration. Available at: http://www.unemploymentinsurance.doleta.gov/unemploy.

Table 1: Externally Calibrated Parameters

Parameter	Value	Source
Preferences		
$u(c)$	Logarithmic	
Labor income process		
Median labor income	\$3,010 (monthly)	Current Population Survey (2007)
Initial employment rate	92%	Shimer (2012)
Life-cycle trend (k_t)	See text	Huggett, Ventura, and Yaron (2006)
Persistence (ρ)	1.00 (annual)	}Heathcote, Perri, and Violante (2010)
Innovation variance (σ_η^2)	0.007 (annual)	
Initial wage variance $(\sigma_{z_1}^2)$	0.242	Storesletten, Telmer, and Yaron (2000)
Savings		
Median initial wealth	\$5,600	}Anderson (1999)
$\frac{\text{Mean}}{\text{Median}}$ initial wealth	4.2	
Interest rate (r)	4% (annual)	Cooley (1995)
Retirement income		
Social Security income	See text	US Social Security formula for 2007

based on the 2007 Social Security formula by simulating labor income paths. I then calculate the retirement income, g, associated with lifetime labor income according to the Social Security formula based on the last observed level of labor income ($g(z) = \gamma_0 + \gamma_1 y_{i,T_r-1} + \epsilon_i$). The resulting formula–with estimators $\hat{\gamma}_0$ and $\hat{\gamma}_1$–is the approximation of retirement income based on the last observed labor income in the model. The variation in the last labor income level explains 85% of the variation in retirement income. This approximation is fairly good because the income shocks are permanent.

Exogenous Separations: In regard to employment opportunities, the model includes two decisions: job-offer rejections while unemployed, and quits of existing jobs while employed. In the model, quits are infrequent under any reasonable calibration. This behavior is not surprising given that, in the model (as well as in reality), a worker who quits a job does not receive benefits.[11]

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[11]Quits can still happen in the model. For example, a poor worker may choose to take a low-paying job for some

Quantitatively, the frequency of quits is typically lower by three orders of magnitude than that of job-offer rejections. This implies that quits are inconsequential for unemployment in the model. I therefore simply use the exogenous transition from employment to unemployment in the data as the model's exogenous separations rates, ψ_t. These are taken from Shimer (2012) on the basis of 1990–2005 CPS data.

3.2 Parameters That Are Matched to Specific Moments

We are left with several key parameters: the discount rate, β; the disutility from effort, ζ; and the parameters that govern the functional form of the exogenous job-offer probability, π_t. For the transition from unemployment to employment, I estimate a two-term exponential model $\pi_t = \xi_1 * exp(\xi_2 * t)$. In this model, π_t is the age-dependent job-offer probability that is *exogenous* to the model and remains fixed throughout all experiments, ξ_1 and ξ_2 are parameters to be estimated, and t is working age in months (1–480).[12]

I choose the model's parameters ξ_1 and ξ_2 to fit key moments regarding unemployment in the data.[13] The first moment is the mean unemployment rate in the economy. Using CPS data for 1990–2007 (and thus excluding the Great Recession) provides the value of 5.4%. To discipline the employment profile over the life cycle by the data, the "second" moment is the shape of the age profile of employment rate.

The third moment is the wealth-income ratio. The wealth-income ratio target of 2.2 is based on PSID data provided in Table 1 in Krueger, Mitman, and Perri (2015), where wealth is net worth and income is pre-tax earnings. In this calculation the top 10% of wealth and income percentiles are excluded; otherwise, those households would skew the wealth distribution to the right.[14]

The fourth and last moment is the elasticity of the hazard rate with respect to benefits. Recall that employment is associated with disutility, ζ. Therefore, a central force in shaping workers'

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time in order to accumulate assets, and then may quit the job.

[12]Michelacci and Ruffo (2015) use a similar approach, although the implementation here uses fewer parameters. This is necessary given the high computational burden of the monthly calibrated model.

[13]Since separations are exogenous, targeting unemployment moments is equivalent to targeting moments that relate to the endogenous job-finding rate.

[14]The households at the top 10% of the wealth distribution in the United States own more than two-thirds of total wealth, while the income share of the top 10% of income is much smaller. Without excluding those households, and given that the model misses the right tail of the wealth distribution, the model's asset distribution will be skewed to the right, especially missing the left tail of the wealth distribution in the data.

Table 2: Moments: Data and Model

Moment	Data	Model
Unemployment rate	5.4%	5.4%
Wealth-income ratio	2.20	2.20
Elasticity of hazard with respect to benefits	-0.50	-0.50

employment decisions is the tension between receiving higher compensation when employed and exerting an effort that reduces their disutility. The elasticity of the hazard rate with respect to benefits captures this tension. The higher the elasticity, the more sensitive workers are to unemployment benefits. This elasticity is calculated in the model–as in the data–as the change in the hazard rate in response to a change in the replacement rate of unemployment benefits given the *actual policy*.[15] The estimations for this value in microdata range considerably. Two recent estimates that are based on SIPP data but differ in their estimation strategies put this elasticity at –0.53 (Chetty, 2008) and –0.36 (Michelacci and Ruffo, 2015). I set this target at –0.5 and report the sensitivity of the results to this parameter in Section 4.4.

Although all moments are affected by all parameters, there are some strong links. The discount rate, β, is the key parameter that affects the wealth-income ratio through the determination of the average savings in the economy. Disutility from work, ζ, affects the elasticity of the hazard with respect to benefits. Finally, the parameters that govern the job-finding rate, ξ_1 and ξ_2, affect the unemployment rate level and its shape, respectively.

Picking the four parameters $(\beta, \zeta, \xi_1, \xi_2)$ to minimize the distance between model and data moments, I arrive at the following values. The monthly discount rate, β, is 0.9950, or about 0.94 in annual terms.; disutility from work, ζ, is 0.48; ξ_1 and ξ_2 are equal to 0.52 and –0.0015, respectively.

Table 2 shows three moments that are tightly linked to three of the four parameters (β, ζ, ξ_1) and are precisely achieved: the unemployment rate, the wealth-income ratio, and the elasticity of the hazard rate with respect to benefits.

The remaining target, the shape of the age profile of employment, which is effectively a collection of 480 moments, is controlled by the slope parameter of the job-finding rate, ξ_2. Hence,

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[15]Specifically, this is done by measuring the hazard at replacement rates of {48%, 50%, 52%}, and then taking the average between the elasticity associated with a change from 50% to 52% and the one associated with a change from 50% to 48%.

Figure 4: Employment Level: Data and Model
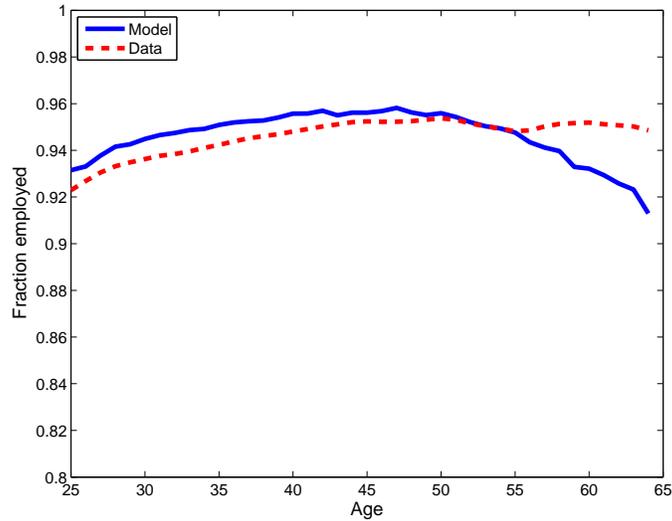
the calibration is strongly overidentified in this aspect. Figure 4 compares the data and model employment rate over the working age. Overall, the fit is good, capturing the light rise in employment in ages 25–50 and the subsequent drop for older ages. The model overstates young workers' employment and understates old workers' employment. Old workers in the model have relatively high levels of savings, some of which were accumulated for precautionary reasons against unemployment and income shocks. Therefore, towards retirement, workers who become unemployed by an exogenous shock choose to remain unemployed by rejecting job offers and receiving unemployment benefits for six months. This is consistent with the observation of Michelacci and Ruffo (2015) that moral hazard increases with age.[16]

3.3 Model Moments

Figure 5 shows the life-cycle means of annual consumption, annual net labor income, and assets in the simulation with the actual unemployment insurance policy. Assets increase over the life cycle and flatten at age 55. Consumption is lower than labor income because workers have two motives for saving: a life-cycle motive to save for retirement given the low income-replacement rate of Social Security, and a precautionary savings motive against unemployment and negative income

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[16]There are various reasons that encourage workers' employment in the data, which are excluded from the model. For example, Wettstein (2015) finds that workers in the United States remain employed in order to retain access to employers' health insurance.

Figure 5: Model First Moments
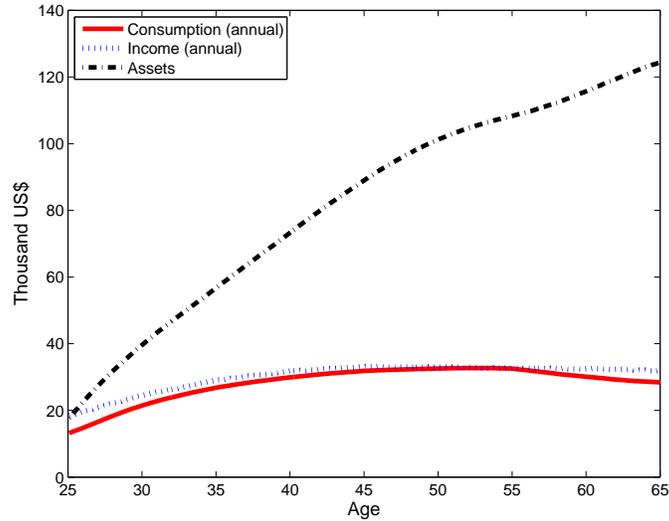
shocks.

Figure 6 shows the Gini coefficients of consumption, labor income, and assets. The assets coefficient starts at a high level that is matched to the data and decreases dramatically as workers with low assets save for precautionary reasons. The coefficient then increases following labor market experience. The consumption and income coefficients are relatively high at the beginning of life because of the already existing heterogeneity at age 25 in assets (affecting only consumption dispersion but not income dispersion) and labor income (affecting both consumption and income dispersion). Those Gini coefficients further increase over the working age following the realizations of unemployment and income shocks.

Figure 7 shows the distribution of unemployment duration in the model relative to the data. The model performs reasonably well in matching those moments, with a somewhat lower weight on long-term unemployment.[17]

Next, I compare the wealth distribution in the model to that of the data. In a recent paper, Krueger, Mitman, and Perri (2015) use a similar model (but a different analysis) to argue that for the wealth distribution to matter for the analysis, it should feature a realistic left tail of assets. Table 3 shows the asset distribution for the benchmark model and the data. The "Data" column, which shows the mean net wealth in thousands of US dollars by percentile groups, is based on Table 1

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[17]Source: http://www.bls.gov/cps/tables.htm. Notice that this distribution is quite different from the one in the Great Recession–e.g., in 2015: http://www.bls.gov/news.release/empsit.t12.htm.
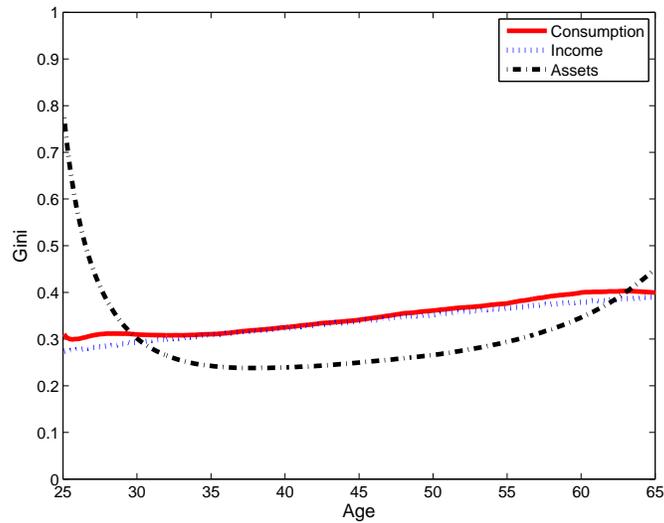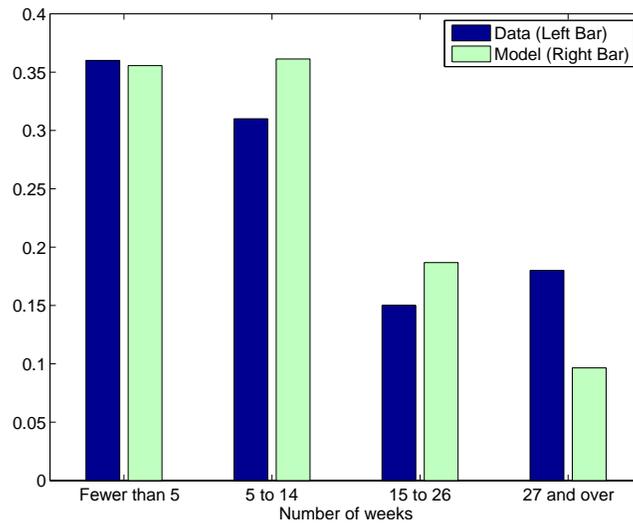
Figure 6: Model Second Moments

Figure 7: Duration Distribution

(column 4) in in Krueger, Mitman, and Perri, which uses data from the PSID for 2006.[18] The "Model" column is calculated for the calibrated model–that is, for UI2 at the actual policy.[19] Since

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[18]Their table shows the percentage share of net worth held by various percentile groups and the mean of wealth in 2006. To calculate the mean net wealth of each group, I multiply the share by the mean and divide by the share of the percentile group in the population.

[19]The PSID data is at the household level, while the model is at the individual level. To account for this, the model's

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Table 3: Assets Distribution

Data group	Model ($K)	Data ($K)
P01–P20	26	−18
P20–P40	65	10
P40–P60	96	60
P60–P80	143	194
P80–P90	290	458

the top 10 percentiles are excluded from the data, the model's percentiles in Table 3 are adjusted to allow comparison with the data. For example, the cell of "P80–p90" represents the top 12.2 percentiles in the model. This adjustment is necessary because the bottom 90% in the data are represented by all 100% in the model.

Clearly, the asset distribution in the data is more dispersed than that delivered by the model. This is true especially for the right tail but also for the left tail. As will become clear in the next section, UIA performs better relative to UI2 the *lower* the assets in the economy are. This is because UIA provides better insurance than UI2 at a lower cost for the government. Therefore, the fact that the asset distribution in the model is skewed to the right is conservative.[20]

4 Results

In this section, I report the optimal UI2 and UIA policies, along with some key statistics and the welfare gain associated with shifting from the optimal UI2 to the optimal UIA. I then analyze of how the mandatory account and the second-tier benefits complement each other under UIA in order to better insure workers. To put the welfare gain into context, I next compare the optimal UI2 to the actual unemployment insurance in the United States and to a laissez-faire policy. I conclude this section with a robustness analysis.

To find the optimal policy for both UI2 and UIA, I apply a grid over the three instruments of each policy, resulting in 567 combinations for each policy. The computational method is described

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levels are slightly normalized such that the mean of assets in the model is the same as the mean of assets of the bottom 90% in the data.

[20]The robustness subsection (Subsection 4.4) provides an analysis for an economy with a wealth-income ratio of 1.5 instead of 2.2; in this economy, the wealth distribution gets closer to the data.

Table 4: Instruments and Statistics for Optimal UI2 and Optimal UIA

Optimal UI2			Optimal UIA	
Instruments				
Benefits duration D_{UI2}	5 months		Deposit rate M_{UIA}	2%
First-tier rate Q^1_{UI2}	40%		Withdrawal rate Q^1_{UIA}	30%
Second-tier rate Q^2_{UI2}	10%		Second-tier rate Q^2_{UIA}	30%
Statistics				
Tax rate	16.4%		Tax level	15.6%
Unemployment tax	1.5%		Unemployment tax	0.3%
Unemployment rate	5.2%		Unemployment rate	5.5%
Welfare gain of a shift from UI2 to UIA				2.4%

in detail in the appendix.

4.1 Optimal UI2 versus Optimal UIA

The Optimal Policies

Table 4 presents the instruments and some cross-sectional statistics for the optimal UI2 and UIA, along with the welfare gain for a shift from the optimal UI2 to the optimal UIA.

The optimal UI2 provides a first-tier replacement rate of 40% for a duration of five months. The second-tier benefit for the optimal UI2 is 10%. Interestingly, the optimal UI2 is quite close to the actual unemployment insurance policy in the United States that provides a first-tier benefit of only 50% for a duration of six months. Notice that this similarity is not targeted in any way.

The optimal UIA is based on a saving rate of 2% and a withdrawal rate of 30%. The deposit and withdrawal rates are key instruments of UIA because they determine the duration of the account payments and hence the delay of government benefits. This delay allows the second-tier replacement rate to be relatively high–at 30%–compared with only 10% under the optimal UI2. Those second-tier benefits are especially important because they are not time limited. This high replacement rate can be provided for a long duration because, as we will see, it is granted to only a small fraction of unemployed workers.

Compared with the optimal UI2 economy, the optimal UIA economy has a higher unemployment rate and a lower tax rate. These two effects can happen simultaneously because the optimal UIA delivers benefits to workers selectively and thus provides more insurance with lower resources. Compared with an unemployment tax of 1.9% in the optimal UI2, the unemployment tax in the optimal UIA is only 0.3%.[21] Quantitatively, the shift from the optimal UI2 to the optimal UIA leads to a welfare gain of 2.4%, measured as consumption equivalent variation at time zero.

The difference between the unemployment rate associated with optimal UIA (5.5%) and that of optimal UI2 (5.2%) is not a core difference between the two policies. It is easy to find among the UIA set of policies a suboptimal policy that delivers a similar welfare gain with a lower unemployment rate. For example, increasing the deposit rate of UIA from 2% to 3% leads to a welfare gain of 2.2% while the unemployment rate is 5.2%. This suboptimal policy delivers lower second-tier benefits because the accumulation of mandatory assets is higher, implicitly increasing the delay before the mandatory account is exhausted.

Employment Decisions

Since the model includes a lot of heterogeneity in workers' characteristics, it is of interest to identify the workers who are most responsive to the unemployment policy. As outlined above, quits are very rare in the model because a quit does not entitle a worker to receive unemployment benefits.

Focusing on the transition between unemployment and employment, a worker who has a job offer faces several disincentives to accept that job offer. First, accepting the offer is associated with disutility from work, which decreases the utility of the worker. Second, a worker receives benefits during unemployment. Here, the benefits depend on the policy (UI2 or UIA) and the state of the worker. Under UI2, the duration determines whether the worker receives first-tier or second-tier benefits. Under UIA, the mandatory account determines whether the worker is allowed to withdraw from her mandatory account or receive second-tier government benefits. Third, a worker who experiences a low income draw may wait for a better draw, similar to the basic McCall search model.[22]

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[21]Notice that under UI2, the unemployment tax is used to finance both first-tier and second-tier benefits. Under UIA, it finances second-tier benefits only.

[22]Another motive for employment decisions is due to the approximation of the replacement rate. Because z changes over the unemployment spell, the replacement rate that a worker receives may go up or down. As I show in Section 3, the quantitative importance of those approximations is low, and since those changes are unexpected, the strategic

Table 5: Statistics by Accept/Reject of Job Offers

	UI2		UIA	
	Accept	**Reject**	**Accept**	**Reject**
Ages 25–34				
Assets ($K)	36	645	23	474
Income ($K)	2.0	1.2	2.0	1.3
Duration (months)	2.1	3.4	2.1	3.3
Mandatory assets ($K)			0.6	0.4
Accept/reject breakdown	0.95	0.05	0.93	0.07
Ages 35–44				
Assets ($K)	69	979	39	693
Income ($K)	2.6	1.4	2.6	1.6
Duration (months)	2.4	3.0	2.4	3.2
Mandatory assets ($K)			2.9	0.8
Accept/reject breakdown	0.98	0.02	0.97	0.03
Ages 45–54				
Assets ($K)	95	936	57	716
Income ($K)	2.7	1.3	2.8	1.5
Duration (months)	2.7	3.5	2.7	3.1
Mandatory assets ($K)			6.0	1.6
Accept/reject breakdown	0.99	0.01	0.98	0.02
Ages 55–65				
Assets ($K)	110	197	80	100
Income ($K)	2.7	1.1	2.7	0.8
Duration (months)	3.1	3.1	3.1	3.1
Mandatory assets ($K)			8.1	2.7
Accept/reject breakdown	0.84	0.16	0.71	0.29

Table 5 displays statistics by age group for wealth, income, and unemployment duration separately for workers who accept or reject job offers.[23] The first two columns (UI2) clearly identify two types of workers who reject job offers: richer workers and lower-income workers. Richer workers are more likely to reject a job offer because they have more self insurance to rely on.[24] Lower-income workers face a lower return on their effort relative to higher-income workers and therefore are more likely to reject a job offer. Unemployment duration is somewhat higher for workers who reject the job offer than for workers who accept it. The difference in unemployment duration is less dramatic than that for assets and income, especially if we take into account the fact that a rejection may follow another rejection, with each being associated with longer durations. In comparison, acceptance of a job offer terminates the unemployment spell.

Columns 3 and 4 of Table 5 (UIA) reflect a similar pattern of wealth, income, and duration while also showing the balances of the mandatory account. Overall, a similar pattern of wealth, income, and duration characteristics emerges for UIA.[25] As somewhat expected, workers who reject job offers have, on average, lower balances in their mandatory accounts. This reflects the moral hazard for workers who are close to receiving second-tier benefits. Notice that the increase in unemployment associated with the shift from optimal UI2 to optimal UIA is accompanied by more rejections across all age groups.

Figure 8 compares the employment rate associated with the two optimal policies over the life cycle. The difference is almost entirely the result of a decrease in older workers' employment under UIA. About 75% of those older unemployed workers use their account balances. The rest are responsive to the relatively generous second-tier benefits.[26]

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behavior of workers is limited.

[23]The mean durations exclude long-term unemployment of nine months and beyond to eliminate the effect of long-term unemployed workers.

[24]Notice that the statistics for wealth by the accept/reject decision imply that benefits are provided selectively to richer workers. This is in sharp contrast to the asset-based unemployment insurance in Rendahl (2012) and Koehne and Kuhn (2015). Even though this selection is not desired, it is of small magnitude, and UIA can lead to a substantial welfare gain.

[25]Notice that wealth levels for both the "Accept" and "Reject" columns are lower under UIA than under UI2. As will become clear, voluntary assets are lower under UIA as this policy provides better insurance, reducing the need for precautionary savings.

[26]To demonstrate this, consider a suboptimal UIA that is similar to the optimal one but provides a second-tier replacement rate of 20% instead of 30%. This policy results in an unemployment rate of 5.1% and a welfare gain relative to the optimal UI2 of 1.5%. This finding implies that the policy could be fine-tuned (e.g., by age) to better

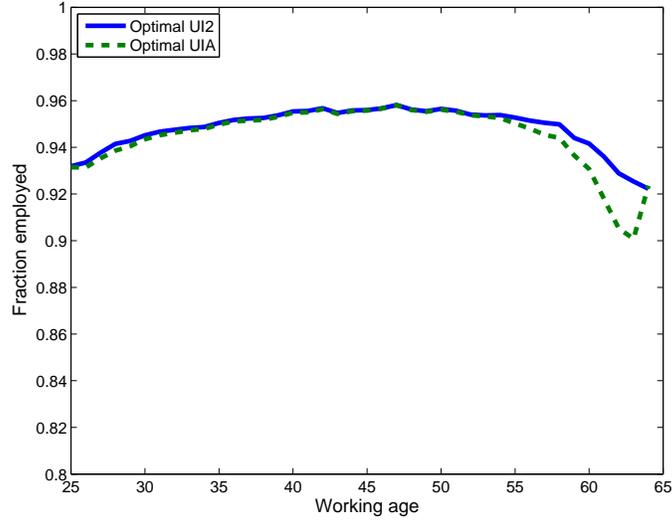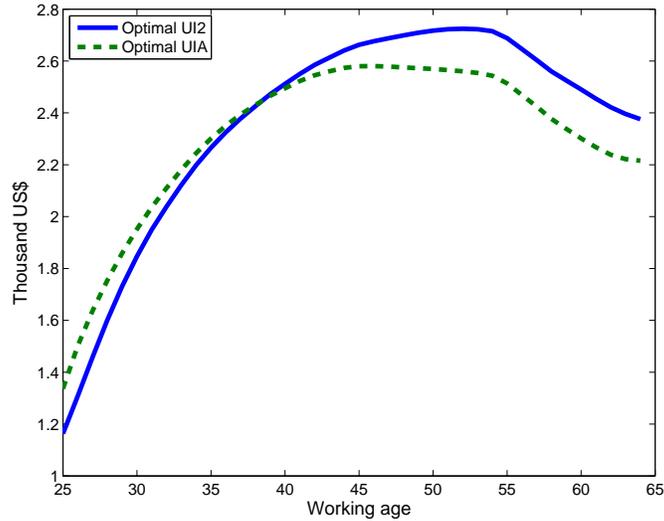Figure 8: Employment: Optimal UI2 versus Optimal UIA

Figure 9: Life-Cycle Consumption: Optimal UI2 versus Optimal UIA

Consumption-Saving Decisions and Government Insurance

I now analyze workers' consumption and asset decisions and how those decisions are affected by government insurance. As Figure 9 shows, there is a large difference in the life-cycle profile of average monthly consumption across the two optimal policies. Under UIA, workers are better able to smooth consumption over the life cycle. Compared with a worker under the optimal UI2, a

cope with this particular source of moral hazard.

Figure 10: Government Cost Profile: Optimal UI2 versus Optimal UIA
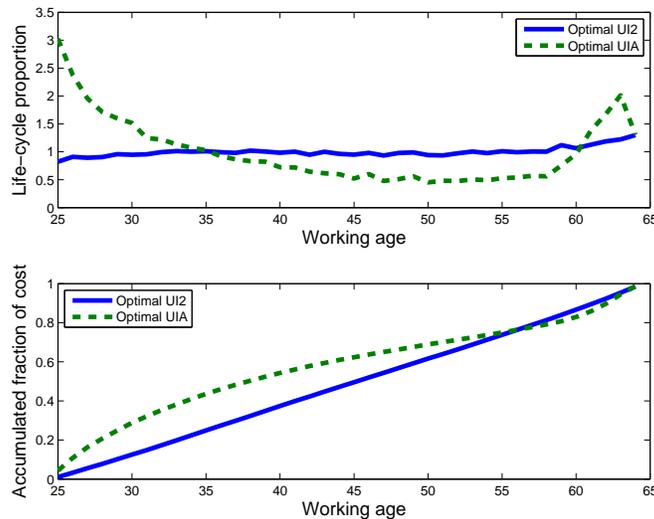
worker under the optimal UIA consumes, on average, $160 (or 11%) more each month in ages 25–30, the same at age 37, and $180 on average (or 7%) less each month in ages 60–65. What allows this significant transfer of resources over the life cycle? The two possible explanations are (1) a direct government redistribution across age groups and (2) a change in the worker's consumption-savings decisions.

The top panel of Figure 10 shows the life-cycle profile of the government's expenditure on benefits for the two optimal policies. Each profile is derived by normalizing its average to 1. In this figure, the profile of the government's expenditure under UI2 is based on the cost of both first-tier and second-tier benefits; for UIA it is based on the cost of second-tier benefits. While UI2 has a flat profile of expenditures, the UIA's profile shows a strong redistribution from middle-aged workers to both young and old workers. The support for young and old workers stems from different driving forces: young workers are only slightly more unemployed than middle-aged workers (see Figure 8). The young, however, have very low account balances, so when they are unemployed, they receive the government second-tier benefits quickly. Old workers receive support simply because they are unemployed at a higher rate (see Figure 8).

The importance of consumption smoothing for young workers is also emphasized in Michelacci and Ruffo (2015). They show that a life-cycle profile of benefits that favors the young improves average welfare because young workers have low consumption and a low hazard rate. The mechanism of UIA is different from that of Michelacci and Ruffo's model because it favors not only the young but also middle-aged workers with bad experiences in the labor market.

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Figure 11: Average Life-cycle Savings: UI2 versus UIA
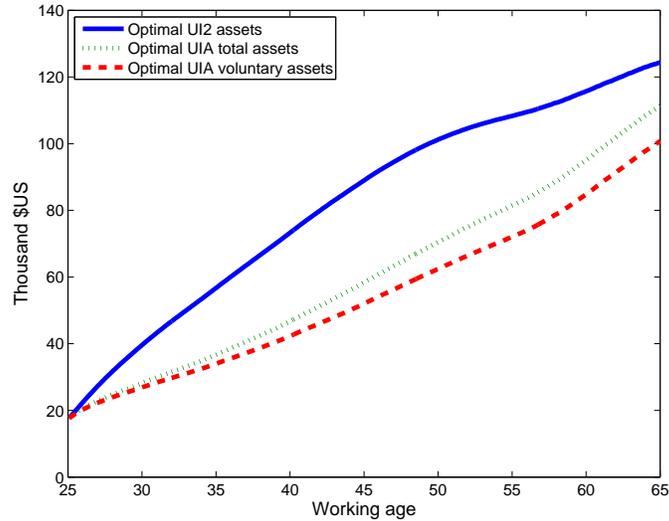
The bottom panel of Figure 10 shows the accumulated fraction of the total cost by age for UI2 and UIA. The concavity of that fraction in ages 25 through 55 reflects the relative importance of benefits to young workers. However, looking at ages 35–55 shows a substantial increase in the fraction of that cost, from 41% to 74%.[27] Therefore, while there is a clear importance for the young in this analysis, other groups are important as well.

Can the difference in government expenditure between the two optimal policies explain the large difference in consumption between them? The answer is no. This profile of support for the young under the optimal UIA is attractive given that workers have little means to insure themselves against unemployment. But since the absolute government expenditure for young workers is only about $25 under optimal UIA, compared with $50 under the optimal UI2, the payments profile cannot explain the consumption-smoothing ability under UIA.

Figure 11 shows the average assets over the life cycle under the optimal UI2 and UIA. The savings under UI2 are voluntary, whereas under UIA they are the sum of both voluntary and mandatory savings. Yet total savings under UIA are considerably lower than those under UI2. To validate the argument that the difference in assets explains the majority of consumption smoothing, I plot in Figure 12 the difference in deposits into the savings accounts for both optimal policies–a difference that very closely follows the difference in consumption illustrated in Figure 9.

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[27]Another way to look at the total cost is that it splits approximately three ways among the age groups of 25–32, 33–49, and 50–65.

Figure 12: Average Life-Cycle Deposits: UI2 versus UIA
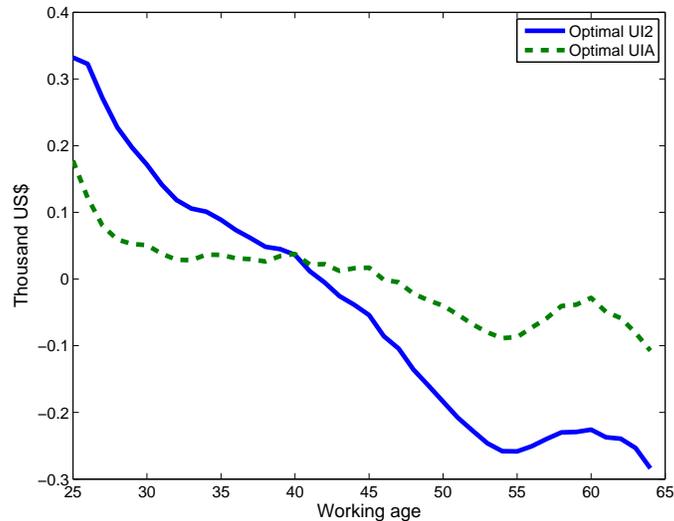
What drives the difference in savings between the optimal UI2 and the optimal UIA? The optimal UIA includes a generous indefinite second-tier replacement rate of 30%, which effectively insures workers against long spells of unemployment and reduces the precautionary motive for young workers. Since their total savings go down, young workers can better smooth their consumption over the life cycle..[28]

Given this important implication of indefinite second-tier benefits, what prevents the optimal UI2 from providing such generous benefits?The answer lies in different incentive-insurance trade-offs. Under UI2, higher insurance implies lower employment incentives. By construction, UI2 benefits cannot be provided selectively. Therefore, if UI2 were to allow 30% second-tier benefits, it would create a serious moral hazard problem that would result in a considerable increase in the unemployment rate and in the government taxes required to provide benefits. The next subsection demonstrates this.

4.2 Insurance versus Accounts: The Best of Both Worlds

I illustrate the importance of combining the mandatory account with insurance by transforming the optimal UIA into two policies, each with only one component–either the mandatory account

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[28]To further emphasize the importance of insurance against long-term unemployment, recall that according to Figure 7, 28% of unemployed workers in the model are unemployed for at least four months. Also notice that this somewhat underrepresents long term in the data.

Table 6: UI2 – Actual and Optimal – Relative to Laissez Faire

| Instruments and statistics	Laissez faire	Actual policy	Optimal UI2
Instruments			
Time limit of benefits D_{UI2} (months)	0	6	5
First-tier replacement rate Q^1_{UI2}	0%	50%	40%
Second-tier replacement rate Q^2_{UI2}	0%	0%	10%
Statistics			
Tax level	14.8%	16.9%	16.4%
Unemployment tax	0.0%	1.9%	1.5%
Unemployment level	4.9%	5.4%	5.2%
Welfare gain relative to laissez faire		2.1%	2.3%

or insurance. The first policy has only the accounts component, which is achieved by setting the second-tier payment at 0% instead of the optimal 30%. The welfare gain of 2.4% (see Table 4) relative to the optimal UI2 now becomes a welfare *loss* of 2.2%. Without the insurance component, UIA loses its advantage of effectively insuring unemployed workers especially in middle age. In particular, this policy is not superior to laissez faire because workers can mimic the forced savings and possibly do better.[29]

The second variation of the optimal UIA has only the insurance component, which is achieved by setting the deposit rate at 0%. Therefore, any worker who is eligible for second-tier benefits receives benefits of 30% immediately and without a time limit. Here the welfare gain of 2.4% becomes a welfare *loss* of 1.9%. This policy causes a very high unemployment rate of 9.8%. Since all workers receive the benefits without a delay, the moral hazard problem of providing generous benefits for an unlimited time is very strong.

This comparison demonstrates that generous indefinite benefits are possible only when they are provided *selectively* to workers. Whether this selection is desired depends on the specific mechanism. In the case of UIA, the account screens out those who need the insurance less, thus allowing the provision of generous benefits at a low cost.

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[29]Interestingly, the welfare loss under this policy relative to that under laissez faire is only 0.1%. This indicates that workers are generally insensitive to the forced savings because there is a retirement savings motive in the model.

Figure 13: UI2 Deciles Relative to Laissez Faire
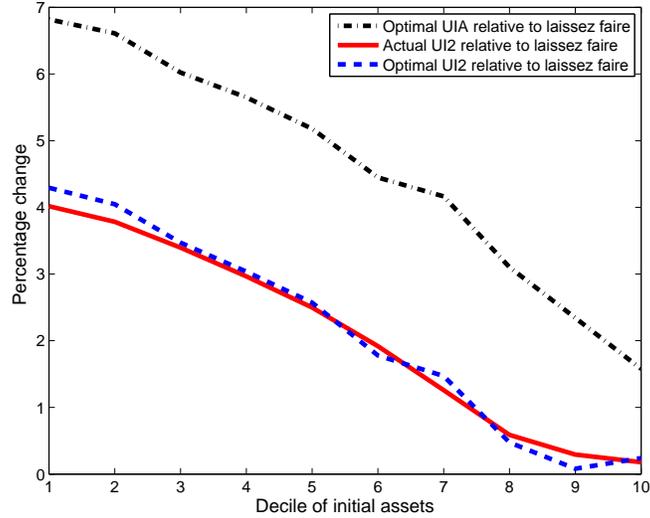
4.3 The Welfare Gain in Context

To put the welfare gain associated with the shift from UI2 to UIA in context, I compare the optimal UI2 to two other policies within the UI2 set: the actual unemployment insurance policy in the United States, which provides only a first-tier replacement rate of 50% for six months, and laissez faire, which provides neither first-tier nor second-tier benefits. Table 6 shows the instruments' values and some statistics for these three policies. The welfare gain is calculated in this table with respect to the laissez-faire policy. Note that Social Security is unchanged, allowing for an analysis of the specific effect of UI2 benefits.

The laissez-faire policy is associated with high employment and a low tax rate. In comparison, the optimal UI2 provides insurance that increases both the unemployment rate and the tax level, leading to a welfare gain of 2.3%. This gain is the value of insurance through the optimal unemployment insurance policy. Figure 13 shows the welfare gain by deciles of initial assets. The welfare gain is especially high for poor workers, standing at 4.3% for workers in the lowest decile of initial assets. This reflects the importance of insurance especially for poor workers. Notice that the same holds for the importance of insuring workers through UIA, relative to laissez faire.

Compared with the actual unemployment insurance policy, optimal UI2 decreases the unemployment rate by 0.2 percentage points, mainly by increasing the employment rate of old workers. The tax rate (which includes the unemployment tax) decreases by 0.4 percentage points, following a similar decrease in the unemployment tax. In this aspect, optimal UI2 is slightly less generous

Figure 14: UI2 Consumption Relative to Laissez Faire
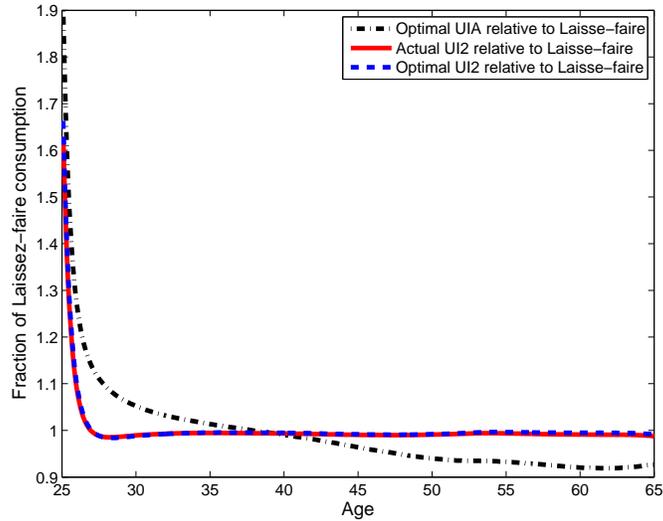
than the actual policy. Relative to the actual unemployment insurance, the optimal UI2 improves welfare by only 0.2%, indicating that the actual and optimal policies are quite similar. The small welfare gain is the value of fine-tuning the instruments of the unemployment insurance policy.

Quantitatively, the welfare gain associated with a shift from the optimal UI2 to the optimal UIA of 2.4% (see Table 4) is similar to that of a shift from laissez faire to either the actual or the optimal UI2. Thus, according to the model, choosing the correct policy – UI2 versus UIA–is as important as providing adequate insurance to workers in the economy through a UI2 system.

Figure 14 shows the life-cycle ratio of workers' consumption under the optimal UI2 or under actual unemployment insurance policies to workers' consumption under laissez faire. The advantage of providing insurance is clearly an increase in consumption for the very young, which comes at the cost of reducing life-cycle consumption. This trend is more pronounced for the actual policy than for the optimal UI2. It is interesting to compare this figure with Figure 9, where the substantial increase in consumption of UIA relative to UI2 continues until age 35. Here in Figure 14, unemployment insurance has important implications for consumption only in the first year.

4.4   Robustness

In this section I study to what extent the optimal policies and the model's main result are affected by changes in some of the model's parameters. Table 7 presents the optimal policy, the unemployment tax rate, and the unemployment rate for both optimal UI2 and optimal UIA for each scenario, along

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with the welfare gain associated with shifting from optimal UI2 to optimal UIA. The model is recalibrated for each of Panels B through E, following the strategy outlined above.

In what follows, some of the optimal UI2 policies use a combination of high-replacement rate low-duration UI2, resulting in a dramatic decrease of the replacement rate from the first tier to the second one. This is a consequence of a tension in the choice between providing a relatively low replacement rate for a long duration and providing a high replacement rate for a short duration. The latter is desirable as there is no moral hazard during the first period of unemployment (because quits are observable) but it fails to condition the benefits on unemployment duration in a precise way.

Initial Assets

The optimal UIA provides workers with insurance against future bad shocks. As argued above, this is especially important for workers with low assets. Panel B of Table 7 shows the results for calibrations with two alternative assumptions for initial assets. In the first case, where heterogeneity in initial assets is eliminated, the welfare gain is only slightly changed. This is consistent with Figure 13, which shows that the welfare gain from optimal UI2 to optimal UIA is fairly flat over deciles of initial assets.[30] In the second case, initial assets are set to zero to demonstrate the importance of savings for workers. In this scenario, an efficient insurance becomes even more important as the ability of workers to self-insure, especially at young ages, is much more limited. In this case, the gain is particularly high at 3.7%.

Income Process

The life-cycle income process is dictated by two parameters: the persistence and the variance of the income shock. The higher these parameters, the higher the variance of income, especially in old age. Overall, Panel C of Table 7 shows that the welfare gain does not change much across the various parameterizations. When $\rho = 0.96$, UIA becomes more generous by speeding up the depletion of the mandatory account. Similarly, when $\sigma_\eta = 0.008$, UI2 becomes more generous as well. Notice the sensitivity of unemployment to the second-tier benefits under UI2, rising to 6.2%.

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[30]This robustness exercise is somewhat informative on the qualitative and quantitative importance of borrowing. Under this exercise, all agents have initial assets of about $USD 24,000 (the mean initial wealth in the benchmark calibration); thus all workers have about one year's annual salary of a young worker (12 months of 60% of the median labor income). Their situation is at least as good as that of workers with zero assets who can borrow one year's annual salary.

Table 7: Robustness

Experiment	Optimal UI2		Optimal UIA		Gain
	D, Q^1, Q^2	u **tax rate,** u	M, Q^1, Q^2	u **tax rate,** u	
	(months, %, %)	(%, %)	(%, %, %)	(%, %)	(%)
A. Benchmark					
Benchmark	{5, 40, 10}	{1.5, 5.2}	{2, 30, 30}	{0.3, 5.5}	2.4
B. Initial assets					
Homogeneous initial assets	{2, 90, 10}	{2.3, 5.0}	{2, 30, 30}	{0.3, 5.5}	2.2
No initial assets	{6, 40, 10}	{1.4, 5.3}	{2, 30, 30}	{0.3, 5.4}	3.7
C. Income process					
Low persistence ($\rho = 0.98$)	{2, 90, 10}	{2.3, 5.0}	{2, 30, 30}	{0.3, 5.3}	2.5
Low persistence ($\rho = 0.96$)	{2, 70, 20}	{2.0, 5.3}	{2, 40, 30}	{0.4, 5.5}	2.7
Low variance ($\sigma_\eta = 0.006$)	{2, 90, 10}	{2.3, 5.0}	{2, 30, 30}	{0.3, 5.5}	2.5
High variance ($\sigma_\eta = 0.008$)	{4, 50, 20}	{1.9, 6.2}	{2, 30, 30}	{0.3, 5.5}	2.3
D. Elasticity of hazard					
Low elasticity (-0.4)	{5, 40, 10}	{1.5, 5.1}	{2, 30, 30}	{0.3, 5.4}	2.5
High elasticity (-0.6)	{5, 40, 10}	{1.4, 5.1}	{2, 30, 30}	{0.3, 5.2}	2.5
E. Wealth-income ratio					
Low ratio (1.5)	{2, 80, 20}	{2.4, 5.9}	{2, 30, 30}	{0.4, 6.2}	3.7
High ratio (2.7)	{2, 90, 10}	{2.1, 4.9}	{2, 20, 30}	{0.5, 5.0}	2.0
F. Other					
Deferred benefits	{2, 30, 20}	{1.0, 5.9}	{2, 30, 30}	{0.3, 5.5}	3.5
Intertemporal budget constraint	{6, 40, 10}	{1.1, 5.3}	{1, 20, 30}	{0.5, 5.9}	2.7

In this calibration, a similar UI2 policy that provides four months of a first-tier replacement rate of 50% but only a 10% second-tier replacement rate is associated with an unemployment rate of 5.2%. This again shows the challenge of UI2 to provide generous second-tier benefits.

Elasticity of Hazard with Respect to Benefits

The main characteristic that allows UIA to dominate UI2 is the ability to provide relatively high government benefits (30%) for an unlimited duration. This ability depends on the moral hazard level in the model. The key target that affects the employment incentives in the model is the elasticity of hazard with respect to benefits. When this target is increased (in absolute terms), the new calibration results in higher disutility from work.[31] Panel D in Table 7 shows that the results for calibrations using values for the elasticity of hazard with respect to benefits of $\{-0.4, -0.6\}$ remain almost unchanged.

The Wealth-Income Ratio

As explained above, the model overestimates the level of assets at the left tail of the wealth distribution (see Table 3). It is possible to improve the fit of the left tail by targeting a lower wealth-income ratio. This is done by including only the bottom 80% of the wealth distribution instead of the bottom 90%. Again using PSID data as reported in Table 1 (column 4) in Krueger, Mitman, and Perri (2015) for those percentiles provides a low wealth-income ratio of 1.5. The results for this case are shown in Panel E of Table 7

In this calibration, insurance for long unemployment spells is especially important as workers have a low ability to self-insure. The optimal UI2 becomes more generous, providing second-tier benefits of 20%. UIA remains as before. The welfare gain of 3.7% is now much higher than in the benchmark, again reflecting the importance of providing generous second-tier benefits. Notice the difference between this exercise and the one above with no initial assets. In both exercises there are fewer assets. However, in the previous exercise, the emphasis is on initial assets while here it is on assets over the complete life cycle.

Going in the opposite direction by including the bottom 95% of wealth and income percentiles results in a high wealth-income ratio of 2.7. Here, UIA becomes less generous by decreasing the first-tier replacement rate, thereby reducing the speed at which mandatory assets deplete and increasing the delay before unemployed workers receive second-tier benefits. This emphasizes that

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[31]The other calibrated parameters move very little.

when assets in the economy are high, second-tier benefits are of lesser importance as workers can self-insure. The welfare gain goes down but is still high at 2.0%.

Deferred UI2 Benefits

The better insurance that is provided through the optimal UIA is driven by the information carried in the mandatory account. In contrast, under the UI2, workers receive benefits as soon as they become unemployed. To demonstrate the importance of *selectively* deferring benefits in UIA, I test the implications of imposing at least a one-month deferral on UI2 . The optimal UI2 under this constraint provides a 30% replacement rate in months two and three of the unemployment spell, followed by second-tier benefits of 20%. Compared with the previous optimal UI2 (under which benefits are not deferred), there is a welfare *loss* of 1.1%. Thus, deferring benefits under UI2 is undesired as it prevents workers from being insured in the first period of unemployment. This demonstrates the importance of deferring the benefits only for workers with good labor market histories. The first line in Panel F summarizes those results.

Government Budget Constraint

The analysis in this paper is based on a comparison of the steady states of economies with different policies, abstracting from the study of the transition between the two policies. An alternative view of the results is that of an implementation for a new cohort, in which the transition does not come up. Under that view, however, we need to take into account that UI2's taxes are higher than those of UIA. This difference may play for the advantage of UIA, since the higher taxes under UI2 do not bear interest in Equations (9) and (10) while mandatory assets under UIA do. To test the effect of this concern, I run an experiment where the cross-sectional budget constraint is replaced by an intertemporal one; that is, at each age t, the net government income (taxes minus cost) is discounted at the interest rate r.

The results of that experiment are reported in the second line of Table 7, Panel F. The optimal policies in that experiment change slightly relative to the benchmark. The welfare gain, however, *increases* slightly from 2.4% to 2.7%. Inspection of the revenues and the cost of the government at each age reveals why the welfare gain does not decrease. While it is true that taxes under UI2 are higher than those under UIA, the costs under UI2 are also higher and in a similar amount as the revenue from taxes. Thus, although the government income is higher under UI2, the increase in costs does not allow the government to generate a surplus in its budget, making the cross-sectional

assumption of lesser importance for the interpretation of an implementation of UIA for a new cohort.

5   Concluding Remarks

Unemployment accounts are mandatory individual savings accounts that can be used only during unemployment or retirement. Compared with unemployment insurance, these accounts solve the moral hazard problem but provide no public insurance to workers. I study unemployment insurance accounts (UIA), a hybrid policy that borrows concepts from both unemployment insurance and unemployment accounts. Workers save when employed and withdraw from their accounts when unemployed. Once their accounts are exhausted, unemployed workers receive unemployment benefits.

UIA provides benefits to workers selectively on the basis of their labor market history. Thus it is able to support more generous benefits at low tax rates. The generous benefits have important implications for the consumption-savings decisions of workers. Specifically, young workers who are now well insured decrease their saving rate, which allows them to better smooth their consumption over the life cycle.

I compare UIA to a two-tier unemployment insurance policy called UI2. The optimal UI2 provides a replacement rate of 40% for a duration of five months; the replacement rate for the second-tier benefit is 10%. The optimal UIA is based on a saving rate of 2% and a withdrawal rate of 30%; the second-tier replacement rate is 30%. Providing generous indefinite benefits under UI2 is undesirable because UI2 lacks the ability to provide benefits selectively. A shift from the optimal UI2 to the optimal UIA leads to an average welfare gain of 2.4% in lifetime consumption. This shift improves the economic well-being of workers in all deciles of initial wealth. The main result is robust to changes in key parameters such as those that govern initial assets, the income process, and the elasticity of the hazard rate with respect to benefits.

The optimal UIA leads some workers, especially older ones, to reject job offers more frequently than under the optimal UI2. This finding motivates the fine-tuning of the UIA to minimize this incentive. One way to do this would be to decrease benefits for old age, similar to what Michelacci and Ruffo (2015) suggest for optimal unemployment insurance. In this paper I intentionally abstain from fine-tuning UIA both for simplicity and to preserve the symmetry between the instruments of UIA and UI2.

Another way to change the specification of UIA is to allow workers to use their mandatory

savings even if they quit. Under UI2 such a change would result in a substantial increase in moral hazard as more workers would be able to collect benefits. Under UIA, however, moral hazard would not increase as much because most workers would need to exhaust their own resources first.

The concept of unemployment accounts raises three concerns. First, without combining the account with some other government intervention, there is no advantage for the accounts over the laissez-faire policy at least not in a standard economic environment. I address this concern by suggesting a hybrid system that redistributes resources among workers. Second, forced savings form an illiquid asset. However, the model results indicate that liquidity is a minor concern as workers have a life-cycle savings motive for retirement, and the account balance serves that purpose. Third, there could be administrative costs associated with the formation of this system. I exclude those considerations in the paper and leave them for future research.

The analysis in this paper excludes aggregate shocks. After the Great Recession, several authors suggested that unemployment insurance had significantly contributed to the increase in and the persistence of the unemployment rate in the United States during that period.[32] UIA would mitigate this effect because workers would need to exhaust their mandatory accounts before receiving government benefits.

The welfare analysis of UIA also excludes the transition path to the steady state of the new policy. It would be interesting to study the welfare implications of such a transition. Notice that since total assets under UIA are lower than those under UI2, workers could increase their consumption during the transition. An alternative view for the analysis is an implementation of the policy for only new cohorts of workers.[33] Under this interpretation, there is no transition.

Finally, relaxing the assumption that the lower bound of the mandatory account is zero and allowing workers to have negative balances would allow workers to borrow against their future income. This feature of the policy, which is similar to what Stiglitz and Yun (2005) have suggested, can be viewed as complementary to the one presented here. Since their paper is of a qualitative nature, the model presented here can be used to assess the optimal level and the welfare gain resulting from such a policy.

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[32]Estimations vary considerably, from 0.1 to 0.5 percentage points in Rothstein (2011) to approximately the entire increase in unemployment in Hagedorn, Karahan, Manovskii, and Mitman (2013).

[33]The one exception to this argument is the fact that the budget constraint for the government is of a cross-sectional nature. The robustness test in the second line of Panel F of Table 7, however, shows that this assumption has no quantitative importance.

Appendix: Computational Method (for online publication)

This appendix describes the computational method of the model. It has three parts. First, I describe the solution to the worker's problems for a given UI2. Second, I explain how I measure the cross-sectional moments that result from the worker's decisions. Third, I describe the solution to the optimal UI2 given the cross-sectional moments calculated in the second part.

The computational method for the UIA problems and the optimal UIA follow the same principles as the method for UI2, with the necessary adjustments.

1. **Solving the worker's problems**

    I describe here the solution for the worker's problems under UI2 during *working age*. The worker's problems during *retirement age* are a special case of the *working age* one.

    (a) **The state space**

    The worker's state under UI2 is determined by age (t), private savings (a), persistent component of labor income (z). unemployment duration (d), and eligibility for unemployment benefits (e).

    The state space for age is $\{1, 2, ..., 480\}$ because the unit of time in the model is one month. The state space of unemployment duration is $\{1, 2..., D_{UI2} + 1\}$ because unemployment duration becomes irrelevant past the time limit of UI2 benefits. The state space of eligibility for unemployment benefits is $\{0, 1\}$.

    The other two variables–private savings (a) and persistent component of labor income (z)–are continuous. These two variables are discretized linearly over the intervals $[\underline{a}, \overline{a}]$ and $[\underline{z}, \overline{z}]$, respectively.

    $\underline{a}$ equal to zero is the borrowing limit, and $\overline{a}$ is equal to \$900,000 so that workers almost never exceed that level of assets (to avoid unnecessary extrapolations).

    The highest and lowest grid points of z are $\pm 3 * \sigma_{z_1} + \sqrt{t - 1} * \sigma_\eta$, where $\sigma_{z_1}^2$ is the variance of the initial wage and σ_η^2 is the variance of labor productivity innovations (see the calibration part for the values). The rest of the grid values are spread linearly across $[\underline{z}, \overline{z}]$.

    Using 50 values for the grid of assets, 900 for the life cycle (480+420), 2 for eligibility, 9 for duration, and 5 for the grid of the persistent component of labor income, the size of the state space for the worker's problem under the actual unemployment insurance

policy is about 4 million.[34]

(b) **The worker's problems**

For each possible state over the state space described above, I first solve the intertemporal consumption-savings decisions for three types of workers: employed, unemployed with a job opportunity, and unemployed with no job opportunity. These are three standard problems in which the labor income or benefits are well defined. Note that since I apply dynamic programming, the future value is already known for each point on the state space.

(c) **Solution method**

I apply the Endogenous Grid Method (EGM) developed by Carroll (2006) to solve these three standard problems. According to the EGM, the grid of assets is set over future assets rather than current assets. This reformulation of the problem reduces the computational burden significantly. For a more detailed description of this method as well as a comparison of computation time between EGM and Value Function Iteration (VFI), see Barillas and Fernandez-Villaverde (2007). My own experience with using the VFI method for previous versions of the model supports their findings. The binary computations of the employment decision for employed and unemployed workers with job opportunities are trivial (see Section 2).

2. **Cross-section moments**

(a) **Initial state**

To calculate the relevant cross-section moments of the economy (for a given UI2), I start with an initial guess for the tax τ_1^{UI2} and simulate one cohort of $N = 15,000$ workers over dates $\{1, 2, ..., T\}$. Note that these workers face survival shocks, so the size of the population decreases with age.

The initial state of the worker (employment status, income, and assets), as well as the income and unemployment shocks, are drawn from the relevant distributions, as explained in Section 3 above.

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[34]For two reasons this is only an estimation of the number of problems that must be solved. First, the state space increases with the time limit of UI2. Second, the unique number of problems is smaller than the size of the state space since some of the worker's problems over the state space are identical (e.g., the unemployment duration is meaningless for an ineligible worker).

For each worker and for each date (as long as the worker is alive), I collect statistics on taxes and transfers (including unemployment benefits and Social Security).

(b) **Updating the tax rate**

The statistics on transfers, including Social Security, determine the government's expenditure E_G. The government's income I_G is simply the sum of tax income over all workers at all ages. As long as $|E_G - I_G| > \varepsilon$, I adjust the tax rate as follows. Given a tax guess τ_m^{UI2}, if $E_G - I_G > \varepsilon$, then $\tau_{m+1}^{UI2} = \tau_m^{UI2} * \sqrt{E_G/I_G}$. Otherwise, if $E_G - I_G < \varepsilon$, then $\tau_{m+1}^{UI2} = \tau_m^{UI2} * \sqrt{I_G/E_G}$. I use a square root of the expenditure-income ratio to avoid big jumps in the tax level. I also use bounds on the ratio at $\{0.5, 2.0\}$ to avoid overshoots.

(c) **Calculating moments**

When the government budget is balanced according to the conversion criterion above, I calculate the rest of the moments of the model, including average monthly consumption, labor income, assets, employment, and the Gini coefficients for consumption, labor income, and assets. In addition, I calculate the average utility per worker in the economy (over the working age and the retirement age).

3. **The optimal policy**

The process described so far provides the moments of a stationary economy given a UI2. To choose the optimal UI2, I follow these steps:

(a) **The UI2 grid**

Define the UI2 grid as $D_{UI2} \in \mathcal{D}_{UI2} \equiv \{0, 1, ..., 8\}$, $Q_{UI2}^1 \in \mathcal{Q}_{UI2}^1 \equiv \{0.1, 0, 2..., 0.9\}$, $Q_{UI2}^2 \in \mathcal{Q}_{UI2}^2 \equiv \{0.0, 0, 1..., 0.6\}$. Therefore, there are 567 possible policies.

(b) **Solve for all policy grid points**

$\forall D_{UI2} \in \mathcal{D}_{UI2}, Q_{UI2}^1 \in \mathcal{Q}_{UI2}^1, Q_{UI2}^2 \in \mathcal{Q}_{UI2}^2$ repeat steps (1) and (2) above.

(c) **The optimal policy**

The optimal policy is the policy that maximizes the worker's average ex-ante utility. For each optimal policy, I check if the solution is a corner one in terms of the instruments. If it is a corner one, I expand the policy state space until the optimal policy is internal in terms of all three instruments.

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