Expenditure Smoothing under Balanced Budget Rules

Xavier Martin G. Bautista, Steven G. Craig, Annie Yu-Hsin Hsu,
Bent E. Sørensen, Vasundhara Tanwar, Priyam Verma*

This version: February 5, 2026

Abstract

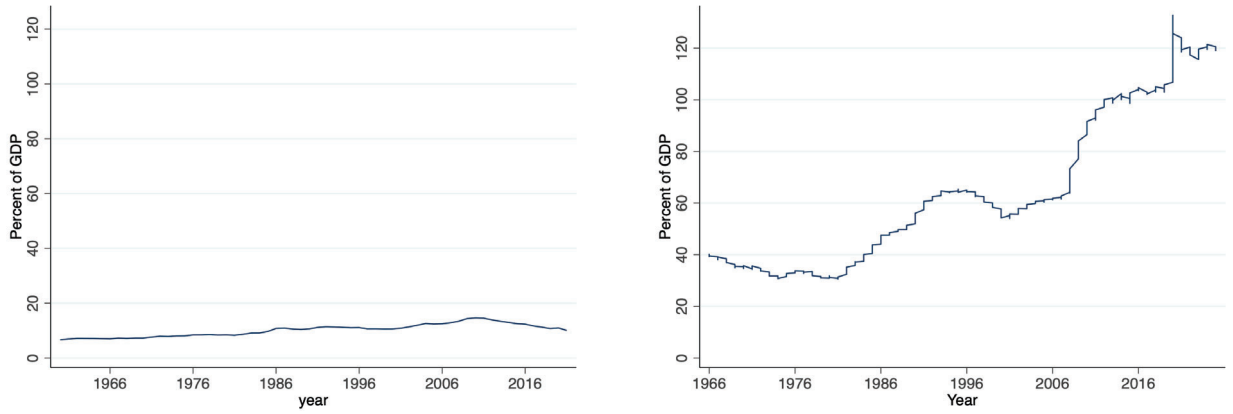
An increasing number of countries use balanced budget rules (BBRs) to control government debt, with the potential cost that BBRs constrain the governments' ability to smooth public expenditures. We find that U.S. state governments, despite having BBRs, smooth expenditures using savings. This is accomplished via substantial cash balances held by agencies outside of the General Fund with only a minor contribution from dedicated "rainy day" funds. We estimate a state government discount rate using a buffer stock model, fitted to fiscal data consolidated over all agencies, and find that expenditures are smoothed as if guided by a planner with a discount rate similar to that typically found for consumers.

Keywords: rainy day funds; U.S. states; buffer stock model; balanced budget requirements

*Bautista: Faculty of Economics, Fulbright University Vietnam. Craig: Department of Economics, University of Houston. Hsu: Paul H. O'Neill School of Public and Environmental Affairs, Indiana University. Sørensen: Department of Economics, University of Houston and CEPR. Tanwar: Bartko LLP. Verma: Department of Economics, Ashoka University. We benefited from comments received at the UH brownbag seminar, Econometric Society World Congress, the Midwest Macro Meetings, Texas Camp Econometrics, Aix Marseille School of Economics eco-lunch seminar, the International Association of Applied Econometrics annual meeting, the North American Summer Econometric Society Meetings, Ashoka University internal seminar, and from Ph.D. students in our joint class. No author received financial support for this work, and there are no conflicts of interest.

1 Introduction

Buchanan and Wagner (1977) argue that politicians are incentivized to spend with little regard for debt that may come due after the next election.[1] Indeed, national governments often accumulate substantial debt, where U.S. national debt is at 120 percent of GDP with a sharp upward trajectory. In response to the large differences in government indebtedness across countries, Alesina and Perotti (1995) state "We believe...that politico-institutional factors are crucial for understanding budget deficits in particular, and fiscal policy in general." Our paper takes this statement seriously and studies savings and expenditures in the particular politico-institutional setup of U.S. state governments ("states"). The motivation for using U.S. states is that they operate without accumulating large and growing debt, despite the recessions that have occurred this century. Figure 1 highlights that U.S state governments' debt levels are stable and much lower than the federal government's debt as a share of GDP.



(a) State governments

(b) Federal government

Figure 1: Comparison to U.S. government debt levels

Note: Panel (a) plots long-term debt from the Annual Survey of State and Local Government Finances (Census) summed across U..S states as a percent of U.S. GDP. Alaska and Hawaii are excluded. Panel (b) plots quarterly total U.S. federal debt as a percent of GDP, seasonally adjusted, from FRED.

Only five countries had fiscal rules or balanced budget rules (BBRs) in 1990, but by 2014 more than 80 countries had some institutional rules to limit indebtedness (Alfaro and Kanzuk

[1]Consistent with this, researchers often assume that governments have very high discount rates—between 0.40 and 0.80—see Aguiar, Amador and Gopinath (2006), Alfaro and Kanczuk (2005), and Arellano (2008).

(2019)). BBRs vary widely in their effectiveness, depending on the details (Potrafke (2025)); however, Bergman, Hutchison and Jensen (2016) find that fiscal rules in the European Union indeed limit deficits. If governments are forward looking and fully internalize the preferences of voters, fiscal constraints serve little purpose. Conversely, if governments tend to accumulate "excessive" debt, there may be a trade-off between limiting debt and smoothing expenditures and/or taxes (Azzimonti, Battaglini and Coate (2016)). One of the salient arguments against BBRs is that they make budgetary smoothing difficult or impossible, and it is the budget smoothing issue that we use states to address.

Our research objective is to examine whether states' that limit their debt, whether by balanced budget rules (BBRs) or any other institution, are associated with lack of smoothing over the business cycle.[2] In order to evaluate this statement, we use a model to estimate a discount rate for a representative state government agent. This may or may not correspond to the discount rate of any politician, but it provides a parameterization to compare governments with residents. Welfare is lower when the government has a discount rate different from that of its citizens—see, e.g., Aguiar, Amador and Fourakis (2020), who model the welfare losses that may occur.[3] States spend about ten percent of U.S. GDP on goods, services, and transfers, so fluctuations in expenditures (or taxes) have the potential to significantly affect national welfare.

As shown in Figure 1, U.S. states are not accumulating debt like many national governments, possibly due to BBRs.[4] Fiscal federalism in the U.S. implies that states have a large degree of autonomy over taxes, expenditures, and debts. While states differ from countries in that states do not have control over the money supply or international policy (including tariffs), it is the internal fiscal discipline (or lack) that is the focus of our investigation.

Our research shows states have converged on using agencies outside of the core budgeting institutions to solve their budgetary smoothing problem. As we show, other possible mechanisms, such as timing of contributions to pension- or unemployment-insurance funds, are not important.[5] While we frame the discussion in terms of BBRs, our results are informative about how states smooth their expenditures without relying on debt. Whether or not it is BBRs that cause the debt

[2] Except for Vermont, all states have BBRs (Posner (1993) and White (2024)).

[3] Alfaro and Kanzuk (2019) provide a model that rationalizes fiscal rules.

[4] See, for instance, Stockman (2001) or Poterba (1995) on the fiscal rules of U.S. states. It may be important that states engage in separating capital from current expenditures, an accounting not practiced at the federal level.

[5] Craig et al. (2016) study how states smooth unemployment insurance budgets, a state policy under a Federal policy umbrella. But, states do not (or cannot) use Unemployment Insurance to smooth any other part of the budget.

limit is not important for our results, our goal is to show whether or not states can fiscally smooth without resorting to increasing debt loads.

We compare the role of balances consolidated across the state government and its agencies to the role of Rainy Day Funds (RDFs), the savings accounts explicitly established for expenditure smoothing. The comparison finds that consolidated balances play by far the larger role in buffering revenue fluctuations.[6] Knight and Levinson (1999) show that savings in RDFs add to the unrestricted funds available for smoothing, but state RDFs are typically small—for example, Zhao (2016) finds that RDFs are too small relative to revenue fluctuations to stabilize General Fund expenditures, and Rosengren (2018) suggests increasing the size of RDFs. States can adjust, e.g., contributions to pension funds, but we find that the bulk of pro-cyclical savings is held by agencies outside of the states' General Fund.

We show in Appendix Figure D.3, that the "tax rate" as defined by revenue over personal income increased in the early part of our sample, but did not systematically move with the business cycle. As states' tax rates vary little over the business cycle, tax revenue fluctuates with the level of economic activity, and we model states as smoothing expenditures in the face of exogenous revenue fluctuations.

States allocate core fiscal activities through a General Fund budget to which the BBRs apply. Much previous work focuses on General Fund allocations; see for example Poterba (1994), who finds that BBRs are binding, using data from the National Association of State Budget Officers (NASBO). What NASBO lists as "General Fund Expenditures," however, include spending plus allocations to agencies outside of the General Fund. But allocations to outside agencies do not equal expenditures in a given year, because outside agencies, such as medical centers and universities, have significant discretion over when General Fund allocations are expended. We therefore use the term "allocations," rather than expenditures, when referring to distributions from the General Fund.

What matters for stimulus and consumer welfare is when funds leave states' accounts as purchases of goods and services, or as transfers to local governments, individuals, or firms. We refer to funds which leave states' coffers consolidated across all accounts as expenditures. Consolidated data are available from the Census of Governments Annual Survey of State and Local Government

[6] Twenty-seven states had RDFs in 1988. Since then, all states have created RDFs, with Montana being the last state to initiate such a fund in 2018.

Finances ("Census"), where data on expenditures in a year are dollars that leave the states' consolidated coffers in that year. Because much work has studied the General Fund using the NASBO data, we additionally analyze General Fund allocations. We find that budget smoothing comes mainly from the consolidated accounts outside of the General Fund.

The stock of funds (which we refer to as "cash") in the consolidated accounts, including the General Fund and all state agencies, dwarfs the funds in RDFs, and we treat cash in the consolidated accounts as savings. Importantly, we do not include assets in restricted funds, such as pension or Unemployment Insurance funds, which mainly are unavailable for expenditure smoothing. Consolidated revenues and expenditures are much larger than General Fund revenue and allocations; for example consolidated (annual real) expenditures are (on average) $5,174 per capita while General Fund allocations are $2,210. Savings have an even larger relative disparity: consolidated cash balances are $2,387, while RDF balances are $111, or $219 including end-of-year balances. Consolidated cash balances (which includes RDFs) are subject to various constraints specific to individual agencies, and "cash" is funds held in many different types of assets, but Consolidated Savings are highly pro-cyclical implying an important role in expenditure smoothing.

To quantify the extent of states' expenditure smoothing, we fit a version of the buffer stock model of Carroll (1992) to states' propensity to spend. This process allows an estimate of states' time discount rate under the model assumption that states evaluate expenditures as a consumer would value consumption, taking revenue as exogenous "income." We find that states' fiscal policy corresponds to the choices of an agent with a discount rate similar to that of a typical citizen; see, e.g., Gourinchas and Parker (2002), who find an annual discount rate of about 4 percent for U.S. consumers. The buffer stock model assumes an infinitely lived consumer, which may jar with politicians' time horizon, but it is not clear what is that horizon nor how governmental institutions may affect it. It is also not obvious that consumers, to whose typical discount rate we compare, plan over longer horizons.

Previous work applying consumer models to governments has focused on whether government expenditure patterns are "optimal" by testing versions of the Hall (1978) Permanent Income Hypothesis (PIH). Using disaggregated data for state governments, a number of papers reject the PIH model or its extension including rule-of-thumb consumers; see e.g., Dahlberg and Lindström (1998) and Borge and Tovmo (2009). We do not test our model, as such, although our simula-

tions would not converge if consolidated government behavior deviated too much from the model assumptions. Holtz-Eakin, Rosen and Tilly (1994), using National Income and Product Accounts (NIPA) data, find that aggregate U.S. state and local consumption follows available resources, implying no intertemporal smoothing. This conclusion deviates from ours in part because government consumption in the NIPA is defined as purchases of goods and services, while our definition of government "consumption" further includes transfers. Fournier (2019) derives policy suggestions by simulating a calibrated buffer stock model in partial equilibrium, but he does not fit the model to evaluate the parameters of the utility function as we do. Wilson (2023), in a descriptive paper, considers both General Fund balances and consolidated cash balances. He shows that both balances are pro-cyclical, but he does not quantify the cyclicality of consolidated expenditures or evaluate the discount rate.[7]

The rest of the paper is organized as follows. Section 2 describes the data and documents that state governments smooth consolidated expenditures. Section 3 presents the buffer stock model in the context of government behavior. Section 4 explains our Indirect Inference approach and presents discount rate estimates. Section 5 discusses implications of our results for institutional reform and we summarize and conclude in Section 6.

2 Data

We use two panel datasets for our analysis. The Census is the primary source, as it reports the consolidated accounts of states, while NASBO provides data for the General Fund. The datasets cover the 48 mainland states over the period 1988—2021, aligned with the availability of the NASBO data.[8] Revenues, expenditures, and their components are flow variables, whereas cash and security holdings, debts, and their components are stock variables measured as end-of-year balances. When fitting the model, we take government "consumption" as total expenditures minus capital spending. All data are converted to per-capita 2015 dollars.

Panel (a) of Table 1 presents selected summary statistics for consolidated accounts reported by the Census and Panel (b) reports the summary statistics for the General Fund reported by NASBO.

[7] Wilson (2023) also shows that state governments exhibit precautionary savings behavior with higher pro-cyclicality of savings in states whose Gross State Product (GSP) is more correlated with U.S. aggregate Gross Domestic Product. This finding is consistent with buffer stock saving.

[8] Alaska is excluded because of its atypical dependence on revenue from oil extraction, and Hawaii is excluded because of its atypical dependence on revenue from tourism; see (Wagner, 2003).

Table 1: Summary Statistics: Consolidated Data vs. General Fund

	Mean	Std 1 (States)	Std 2 (Time)
(a) Consolidated Funds (Census Source)			
Revenue	5,276	1,157	1,004
Own Revenue	3,602	842	549
Intergovernmental Rev.	1,674	503	512
Expenditures	5,174	1,036	957
Capital Expenditures	408	150	83
Interest on Debt	162	107	37
Current Expenditures	4,765	970	926
Long-Term Debt	3,226	2,037	696
Cash & Securities Holdings	11,856	4,986	3,326
Insurance Trust Funds	7,639	2,628	2,357
Offsets to Debt	1,785	1,299	423
Other Funds ("Consolidated Savings")	2,287	3,274	1,061
(b) General Fund (NASBO Source)			
Revenue	2,210	810	313
Allocations for Capital	23	51	27
Current Allocations	2,170	796	286
Cash & Securities Holdings			
Rainy Day Funds	111	170	102
End-of-Year Bal. + RDF	219	246	174
Observations	1,632		

Notes: Panel (a) reports summary statistics of consolidated account variables in 2015 dollars per capita from the *Annual Survey of State and Local Government Finances* (U.S. Census). Std 1 is the average of state-level standard deviations across periods. Std 2 is the average of time-series standard deviations across states. Panel (b) reports summary statistics for General Fund variables from NASBO's Fiscal Survey of States. Current allocations = total allocations minus capital allocations. End-of-Year Balance + RDF combines end-of-year balances and Rainy Day Funds. Revenue is missing for Texas in 1998. Alaska and Hawaii are excluded.

The General Fund reports state government allocations but omits important budget components such as federal aid and capital expenditures.[9] Census expenditures are recorded when funds leave the state government as transfers to individuals or other governments (such as school districts) or as purchases of goods and services. Consolidated Savings equals cash and security holdings minus insurance trust fund holdings (the major component) minus offsets to debt. Consolidated Savings in Panel (a) of Table 1 average about ten times the end-of-year NASBO balance ($2,287 vs. $219), suggesting that only Consolidated Savings are large enough to meaningfully smooth state revenue fluctuations. Panel (b) of Table 1 shows that the average RDF balance is $111 per capita—only about 5 percent of NASBO-reported current expenditures, which themselves are less than half of consolidated current expenditures. Adding end-of-year balances roughly doubles average General Fund savings, but these remain significantly smaller than the average time-series standard deviation of NASBO revenues. State governments have several potential tools for maintaining consumption in the face of business-cycle-induced revenue fluctuations. To demonstrate that Consolidated Savings are the most important channel of smoothing, we estimate the following regression with the dependent variable being different budget items to capture how these respond to personal income shocks:

$$\Delta\text{Budget Item}_{it} = \alpha + \beta\Delta\text{Pers. Income}_{it} + \gamma_i + \epsilon_{it}\,. \tag{1}$$

Given the lagged response of state budgets, we treat each period as spanning three years, by which point state revenues have responded to business-cycle fluctuations (this assumption is discussed further below). General revenues comprise own-source revenues and federal transfers. In Panel (a) of Table 2, we report estimates of Equation (1) with general revenue and current expenditures as dependent variables. The coefficient on current expenditures in Column (2) is an order of magnitude smaller than that on general revenue in Column (1), indicating smoothing. The coefficient on federal transfers in Column (1.2) is positive but as it is smaller than the coefficient for own revenue in Column (1.1) federal transfers provide some smoothing.

For the purposes of our model, we assume that federal transfers, like other revenue sources, are exogenous to consumption. An important development in the 21st century is that the federal

[9]The Fiscal Survey of States does not report capital expenditures, so for this variable we rely on the State Expenditure Reports, also produced by NASBO, as described in Appendix A.

Table 2: Business Cycles and Potential Smoothing Mechanisms

	(a)			
	(1)			(2)
	Δ Gen Rev.	(1.1)	(1.2)	Δ Curr. Exp.
		Δ Own Rev.	Δ Fed. Trans.	
Δ Pers. Inc.	0.115***	0.087***	0.028***	0.046***
	(0.016)	(0.014)	(0.006)	(0.007)
N	912	912	912	912
R^2	0.326	0.283	0.079	0.144

	(b)				
	Δ Savings		Δ Insurance	Δ Short-term	Δ Long-term
	All	RDF	Trust Fund	Debt	Debt
	(1)	(2)	(3)	(4)	(5)
Δ Pers. Inc.	0.045***	0.008***	–0.013*	0.000	–0.009**
	(0.007)	(0.002)	(0.007)	(0.000)	(0.004)
Δ S&P500			1.683***		
			(0.110)		
N	912	528	912	912	912
R^2	0.266	0.131	0.359	0.006	0.049

Note: We run the regression $\Delta\text{Budget Item}_{it} = \alpha + \beta\Delta\text{Pers. Income}_{it} + \gamma_i + \epsilon_{it}$ using data on consolidated funds from the *Annual Survey of State and Local Government Finances* (U.S. Census). Regressions are run on 3-year periods and are in terms of dollars on dollars. In Panel (a), Columns (1), (1.1), (1.2), and (2), the dependent variable is general revenues, own revenues, federal transfers, and current expenditures, respectively. In Panel (b), Columns (1)–(5), the dependent variable is Consolidated Savings, Rainy Day Funds, insurance trust fund balances, short-term debt, and long-term debt, respectively. Each period equals 3 years, and the time span is 1988–2021. Alaska and Hawaii are excluded. Standard errors are clustered at the state level. Fixed effects are included in the regression. Robust standard errors in parentheses. * indicates $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

government has implemented policies to directly assist state governments during national recessions. In contrast, there was no incremental federal aid to state and local governments during the last three recessions of the 20th century (GAO, 2011). We treat emergency aid as part of own revenue and treat total revenue as exogenous.[10]

To document the smoothing mechanisms by different funds of the state governments over business cycle fluctuations, we regress Equation (1) using for the dependent variables Consolidated Savings, rainy day funds, insurance trust funds, short-term debt, and long-term debt. The results are reported in Panel (b) of Table 2. "Other Funds" in the Census tables——which we relabel as "Consolidated Savings"——include RDFs and consist of balances held across the state government, including large balances in agencies such as medical centers and universities that are outside the General Fund. These outside agencies presumably hold balances to smooth their own operations, but these balances indirectly help states smooth other expenditures. If an outside agency's allocation is reduced, the legislature can redirect the saved funds to support other expenditures and rely on the agency to draw on its own reserves. The General Fund is subject to limitations on expenditures and savings and includes RDFs which are intended to absorb revenue fluctuations.[11]

Consolidated Savings absorbs by far the largest share of fluctuations in revenue due to changes income, as they increase (decrease) by 4.5 dollars when personal income increases (decreases) by 100 dollars. RDFs are also pro-cyclical, but the magnitude of its coefficient in Column (2) in Panel (b) of Table 2) is 1/5th of that with respect to Consolidated Savings in Column (1), so fluctuations in revenue are largely offset by fluctuations in Consolidated Savings. In Appendix Table C.5, we show a regression of savings on revenue at a 3-year frequency, which gives a similar picture with Consolidated Savings going up (down) by 32 dollars when consolidated revenue goes up (down) by 100 dollars, while the corresponding reaction of General Fund savings to General Fund revenue is 11 dollars per 100. Reserves of insurance trust funds do not smooth expenditures much.[12] During the 2007 financial crisis, 35 states depleted their UI trust funds and had to borrow from the federal government; see (Weiner, 2012). Hence, limited solvency of trust funds restrict their ability to

[10] Additional dataset details are reported in Appendix A.

[11] We ignore tax and expenditure limitations (TELs), which were generally imposed in the 1970s and early 1980s and constrain the growth rate of taxes or General Fund allocations and limit surpluses. Wagner and Sobel (2006) hypothesize that the adoption of TELs led states to create RDFs. Our analysis cannot incorporate such institutional details, but it is possible that expenditure smoothing outside the General Fund developed partly because of constraints on General Fund spending and savings.

[12] Given that a part of the co-movement between insurance trust funds and personal income could be in response to equity prices, we control for S&P500 index in that regression.

buffer above and beyond their intended objective.

Capital spending is treated differently from current spending in state budgets: whereas BBRs prevent borrowing for current spending, all states allow borrowing for capital projects. If funds are short-run fungible across budgets, debt could, in principle, aid expenditure smoothing and we show results from regressing short-term debt on income in Column (4) of Panel (b). However, short-term debt does not respond to income shocks and while long-term debt is counter-cyclical, the coefficient is small relative to that of Consolidated Savings and because long-term debt is largely tied to capital expenditures, their uptake during business cycle downturns might indicate falling cost of capital investments. Moreover, capital spending is small relative to current spending, so we conclude that debt plays a minimal role in smoothing.[13] Overall, pro-cyclical Consolidated Savings are the main source of revenue smoothing (taking federal transfers as part of exogenous revenue).

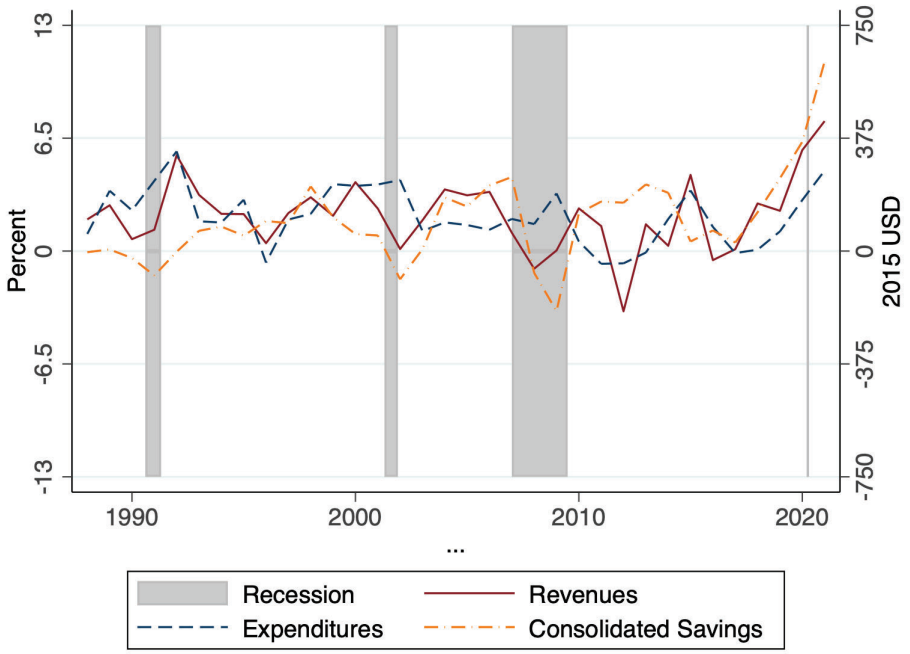
Figure 2 illustrates graphically the smoothing of expenditures in the consolidated accounts versus the smoothing of allocations in the General Fund. The figure shows percentage deviation in revenue and expenditures while the savings variables are in dollar changes in order to make them visible in the figure. In Panel (a), we see that expenditures rarely declines, even after recessions, and never by very much. In contrast, Consolidated Savings declines significantly in all recessions, thereby absorbing the revenue shocks. This clearly illustrates our point that whatever else is happening, revenue fluctuations are partly off-set by pro-cyclical fluctuations of Consolidated Savings.

From Panel (b) of Figure 2, General Fund revenue growth becomes negative in recessions, and the drop in allocations (the blue dotted line) matches or exceeds the revenue drop. RDF balances drop in response, but the amounts of money released from the RDFs are not large enough to prevent the drop in allocations. Comparing Panels (a) and (b), what stands out is how the large drop in allocations at the end of the last two recessions is not mirrored by large drops in consolidated expenditures, illustrating the important role of agency savings in the smoothing of revenue fluctuations.

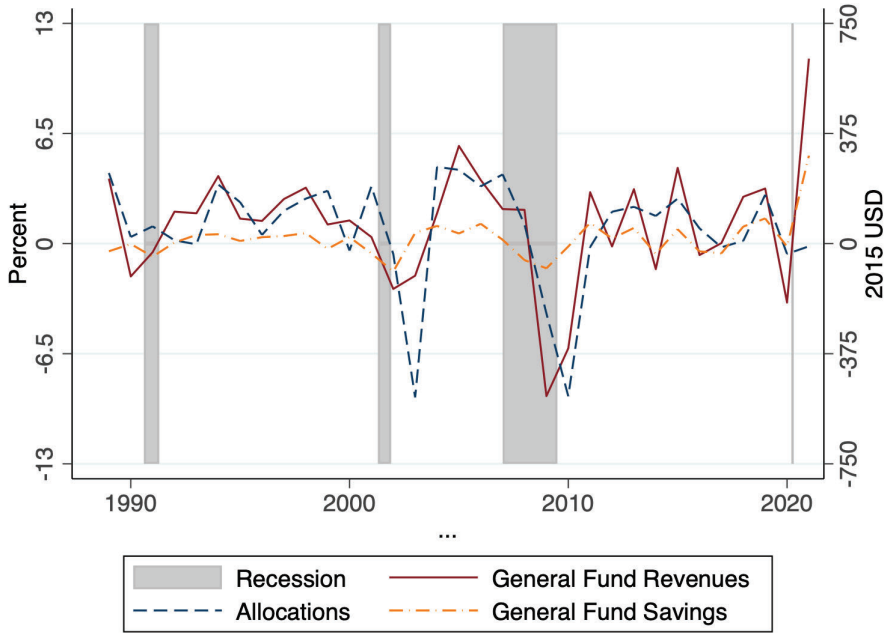
2.1 An Example of an Agency Account

To provide an explicit example of a state agency outside of the General Fund, we consider the State University of New York (SUNY), using data from the SUNY website. Figure 3 plots against time

[13] Figure D.1 in Appendix D displays long- and short-term debt over time.



(a) Consolidated Funds



(b) General Fund

Figure 2: Fund Growth Rates and Recessions: Consolidated vs. General Fund

Note: This figure plots average growth rates of revenue and consolidated expenditure/General Fund allocations per capita in 2015 dollars. It contrasts it with dollar changes in consolidated savings and General Fund savings in 2015 dollars. General Fund allocation data are from the Fiscal Survey of States, administered by NASBO. Consolidated data are from the Annual Survey of State and Local Government Finances, administered by the Census. Alaska and Hawaii are excluded. The secondary axis are for changes in savings per capita.

the allocations from the New York State General Fund to the SUNY campus at Stony Brook (Stony Brook) and the cash balances of Stony Brook. The axis is in total 2015 dollars. From the figure, Stony Brook has substantial cash holdings (the blue dotted line) varying between 25 and 50 percent of annual expenditures. As an important illustration of agency expenditure smoothing, we observe that as allocations from the state (the red solid line) level off and fall after the 2008 recession, cash balances fall almost as much as the fall in the state allocations. That is, the drop in state revenue is almost entirely offset by running down the cash balances, but these never are close to exhaustion. We do not observe the details of the process, but is clear that the overall consolidated state sector delivers expenditure smoothing, and that agency accounts play an important role.

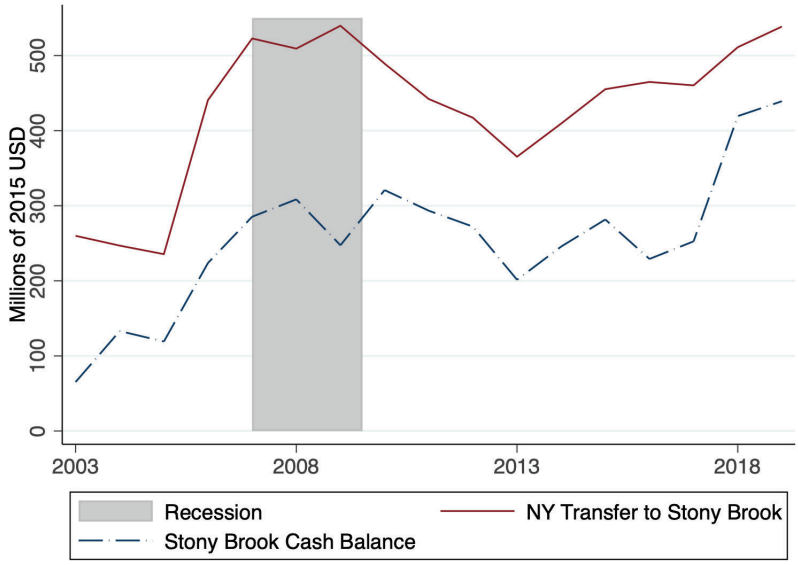


Figure 3: Stony Brook Cash Balances

Note: This figure plots transfers from New York State to the State University of New York at Stony Brook and the available cash balances of Stony Brook in millions of 2015 U.S. dollars.

2.2 Frequency of the Analysis

Sørensen, Wu and Yosha (2001) find that the state revenue response to state income shocks is immediate, but that the resulting adjustments in state expenditures take about years. To illustrate

the temporal behavior of revenue and expenditures, we estimate the equation:

$$\Delta z_{it} = \mu_i + \phi_0 \Delta x_{it} + \phi_1 \Delta x_{it-1} + \ldots + \phi_j \Delta x_{it-5} + \varepsilon_{it} \ , \tag{2}$$

where z_{it} is either log revenue or log current expenditure. In each equation, μ_i is a state fixed effect, while x_{it} is log personal income including lags. We take the first difference of the variables to avoid spurious results and state fixed effects allow for state-specific time trends in levels.

The results are plotted in Figure 4, which shows that in response to a one percent permanent change in per capita income, tax revenue increases by 0.50 percent the first year, reaching one percent after three years, while current expenditures increase only by 0.25 percent the initial year, reaching one percent after three years. The results of this estimation agrees with the results of Sørensen, Wu and Yosha (2001), who find that it takes about three years for expenditures to adjust to revenue shocks.

Partly based on this observation, we chose to model the decision period as three years. Another related reason for this choice is that state legislatures do not meet annually in every state and even in states where the legislature meets annually, there is a variety of mechanisms that dictate that changes come slowly and not every expenditure is re-considered each year. The pattern in Figure 4 is consistent with slow adjustment, and while there is no objectively "correct" horizon at which to fit a parsimonious model, the three-year interval where agents in the state government sector have time to adjust budgets, should they choose to do so, seems the most interesting and informative to study.

Flow variables, such as revenue and current expenditures, are computed as the sums over the relevant three years. Stock variables, such as cash and security holdings, are taken as the end-of-year value from the final year of each three-year period. For example, the final period in our sample is 2019–2021, so the flow variables are the sum of the amounts from 2019, 2020, and 2021, and the stock variables are the balances at the end of 2021.

2.3 Heterogeneity

Even though 49 U.S. states have BBRs, there is variation in the stringency with which these rules are implemented. A subset of these rules was examined by Poterba (1994), but the comprehensive ACIR index (Advisory Commission on Intergovernmental Relations) introduced in ACIR (1987)



Figure 4: Response to Personal Income Shock

Note: This figure plots the response of consolidated revenues and current expenditures in response to a one-time permanent one percent increase in the growth rate of personal income. We estimate the equation $\Delta z_{it} = \mu_i + \phi_0 \Delta x_{it} + \phi_1 \Delta x_{it-1} + \ldots + \phi_5 \Delta x_{it-5} + \varepsilon_{it}$, using data on consolidated funds, where x_{it} is log personal income and z_{it} is either log revenue or log current expenditure. Consolidated data are from the Annual Survey of State and Local Government Finances, administered by the Census. We exclude Alaska and Hawaii.

has since become the standard measure in the literature. Using the ACIR index, we conduct a heterogeneity analysis based on the strictness of balanced budget rules. Specifically, we split the sample into states with a perfect ACIR score of 10 (roughly half of all states) and those with less-than-perfect scores (9, 8, and so on). We refer to these groups as "strict" and "weak," respectively, to test whether BBR stringency affects savings behavior. Table 3 report results for strict and weak states and shows no significant difference between the groups in the cyclicality of savings vis-a-vis revenues as seen in Panel (a). We also find no difference between the groups in saving rates as shown in Panel (b). Thus, although BBRs constrain states' ability to overspend (Bohn and Inman, 1996; Poterba, 1996), they do not influence states' expenditure smoothing behavior to the extent that we can estimate separate discount rates for these groups.

2.4 Summary of Data Analysis

To summarize our descriptive results, we showed that states maintain large balances in Consolidated Savings that are pro-cyclical and are held across government agencies such as universities

Table 3: Heterogeneity of States

(a) Saving Elasticities		
	Dep. Variable: log(Savings)	
	Strict	Weak
log(Revenue)	1.28***	1.29***
	(0.12)	(0.23)
R^2	0.52	0.42
(b) Savings Ratios		
Savings to Revenue ratio	0.144	0.145

Notes: Regressions use consolidated funds from the *Annual Survey of State and Local Government Finances* (U.S. Census). Panel (a) reports a log-log regression of Consolidated Savings on consolidated revenues with state and time fixed effects. "Strict" denotes ACIR index = 10; "Weak" denotes ACIR index < 10. Panel (b) reports group means of Consolidated Savings to consolidated revenues. Period length: 3 years. Sample: 1988–2021. Alaska and Hawaii excluded. Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

and hospitals. Among the alternative potential channels of smoothing, RDFs are too small, at approximately 5 percent of Consolidated Savings, to absorb cyclical fluctuations. Federal transfers help cushion revenue fluctuation as they do not fall as sharply as own revenues but, in our model, we assume that federal transfers are part of exogenous total revenue. Balances of insurance trust funds, another major component of states' cash and security holdings, do not absorb fluctuations and short-term debt is unresponsive to income changes. Taken together, these patterns imply that states' off-set revenue fluctuations with pro-cyclical savings which are mainly held in balances outside the General Fund. An analysis at the 3-year frequency seems the most informative about smoothing patterns and heterogeneity in BBR-stringency across states does not result in differences in savings ratios and cyclicality that would allow us to estimate separate parameters for sub-groups of states.

3 Model of State Governments

This section presents our model of infinitely lived forward looking rational agents making decisions in the face of cyclical revenue. We do not literally model politicians but rather the interplay between politicians and long-term institutions. We match the model to current outcomes and, in the model, choices far out in the future matter little. It is possible that our estimate of the discount rate will be biased if politicians behave with a finite horizon, but our objective is not to measure the exact magnitude of the discount rate, but to estimate a discount rate that can be compared to that typically estimated for residents.

Consolidated Savings and expenditures are modeled as choices made by a single agent behaving like a buffer stock consumer subject to exogenous revenue shocks with a small probability of zero revenue. Current expenditures, including purchases of goods and services and transfers to governments, firms, and consumers, are treated in the model as the equivalent of consumption for consumers.

3.1 The Buffer Stock Model for State Government Fiscal Decisions

"States" are infinitely living agents which maximize the present discounted value of utility derived from state current expenditures. The objective of the state is to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\rho}}{1-\rho}, \tag{3}$$

where $\beta \in (0,1)$ is the time discount factor; $C_t > 0$ is current expenditures and $\rho > 0$ is the coefficient of relative risk aversion, which we set to unity in our main regressions (logarithmic utility). The dynamic budget constraint is

$$W_{t+1} = (1+r)(W_t + Y_t - C_t) \ , \tag{4}$$

where W_t is savings, r is the interest rate, and Y_t is revenue. Following Carroll (1992), we define cash-on-hand ("M") as the beginning of period savings plus current period revenue,

$$M_t = W_t + Y_t \ . \tag{5}$$

States are not allowed to borrow, consistent with balanced budget rules, so

$$W \geq 0\,,$$

implying that expenditures are at most equal to cash-on-hand at the beginning of each period. Revenue is the product of a random walk and an i.i.d. transitory component:

$$Y_t = P_t \nu_t \text{ and} \tag{6}$$

$$P_t = G P_{t-1} \psi_t \ , \tag{7}$$

where P_t is the permanent component of revenue, G is a deterministic growth rate of revenue, ν_t is a transitory shock to revenue, and ψ_t is a permanent shock to revenue. The distribution of the shocks to revenue are

$$\log(\psi_t) \sim N(-0.5\sigma_\psi^2, \sigma_\psi^2) \text{ , where}$$

$$\nu_t = \begin{cases} 0 & \text{with probability } \omega \\ \frac{\epsilon_t}{1-\omega} & \text{with probability } 1-\omega, \text{ where } \log(\epsilon_t) \sim N(-0.5\sigma_\epsilon^2, \sigma_\epsilon^2) \ . \end{cases}$$

We normalize all variables by permanent revenue, making them stationary.[14] Normalized variables are in lower case: $c_t = \frac{C_t}{P_t}$, $m_t = \frac{W_t + Y_t}{P_t}$, and $y_t = \frac{Y_t}{P_t}$. The key parameters are the discount factor and the risk aversion coefficient—the discount factor measures the patience of the state government and risk aversion measures how averse state governments are to variation in expenditures (across states of the world and over time).

The model has the feature that a "target" buffer stock, m^*, exists such that cash-on-hand, m_t, fluctuates around that target. A condition for this result is that the constraint

$$\frac{\ln(1+r) + \ln(\beta)}{\rho} + \frac{\rho\sigma_\psi^2}{2} < \ln(G) - \frac{1}{2}\sigma_\psi^2\,, \tag{8}$$

holds; see Carroll (1997).

The first term of Equation (8) is usually interpreted as a measure of patience (approximately the

[14] Because of the homotheticity of the utility function, the analysis can be accomplished using the normalized variables, allowing us to eliminate permanent revenue as a state variable; see Carroll (1997).

discount rate minus the interest rate), and our focus is on the magnitude of the discount factor.[15] We calculate cash-on-hand as savings plus revenue and, following the approach of Friedman (1957), permanent revenue as a three-period (nine-year) moving average of revenue.[16] From Equation (8), if the discount factor β is large, ρ needs to be large. Intuitively, a very patient agent (high β) will not have a target buffer stock of savings unless he or she is very risk averse (high ρ). The exact values where the constraint binds depend on the deterministic growth rate of revenue, G, and the variance of the "permanent" shocks, σ^2_ψ, where

$$P_{it} = \frac{Y_{it-1} + Y_{it} + Y_{it+1}}{3} \,. \tag{9}$$

4 Results

We implement Indirect Inference estimation of the states' discount rate by matching three statistics from simulated data to the actual data. The statistics are the target level of savings and two parameters from a general quadratic consumption function. There are no "optimal" statistics to match, but these statistics are clearly informative about patience. We estimate the state government discount rate for each of the data sets, the consolidated data reflecting fiscal outcomes of the entire state government sector, and the General Fund for comparison.[17]

The first statistic is a proxy for target cash-on-hand normalized by permanent revenue, where we denote the time average of normalized cash-on-hand for state i by $\bar{m}_i$ and define target cash-on-hand as the average of $\bar{m}_i$ across states: $\bar{m} = \sum_i \bar{m}_i / N$.[18] The second and third statistics describe the relationship between cash-on-hand (m_{it}) and consumption (c_{it}). We use the estimated parameters, $\hat{\gamma_1}$ and $\hat{\gamma_2}$, from an OLS regression of the consumption function:

$$c_{it} = \alpha_i + \delta_t + \gamma_1 m_{it} + \gamma_2 m^2_{it} + \epsilon_{it} \ , \tag{10}$$

where c_{it}, m_{it}, and m^2_{it} are normalized by permanent income. We include a quadratic term to

[15] See Carroll (1997) for further interpretation of Equation (8).

[16] We found that the data series are too short to use a Kalman smoother to extract the permanent components by state.

[17] We solve the model using the method of endogenous grid points developed by Carroll (2006), see Appendix B for details.

[18] For the purpose of calculating standard errors of our estimates, we calculate the variance of this statistic by finding the empirical variance of $\bar{m}_i$ across states.

allow for concavity as displayed by the simulated consumption function shown in Figure D.5 in Appendix D.

Model estimation also requires a real interest rate, which we compute from the Census data by dividing interest expenditures by debt outstanding. We subtract the inflation rate and average over the entire sample. This procedure gives a one-period (three-year) average real interest rate, r, of 3.93 percent.[19]

The other two calibrated parameters are the average one-period (three-year) growth rate of permanent real revenue and the distribution of revenue shocks. We calculate the growth rate of permanent real revenue as average of real revenue growth, at 7.45 percent, giving $G = 1.075$. The standard deviations of permanent shocks and transitory shocks are $\sigma_\psi = 0.051$ and $\sigma_\epsilon = 0.031$, respectively. Further, we set the probability of zero revenue to 0.5 percent, as in Carroll (1992).

4.1 Parameter Estimates

The Indirect Inference procedure is standard and described in Appendix B.1 and the results are presented in Table 4. The first panel presents the estimates from consolidated (Census) data, while the second panel presents the estimates from General Fund (NASBO) data. The bottom panel shows the relative success of the parameter matching process. As discussed above, the estimates for the discount rate β are presented with the risk aversion ρ parameter fixed to unity.[20]

From first panel of Table 4, the annual real discount rate for consolidated state governments is 0.970, which is derived from the estimated three-year parameter of 0.912. The 0.970 value is similar to what is typically estimated for consumers. Guvenen and Smith (2014), for instance, find an annual value of about 0.953 for U.S. consumers. This is an important result, as it shows that state governments expenditure patterns correspond to relatively patient behavior.

The second panel of Table 4 reports estimates for the discount rate using General Fund data. The estimated β is 0.875, which results in an annual discount rate of 0.956. The point estimate is not statistically different from that using consolidated data, but it is unsurprising that the General

[19] Municipal interest rates in the United States are low because interest paid by governments is generally income tax free.

[20] In Table C.11 of Appendix C, we display the results from an estimation where ρ is allowed to vary. The estimated value of ρ is larger than one, but not significantly so, and the discount factor is smaller, but not significantly so. We also display, in Figure D.6, a confidence ellipse for the two parameters, which reflect that high risk aversion and high patience both are consistent with high savings and therefore hard to statistically separate with data such as ours. We choose to interpret relatively high precautionary savings as reflecting patience by fixing ρ at unity.

Table 4: Indirect Inference Estimates

	Consolidated Funds	
β (three-year; estimated)	0.912***	
	(0.052)	
β (one-year; implied)	0.970***	
	(0.018)	
ρ	1.000	
	(Fixed)	
	General Fund Allocations	
β (three-year; estimated)	0.875***	
	(0.072)	
β (one-year; implied)	0.956***	
	(0.026)	
ρ	1.000	
	(Fixed)	
	Consolidated Funds	
	Data	Model Simulated
Target Cash-on-Hand (m^*)	1.105	1.043
Cash-on-Hand (γ_1)	0.762***	1.166
Cash-on-Hand Squared (γ_2)	–0.234***	–0.195
	General Fund Allocations	
	Data	Model Simulated
Target Cash-on-Hand (m^*)	1.027	1.038
Cash-on-Hand (γ_1)	2.639***	1.146
Cash-on-Hand Squared (γ_2)	–0.981***	–0.176

Note: This table displays estimated preference parameters and model fit using consolidated funds (top panel) and General Fund data (second panel). β is the one-period (three-year) discount factor; the one-year discount factor is calculated from the estimated three-year coefficient. ρ is the coefficient of relative risk aversion and is fixed at one. The targets to match are the target cash-on-hand and the estimated coefficients of m_{it} and m_{it}^2 from Equation (10). All variables are normalized by permanent income. Standard errors are in parentheses and computed using a diagonal weighting matrix from the data; the standard error for the one-year discount factor is calculated from the estimated three-period rate using the delta method. Alaska and Hawaii are excluded.

Fund estimate shows less patience given the much more pronounced expenditure smoothing for consolidated expenditures observed in Figure 2. These results, together with the descriptive results shown in Section 2, support that consolidated expenditures behave as if chosen by an agent with higher patience than that of an agent choosing General Fund allocations.

The bottom panels of Table 4 report the three statistics we seek to match; target cash-on-hand and the parameters for the linear and squared terms estimated from Equation (10). The first column in the third panel of Table 4 reports the estimates using the actual data, and the second column reports results using the simulated data. We see that the data matches target cash-on-hand reasonably well for both data sets. The simulated statistics calculated using the estimated parameters match better for the consolidated data than for the General Fund data, which suggests that the consolidated data are more consistent with the precautionary behavior of a buffer-stock agent.

5 Discussion

Government debt in developed countries has ballooned: for the 27 non-U.S. OECD countries debt grew from just over 50 percent of GDP in 2000 to over 100 percent in 2020. U.S. government debt has grown even faster as a share of GDP, leading some to argue that fiscal rules are becoming more urgent; see Blanchard, Leandro and Zettelmeyer (2021) for further discussion and references. In contrast, U.S. states' debt per capita (mainly tied to capital spending) grew over the first ten years of this century slightly faster than GDP, and has been about constant in nominal terms per capita since then. (Details can be seen in Figure D.1 of Appendix D.)

Quite why national debts have risen so quickly is opaque, but interest in fiscal constraints is a natural result. Our study of state government behavior helps to understand whether fiscal rules can align with reasonable expenditure smoothing.[21] All U.S. states but one have BBRs, and there is no extant evidence that they are borrowing to maintain their current (as opposed to capital) expenditures in the face of revenue shocks. Our research shows that consolidated state government expenditures, nonetheless, are quite smooth despite BBRs covering General Fund allocations. Our work here does not identify the key institutional feature(s) that helps state governments achieve substan-

[21] Caselli and Wingender (2021) study the efficiency of the budget rules in the EU and provide further references on this issue. Bohn and Inman (1996) also discuss the institutional environment, but limit their empirical work to General Fund allocations.

tial expenditure smoothing without significant borrowing—is the "two-tier" allocation-expenditure setup essential? If politicians think of allocations as expenditures, our estimates using NASBO General Fund data indicate that they are less patient than typical agency heads, such as university presidents. It is possible that politicians are fully aware that further smoothing takes place in agencies and the "discount rate" estimates from NASBO data are then not informative about patience. We do not have systematic data to study whether the fiscal system of the states is optimal. Nor do we have sufficient information to evaluate why institutions outside the General Fund, such as universities and hospital systems, act more patiently than politicians in charge of the General Fund.

In terms of average expenditure smoothing at the state level, the existence of substantial savings outside of the General Fund adds an institutional dimension that appears to help with smoothing over the business cycle. Overall, the current consolidated state budget setup achieves substantial expenditure smoothing without increasing debt levels—an objective that eludes many national governments. Our work suggests that the choice of whether to increase debt loads on future generations is affected by the institutional environment.

Clearly, if states are to smooth expenditures without resorting to debt, they need savings. There may be efficiency costs of public savings in geographic entities with mobile residents, but such costs may be smaller than the efficiency cost of cyclical expenditures.[22] We explore savings in different accounts: in RDFs that apply to the General Fund, and in balances consolidated across the state government and its agencies, most of which are outside the General Fund. In about half of the states RDFs are relatively new, and many states have recently increased their RDF balances. States mainly use off-General Fund budgetary smoothing, but possibly the recent increases in RDF balances indicate a shift in recent preferences towards centralized control. It is too early to evaluate this change empirically, but such an institutional change may be welfare decreasing because we find the current environment works surprisingly well.

Despite the opening cite of Buchanan and Wagner (1977), we find U.S. states' expenditure smoothing is consistent with a reasonable discount rate. We have not determined whether this is a feature of the institutional environment, or an attribute of the legislators. However, the behavior of U.S. states in this dimension differs from the behavior of many national governments, including

[22] High government savings may attract residents who did not contribute to savings or, maybe more likely, residents may flee states with no buffer stock of savings in long-lasting recessions.

the U.S. federal government, suggesting that a suitable institutional environment is essential.[23]

6 Summary and Conclusion

Our work makes four points that helps demonstrate that despite BBRs, state governments successfully smooth their expenditures. First, we illustrate that General Fund allocations are not expenditures from the overall state government sector—the General Fund is on average less than half of consolidated expenditures, and allocations may not be expended the year they are allocated by the legislature. Second, rainy day funds, most of which have been only recently created, are relatively small and incapable of smoothing public expenditures substantially over business cycles. Third, we highlight the substantial balances that state governments use to smooth their expenditures without resorting to debt. Cash balances in agencies outside of the General Fund provide an important counter-cyclical buffer against revenue fluctuations. Fourth, Indirect Inference estimates using a buffer stock model for consolidated accounts shows that fluctuations in consolidated expenditures, and the level of Consolidated Savings, are similar to what would have been chosen by a planner with a discount rate similar to that typically found for consumers. In contrast, the governments of many countries, including the federal U.S. government, allow debt to grow rapidly. That U.S. states operate within an institutional environment that has resulted in low debt and relatively low volatility of expenditures suggests an institutional framework deserving of more attention.

[23] A different institutional setup is examined in Craig et al. (2016), who examine the UI system operated by U.S. states within a federal framework. They find that the fiscal behavior of the UI system, if mapped into a consumer model, delivers discount rates similar to what we find here. The UI system operates in a very different environment than the consolidated state budget: it is designed explicitly to accommodate smoothing, it is subject to federal guidelines, and there is a designated trust fund for saving during good times to be used during bad times. The UI savings account is explicitly not tied to the General Fund, making fungibility at least as difficult as the Consolidated funds studied here.

References

ACIR. 1987. "Fiscal Discipline in the Federal System: Experience of the States." *Advisory Commission on Intergovernmental Relations*.

Aguiar, Mark, Manuel Amador, and Gita Gopinath. 2006. "Efficient expropriation: sustainable fiscal policy in a small open economy." *Working Paper. Federal Reserve Bank of Boston*.

Aguiar, Mark, Manuel Amador, and Stelios Fourakis. 2020. "On the Welfare Losses from External Sovereign Borrowing." *IMF Economic Review*.

Alesina, Alberto, and Roberto Perotti. 1995. "Fiscal expansions and adjustments in OECD countries." *Economic Policy*, 10: 205–248.

Alfaro, Laura, and Fabio Kanczuk. 2005. "Sovereign debt as a contingent claim: a quantitative approach." *Journal of International Economics*, 65(2): 297–314.

Alfaro, Laura, and Fabio Kanzuk. 2019. "Fiscal Rules and Sovereign Default." *Working Paper. Harvard Business School*, 16-134.

Altonji, Joseph G, and Lewis M Segal. 1996. "Small-sample bias in GMM estimation of covariance structures." *Journal of Business & Economic Statistics*, 14: 353–366.

Arellano, Cristina. 2008. "Default risk and income fluctuations in emerging economies." *The American Economic Review*, 98: 690–712.

Azzimonti, Marina, Marco Battaglini, and Stephen Coate. 2016. "The costs and benefits of balanced budget rules: Lessons from a political economy model of fiscal policy." *Journal of Public Economics*, 136(C): 45–61.

Bergman, Michael, Michael M. Hutchison, and Svend E. Hougaard Jensen. 2016. "Promoting sustainable public finances in the European Union: The role of fiscal rules and government efficiency." *European Journal of Political Economy*, 44: 1–19.

Blanchard, Olivier, Alvaro Leandro, and Jeromin Zettelmeyer. 2021. "Redesigning EU fiscal rules: from rules to standards." *Economic Policy*, 36(106): 195–236.

Bohn, Henning, and Robert P Inman. 1996. "Balanced-budget rules and public deficits: evidence from the US states." Vol. 45, 13–76.

Borge, Lars-Erik, and Per Tovmo. 2009. "Myopic or constrained by balanced-budget rules? The intertemporal spending behavior of Norwegian local governments." *FinanzArchiv/Public Finance Analysis*, 200–219.

Buchanan, James M., and Richard E. Wagner. 1977. *Democracy in Deficit: The Political Legacy of Lord Keynes.* Academic Press.

Carroll, Christopher D. 1992. "The buffer-stock theory of saving: Some macroeconomic evidence." *Brookings Papers on Economic Activity*, 61–156.

Carroll, Christopher D. 1997. "Buffer-stock saving and the life cycle/permanent income hypothesis." *The Quarterly Journal of Economics*, 112: 1–55.

Carroll, Christopher D. 2006. "The method of endogenous gridpoints for solving dynamic stochastic optimization problems." *Economics Letters*, 91: 312–320.

Caselli, Francesca, and Philippe Wingender. 2021. "Heterogeneous effects of fiscal rules: The Maastricht fiscal criterion and the counterfactual distribution of government deficits." *European Economic Review*, 136(C).

Craig, Steven G, Wided Hemissi, Satadru Mukherjee, and Bent E S{ø}rensen. 2016. "How do politicians save? Buffer-stock management of unemployment insurance finance." *Journal of Urban Economics*, 93: 18–29.

Dahlberg, Matz, and Tomas Lindström. 1998. "Are local governments governed by forward looking decision makers?: An investigation of spending patterns in Swedish municipalities." *Journal of Urban Economics*, 44: 254–271.

Fournier, Jean-Marc. 2019. "A Buffer-Stock Model for the Government: Balancing Stability and Sustainability." International Monetary Fund IMF Working Papers 2019/159.

Friedman, Milton. 1957. *Theory of the consumption function.* Princeton University Press.

Gourinchas, Pierre-Olivier, and Jonathan A Parker. 2002. "Consumption over the life cycle." *Econometrica*, 70: 47–89.

Guvenen, Fatih, and Anthony A Smith. 2014. "Inferring labor income risk and partial insurance from economic choices." *Econometrica*, 82: 2085–2129.

Hall, Robert E. 1978. "Stochastic implications of the life cycle-permanent income hypothesis: theory and evidence." *Journal of Political Economy*, 86: 971–987.

Holtz-Eakin, Douglas, Harvey S Rosen, and Schuyler Tilly. 1994. "Intertemporal analysis of state and local government spending: Theory and tests." *Journal of Urban Economics*, 35: 159–174.

Knight, Brian, and Arik Levinson. 1999. "Rainy Day Funds and State Government Savings." *National Tax Journal*, 52(3): 459–472.

Posner, Paul L. 1993. *The politics of federal mandates: Congress on the frontiers of federalism.* Columbia UniversityProQuest Dissertations Theses, 1995.9533646.

Poterba, James M. 1994. "State responses to fiscal crises: The effects of budgetary institutions and politics." *Journal of Political Economy*, 102: 799–821.

Poterba, James M. 1995. "Balanced budget rules and fiscal policy: Evidence from the states." *National Tax Journal*, 48: 329–336.

Poterba, James M. 1996. "Budget institutions and fiscal policy in the US states."

Potrafke, Niklas. 2025. "The Economic Consequences of Fiscal Rules." *Journal of International Money and Finance*, 153(2): 103286.

Rosengren, Eric S. 2018. "Ethics and economics: Making cyclical downturns less severe."

Sørensen, Bent E, Lisa Wu, and Oved Yosha. 2001. "Output fluctuations and fiscal policy: US state and local governments 1978–1994." *European Economic Review*, 45: 1271–1310.

Stockman, David R. 2001. "Balanced-Budget Rules: Welfare Loss and Optimal Policies." *Review of Economic Dynamics*, 4(2): 438–459.

Wagner, Gary A. 2003. "Are state budget stabilization funds only the illusion of savings?: Evidence from stationary panel data." *The Quarterly Review of Economics and Finance*, 43: 213–238.

Wagner, Gary, and Russell Sobel. 2006. "State budget stabilization fund adoption: Preparing for the next recession or circumventing fiscal constraints?" *Public Choice*, 126(1): 177–199.

Weiner, Jennifer. 2012. "When the Tide Goes Out: Unemployment Insurance Trust Funds and the Great Recession, Lessons for and from New England." *Research Review*, , (17).

White, Katheryn Vesey. 2024. *The Fiscal Survey of States.* NASBO Report.

Wilson, Matthew. 2023. "State government saving over the business cycle." *Regional Science and Urban Economics*, 98: 103862.

Zhao, Bo. 2016. "Saving for a rainy day: Estimating the needed size of US state budget stabilization funds." *Regional Science and Urban Economics*, 61: 130–152.

Supplemental Appendices

A Data Details

A.1 The General Fund

In this section, we provide additional information on the budgeting process and the General Fund data from the Fiscal Survey of States administered by the National Association of State Budget Officers (NASBO). The budgeting process for the General Fund is as follows. At the beginning of the budget cycle, state agencies submit their budget request to the governor and, if applicable, to the legislature. For around half of states, this cycle is annual while for the remaining states, this cycle is biennial.[24] The governor then proposes a budget to the legislature, who deliberate this. The enacted budget for the next fiscal year is that which is adopted by the legislature and signed by the governor. During the budget process for the General Fund, most states adhere to a balanced budget requirement, which mandates that expenditures not exceed revenues and, depending on the state, can apply to the proposed budget, the adopted budget, or the signed budget.

The Fiscal Survey of States is administered to the budget offices of each state twice a year—once in the spring and once in the fall. We use the fall survey reports because the data in these are revisions of those in the spring. Furthermore, the spring survey report contains information on the budget that has been proposed by the governor but not yet adopted by the legislature, while the fall survey contains the adopted budget. States with biennial budget cycles report revised budgets in the intervening years. A typical report includes state-level information on the beginning-of-year and end-of-year balances of the General Fund, revenues, expenditures, and the end-of-year balance of the rainy day funds (RDFs). RDFs are also referred to as budget stabilization funds (BSFs). NASBO uses RDFs and BSFs interchangeably and considers funds that function as savings as RDFs, even if they are not explicitly designated as RDFs. For example, Kansas has a statutory requirement that the enacted General Fund budget have an uncommitted balance equal to 7.5 percent of their expenditures. Even though Kansas did not have an RDF until 2016, NASBO has historically considered this uncommitted balance to be the RDF of Kansas.

The State Expenditure Report is an annual report produced by NASBO. It contains information

[24] The fiscal year starts on the first of July for most states.

on state expenditures by function, capital expenditures, and General Fund and transportation revenue. From this data, we use information on capital expenditures by states to compute current expenditures and information on each revenue source in the General Fund.

A.2 Consolidated Funds

In this section, we provide additional information on consolidated funds. State agencies request funds during the budget process and, once they receive these funds, may spend them for their designated purposes. In addition to the funds allocated from the general budget, these agencies may receive revenues from other sources, such as the federal government and fees they collect.

The Annual Survey of State and Local Government Finances has been administered by the U.S. Census Bureau since 1957. The data typically come from unaudited state financial reports and contain information on the revenues, expenditures, cash and security holdings, and debts of state governments, by function.[25] A given survey year covers July 1 of the previous year to June 30 of that survey year. Data from years ending in 2 or 7 are a census of government finances while data in other years are from samples of state and local governments. A new sample of state and local governments is selected in years that end in 4 or 9. The survey's target population consists of all 50 U.S. state governments, the District of Columbia, and all active local government units, the last of which consists of counties, cities, townships, special districts, school districts, and dependent agencies.[26]

The Census has four categories of government activities: the general government sector, the utilities sector, the liquor stores sector, and the social insurance trust sector. In our analysis, we focus on the funds in the general government sector, which the Census Bureau considers the primary fund of states. Note that the Census refers to the revenue from this sector as "general revenue" while the sum of the revenue from all sectors is referred to as "revenue." To avoid confusion, when comparing to the General Fund, we refer to what is called "general revenue" in the Census as "consolidated revenue." Expenditures are similarly defined. The general government sector excludes transfers to and from the utilities, liquor stores, and social insurance trust sectors and excludes activities in these sectors. The data exclude financial transactions that a government

[25] For example, see https://www2.census.gov/programs-surveys/gov-finances/technical-documentation/methodology/2021/2021_methodology.pdf for the technical documentation for the 2021 survey.

[26] See https://www.census.gov/programs-surveys/gov-finances/about.html for an overview of the data.

undertakes for another if the former has no discretion regarding the amount or recipient.

A.3 Other Data

In addition to data on state finances, we use data on population and personal income for each state, and national CPI. Population data are from the U.S. Census Bureau. We use intercensal estimates of the population as of July 1 of each year.[27] Personal income data are from the Bureau of Economic Analysis. We use data for the second quarter of each year to align with the population data and the data on consolidated funds. National CPI data come from the Bureau of Labor Statistics. We use the CPI for all items in the United States.

B Estimation Details

B.1 Indirect Inference Details

Denote the vector of statistics, also called "auxiliary parameters," consisting of $\bar{m}$, $\hat{\gamma}_1$, and $\hat{\gamma}_2$ as Λ^{Data}. For given values of β and ρ, we simulate the model and generate S simulated data sets of the same size as the actual data set.[28] For each simulated data set, s, we compute the vector of auxiliary parameters, Λ_s^{Model}, the same way as we calculated these statistics from the empirical data. The Indirect Inference estimator is then defined as

$$\widehat{\Theta} = \text{argmin} \left(\frac{1}{S} \sum_{s=1}^{S} \Lambda_s^{Model}(\Theta) - \Lambda^{Data} \right)' W \left(\frac{1}{S} \sum_{s=1}^{S} \Lambda_s^{Model}(\Theta) - \Lambda^{Data} \right), \tag{B.1}$$

where W is a weighting matrix. We use a diagonal weighting matrix whose elements are the inverse of the variances of the statistics computed from the data, where the covariance matrix of the statistics is denoted $\hat{\Omega}$.[29] We compute the standard errors as the square root of the diagonal

[27] This is available for all years except 1980, where we instead use the population from the Census as of April 1, 1980.

[28] We set S to 5000. For each simulated data set, we draw from the initial distribution of beginning-of-period savings in the data, which is the end-of-period savings in the first period.

[29] The variance of target cash-on-hand is the variance of the state-specific average cash-on-hand while the variances of the consumption function coefficients are the squares of the standard errors. We use a diagonal matrix so that the first step objective function is scale-free and to avoid the issues associated with the optimal weighting matrix in finite samples (Altonji and Segal, 1996).

elements of

$$\widehat{\Sigma} = (Dg'WDg)^{-1}(Dg'W\hat{\Omega}WDg)(Dg'WDg)^{-1} \ , \tag{B.2}$$

where $g_s = \Lambda_s^{Model}(\hat{\Theta}) - \Lambda^{Data}$, and Dg is the numerical Jacobian matrix whose elements are the first partial derivatives of g with respect to each parameter to be estimated.

B.2 Simulation details

We use Gauss-Hermite quadrature to discretize the distributions of the income shocks—10 points for the permanent shocks, ψ, and 11 points for the transitory shocks, ν.[30] Denote variables normalized by permanent income using lowercase letters and grid points using hats. We solve the model using the method of endogenous grid points developed by Carroll (2006) as follows.

1. Fix a triple-exponential grid for end-of-current-period liquid assets normalized by permanent income, $\hat{a}$, with 200 points and ranges from 0 to 10.

2. Construct the array for beginning-of-next-period cash-on-hand, $\hat{m}^{next}$, whose elements are given by $\hat{m}_{ijk}^{next} = (1+r)\frac{\hat{a}_k}{G\hat{\psi}_j} + \hat{\nu}_i$. This array is fixed because its components are fixed.

3. Guess that the initial approximation of the consumption function is $\hat{c} = \hat{m}$, where $\hat{m}$ is an equally spaced grid from 1 to 200 and has the same length as $\hat{a}$.[31]

4. Given the consumption function approximated by $\hat{m}$ and $\hat{c}$, interpolate each point in $\hat{m}^{next}$ using cubic interpolation to obtain the corresponding array for next-period consumption, $\hat{c}^{next}$. Extrapolate points outside of $\hat{m}$ using the same method.[32]

5. Construct the grid $\hat{c}^{endo}$, which has the same length as $\hat{a}$, and whose elements are given by

$$\hat{c}_k^{endo} = \left(\beta(1+r) \sum_{i=1}^{11} \sum_{j=1}^{10} w_i w_j \left[(G\hat{\psi}_j)^{-\rho} u'(\hat{c}_{ijk}^{next}) \right] \right)^{-\frac{1}{\rho}} \ , \tag{B.3}$$

[30] We use ten points for ϵ and augment the nodes and weights with an additional point to construct the grid for ν, as defined in the text.

[31] The length of the initial approximation does not matter because the length of the next and subsequent approximations are the same length as $\hat{a}$.

[32] We use the modified Akima algorithm in MATLAB, which uses cubic interpolation to produce piecewise polynomials with continuous first derivatives. Our results do not depend on the method used.

which is the numerical approximation of the Euler equation implied by the model, inverted to obtain $\hat{c}_k^{endo}$.[33]

6. Compute $\hat{m}^{endo} = \hat{c}^{endo} + \hat{a}$, which is the grid of cash-on-hand associated with $\hat{c}^{endo}$.[34] The grid $\hat{m}^{endo}$ is the endogenous grid that depends on $\hat{c}^{endo}$.

7. Update the approximation of the consumption function by setting $\hat{c} = \hat{c}^{endo}$ and $\hat{m} = \hat{m}^{endo}$.

8. Repeat steps 4 to 7 until the consumption function converges.

[33] The Euler equation is $u'(c_t) = \beta(1+r)\mathbb{E}_t[(G\psi_{t+1})^{-\rho}u'(c_{t+1})]$, where the expectations are taken over ψ and ν.

[34] This equation comes from the budget constraint, $W_{t+1} = (1+r)(W_t + Y_t - C_t)$, which can be re-written as $A_t = (1+r)A_{t-1} + Y_t - C_t$, where $W_t = (1+r)A_{t-1}$ and $M_t = (1+r)A_{t-1} + Y_t$.

C Additional Tables

Tables C.1 and C.2, taken directly from the Census source, display (most of) the components of Consolidated Savings. As can be seen, what we call cash is held in a number of different assets.

Table C.3 shows details of the SUNY Stony Brooks accounts where it can seen that savings are substantial relative to the overall budget.

Table C.4 displays revenue and expenditures with or without capital. Capital spending is a small fraction of total spending.

Table C.5 displays regressions of the changes in savings balances on revenues. To examine how state savings respond to the business cycle and how this response has changed over time, we estimate the equation

$$\Delta s_{it} = \mu_i + \phi \Delta y_{it} + \varepsilon_{it} \ , \tag{C.1}$$

where s_{it} is either General Fund end-of-year savings or Consolidated Savings and y_{it} is the corresponding revenue variable. We take three years as one period. The OLS estimates of the coefficients on these variables are presented in Table C.5. We see that Consolidated Savings and General Fund savings are pro-cyclical and Consolidated Savings absorbs a substantially larger dollar amount than does General Fund savings—even if a large part of General Fund savings are RDFs, which are intended for budget smoothing.

The second panel of Table C.5, presents the ratios of the savings variables to the revenue variables for each period. Consolidated Savings relative to General Fund revenue is 31 percent on average while General Fund savings relative to General Fund revenue is only 2 percent. General Fund savings, including RDFs, seem to low to meaningfully smooth allocations (which again make up less than half of consolidated expenditures).

Table C.6 shows descriptive consolidated account statistics for 3-year periods which is the frequency at which we use the data in our empirical work while Table C.7 shows 3-year-period data for the General Fund.

Table C.8 compares RDFs and Consolidated Savings for a random selection of states (we chose every 5th when order by alphabet). For almost all states—with Connecticut the exception—Consolidated Savings dwarf RDFs.

Table C.9 shows consolidated revenue, expenditures, and Consolidated Savings when normalized by permanent income (see text). This is the way the variables enter our estimation.

Table C.10 shows the results of the regression of (normalized) expenditures on cash-on-hand (see text) and squared cash-on-hand using consolidated account data. The estimated coefficients are statistics we match in the Indirect Inference estimation.

Table C.11 shows estimates when the parameter for risk aversion is estimated together with the discount factor. The risk aversion parameter is close to 2, but not significantly different from unity and the discount factor is now slightly smaller, with an annual discount rate of 4.4 percent. We think that the estimates for logarithmic utility gives a cleaner interpretation, but in either case, we find results not dissimilar to what might be found for a typical consumer. We did not obtain convergence using General Fund allocations, which indicates that the buffer stock model is not very suitable for allocations, but as allocations are not our focus, we do not explore that issue further.

Table C.1: Examples of Assets Included and Excluded from Census Definition of Cash & Securities

Includes	**Excludes**
Bankers acceptances	Accounts receivables
Cash on deposit	Accrued interest or dividends on investments
Cash on hand	Advances to other funds
Cash with fiscal agent (e.g., for debt service)	Allowances for delinquent taxes
Cash "equivalents"	Amortized or deferred bond issue costs
Certificates of deposit (CDs)	Construction-in-Progress
Commercial paper	Customer deposits
Conditional sales contracts	Deferred charges (or other revenues)
Corporate bonds (including debentures, Convertible bonds, and railroad equipment certificates)	Deferred compensation
Corporate stock (common and preferred)	Deposits with other governments
Current investments	Depreciation
Debentures held	Dividends receivables
Demand deposits	Due from other funds
Equity in pooled cash or investments accounts	Fixed assets (land, equipment, buildings, and other structures)
Federal agency securities (FHA, TVA, etc.)	Improvements "other than buildings"
Federally-Sponsored agency securities	Goodwill
Federal treasury notes	Grants receivable
Finance company papers	Interest receivables
Foreign and international securities	Interfund receivables
Guaranteed investment accounts	Inventory
Leveraged buyouts	Investment in general fixed assets
Loans to members of insurance trust systems	Leases receivable (other than industrial leases as offsets to industrial development debt)
Loans receivables	Letters of credit

Note: This is Table 7.1 from Chapter 7 of the U.S. Census classification manual and is continued in Table C.2. This lists examples of assets found on a government's balance sheet and their classification for Census Bureau purposes.

Table C.2: Examples of Assets Included and Excluded from Census Definition of Cash and Securities

Includes	**Excludes**
Marketable equity securities	Machinery and equipment
Marketable securities	Materials and supplies
Money market funds	Net depreciation
Mortgages (receivable) held directly	Prepaid expenses
Mutual funds	Real property*
Notes receivables	Special assessments receivables
Partnerships	Tax liens receivables
Real estate investment trusts (REITS)	Taxes receivables
Repurchase agreements ('repos')	Unamortized premiums on investments
"Restricted" cash and investments	Unbilled accounts receivables
Savings accounts	Unrealized gains on investments**
Share of funds in governmental investment accounts or pools	
State and local government securities (including own securities held by its insurance trusts)	
Time deposits	
Venture capital	
Warrants (to purchase securities)	
Unrealized gains on investments**	

Note: This replicates the full Table 7.1 from Chapter 7 of the U.S. Census classification manual and is a continuation of Table C.1. This lists examples of assets found on a government's balance sheet and their classification for Census Bureau purposes.

Table C.3: New York State and SUNY Accounts

Year	NY Revenues	Transfers to SUNY	SUNY Balance
2003	127351	260	65
2004	135952	247	133
2005	139398	236	119
2006	145738	441	224
2007	147069	522	285
2008	144394	509	308
2009	149091	540	247
2010	152425	490	321
2011	156832	442	293
2012	149802	417	272
2013	146668	365	201
2014	148079	409	246
2015	156767	455	282
2016	159971	465	229
2017	157469	511	252
2018	164742	539	419
2019	165187	138	439

Note: This table presents the consolidated revenues of the state of New York, transfers from the state of New York to SUNY, and the SUNY cash balances, in millions of 2015 U.S. dollars.

Table C.4: Responses to Personal Income Shocks

	$\Delta \log$ (Revenues$_t$)	$\Delta \log$ (Current Expenditures$_t$)	$\Delta \log$ (Expenditures$_t$)
$\Delta \log$ (Personal Income$_t$)	0.489***	0.251***	0.236***
	(0.052)	(0.048)	(0.049)
$\Delta \log$ (Personal Income$_{t-1}$)	0.279***	0.247***	0.192***
	(0.027)	(0.029)	(0.032)
$\Delta \log$ (Personal Income$_{t-2}$)	0.073*	0.292***	0.334***
	(0.043)	(0.032)	(0.030)
$\Delta \log$ (Personal Income$_{t-3}$)	0.170***	0.272***	0.281***
	(0.025)	(0.027)	(0.028)
$\Delta \log$ (Personal Income$_{t-4}$)	0.031	0.197***	0.109***
	(0.023)	(0.020)	(0.023)
$\Delta \log$ (Personal Income$_{t-5}$)	0.078**	0.149***	0.076***
	(0.038)	(0.023)	(0.021)
Observations	2688	2688	2688

*** 1% level of significance.

** 5% level of significance.

* 10% level of significance.

Note: This table presents OLS estimates of the equation $\Delta z_{it} = \mu_i + \phi_0 \Delta x_{it} + \phi_1 \Delta x_{it-1} + \ldots + \phi_j \Delta x_{it-5} + \varepsilon_{it}$, using data on consolidated funds, where x_{it} is log personal income and z_{it} is either log revenue or log expenditure (excluding capital). Robust standard errors, clustered by state, are in parentheses. We exclude Alaska and Hawaii.

Table C.5: Cyclical Behavior of Savings

	Δ Consolidated Savings	Δ General Fund Savings
Δ (Consolidated Revenues)	0.32***	
	(0.03)	
Δ (General Fund Revenues)		0.11***
		(0.01)
Observations	528	445
	Consolidated Savings	General Fund Savings
Ratio to Consolidated Revenues	0.13	
Ratio to General Fund Revenues		0.03

Note: This table presents OLS estimates of estimated slope term from the equation $\Delta s_{it} = \mu_i + \phi \Delta y_{it} + \varepsilon_{it}$, where s_{it} is either General Fund or Consolidated Savings and y_{it} is the corresponding revenue variable, all in per capita 2015 U.S. dollars. One period is three years. Consolidated Savings and consolidated revenue are from the Annual Survey of State and Local Government Finances, administered by the U.S. Census Bureau. General Fund savings and revenue data are from the Fiscal Survey of States, administered by NASBO. We exclude Alaska and Hawaii. Standard errors are in parentheses.

Table C.6: Summary Consolidated Account Statistics, Three-Year Periods

Consolidated Funds, Three-Year Periods			
	Mean	Std1 States	Std2 Time
Revenues	12409	2700	4802
Own Revenues	8603	1980	3059
Intergovernmental Revenues	3806	1125	1857
From Federal	3685	1082	1824
Expenditures	12169	2425	4660
Direct Expenditures	8665	1954	3556
Capital Expenditures	1206	451	271
Interest on Debt	374	255	195
Intergovernmental Expenditures	3504	1160	1200
Current Expenditures	10963	2213	4625
Debt	2429	1622	1175
Long-term Debt	2400	1600	1179
Short-term Debt	29	70	46
Cash and Security Holdings	7969	3391	5407
Insurance Trust Funds	4986	1780	3677
Non-Insurance Trust Funds	2983	2547	1872
Offsets to Debt	1165	933	877
Bond Funds	133	131	99
Consolidated Savings	1685	2235	1195
Observations	960		

Note: This table displays summary statistics for the three-year per capita consolidated funds in 2015 dollars. For flow variables, we take the sum of three years. For stock variables, we take the end-of-year value before the three-year period. Std1 is computed by calculating the standard deviation across states and taking the average of the standard deviations across periods. Std2 is computed by calculating the standard deviation over time for each state and taking the average of the standard deviations across states. We exclude Alaska and Hawaii.

Table C.7: Summary Statistics For the General Fund

General Fund, Three-Year Periods			
	Mean	Std1 States	Std2 Time
Revenues	6688	2443	855
Allocations	6607	2411	816
Capital Allocations	68	140	61
Current Allocations	6544	2392	799
End-of-Year Balance	148	183	146
Excluding co-mingled RDFs	123	158	132
Rainy Day Funds	115	178	113
General Fund Savings	238	259	210
Observations	527		

Note: This table displays summary statistics for the three-year per capita NASBO funds in 2015 dollars. We refer to what is called expenditures in the NASBO tables as allocations to avoid confusion with consolidated expenditures. For flow variables, we take the sum of the three years. For stock variables, we take the end-of-year value before the three-year period. Std1 is computed by calculating the standard deviation across states and taking the average of the standard deviations across periods. Std2 is computed by calculating the standard deviation over time for each state and taking the average of the standard deviations across states. We exclude Alaska and Hawaii.

Table C.8: Consolidated Savings and Rainy Day Funds, Three-Year Periods

	Consolidated Savings		RDFs		Correlation
	Min	Max	Min	Max	
Connecticut	65	1587	0	751	0.83
Idaho	990	4097	0	362	0.92
Kentucky	285	2370	0	342	0.64
Michigan	377	2748	0	175	0.24
Nebraska	473	5434	23	385	0.54
New York	254	2209	0	109	0.96
Oregon	413	4003	0	283	0.93
Tennessee	336	2249	2	182	0.89
Washington	410	2154	-0.15	176	0.26

Note: This table reports the summary statistics of the three-year Consolidated Savings and rainy day funds (RDFs) per capita data for 16 states. We select the 5^{th}, 10^{th}, 15^{th}.... 45^{th} state after arranging them alphabetically. All variables are in per capita 2015 U.S. dollars. For flow variables, we take the sum of the three years. For stock variables, we take the end-of-year value before the three-year period. The first and third columns report the minimum values of Consolidated Savings and RDFs. The second and fourth columns report the maximum values of these funds. The last column shows the correlation between these funds. Consolidated Savings are from the Annual Survey of State and Local Government Finances, collected by the U.S. Census where they are labeled "Other Funds." These are reported under cash and security holdings. Rainy day fund data are from the Fiscal Survey of States collected by NASBO.

Table C.9: Summary Statistics, Three-Year Periods

Normalized Variables			
	Mean	Std1 States	Std2 Time
Revenues/permanent income	0.999	0.024	0.031
Current Expenditures/permanent income	0.876	0.054	0.060
Cash-on-hand/permanent income	1.105	0.091	0.048
Observations	864		

Note: This table displays summary statistics for the relevant three-year model variables from 1960 to 2021 in 2015 dollars. For flow variables, we take the sum of the three years. For stock variables, we take the end-of-year value before the three-year period. Std1 is computed by calculating the standard deviation across states and taking the average of the standard deviations across periods. Std2 is computed by calculating the standard deviation over time for each state and taking the average of the standard deviations across states. Variables are normalized by permanent income, which is defined as a three-period (nine-year) moving average of income. We exclude Alaska and Hawaii.

Table C.10: Consumption Regressions, Three-Year Periods

Cash-on-Hand$_{it}$ (γ_1)	0.762***
	(0.221)
Cash-on-Hand$_{it}$ Squared (γ_2)	–0.233***
	(0.082)
State and Time Fixed Effects	Yes
Observations	864
*** 1% level of significance.	

Note: This table presents estimates of a regression of consumption on cash-on-hand for U.S. states. Consumption is expenditure minus capital expenditure. Cash-on-hand is the sum of Consolidated Savings and consolidated revenue. Flow variables are taken as three-year sums, while stock variables are taken as the end-of-period value from the previous period. All variables are normalized by permanent income. Permanent income is a three-period (nine-year) moving average of consolidated revenue. Robust standard errors, clustered by state, in parentheses. We exclude Alaska and Hawaii.

Table C.11: Indirect Inference Estimates, with free CRRA parameter

	Consolidated Funds
β (three-year; estimated)	0.873***
	(0.137)
β (one-year; implied)	0.956***
	(0.050)
ρ	1.923***
	(0.722)
	General Fund Allocations
β (three-year; estimated)	No convergence
β (one-year; implied)	No convergence
ρ	No convergence

Consolidated Funds:	Data	Model Simulated
Target Cash-on-Hand (m^*)	1.105	1.134
Consumption Function Parameters		
Cash-on-Hand (γ_1)	0.762***	1.087
Cash-on-Hand Squared (γ_2)	–0.234***	-0.187

Note: This table displays the estimated preference parameters and model fit. The model is estimated using current expenditure data. β is the one-period (three-year) discount factor; the one-year discount factor is in brackets. ρ is the coefficient of relative risk aversion. The targets to match are the target cash-on-hand and the estimated coefficients of m_{it} and m_{it}^2 from the regression $c_{it} = \alpha_i + \delta_t + \gamma_1 m_{it} + \gamma_2 m_{it}^2 + \epsilon_{it}$. All variables are normalized by permanent income. Standard errors are in parentheses and computed using a diagonal weighting matrix from the data; the standard error for the one-year discount factor is computed using the delta method. We exclude Alaska and Hawaii.

D Additional Figures

Figure D.1 shows the evolution of short- and long-term debt. Short-time debt levels are very small and while long-term debt levels are higher and increase until 2010, this debt is predominantly tied to capital investments.

Figure D.2 shows the evolution of consolidated revenue and current expenditures together with General Fund revenue and current expenditures over time (for the year available). The consolidated funds have been growing faster than those in the General Fund.

Figure D.3 plots taxes as a fraction of personal income (the "tax rate.") It is evident that taxes rates do not change significantly in recession which is why we do not consider tax-rate fluctuations as part of states' expenditure smoothing.

Figure D.4 shows average Consolidated Savings by state with "whiskers" of one standard deviation. Consolidated Savings are on average about $1000 per capita, with some dispersion in means and standard deviations across states, but in all states the balances are substantial.

Figure D.5 show consumption as a function of cash-on-hand conditional on our estimated parameters values. The function if quite concave around the target-cash-on-hand value as already shown by Carroll. Cash-on-hand is endogenous, so this relation can not be estimated without bias using OLS.

Figure D.6 shows confidence ellipses for estimated risk aversion and patience when both parameters are estimated in the Indirect Inference estimation. It illustrates that our data cannot very well separate risk aversion from impatience as an agent may hold large precautionary savings either because he or she is patient or because he or she is risk averse. By fixing risk aversion at ρ=1 (logarithmic utility), we choose to interpret (relatively) high savings and low tendency to consume as reflecting patience.

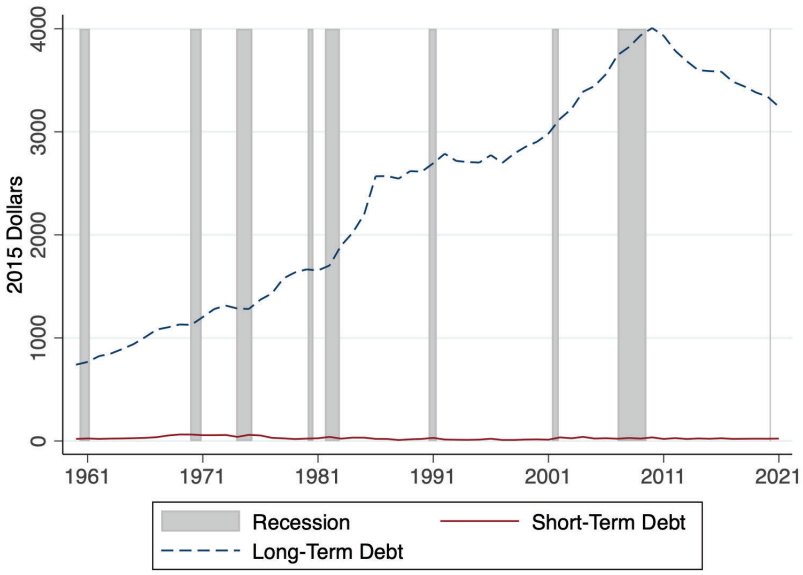
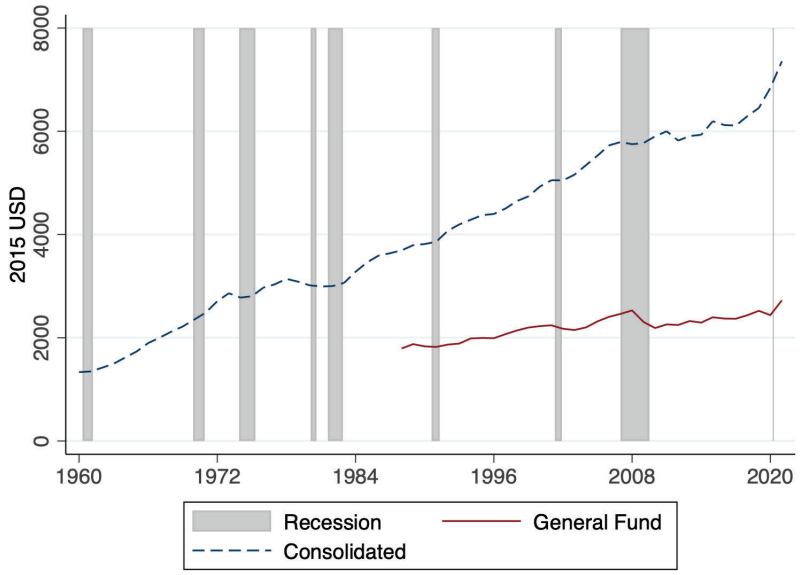
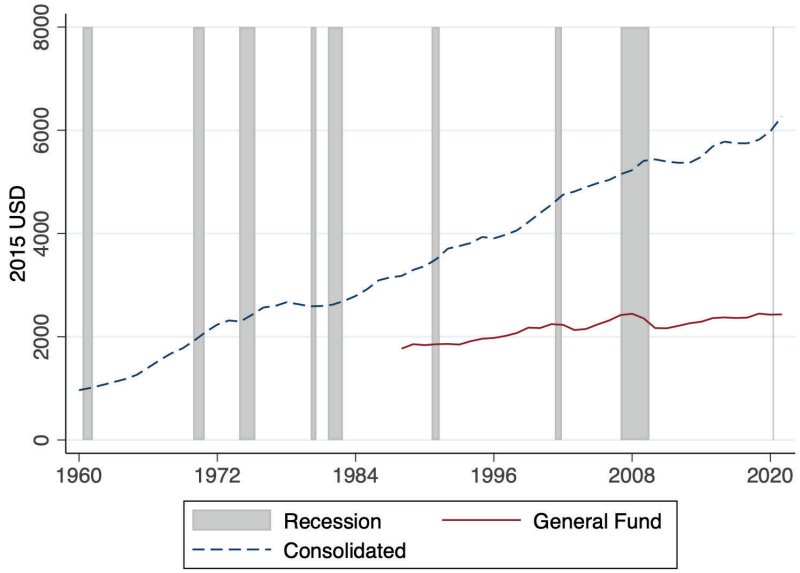


Figure D.1: Short- and Long-Term Debt

Note: This figure plots the average short-term (nearly invisible) and long-term debt in 2015 dollars per capita. Data are consolidated from the Annual Survey of State and Local Government Finances, administered by the Census. We exclude Alaska and Hawaii.



(a) Revenues per Capita



(b) Current Expenditures per Capita

Figure D.2: Revenues and Current Expenditures

Note: This figure plots average revenues and current expenditures per capita across US states. Revenues and current expenditures per capita are in 2015 U.S. dollars. Allocated funds data are from the Fiscal Survey of States, administered by NASBO. Consolidated funds data are from the Annual Survey of State and Local Government Finances, administered by the Census. We exclude Alaska and Hawaii.

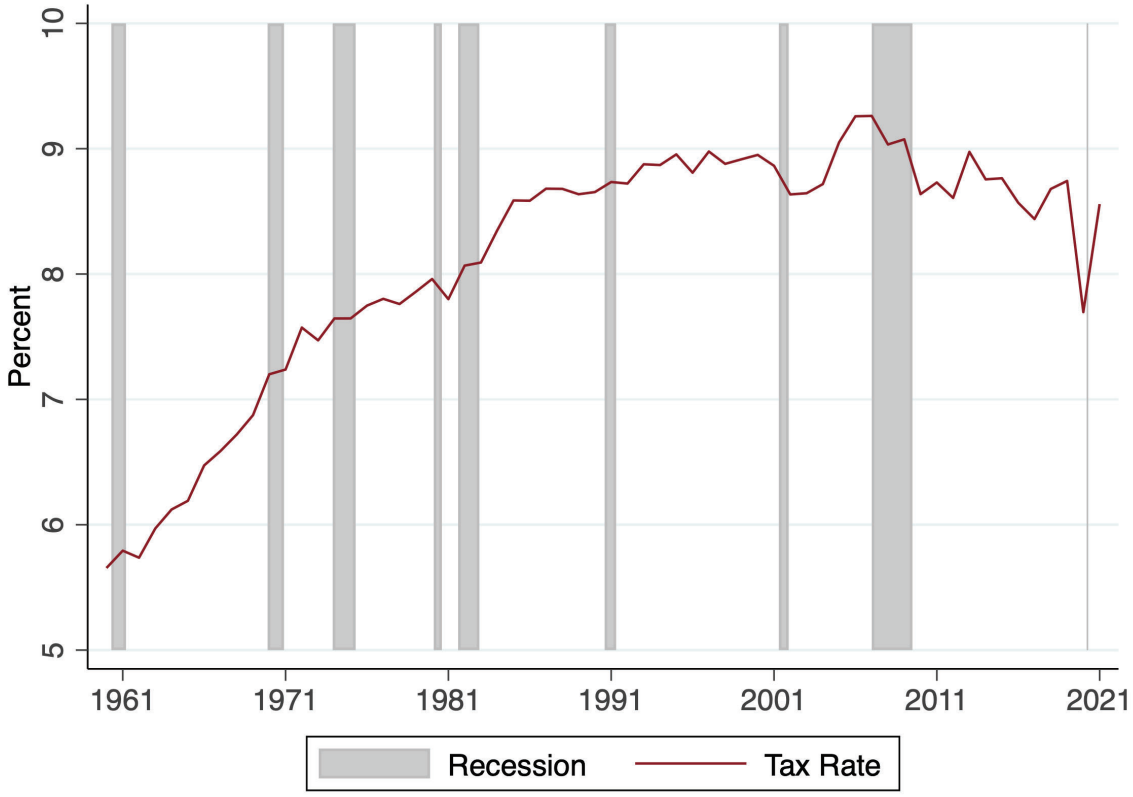


Figure D.3: Average Tax Rates

Note: This figure plots the average "tax rate" in 2015 dollars per capita. The "tax rate" is computed as consolidated revenue from own sources divided by personal income. Consolidated funds data are from the Annual Survey of State and Local Government Finances, administered by the Census. Personal income data are from the Bureau of Economics Analysis. We exclude Alaska and Hawaii.

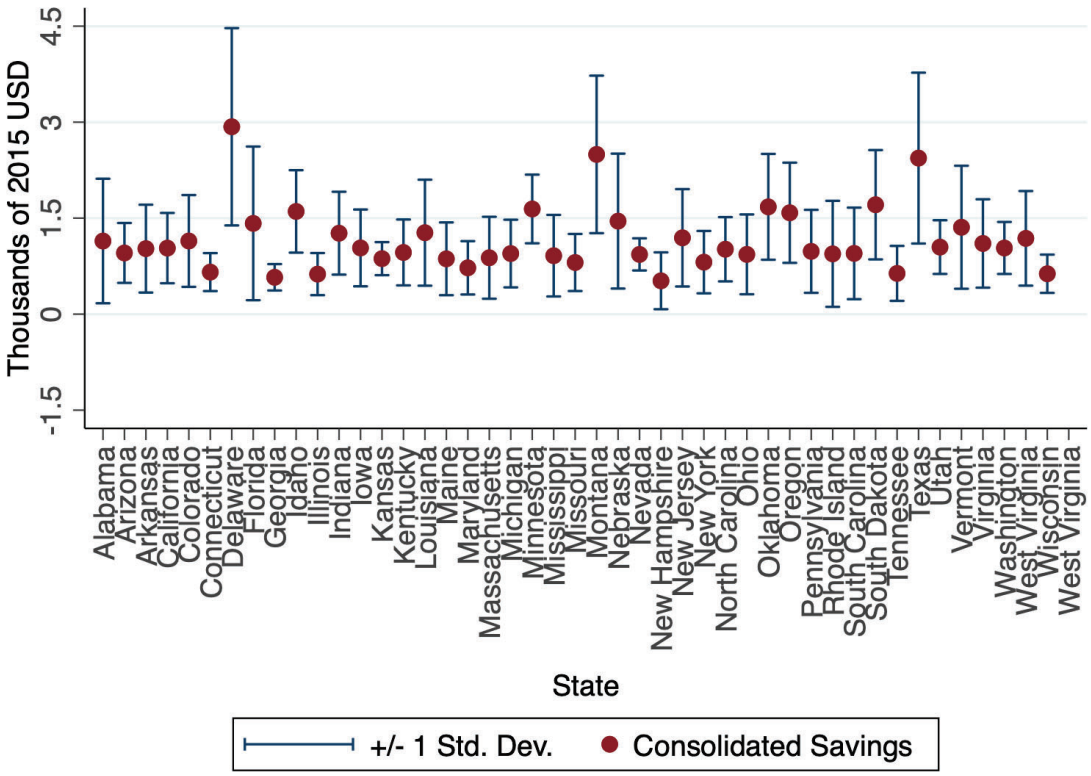


Figure D.4: Average Consolidated Savings per Capita

Note: This figure plots the average Consolidated Savings in 2015 dollars per capita. Consolidated Savings are the component of cash and security holdings listed as "other funds." Consolidated funds data are from the Annual Survey of State and Local Government Finances, administered by the Census. We exclude Alaska and Hawaii.

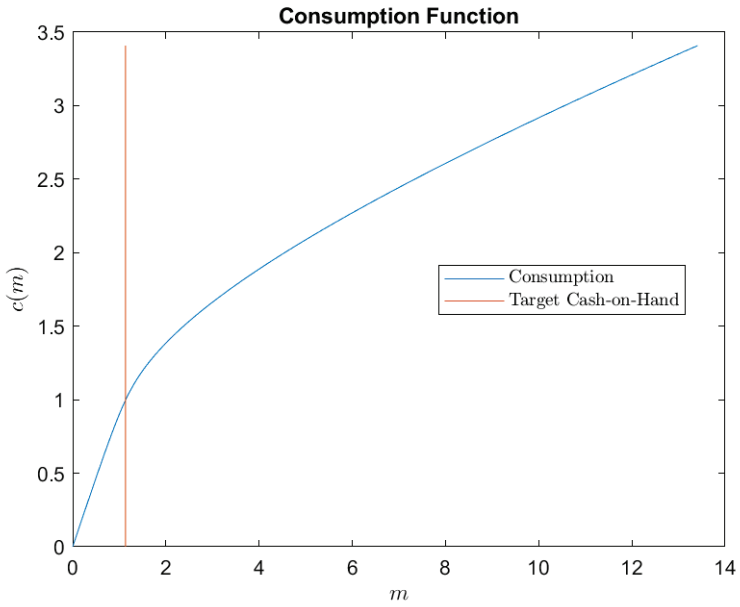
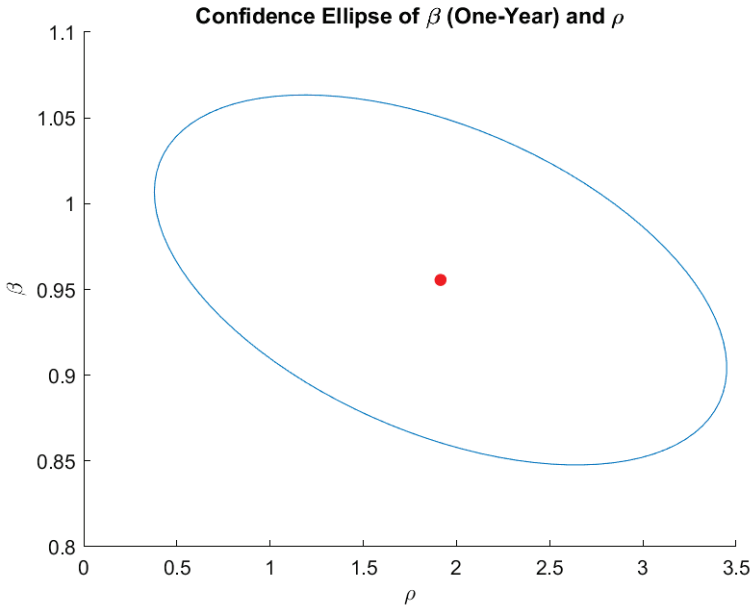
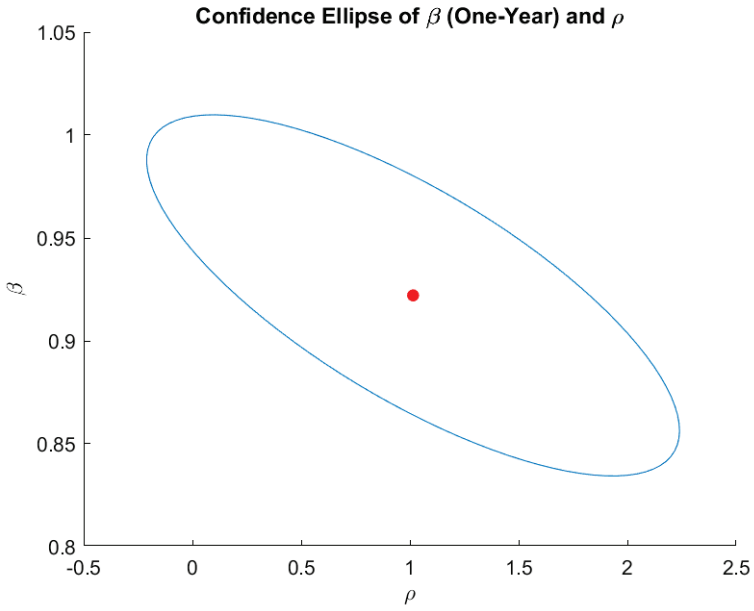


Figure D.5: Model Consumption Function and Target Cash-on-Hand

Note: This figure plots the model-implied consumption function and target cash-on-hand given the estimated ρ and β and fixed parameters. One period is three years. For flow variables, we take the sum of the three years. For stock variables, we take the end-of-year value before the three-year period. We exclude Alaska and Hawaii.



(a) High Unemployment Rate ($\omega = 0.05$)



(b) Low Unemployment Rate ($\omega = 0.025$)

Figure D.6: 90% Confidence Ellipse for β and ρ

Note: This figure plots the 90 percent confidence ellipse of the estimated ρ and β, given the fixed parameters and a diagonal weighting matrix in estimation. β is converted to its one-year equivalent and its standard error is computed using the delta method. One period is three years. For flow variables, we take the sum of three years. For stock variables, we take the end-of-year value before the three-year period. We exclude Alaska and Hawaii.