How do politicians save? Buffer-stock management of unemployment insurance finance

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Abstract

We fit an empirical structural model of forward looking government savings behavior to data from the U.S. state Unemployment Insurance (UI) programs 1976-2008. States increase benefits or lower taxes when Unemployment Trust fund balances are high, consistent with a desired target level of savings. This can be explained by the representative state program behaving like a Carroll (1992) buffer-stock consumer who trades off a desire to expend savings (impatience) against the fear of running out of funds (risk aversion). We calibrate the model to the data and find that statistics from model simulations match similar statistics produced from the data for reasonable levels of risk aversion and impatience.

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1 Introduction

Many local governments in the United States suffered fiscal stress and accumulated debt in the Great Recession. In some cases, deficits have been reversed, while in other cases, such as the state of Illinois or the city of Detroit, deficits appear to be structural. The study of dynamic public savings behavior is therefore a highly relevant topic for economic research. Several questions seem particularly relevant: are deficits and the risk of default an inherent tendency due to agency problems caused by public budgets being administered by politicians with uncertain, often brief, tenure? Are fiscal outcomes dependent on specific fiscal institutions? For example, are balanced budget rules, such as those imposed on almost all U.S. cities and states, needed to temper the desire of politicians to spend beyond tax revenues? Before such questions can be answered and policy proposals evaluated, it is important to know whether governments' forward looking behavior is consistent over time to the extent that it can be captured empirically by models of optimizing agents. We examine this issue in the specific setting of the Unemployment Insurance (UI) program in the United States.

On the one hand, it is easy to believe that politicians are more impatient than the general public when making budget decisions, possibly to the extent that governments under-save such that the intertemporal budget constraint will only be satisfied via occasional budget crises. Politicians may not have different preferences than the voters, but rather their actions may be "as if" they were impatient. Politicians do not expect to be in office forever and may not worry about long term saving, or they may act strategically when expecting to be followed by politicians with other preferences.[1] On the other

[1]See, for example, the model of Persson and Svensson (1989), where government regimes amass debt in an attempt to forestall the choices of the next regime.

hand, politicians are often sensitive to public opinion and may want to avoid the embarrassment of budget crises. On net, it is hard to predict whether governments would maintain precautionary savings accounts consistent with the level of impatience and risk aversion of a typical voter, even if they had the means to do so, because we do not yet have an empirically successful structural model that explains dynamic planning by governments. In this paper, we attempt to redress this omission by proposing and testing a version of the Carroll (1992) buffer-stock model to explain government behavior. This model is attractive because it combines impatience and risk aversion in an explicitly optimizing framework.

In our discussion, we use the terms "governments" and "politicians" interchangeably, consistent with elected governments controlling the state-specific laws governing the unemployment systems. We do not know whether our results are externally valid in the sense that politicians are as risk averse and patient in other settings as they are in the unemployment system setting. The unemployment systems' finances are very transparent and the money amounts involved are not as large as, say, government pension savings and these, and likely many other, institutional features may influence the political decision making. We hope our work will stimulate work using the approach of the present paper to study governmental behavior in other institutional frameworks.

Our empirical model uses pooled data, collected by the common U.S. unemployment program, for the 48 mainland U.S. states as its "laboratory." We choose to study this program because it provides a unified framework with explicitly earmarked savings accounts for each state, which makes it easy to identify buffer stocks of savings. The joint program allows the individual states to choose the generosity of the program within the state as well as the level of earmarked taxes. The use of sub-national data circumvents some of the problems of applying structural models to national governments: samples of countries have small sizes and, with many and varied important actors, may not satisfy the homogeneity conditions for pooling. We choose to model the UI system, rather than U.S. state governments, because the latter have more complicated budgets involving capital accounts and, in particular, balanced budget constraints whose stringency varies across states.[2]

The setup of the unemployment system lines up well with the assumptions of the model, in that savings are credited with a fixed interest rate by the U.S. Treasury, which helps us avoid issues related to capital gains and losses that the buffer-stock model, in its current incarnation, ignores. Additionally, we are able to match the features of the UI system into other central attributes of the buffer-stock model; namely, we can define an "income" component and a "consumption" component of UI taxes and expenditures. We can do so even if all state governments insure unemployment among full time workers well attached to the labor market, because there is considerable variation between states in choices of whether and to what extent UI benefits are available to part time workers, or to workers that are less fully attached to the labor market (Craig and Palumbo, 1999).

Government savings behavior may be indeterminate and matter little for welfare if Ricardian Equivalence holds, such that government saving is completely offset by household behavior. By studying state unemployment systems, we attack the dynamic budgeting problem in a setting where market

[2]Many states have recently created "rainy day" fund accounts that allow some inter-temporal substitution in the current account by allowing state governments to transfer funds from one year to another without violating their balanced-budget rules (Knight and Levinson, 1999); nonetheless, the policy and investment options of the unemployment systems are simpler than those of state governments and we elect to fit the model to the simpler institutional framework.

failure in employment insurance mutes such potential issues.[3]

Jappelli, Padula, and Pistaferri (2008) (hereafter JPP) devise an empirical test of the buffer-stock model, but do not find empirical support using savings data for individuals. We apply JPP's methodology to government UI behavior and find it has substantial explanatory power for the behavior of the state UI systems. We test the model by comparing the average level of savings, and the spending response to changes in the stock of savings, of the UI systems to the corresponding statistics predicted by a suitably calibrated version of the model. Our approach is two-pronged: first, we perform a regression analysis of how state governments adjust their savings in response to observed deviations from the desired savings level. Second, we simulate the buffer-stock model for a range of preference parameters. We calculate the predicted level of savings, and regressions with the simulated data are used to derive the UI policy responsiveness to the level of savings. For suitable parameter values, we find that the simulation statistics closely match the actual empirical outcomes, and we conclude that government behavior can be well explained by buffer-stock behavior with quite risk averse, mildly impatient politicians.

We believe our work provides the first successful estimation of an explicitly optimizing model of government behavior towards saving over time. Having a well-fitted structural model of government behavior allows researchers to provide important input into the debate on whether governments need, or would use, more latitude to deal with business cycles (Fatas and Mihov, 2003). In the conclusion, we briefly speculate on how institutional settings may affect prudence and impatience of governments.

The remainder of the paper is laid out as follows. Section 2 discusses previ-

[3]See Rothschild and Stiglitz (1976) for the basic asymmetric information problem underlying UI. It is also possible that unemployed agents have a lower ability to borrow during recessions.

ous empirical work on optimal government savings while Section 3 outlines the institutional setting for UI and presents the panel data for the 48 contiguous U.S. states 1976-2008. Section 4 describes the buffer-stock model and explains how we map the UI institutional environment into the model. Section 5 presents the key results, which illustrate how states adjust their UI taxes and benefits in response to deviations of UI savings from the target level of savings. Finally, Section 6 summarizes the evidence and speculates whether the particular institutional setting studied is important for our empirical results.

2 Modeling government savings behavior

Past empirical work has attempted to fit government behavior to Hall's (1978) Permanent Income Hypothesis (PIH). This line of modeling considers the government to be an agent, who receives exogenous "labor income" (income excluding interest on assets) and derives utility from "government consumption," typically identified with government expenditure or government consumption. The literature has tested the strong prediction of the PIH model that consumption is a random walk (strictly speaking, a martingale) and rejected it. Campbell and Mankiw (1990) suggest an extension of the PIH model, labelled the "rule-of-thumb" consumer model, where a certain fraction of agents consume their current income (the rule-of-thumb consumers) while the remaining fraction behave as prescribed by the PIH. This model is somewhat ad hoc, because consumption of current income is not an outcome of intertemporal optimization, but governments may consume their current resources because they are constrained by explicit or implicit balance budget rules or they may be myopic. Holtz-Eakin, Rosen, and Schuyler (1994) estimate the rule-of-thumb consumer model for aggregate U.S. state and local spending and find that state and local government spending follows available resources, in other words, the average state/local government is a rule-of-thumb consumer. However, the use of aggregated data may hide important variation across the many different state and local governments in the United States. For state governments, a number of papers have rejected the PIH model and some have extended the model to include rule-of-thumb consumers; see, e.g., Dahlberg and Lindstrom (1998). Borge and Tovmo (2009) estimate the rule-of-thumb model for Norwegian municipalities and find important variation which allows them to examine if entities that face tougher fiscal environments are more likely to display rule-of-thumb behavior—throwing light on whether such behavior is a reflection of constraints rather than behavioral myopia.

An alternative approach is to consider expenditure as exogenous and taxes as endogenous. Barro (1979) shows that, if government expenditures are exogenous and tax collection costs are increasing in tax rates, governments should (if they are efficient) smooth taxes over time and—for typical modeling choices—tax rates should behave like random walks. The Barro tax smoothing model successfully explains why national governments run deficits in the face of large shocks, such as wars and devastating earthquakes, but it has met with little success in explaining more normal fluctuations in government deficits and saving.

The Barro (1979) article triggered a large research agenda, which aims at modeling optimal fiscal policy. For example, Lucas and Stokey (1983) show that Barro's random walk result disappears in a Ramsey setting with complete markets where a government can issue state-contingent debt. Aiyagari et al. (2002) analyze a Ramsey model without contingent markets and find that whether outcomes are close to the prediction of the Barro model depends on details such as whether the government faces a limit on asset holdings. We are unable to summarize the large theoretical literature on optimal taxation here, but while many important theoretical insights have been made, tight empirical predictions are few. Related work in the Dynamic Stochastic General Equilibrium (DSGE) modeling tradition has produced quantitative insights for optimal government debt. For example, Aiyagari and McGrattan (1998) calibrate a closed economy model, where government debt helps atomic agents smooth consumption over time at the cost of adverse incentive effects, to post World War II U.S. data and find that it predicts a level of government debt around 60 percent.

Another branch of the recent empirical literature on public debt has taken a statistical time-series approach to examine if public debt is "sustainable," roughly defined to mean that government behavior on average is consistent with maintaining limited debt without defaulting. Antonini, Lee, and Pires (2013) examine if public debt in EU countries is stationary around the level suggested as optimal by Aiyagari and McGrattan (1998), but the econometric literature typically does not relate closely to a structural model. Cornia and Nelson (2003) suggest a Value-at-Risk (VaR) approach, where one estimates a probability model for revenue and then finds the level of saving that allows government to maintain a given level of spending in the face of shocks with a given probability. Wagner and Elder (2007) use a similar method for U.S. states, applying a more advanced time series model with regime shifts, and find fairly large differences across states in "optimal" saving in the VaR sense. Bohn (1995, 1998), in a series of papers, discusses the issue of sustainability and suggests a test. The details will take us too far afield but Bohn's test essentially examines if government surpluses increase when debt is high, thereby "self correcting" towards a limited real debt level relative to gross domestic product.

The buffer-stock model departs from the vantage point of the PIH model in taking income as exogenous and solving for optimal consumption, but it relaxes the assumptions of quadratic utility and lack of credit constraints underlying the martingale result. As the Aiyagari and McGrattan (1998) model, the buffer-stock model predicts a target level of government saving, which the PIH and Barro models do not. The buffer-stock model imposes sustainability because the decision makers cannot borrow, suffer high disutility from low spending, and therefore avoid fully running down savings. If this model fits the data for a given government, it can be interpreted as confirming sustainable fiscal policy. Further, the model is related to the statistical approaches outlined in that the target level of the buffer-stock saving is optimally chosen by the agent to avoid steep cut-backs in consumption. The agent in the model will endogenously adjust spending in response to shortfalls and therefore "self correct," while dynamically adjusting optimal consumption.

3 The UI system and the data

We sketch the main features of the system and refer the reader to the recent survey by Nicholson and Needels (2006) for more details.[4] Each U.S. state manages its own UI program under a federal policy umbrella, where state governments select most major policy options including eligibility criteria, tax rates, and the level and duration (or schedule) of benefit payments. For example, states differ in determining which "laid off" workers are eligible for UI, including the length of time a worker needs to be employed before being UI eligible, the minimum number of weekly hours, as well as the circumstances that result in work separation being considered "involuntary unemployment"

[4]http://www.ows.doleta.gov/unemploy/uifactsheet.asp is the U.S. Labor Department website with facts about the program.

for which the worker is eligible for benefits. UI is financed by an earmarked tax on firms, so if savings are insufficient to fund increased UI benefits during a recession, the required tax increases will place an obvious burden on the public. At the same time, using tax money raised from firms without providing an immediate public expenditure benefit may be perceived by politicians as "expensive" in terms of foregone political benefits. States adjust their rules frequently, consistent with the model's assumption that "consumption" can be freely adjusted in response to shocks.[5]

A final institutional element, which completes the budget constraint, is that the federal government essentially caps borrowing for UI, forcing states to balance their UI budget over time. State governments are allowed to borrow to fund UI, if they run out of savings, but there is an implicit limit on their borrowing. Specifically, state UI systems must be "fundamentally solvent" as determined by the U.S. Department of Labor (DOL) to be eligible for federal loans. [6] This suggests that the shadow price on borrowing for states could be very high and indeed, state borrowing from the Treasury is limited—our data suggest that no state goes beyond borrowing 5 percent of its covered wages.

The UI program has existed for a long period of time without significant changes in the federal rules (consistent with the model's parameters being con-

[5]The National Conference of State Legislatures (NCSL) presents rule changes for individual states since 2010 (see http://www.ncsl.org/research/labor-and-employment/unemployment-legislation-database.aspx). States are fully responsible for the first 26 weeks of UI payments, but a permanent Extended Benefits program is in place which typically provides an additional 13 or 20 weeks of compensation to jobless workers who have exhausted their regular benefits. However, this is available only in states where the unemployment situation has worsened dramatically. The total number of weeks available depends on a state's unemployment rate and its unemployment insurance laws. The federal government and the states split the cost of Extended Benefits 50-50 (although the federal government fully funded the program during the Great Recession), while further "emergency" extensions of benefits in U.S.-wide recessions are fully paid by the federal government. In our empirical work, we model only the portion of benefits that state governments are responsible for. See Stone and Chen (2013) and U.S. Department of Labor (2013) for more details.

[6]The rules, see U.S. Department of Labor (2013), are: "In order to assure that a state will repay any loans it secures from the [federal UI] fund, the law provides that when a state has an outstanding loan balance on January 1 for two consecutive years, the full amount of the loan must be repaid before November 10 of the second year, or the federal tax on employers in that state will be increased for that year and further increased for each subsequent year that the loan has not been repaid." In the high unemployment environment of 2010-11, Congress passed a waiver on interest payment on loans for all states.

stant over our sample) and UI savings are not subject to the contemporaneous balanced budget requirements of state governments' general funds.[7]

Benefits are generally paid in an amount equal to about 60 percent of prior wages for full time workers. Each state finances its UI program with an earmarked tax paid into the UI trust fund by employers. The tax rate varies between firms because it is partially experience rated (higher for firms with more lay-offs in the past), and it is typically only levied against the first $9,000 in annual wages.[8] In this way, the tax is essentially an annual lump sum tax per employee. While in theory there is no interaction between the UI trust fund and the general fund of the state government as the UI program is administratively separate, in fact, there is a variety of state taxes on firms. State governments could raise or lower the level of UI taxation and compensate with reverse changes in firm taxation that is credited to the general fund to move money from the UI trust fund to the general fund or vice versa.

Table 1 presents means and standard deviations over time and across states for the main variables. Our panel of the 48 mainland U.S. states covers the years 1976-2008. The start date is dictated by the absence of state specific unemployment rates before 1976. The UI trust fund balances are reported as of the first day of each year. The UI benefit and tax amounts are those expended throughout the year. UI does not necessarily cover all wages earned in the economy; for example, self employed workers are not generally covered (unless incorporated), and there are often caps on the total wages covered by UI (because benefits are a function of covered wages). Nonetheless, covered wages (i.e., total wages of covered individuals) are over 90 percent of total

[7] The federal laws governing the unemployment program has changed little over time, except for the granting of extended benefits in recessions, which we do not attempt to model; see http://workforcesecurity.doleta.gov/unemploy/pdf/chronfedlaws.pdf for a chronology.

[8] The tax base varies between $7,000 and $16,000 in annual wages.

wages.

In Table 1, we normalize all variables by covered wages (aggregate wages of workers covered by UI) to put the variables on a similar scale across states and time. The UI program benefits and taxes are just under 1 percent of covered wages on average, although the share fluctuates with the business cycle. The variables show higher cyclical (time-series) variation than variation between average levels across states. The trust fund balance averages about 16 months of UI taxes and so is substantial, although not large enough to forego taxation altogether for long periods. Interest earned by the trust fund averages 0.1 percent of covered wages. About 12 percent of states are in debt to the federal government at any point in time and, for those in debt, the debt levels are slightly above the average year's reserves, so debt is important but clearly not the modal behavior of states. Table 2 presents the statistics of Table 1 in dollars per capita. On average, UI benefits and taxes are around $50 per capita while the trust fund balances average about $71 per capita.

Figure 1 shows average (across states) trust fund balances normalized by covered wages over time with national recessions indicated by grey shaded areas. Trust fund balances fluctuate over time, tending to rise in normal times and decline during and after recessions. There is a clear tendency for the average level of trust fund balances to settle down in a relatively narrow range which suggests that policy makers have a target range for UI savings which fits well with the intuition of the buffer-stock model.

3.1 PIH and tax smoothing

We analyze benefits and tax data, for the purpose of verifying if the variables are stationary and, in the process, test the simple Barro and Hall models.

We assume that the relevant decision period for each state is two years. It turns out this assumption is not essential for the qualitative results (see the appendix), but it allows the data to fit the model somewhat better. The two year assumption is consistent with the decision period of the few states that do two year budgeting, but also with states that budget annually because governments typically react slowly to shocks, adjusting tax and benefit rates only at the regularly scheduled budget deadlines; see, e.g. Sørensen, Wu, and Yosha (2001).[9] We use non-overlapping two-year periods to avoid adjusting the standard errors for the serial dependence one would generate using overlapping data.

We estimate first order autoregressive panel regressions of the form $X_{st} = \mu_s + \alpha X_{s,t-1} + u_{st}$. The results of this regression are that taxes are quite persistent with an estimated α of 0.94 while benefits are slightly less persistent with an estimated α of 0.87. These coefficients are precisely estimated and clearly different from the random walk value of unity.[10] Our results indicate that neither tax smoothing in the sense of Barro nor benefits smoothing in the sense of Hall describes well how state governments manage their UI savings accounts. We therefore turn to the buffer-stock model.

4 The buffer-stock model

Our overall strategy follows JPP although a complicating factor for us is to define "income" and "consumption" variables. However, our setting is less complicated than a consumer's problem because the UI systems do not need

[9] We do not have enough degrees of freedom to model states with different budgetary structures separately.

[10] We also perform the unit root test suggested by Im, Pesaran, and Shin (2003). This test rejects unit roots in both series and, therefore, also random walks. We do not report on individual state tests, which have very low power because of the low number of observations per state.

to accumulate life-cycle savings and do not invest in capital projects or other assets than bonds. We estimate an equation as specified by JPP which measures the response of governments to deviations in savings from the target level and we calculate the average level of saving which we interpret as the target level. Then we simulate the buffer-stock model and estimate the same equation on simulated data and calculate the predicted optimal buffer stock of saving in order to see if the estimations on empirical versus simulated data match up for reasonable values of the behavioral parameters. Like JPP, we calibrate the model to the volatility of income which we estimate from the data. As in standard statistical inference, we do not reject the model if the simulated parameters are within two standard deviations of the estimated parameters.[11] (We can of course not rule out type 2 error where the model is falsely accepted due to low power.)

In order to apply the model to governments, we define "UI consumption" and "UI income" in place of a consumers consumption and labor income, but before defining those variables, we outline the model, following Carroll and JPP: The buffer-stock model of government behavior takes the form of maximizing:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\rho} C_t^{1-\rho} \ , \tag{1}$$

where β is the time discount factor, C_t is UI consumption, and $\rho > 0$ is the coefficient of relative risk aversion. Key behavioral parameters in the model are the degree of risk aversion—high risk aversion induces a high level of savings—and the rate of time discounting—high time discounting induces a low level of savings.

The dynamic budget is $W_{t+1} = R\left(W_t - C_t + Y_t\right)$, where W_t is financial

[11] We ignore the uncertainty involved in calibrating the model—taking this into account would only make it harder to reject the model.

wealth, R is an interest rate factor assumed constant over time, and Y_t is "current UI income" (i.e., income apart from interest income). Agents are assumed to be credit constrained and unable to borrow; i.e., $W_t > 0$. The funds available for UI consumption during period t are savings (the UI trust fund balance) at the beginning of the year plus the current year's UI income, $W_t + Y_t$ which we, following Carroll (1997), denote "cash-on-hand."

The logarithm of UI income is modeled as the sum of a persistent (random walk) component and a temporary (white noise shock) component: $Y_t = P_t V_t$, where the permanent (unit root) component of income, $P_t = G P_{t-1} N_t$, has a log-normally distributed innovation N_t, where $\text{Var}\{\ln(N_t)\} = \sigma_N$ and $E\{\ln(N_t)\} = 0$. V_t is the transitory (white noise) component of income which is log-normally distributed with $\text{Var}\{\ln(N_t)\} = \sigma_V$, and $E\{\ln(V_t)\} = 0$.[12] G is the deterministic growth rate of income.

In this model, near-zero consumption implies very high (tending to minus infinity) disutility, which balances the impatience that otherwise would cause agents to spend down savings. The fear of extreme disutility causes the government to hedge against very low consumption by building a "buffer stock" of saving which, along with current tax income, is denoted cash-on-hand. The loss in utility as consumption approaches zero increases with the level of the risk aversion parameter ρ.

UI income and UI consumption are non-stationary because permanent income is non-stationary, so, following JPP, the model is reformulated with wealth, income, and consumption expressed as ratios to permanent income. We use lower-case letters to identify the transformed variables: $y_t = Y_t/P_t$ and $c_t = C_t/P_t$ and we refer to $x_t = (W_t + Y_t)/P_t$ as cash-on-hand or, alternatively,

[12] P_t is usually referred to as permanent income, although in the context of the PIH model, permanent income shocks would be $\Delta P_t + (R-1)N_t$—we will follow the convention of referring to P_t as permanent income.

as the buffer stock of saving. We refer to c_t as UI consumption.

In the buffer-stock model, consumption is a non-linear function of cash-on-hand and the function is particularly non-linear in the vicinity of the target level. The innovation in JPP is that they utilize a convenient covariance condition reflecting how consumption will change depending on deviations from the target (or desired) level of buffer-stock savings, called the target gap. The target gap is simply $x_t - x^*$, where x_t is current cash-on-hand and x^* is the target cash-on-hand. State governments are expected to increase UI consumption and draw down their buffer-stock trust fund saving when the target gap is positive. Conversely, a negative gap where current buffer-stock savings x_t is less than target buffer-stock savings x^* would lead the state government to decrease its consumption to build up savings.

We focus on the statistic

$$\theta = \frac{\text{Cov}\{x_t - x^*, c_t\}}{\text{Cov}\{x_t - x^*, x_t\}} , \tag{2}$$

which JPP refer to as the "covariance ratio." Equation (2) is useful because the sample equivalent of θ is the standard IV estimator of c_t on x_t using the target gap as an instrument. θ, therefore, is an intuitive linear expression which predicts how UI consumption will change based on the current level of the UI trust fund relative to the target level, and which is straightforward to estimate from the data.

The covariance ratio (2) satisfies the theoretical constraint that it is larger than $[1 - G/(Re^{\sigma_N^2})]$, but to find exact numerical values for θ as a function of preference and income parameters, one needs to simulate the model. We do so below for a range of values of the government agent's risk aversion parameter ρ and discount factor β. We also estimate the covariance ratio θ from our data on the UI program using equation (2). Together this allows us to compare the estimated θ with the simulated values to judge whether state governments trade off impatience and risk aversion as predicted by the model and, if so, for which levels of risk aversion and impatience.

4.1 Application of the buffer-stock model to UI

This subsection explicitly defines "UI consumption" and "UI income." Our definition of UI consumption has two components reflecting both elements of the UI policy budget constraint. Policy makers may receive "consumption" benefits by offering higher UI benefits to those on the margin of being UI recipients. These political consumption benefits would likely take the form of voters receiving higher unemployment benefits being more likely to vote for the incumbent party. Further, policy makers may receive "consumption" benefits through lower UI taxes on firms. In this case, if UI taxes are lower, politicians may receive political consumption benefits through the political process by which firms provide support to politicians.

The basic federally mandated elements of UI are not under the control of state politicians, so we define the political "consumption" and "income" components from those that are additional to the federal mandates. We consider the benefits and taxes that respond to unemployment across states and time as the mandatory components and the fluctuations in UI benefits and UI taxes that are orthogonal to changes in the unemployment rate as the discretionary components. We approximate the non-discretionary components of taxes and benefits by linear functions of the states' unemployment rates, with permanent differences between states absorbed into state-level fixed effects and federal policy absorbed into time fixed effects.[13]

Non-discretionary UI benefits are determined in two steps. First, we regress UI benefits normalized by covered wages on the state unemployment rate.[14] Second, we use the fitted value multiplied by covered wages (turning the numbers back into dollar values) as our estimate of non-discretionary benefits. Similarly, we determine non-discretionary taxes by regressing UI taxes on the state unemployment rates and use the fitted value multiplied by covered wages as our estimate of non-discretionary taxes. The regression for benefits takes the form:

$$\text{benefits/covered wages}_{st} = \mu_s + \nu_t + \alpha U_{st} + u_{st} \,, \tag{3}$$

where μ_s and ν_t denote state and time-fixed effects; respectively, and U is the unemployment rate. We allow taxes to have more lags based on unreported preliminary regressions, so:

$$\text{taxes/covered wages}_{st} = \mu_s + \nu_t + \beta_0 U_{st} + \beta_1 U_{st-1} + \beta_2 U_{st-2} + u_{st} \,. \tag{4}$$

Using the predicted (fitted) values from these regressions, we define non-discretionary benefits and taxes as

$$\begin{aligned}
\text{non-disc. benefits}_{st} &= \text{Predicted}\left[\text{benefits/covered wages}\right]_{st} * \text{covered wages}_{st} \,, \\
\text{non-disc. taxes}_{st} &= \text{Predicted}\left[\text{taxes/covered wages}\right]_{st} * \text{covered wages}_{st} \,.
\end{aligned}$$

Residuals from regressions (3) and (4) reflect benefit and tax changes which

[13]While data are available, we find no further benefit from attempting highly complicated imputations intended to distinguish the extent to which state policy is incremental to federal minimum policy. The assignment as to what expenditures are discretionary is in any event an approximation.

[14]Benefits and taxes are normalized by covered wages in order to reduce the severe heteroscedasticity that would otherwise be present and it allows us to regress unit free variables of size between 0 and 1 on the unit free unemployment rate.

are not functions of unemployment, and thus we consider these discretionary UI payments as "UI consumption." More precisely, we define

$$\begin{aligned} \text{discretionary benefits}_{st} &= \text{benefits}_{st} - \text{non-disc. benefits}_{st} \ , \\ \text{discretionary taxes}_{st} &= \text{taxes}_{st} - \text{non-disc. taxes}_{st} \ . \end{aligned}$$

We then, for each state, define

$$\text{UI consumption} \equiv \text{mean UI benefits} + (\text{disc. benefits} - \text{disc. taxes}) \ . \quad (5)$$

That is, UI consumption reflects UI benefits and taxes that do not fluctuate with unemployment rates. We term these amounts discretionary, because fluctuations in these variables are likely politicians' choices to raise UI benefits or lower UI taxes while the non-discretionary part captures changes in benefits and taxes caused by the condition of the state economy.

An informal test of whether UI consumption, as we have defined it, provides utility for politicians is to examine whether UI consumption displays evidence of a political business cycle (Aidt, Veiga, and Veiga, 2011). Regressing UI consumption on a dummy for years in which governors are up for election, we find a positive significant coefficient implying that UI consumption is higher in election years by 16 percent of UI permanent income compared to other years. This suggests our definition of UI consumption is correlated with political discretion.[15]

UI income is defined in an analogous manner. Specifically, UI political income is defined as the average level of UI taxes plus non-discretionary taxes

[15]We thank Søren Leth-Petersen for suggesting this calculation. In our model based regressions below, the election year variation is relegated to the error term.

minus non-discretionary benefits:[16]

$$\text{UI income} \equiv \text{mean UI taxes} + (\text{non-disc. taxes} - \text{non-disc. benefits})\ . \quad (6)$$

Our definitions of UI income and UI consumption are consistent with the state government's UI budget constraint as shown by setting equations (5) and (6) equal to each other. That is, the sum over time of UI income should equal the sum over time of UI consumption, as: $\sum_{t=0}^{\infty} \beta^t\,(\text{mean UI taxes}_s + \text{non-disc. taxes}_{st} - \text{non-disc. benefits}_{st}) = \sum_{t=0}^{\infty} \beta^t\,(\text{mean UI benefits}_s + \text{disc. benefits}_{st} - \text{disc. taxes}_{st})$; by reordering and using that the discounted present value of taxes equals the discounted present value of benefits (ignoring any initial assets).[17] Thus, our definitions of UI consumption and UI income are consistent with state governments' regular budget constraints.

Finally, we define permanent UI income in the manner of Friedman (1957), as a 3-period (6 years) moving average of UI income, and transitory UI income as UI income minus permanent UI income. (We found that the results are robust to the exact number of periods that we average over, unless we average over so many years that it leads to a substantial loss of data.)

The results for estimating equations (3) and (4) are reported in Table 3 (Appendix Table A.2 displays estimates of the same regressions for alternative initial years and Table A.4 displays results obtained using a single year time frame). The first column in Table 3 shows, not surprisingly, that benefits respond significantly to the current unemployment rate, and there is no delayed adjustment, so we do not display coefficients to the lagged unemployment rate. The second column shows that taxes react significantly to the current

[16] Adding mean UI taxes (UI benefits) allows the state specific mean over time of UI income and UI consumption to be in the range of typical UI taxes and benefits in the state. Without this normalization, these variables would fluctuate around zero.

[17] Mean UI taxes are approximately equal to mean UI benefits, so those terms cancel out.

unemployment rate, but with the majority of the adjustment taking place after one (two year) period.[18]

5 Buffer-stock regressions

Table 4 displays descriptive statistics for the data used to estimate equation (2). Cash-on-hand, defined as beginning-of-period savings plus UI income, is 2.17 times permanent income on average over time and states. The standard deviation over time for the trust fund balance is not as large as the standard deviation across states which suggests that states desire to not veer too far from their target savings level.

Our key regression result is presented in Table 5. It reports on the IV-regression, equation (2), which shows how consumption varies with deviations in the level of savings from the target level. Table 5 also reports the level of target cash-on-hand, which we calculate as the average over time for each state, and we then report the average (which equals the average over all observations) and the standard deviation across states. The behavioral idea is that as realized savings differ from target savings, agents will change their consumption to bring actual savings closer to the target. From Table 5, the parameter estimate of 0.25 is precisely estimated and the value powerfully suggests that when cash-on-hand is high, UI consumption is high. That is, when a political agent observes substantial resources in the UI trust fund, the tendency is to make UI benefits more generous or to lower UI taxes.

[18]This provides a second piece of evidence that state governments do not follow the Barro tax smoothing model in which taxes adjust instantaneously to changes in permanent income.

5.1 Potential heterogeneity across states

We explore whether states are heterogenous in their behavior. Specifically, whether the results vary with political ideology (which could be captured in the model via heterogenous preferences), if savings behavior varies across rich and poor states (which the model does not predict), and if the savings behavior differs across states with more or less volatile Gross State Product (GSP) (which could be captured via differences in the calibration of UI income). We split the sample of states according to the criteria mentioned and estimate the covariance ratio (θ) for pairs (liberal, conservative), (high income, low income), (high volatility, low volatility), and test if the θ coefficients are significantly different between the members of each pair. States are classified as "liberal" or "conservative" according to political ideology using an index of political ideology due to Erikson, Wright, and McIver (1989).[19] We then test if, say, $\theta_{\text{liberal}} = \theta_{\text{conservative}}$ (where the coefficients are intuitively labeled within the subset on which they were estimated) and similarly for the other splits where a state is considered rich or poor according to whether average per capita real income is higher or lower than the mean across states, and states are considered to have high or low volatility according to whether the volatility of GSP-growth is above or below the median.

Table 6 reports the results for testing heterogeneity. The results are easily summarized: the differences across groups of states are minor and clearly not significant; similarly, in Appendix Table A.7, we cannot reject homogeneity across the four major census regions. We do not report on further heterogeneity tests, but plots of coefficients against GSP-volatility do not show any relation,

[19]The split is based on an index of liberal/conservative constructed by political scientists. The index is of politicians themselves, not the population. Each of the two major political parties gets an index and each of the party indices by the share of the legislature of that party. The index never changes over time, only the weights. The split used is based on the time average by state from 1976 through 1990—we were not able to locate more recent compatible data.

and a formal test of whether all states can be pooled easily do not reject the homogeneity assumption. We therefore continue by examining whether the model can fit the data when calibrated to the volatility of the UI-income components averaged over all states.

5.2 Simulation results

To gauge if our empirical findings can be rationalized by the model, we simulate the responsiveness to deviations from target savings, as well as the target savings level, and compare to our empirical estimates. For any given preference parameters for time discounting, β, and risk aversion, ρ, and with a given probability of zero income, p, the simulation yields both the covariance ratio θ and the target level of savings x^*. If the buffer-stock model is a reasonable approximation to how governments manage their savings accounts, the simulated value of these parameters should be close to those reported in Table 5. JPP find through simulations, for their calibrated values for the income processes and reasonable value for risk aversion and impatience, a covariance ratio in a range from 0.485 to 0.757. They reject the buffer-stock model for their data, because their empirical estimate for the covariance ratio, θ, is 0.025 or lower. Our estimated covariance ratio of 0.25 is much closer to the range predicted by the model as it was calibrated by JPP, and we next calibrate the model to our data to see if it then predicts values for θ and the level of target cash-on-hand, x^*, close to those observed in the data for reasonable values of the discount factor and risk aversion parameter.

5.3 Model calibration.

We calibrate the real interest rate and growth to the corresponding two-year averages in our data, resulting in a real interest rate of 8 percent and a growth rate of UI income of 9 percent. We set the probability of zero income—capturing the risk of economic meltdown—at 0.001 and 0.01 percent and explore higher probabilities in the appendix.[20] The variance of permanent income, σ_N^2, is calculated directly from the growth rate of permanent UI income. We calculate transitory income as the difference between UI income and permanent UI income and directly calculate the variance, σ_V^2. We find σ_N=0.173 and σ_V=0.304.

5.4 Simulation results.

We simulate the buffer-stock model for 50 *a priori* identical consumers (UI systems) with identical discount factors and identical coefficients of risk aversion for $T = 100$ periods. This process generates a data set of size comparable to the data so that the simulation results can be compared to the empirical results. We calculate the median buffer-stock x^* (across the 50 simulated agents) and the median (across time) covariance ratio θ, estimated cross-sectionally for each $t = 2, ..., T - 10$, from the simulated data.[21] The objective is to find which, if any, (β, ρ) combination of time discounting and risk aversion results in simulated values of θ and x^*, that matches the empirical counterparts from Table 5. We choose a grid of a priori reasonable values with $\beta = 0.86, 0.90$ or 0.94 and the risk aversion parameter taking values $1, 2, 3, 4, 4.5$ and 5. For our interest rate of 8 percent, a discount factor β lower than 0.92 (corresponding to

[20] JPP use p=0.005. Results under this alternative calibration value for the probability of zero income are shown in the Appendix. It does not materially alter the results.

[21] We drop the last 10 observations simulated, because we use a finite lifetime version of the model. The results are virtually unchanged, if we instead drop the last observation only.

a discount rate higher than 8 percent) implies impatience; the situation where present consumption is, everything else equal, preferred to waiting one period and consuming a fraction r more. Because there is positive growth, the model delivers a target buffer stock even if the discount rate is somewhat lower than the interest rate. Further, the simulations show that alternative values of the discount rate and risk aversion can trade-off to effect target cash-on-hand.

Figure 2 illustrates the effect of impatience by changing the value of β in the simulations for ρ fixed at 3. Not surprisingly, target wealth increases monotonically with patience; i.e., with larger values of β: less impatient agents are willing to postpone some consumption in order to hold a larger buffer stock. The results (not shown) are qualitatively similar for other values of ρ. Figure 3 illustrates, for β fixed at 0.9, the partial effect of changing risk aversion, ρ. More risk averse individuals suffer relatively more in case they are hit by a series of bad shocks and, therefore, hold more savings to insure (buffer) against such a risk. From the two figures, a large buffer stock can be due to relatively high patience or to relatively high risk aversion, making identification of both parameters challenging.

The simulation results are presented in Table 7. We find values of the covariance ratio, θ, between 0.32 and 0.73, while the target wealth over permanent UI income, x^*, is found to be between 1.10 and 2.09. The best fit is (β, ρ)=(0.94, 4.5), with p=0.01, for which the simulated (θ, x^*)=(0.32, 2.09), which is very close to the observed $(\theta, x^*) = (0.25, 2.17)$. The standard errors are 0.05 and 0.87 for the estimated θ and and target savings ratio, respectively (see Table 5), so the simulated values for these parameter combinations are within any reasonable confidence band. In other words, the buffer-stock model fits how state governments manage their UI savings accounts very well. We cannot for sure rule out that politicians are somewhat more impatient (increasing the covariance ratio and lowering the buffer stock) or somewhat more risk averse, but our empirical results can clearly rule out combinations of low risk aversion combined with high impatience. Overall, we conclude from our empirical results and model simulations that the savings behavior of the UI systems is well captured by the buffer-stock model. The range of parameters where the simulations fit the data suggest politicians are quite risk averse and mildly impatient.

5.5 Discussion

Our results suggest that governments, at least in the UI setting, are systematically behaving as forward looking agents with moderate degrees of impatience and significant risk aversion. The risk aversion of decision makers likely depends on the institutional environment—in the UI setting, curtailing unemployment insurance in bad times is likely to be visible enough to entail political costs which motivate politicians to maintain a buffer stock of savings. Alternatively, and empirically equivalent in our setting, it may be that the business community has sufficient leverage to penalize politician for raising unemployment taxes when the trust fund is low.

Given this understanding, it is interesting to speculate whether institutions such as rainy day funds are likely to be successful as management tools for smoothing taxes.[22] Based on our work here, an aspect that might affect government savings would be whether the public holds politicians responsible if saved resources are seen as inadequate, thus providing an incentive for politicians to operate with a degree of risk aversion to offset their impatience. Another possibility is that earmarked taxes, long excoriated by economists for

[22]See Knight and Levinson (1999), who find that rainy day funds are a net increase in savings by state governments. They do not, however, analyze the behavioral consequences in response to economic cycles.

providing an administrative constraint that politicians can nonetheless circumvent, may be important for linking the management of savings to a specific function. It might also be worth considering whether other government institutions which provide income or consumption "insurance" might be modeled on UI. One example would be low income assistance, such as Temporary Assistance to Needy Families (TANF) and Medicaid (low income health care). Separate trust funds for these activities, similar to those of the UI system, financed by a dedicated part of a state tax, might function more effectively than when all activities are pooled within the general fund. Clearly, more research is required, but models such as the buffer-stock model, which allows for impatience as well as risk aversion, may provide a fruitful approach to building policy models of public savings.

5.6 Implied budget behavior

To illustrate the effect of buffer-stock saving on government budgets, Table 8 shows the relative response of the UI system to a temporary one period 50 percent increase in the unemployment rate. Based on the estimated effect of the unemployment rate on UI benefits from Table 3, national UI benefits would increase by $40.01 per capita, which is $10.2 billion nationwide. If UI is financed out of the general fund, assuming borrowing would count against the state balanced-budget constraints (Poterba, 1995), then UI taxes would have to increase by an equal amount, and there would be no net fiscal stimulus. On the other hand, if states exercise perfect tax smoothing in Barro's sense, there would be no marginal change in taxes except to the extent the shock represents a permanent decrease in income. In this case, as shown by the lower panel in the table, the net fiscal stimulus would be $37.05 ($40.01 per capita less an increase in taxes of \$2.96 per capita).[23] Finally, the top panel shows the prediction of the buffer-stock model. The non-discretionary tax change caused by the change in unemployment is \$8.00. The buffer-stock model includes an additional complication, as shown in the estimates from Table 5: UI consumption decreases because cash-on-hand at the beginning of the recession drops due to the non-discretionary outlay of unemployment benefits. UI consumption therefore drops by \$8.00 which, as the model is silent on the breakdown, we have allocated as a \$4.00 drop in benefits and \$4.00 increase in UI taxes. The net fiscal stimulus in the year of the recession based on the decrease in savings would therefore be \$24.01 (\$40.01 - \$8.00 - \$8.00). In the following period, taxes react to the previous periods's jump in unemployment, and discretionary benefits are curtailed and discretionary taxes are increased because of the decrease in the trust fund (buffer stock), leading to savings of \$22.40. In the third period, the model predicts savings of \$2.86 after which the buffer stock is fully replenished and no more savings take place in the absence of further unemployment shocks.

6 Summary and conclusion

This paper examines how state governments manage the savings they accumulate to finance unemployment benefits. The UI system has a clear objective as well as clearly earmarked funds, and the public good justification for state intervention seems relatively well justified, thus private individual or firm actions are unlikely to counter the objectives of state government officials. We propose using the buffer-stock model, commonly used to model consumers but

[23]The net present value of an increase in taxes of \$2.96 in the current and all future periods is \$40.01 under our parametric assumptions.

not previously used to model governments, to rationalize the savings behavior of the UI system within a dynamic forward looking setting. The attractive feature of the buffer-stock model in the context of the UI program is that impatience by political actors is modeled, yet the model also allows the dis-savings associated with impatience to be tempered by risk aversion, because politicians fear the negative consequences of having insufficient savings when needed.

We bring two pieces of empirical evidence to bear on the appropriateness of the buffer-stock model to state government behavior. First, we show that state governments respond to deviations of their saving from the target level by spending about 25 percent of the deviation from the target level during each two-year period. This finding is statistically significant, and we show through simulations of the model calibrated to the data, that the magnitude of this response can be rationalized for reasonable values of risk aversion and discount rates. Second, we show that the average size of the trust fund is consistent with the prediction of the model. Our results imply that state governments in the year of an unemployment shock adjust UI spending and taxes in such a manner that the overall fiscal stimulus is about 65 percent of the fiscal stimulus predicted by a Barro model with exogenous spending and perfect tax smoothing.

The question which we have not yet addressed, but which would be crucial for understanding whether the UI institutional model could be extended more broadly to overall government expenditure, is the relative importance of specific institutional features. For example, it would be interesting to know if urban government politicians, being closer to the voters, are more sensitive to public scrutiny than state government politicians, in which case they may be more forward looking. Alternatively, urban government politicians may expect state governments to provide insurance against disastrous outcomes and therefore display less risk aversion. We believe further work applying the buffer-stock model can address such issues. An implication of our findings is that there is little government behavior that is “automatic,” as in automatic stabilizers, rather governments continually make choices and these choices depend on the objectives and tastes of policy makers, captured here by the trade-off between impatience and risk aversion.

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Table 1: Summary Statistics By State

UI Benefits (percent)	Mean	0.92
(UI payments/covered wages)	std1	0.31
	std2	0.37
UI Taxes (percent)	Mean	0.90
(UI taxes/covered wages)	std1	0.31
	std2	0.35
Trust fund balance (percent)	Mean	1.23
(UI trust fund balance/covered wages)	std1	0.75
	std2	1.05
Federal loan balance (percent)	Mean	0.17
(Federal loan balance/covered wages)	std1	0.26
	std2	0.53
Federal loan balance (if > 0)(percent)	Mean	1.39
(Federal loan balance/covered wages)	std1	0.84
	std2	0.77
Interest credited to trust fund (percent)	Mean	0.10
(Interest/covered wages)	std1	0.05
	std2	0.06
GSP (ratio)	Mean	2.97
(GSP/covered wages)	std1	0.34
	std2	0.15
Unemployment rate (percent)	Mean	5.79
	std1	1.06
	std2	1.65
Observations		1,584

Notes: The data cover 33 years from 1976 to 2008. "std1" (cross-section) is for any variable X, the time average of $\left[(1/n)\sum_i (X_{it} - \bar{X}_t)^2\right]^{1/2}$ where $\bar{X}_t$ is the period t average of X_{it} across states, and n is the number of states. "std2" (time-series): average over i of $\left[(1/T)\sum_t (X_{it} - \bar{X}_i)^2\right]^{1/2}$ where $\bar{X}_i$ is the time average of X_{it} for state i, and T is the number of years in the sample. Benefits, Taxes, UI trust fund balance, GSP, Federal loan balance, Interest credited to trust fund are all normalized by covered wages. Federal loan balance is positive for 12 percent of the observations.

Table 2: SUMMARY STATISTICS (REAL 1983 DOLLARS PER CAPITA)

Benefits	Mean	52.19
	std1	21.21
	std2	16.79
Taxes	Mean	51.16
	std1	21.51
	std2	15.33
Trust fund balance	Mean	71.28
	std1	39.85
	std2	62.40
GSP	Mean	17,153
	std1	2,733
	std2	2,570
Federal loan balance	Mean	9.13
	std1	14.69
	std2	28.26
Federal loan balance (if > 0)	Mean	75.29
	std1	44.66
	std2	38.85
Interest credited to trust fund	Mean	5.80
	std1	2.68
	std2	3.72
Population (millions)	Mean	5.32
	std1	5.61
	std2	1.02
Observations		1,584

Notes: The data cover 33 years from 1976 to 2008. "std1" (cross-section) is for any variable X, the time average of $\left[(1/n)\sum_i (X_{it} - \bar{X}_t)^2\right]^{1/2}$ where $\bar{X}_t$ is the period t average of X_{it} across states, and n is the number of states. "std2" (time-series): average over i of $\left[(1/T)\sum_t (X_{it} - \bar{X}_i)^2\right]^{1/2}$ where $\bar{X}_i$ is the time average of X_{it} for state i, and T is the number of years in the sample. Benefits, Taxes, Trust fund balance, GSP, Federal loan balance, Interest credited to trust fund are all deflated by the 1982-84 CPI. The federal loan balance is positive for 12 percent of the observations.

Table 3: DETERMINATION OF NON-DISCRETIONARY UI BENEFITS AND TAXES

	Benefits/Covered Wages	Taxes/Covered Wages
Two-year periods		
Start period	1981-1982	1985-1986
Unemployment rate	0.15***	0.03**
	(0.01)	(0.01)
Unemployment rate$_{t-1}$		0.08***
		(0.01)
Unemployment rate$_{t-2}$		0.01
		(0.01)
State and Year fixed effects	Yes	Yes
Observations	672	576

Notes: In the regressions, we treat two consecutive years to be a period. The predicted values from the regressions (multiplied by covered wages) define non-discretionary UI benefits and non-discretionary UI taxes. The data are for the 48 contiguous states over 14 periods from 1981-1982 to 2007-2008. Benefits/covered wages is calculated by summing over two years and then taking the ratio, while the unemployment rate is the average over two years (e.g., the unemployment rate for the period 1981-1982 is the average unemployment rate of 1981 and 1982). Unemployment rate$_{t-1}$ and Unemployment rate$_{t-2}$ denote the first and second period lags of the unemployment rate, respectively. Robust std. errors clustered by state are in parentheses. *, **, *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table 4: Descriptive Statistics of Key Buffer-Stock Model Variables by State

	Mean	std1 (cross-section)	std2 (time-series)
Two-year periods			
Cash-on-hand/Permanent income	2.17	0.71	0.52
UI income/Permanent income	0.99	0.03	0.28
UI consumption/Permanent income	1.17	0.18	0.29
Trust fund balance/Permanent income	1.18	0.72	0.59
Observations	480		

Notes: "std1" (cross-section): time average of $\left[(1/n)\sum_i (X_{it} - \bar{X}_t)^2\right]^{1/2}$ where $\bar{X}_t$ is the period t average of X_{it} across states, and n is the number of states. "std2" (time-series): average over i of $\left[(1/T)\sum_t (X_{it} - \bar{X}_i)^2\right]^{1/2}$ where $\bar{X}_i$ is the time average of X_{it} for state i, and T is the number of years in the sample. For the flow-variables, we define a period as the sum over two consecutive annual values. Non-discretionary taxes are the predicted values from the regression reported in Table 3 and discretionary taxes are the residuals, both scaled by covered wages. Similarly, non-discretionary benefits are the expected value from Table 3, while discretionary benefits are the residuals, both scaled by covered wages. UI consumption is average UI benefits plus discretionary benefits minus discretionary taxes. UI income is average UI taxes plus non-discretionary taxes minus non-discretionary benefits. Cash-on-hand is the trust fund balance plus UI income. Permanent income is defined as the 3 period moving average of UI income for the specification with 2 years as a period. The initial period—the first period for which permanent income can be calculated—is 1987-1988.

Table 5: Estimate of UI Consumption Responsiveness to Savings: The Covariance Ratio

IV regression: UI Consumption=α+θ∗Cash-on-Hand. Instrument is (Actual – Target Cash-on-Hand).	
	UI Consumption
Two-year periods Start period 1987-1988	
θ (coefficient of cash-on-hand)	0.25***
	(0.05)
Target cash-on-hand	2.17***
	(0.87)
State and year fixed effects	Yes
Observations	480

Notes: This regression is derived in Jappelli, Pistaferri, and Padula (2008), where the estimated parameter θ is labeled the "covariance ratio," see main text for details. The dependent variable is UI consumption [defined as (discretionary benefits – discretionary taxes + mean state UI benefits over time), see Table 3]. The right hand side variable is cash-on-hand minus target cash-on-hand, where cash-on-hand is defined as the UI trust fund balance plus the current year's UI tax revenue. The instrument is (actual cash-on-hand – target cash-on-hand). Two years (summed) are treated as one period. We calculate target cash-on-hand as mean cash-on-hand over all periods for each state. We report the overall mean, and report the standard deviation across states of state-specific mean cash-on-hand. All variables are normalized by permanent income. We define UI permanent income as a 3 period moving average (thus six years) of UI income. Robust std. errors clustered by state are in parentheses. *, **, *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table 6: Estimate of UI Consumption Responsiveness to Savings: The Covariance Ratio (Heterogeneity results)

IV regression: UI Consumption=$\alpha+\theta*$Cash-on-Hand.
Instrument is (Actual – Target Cash-on-Hand).

	Ideology		Income		GSP volat.	
	Lib	Cons	Poor	Rich	Low	High
Two-year periods						
Start 1987-1988						
θ (coefficient of cash-on-hand)	0.28**	0.24***	0.21***	0.29***	0.26***	0.24***
	(0.10)	(0.06)	(0.05)	(0.08)	(0.08)	(0.07)
Target cash-on-hand	1.82***	2.49***	2.23***	2.08***	1.93***	2.41***
	(0.58)	(0.97)	(0.82)	(0.94)	(0.71)	(0.95)
Observations	230	250	280	200	240	240

Testing equality of coefficients

Test: H_0: $\theta_{\text{liberal}} = \theta_{\text{conservative}}$ against H_1: $\theta_{\text{liberal}} \neq \theta_{\text{conservative}}$
F-Statistic: F(1,47)=0.17; Prob >F=0.68

Test: H_0: $\theta_{\text{low income}} = \theta_{\text{high income}}$ against $H_1 : \theta_{\text{low income}} \neq \theta_{\text{high income}}$
F-Statistic: F(1,47)=1.65; Prob >F=0.21

Test: $H_0 : \theta_{\text{more volatile}} = \theta_{\text{less volatile}}$ against $H_1 : \theta_{\text{more volatile}} \neq \theta_{\text{less volatile}}$
F-Statistic: F(1,47)=0.19; Prob >F=0.66

Notes: We define a state as liberal ("Lib") or conservative ("Cons") based on an index constructed by Erikson, Wright, and McIver (1989) as described in the text; as low income ("Poor") if the average state per capita personal disposable income is below the mean across states and high income ("Rich") otherwise; and as more volatile ("High" volatility) if the standard deviation of the growth rate of real per capita GSP is greater than the median and less volatile ("Low" volatility) otherwise. The dependent variable is UI consumption. The right hand side variable is cash-on-hand defined as the UI trust fund balance plus the current period's UI tax revenue. The instrument is (actual cash-on-hand – target cash-on-hand). Two years (summed) are treated as one period. We approximate target cash-on-hand by the mean cash-on-hand over time for each state. All variables are normalized by permanent income. We define UI permanent income as a 3 period moving average (thus six years) of UI income. Robust std. errors clustered by state in parentheses. *, **, *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table 7: SIMULATED COVARIANCE RATIO AND TARGET CASH-ON-HAND. PROBABILITY OF ZERO INCOME =0.001 AND 0.01

	p=0.001			p=0.01		
	β=0.86	β=0.90	β=0.94	β=0.86	β=0.90	β=0.94
ρ=1	θ=0.73 x^*=1.10	θ=0.66 x^*=1.14	θ=0.55 x^*=1.26	θ=0.68 x^*=1.15	θ=0.61 x^*=1.21	θ=0.49 x^*=1.36
ρ=2	θ=0.61 x^*=1.20	θ=0.57 x^*=1.24	θ=0.50 x^*=1.34	θ=0.55 x^*=1.35	θ=0.51 x^*=1.42	θ=0.44 x^*=1.53
ρ=3	θ=0.53 x^*=1.34	θ=0.50 x^*=1.39	θ=0.45 x^*=1.47	θ=0.47 x^*=1.56	θ=0.44 x^*=1.63	θ=0.40 x^*=1.72
ρ=4	θ=0.48 x^*=1.49	θ=0.44 x^*=1.56	θ=0.40 x^*=1.66	θ=0.42 x^*=1.77	θ=0.38 x^*=1.86	θ=0.34 x^*=1.98
ρ=4.5	θ=0.44 x^*=1.58	θ=0.42 x^*=1.65	θ=0.37 x^*=1.76	θ=0.38 x^*=1.90	θ=0.36 x^*=1.98	θ=0.32 x^*=2.09
ρ=5	θ=0.42 x^*=1.66	θ=0.39 x^*=1.74	NA	θ=0.36 x^*=2.01	θ=0.34 x^*=2.08	NA

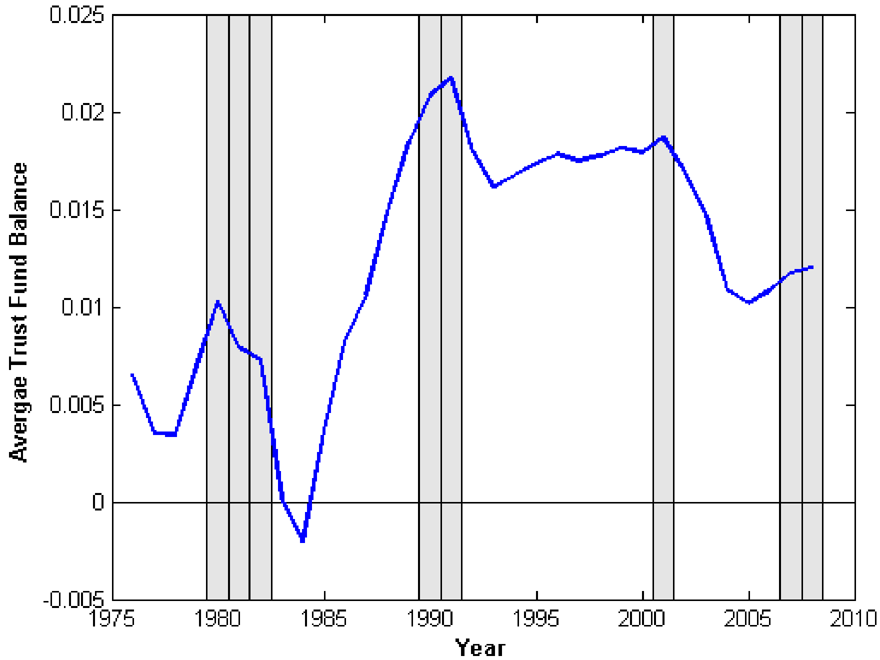
Notes: This table reports the median (across time) of the covariance ratio, θ, estimated cross-sectionally for each period in simulated data, and the median (across agents) of the target cash-on-hand x^* calculated for each agent following Carroll (1997). The results are reported for a grid of coefficients for risk aversion and time discounting. The simulations for each pair of these parameters are done for 50 consumers (UI systems) with identical discount factors β and identical coefficients of risk aversion ρ living for 100 periods. Simulations are based on a standard deviation of permanent income shocks, σ_N, of 0.173, a standard deviation of transitory income shocks, σ_V, of 0.304, and a probability of zero income $p = 0.001$ or $p = 0.01$. Income growth and interest rate are set to 9 percent and 8 percent respectively. *NA* indicates that a fixed point solution does not exist (Carroll, 1997).

Table 8: Change in UI Budgets (per cap.) following a One-Period Recession

	Change in Non-Disc. Benefits	Change in Non-Disc. Taxes	Change in Discretionary Benefits	Change in Discretionary Taxes	Change in Savings End of Year
Buffer-Stock Model:					
Yr of Recession	$40.01	$8.00	–$4.00	$4.00	–$24.01
Next Year	$0.00	$21.34	-$0.57	$0.57	$22.40
Following Yr	$0.00	$2.67	-$0.10	$0.10	$2.86
Barro Tax Smoothing:					
Yr of Recession	$40.01	$2.96	*NA*	*NA*	–$37.05
Next Year	$0.00	$2.96	*NA*	*NA*	$2.96
Following Yr	$0.00	$2.96	*NA*	*NA*	$2.96

Notes: The table displays the change in taxes and benefits as predicted by the buffer-stock model. (The model, as implemented in this article, is silent on the break down of UI consumption between discretionary taxes and discretionary benefits, so we here split the UI consumption response evenly over the two components.) We calculate the effect of a hypothetical 50 percent increase in the unemployment rate, from the average of 5.7 percent to 8.55 percent for one year, after which the unemployment rate is assumed to return to 5.7 percent.

Figure 1: Average Trust Fund Balance 1976-2008



Notes: The figure displays the yearly averages across states of trust fund balances normalized by covered wages. The shaded areas indicate recession years.

Figure 2: Average Simulated Target Ratio of Cash-on-Hand to Permanent Income with Varying Discount Factor ($p = 0.01$)

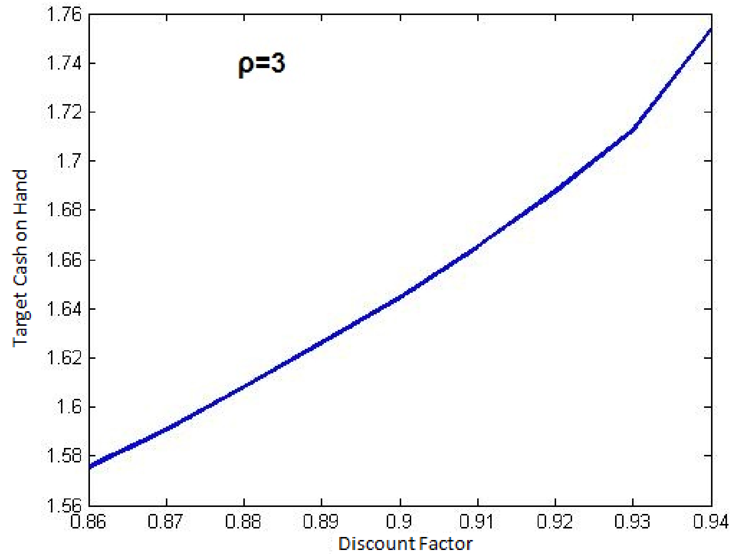
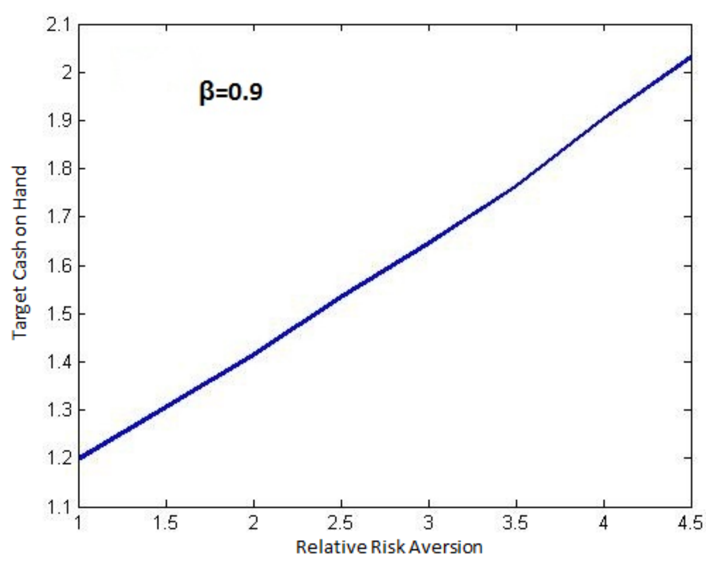


Figure 3: Average Simulated Target Ratio of Cash-on-Hand to Permanent Income with Varying Relative Risk Aversion ($p = 0.01$)



Notes: The figures display the average simulated target amount of cash-on-hand relative to permanent income for a buffer-stock model with 50 homogeneous consumers (having the same relative risk aversion in Figure 2 and the same discount factor in Figure 3) living for 100 periods, having income growth of 8 percent, an interest rate of 6 percent, a probability of zero income of 0.01, and standard deviations of permanent and transitory shocks of 0.173 and 0.304, respectively. Figure 2 graphs the repeated simulations for different discount factors maintaining $\rho = 3$. Figure 3 graphs the repeated simulations for different relative risk aversion parameters maintaining $\beta = 0.9$.

A Appendix: Supplementary results for online Appendix

Table A.1: Panel Unit Root Tests

	log(Taxes/Cov. Wages)	log(Ben./Cov. Wages)
Individual state ADF Unit Root Tests:		
Number of rejections:	12	24
Panel AR(1) estimation	0.94***	0.87***
(Std. error)	(0.01)	(0.01)
IPS panel unit root test (test-statistic)	−2.20	−2.34
(1 percent Critical Value for the IPS test)	−1.81	−1.81
Observations	1,536	1,536

Notes: The first row reports the number of rejections of unit roots for individual state augmented Dickey-Fuller (ADF) tests on taxes and benefits series using the 33 years of data 1976-2008 for the 48 contiguous states. The ADF is estimated from the model: $\Delta X_{it} = \alpha_i + \rho_i X_{it-1} + \sum_{k=1}^{K} \delta_k \Delta X_{it-j}$ where the number of lags K is chosen endogenously. The second row reports the estimated coefficient from a standard panel AR(1) estimation with state fixed effects: $X_{it} = \mu_i + \alpha X_{it-1} + \epsilon_{it}$ with standard errors in parentheses. The last row reports the test-statistic from the Im-Pesaran-Shin panel unit root test which performs ADF tests on individual states, and is based on averaging stat-by-state unit root t-test statistics; i.e., the test statistics is $\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{\rho_i}$. A value smaller than the critical value fails to reject the unit root hypothesis. *, **, and *** refer to the 10 percent, 5 percent, and 1 percent significance levels, respectively.

Table A.2: DETERMINATION OF NON-DISCRETIONARY UI BENEFITS AND TAXES. ALTERNATIVE START YEAR.

	Benefits/Covered Wages	Taxes/Covered Wages
Two-year periods		
Start period	1980-81	1984-1985
Unemployment rate	0.15^{***}	0.03^{**}
	(0.01)	(0.01)
Unemployment rate$_{t-1}$		0.08^{***}
		(0.01)
Unemployment rate$_{t-2}$		0.01
		(0.01)
State and year fixed effects	Yes	Yes
Observations	672	576

Notes: In the regressions, we treat two consecutive years as a period. We sum taxes, benefits, and covered wages for two consecutive years and use that to be the value for a single period. The data consist of a panel of 48 states over 14 periods from 1980-1981 to 2006-2007. The unemployment rate of any given period is the average over two years (e.g., the unemployment rate for the period 1980-1981 is the average of unemployment rates for 1980 and 1981). Unemployment rate$_{t-1}$ and Unemployment rate$_{t-2}$ denote the first and second period lags of unemployment rate. Robust std. err. clustered by state are in parentheses. *, **, *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table A.3: Estimate of UI Consumption Responsiveness to Savings: The Covariance Ratio. Alternative Starting Year.

IV regression: UI Consumption=α+$\theta *$ Cash-on-Hand) . Instrument is (Actual – Target Cash-on-Hand)	
	UI Consumption
Two-year periods Start period 1986-1987	
Estimated coefficient of cash-on-hand	0.26***
	(0.06)
Target cash-on-hand	2.09***
	(0.86)
State and year fixed effects	Yes
Observations	480

Notes: In the above specification, we treat two consecutive years to be a period, where we sum the two annual values for each variable. We run an IV regression of UI consumption, [defined as (discretionary benefits – discretionary taxes + mean state benefits over time)] on cash-on-hand [defined as (trust fund balance + UI income)]. UI income is defined as [non-discretionary taxes – non-discretionary benefits + mean state taxes over time]. Non-discretionary taxes are the fitted values of taxes from the regression in column 2 of Table A.2 while discretionary taxes are the residuals from the regression in column 2 of Table A.2, both scaled by covered wages. Non-discretionary benefits are the fitted values from the regression in column 1 of Table A.2 while discretionary benefits as the residuals from the regression in column 1 of Table A.2, both scaled by covered wages. We use the deviation between cash-on-hand and the target ratio of cash-on-hand as the instrument. We approximate the target cash-on-hand by the mean cash-on-hand over time for each state . All variables are normalized by permanent income. For the two-year period we define permanent income as a 3 period moving average (thus six years) of income. Robust std. err. clustered by state are in parentheses. *, **, *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table A.4: DETERMINATION OF NON-DISCRETIONARY UI BENEFITS AND TAXES. ONE YEAR AS A PERIOD.

	Benefits/Covered Wages	Taxes/Covered Wages
One-year periods		
Start year=1981	1981	1985
Unemployment rate	0.15***	0.01
	(0.01)	(0.01)
Unemployment rate$_{t-1}$		0.03***
		(0.01)
Unemployment rate$_{t-2}$		0.04***
		(0.01)
Unemployment rate$_{t-3}$		0.03***
		(0.01)
Unemployment rate$_{t-4}$		−0.00
		(0.01)
State and year fixed effects	Yes	Yes
Observations	1,344	1,152

Notes: Robust standard errors clustered by state are in parentheses. In the regressions, we treat each year as a period. The data consist of a panel of 48 states over 28 years from 1981 to 2008. Unemployment rate$_{t-1}$, Unemployment rate$_{t-2}$, Unemployment rate$_{t-3}$, Unemployment rate$_{t-4}$ denote the first, second, third, and fourth year lags of the unemployment rate, respectively. Robust std. err. clustered by state are in parentheses. *, **, *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table A.5: Estimate of UI Consumption Responsiveness to Savings: The Covariance Ratio. One Year as a Period.

IV regression: UI Consumption=α+θ*Cash-on-Hand Instrument is (Actual – Target Cash-on-Hand)	
	UI Consumption
One-year periods Start year 1986	
Estimated coefficient of cash-on-hand	0.15^{***} (0.04)
Target cash-on-hand	3.32^{*} (2.04)
State and year fixed effects	Yes
Observations	960

Notes: In the above specification we treat a single year as a period. We run an IV regression of UI consumption, [defined as (discretionary benefits – discretionary taxes + mean state benefits over time)] on cash-on-hand [defined as (trust fund balance + UI income)]. UI income is defined as [non-discretionary taxes – non-discretionary benefits + mean state taxes over time]. Non-discretionary taxes are the fitted values from the regression in column 2 of Table A.4 while discretionary taxes are the residuals from the regression in column 2 of Table A.4, both scaled by covered wages. Non-discretionary benefits are the fitted values from the regression in column 1 of Table A.4 while discretionary benefits as the residuals from the regression in column 1 of Table A.4, both scaled by covered wages. We use the deviation between cash-on-hand and target cash-on-hand as the instrument. We approximate the target cash-on-hand to be the mean cash-on-hand over time for each state. All variables are normalized by permanent income. Permanent income is defined as a 5 year moving average of UI income. Robust std. err. clustered by state are in parentheses. *, **, *** indicte significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table A.6: Estimate of UI Consumption Responsiveness to Savings: The Covariance Ratio. One Year as a Period. Alternative Start Year

IV regression: UI Consumption=α+θ*Cash-on-Hand Instrument is (Actual – Target Cash-on-Hand)	.
	UI Consumption
One-year periods Start Year 1987	
Estimated coefficient of cash-on-hand	0.17***
	(0.03)
Target cash-on-hand	3.44*
	(2.21)
State and year fixed effects	Yes
Observations	960

Notes: In the above specification we treat a single year as a period. We run an IV regression of UI consumption, [defined as (discretionary benefits – discretionary taxes + mean state benefits over time)] on cash-on-hand [defined as (trust fund balance + UI income)]. UI income is defined as [non-discretionary taxes – non-discretionary benefits + mean state taxes over time]. Non-discretionary taxes are the fitted values from the regression in column 2 of Table A.4 while discretionary taxes are the residuals from the regression in column 2 of Table A.4, both scaled by covered wages. Non-discretionary benefits are the fitted values from the regression in column 1 of Table A.4 while discretionary benefits as the residuals from the regression in column 1 of Table A.4, both scaled by covered wages. We use the deviation between cash-on-hand and target cash-on-hand as the instrument. We approximate target cash-on-hand to be the mean cash-on-hand over time for each state. All variables are normalized by permanent income. Permanent income is defined as a 5 year moving average of UI income. Robust std. err. clustered by state are in parentheses. *, **, *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table A.7: ESTIMATE OF UI CONSUMPTION RESPONSIVENESS TO SAVINGS: THE COVARIANCE RATIO (HETEROGENEITY BY CENSUS REGION)

IV regression: UI Consumption=$\alpha+\theta*$Cash-on-Hand.
Instrument is (Actual – Target Cash-on-Hand).

	NE	MidW	South	West
Two-year periods				
Start period 1987-1988				
θ (coefficient of cash-on-hand)	0.23*	0.33***	0.21***	0.28***
	(0.06)	(0.05)	(0.06)	(0.07)
Target cash-on-hand	2.10***	1.94***	2.31***	2.26***
	(1.22)	(0.67)	(0.89)	(0.62)
State and year fixed effects	Yes	Yes	Yes	Yes
Observations	90	120	160	110

Test: $H_0 : \theta_{NE} = \theta_{MW} = \theta_{SO} = \theta_{WE}$ against H_1: at least one unequal
F-Statistic: F(3,47)=0.63; Prob >F=0.60

Notes: The dependent variable is UI consumption defined as (discretionary benefits – discretionary taxes + mean state UI benefits over time). The right hand side variable is cash-on-hand defined as the UI trust fund balance plus the period's UI tax revenue. The instrument is (actual cash-on-hand – target cash-on-hand). Two years (summed) are treated as one period. We approximate target cash-on-hand by the mean cash-on-hand over time for each state. All variables are normalized by permanent income. We define UI permanent income as a 3 period moving average (thus six years) of UI income. Robust std. errors clustered by state are in parentheses. *, **, *** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Table A.8: SIMULATED COVARIANCE RATIO AND TARGET CASH-ON-HAND. PROBABILITY OF ZERO INCOME =0.02 AND 0.05

	p=0.02			p=0.05		
	β=0.86	β=0.90	β=0.94	β=0.86	β=0.90	β=0.94
ρ=1	θ=0.65	θ=0.57	θ=0.47	θ=0.59	θ=0.53	θ=0.41
	x^*=1.20	x^*=1.28	x^*=1.45	x^*=1.33	x^*=1.43	x^*=1.66
ρ=2	θ=0.52	θ=0.47	θ=0.42	θ=0.47	θ=0.43	θ=0.36
	x^*=1.44	x^*=1.53	x^*=1.65	x^*=1.64	x^*=1.73	x^*=1.91
ρ=3	θ=0.45	θ=0.41	θ=0.37	θ=0.39	θ=0.36	θ=0.32
	x^*=1.68	x^*=1.76	x^*=1.89	x^*=1.95	x^*=2.05	x^*=2.19
ρ=4	θ=0.38	θ=0.36	θ=0.33	θ=0.34	θ=0.31	θ=0.28
	x^*=1.94	x^*=2.03	x^*=2.13	x^*=2.26	x^*=2.38	x^*=2.53
ρ=4.5	θ=0.36	θ=0.34	θ=0.30	θ=0.31	θ=0.29	θ=0.26
	x^*=2.06	x^*=2.13	x^*=2.29	x^*=2.42	x^*=2.54	x^*=2.68
ρ=5	θ=0.34	θ=0.31	NA	θ=0.29	θ=0.28	NA
	x^*=2.17	x^*=2.29		x^*=2.57	x^*=2.68	

Notes: This table reports the median (across time) of the covariance ratio, θ, estimated cross-sectionally for each period in simulated data, and the median (across agents) of the target cash-on-hand x^* calculated for each agent following Carroll (1997). The results are reported for a grid of coefficients for risk aversion and time discounting. The simulations for each pair of these parameters are done for 50 consumers (UI systems) with identical discount factors β and identical coefficients of risk aversion ρ living for 100 periods. The simulated model has a standard deviation of permanent income shocks, σ_N, of 0.173, a standard deviation of transitory income shocks, σ_V, of 0.304, and a probability of zero income $p = 0.02$ or $p = 0.05$. Income growth and interest rate are set to 9 percent and 8 percent, respectively. *NA* indicates that a fixed point solution does not exist (Carroll, 1997).