Weathering the Next Recession: How Prepared Are US States?

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Rainy day funds are one tool that most US states use to help mitigate the fiscal stress caused by economic slowdowns that reduce state government revenue. Past research by Wagner and Elder (2007b) uses a switching regression to estimate parameters in order to form a distribution of potential budget shortfalls for each state. This paper updates those results to include post–Great Recession data. A comparison of this distribution to the actual amount of savings that states have accumulated allows an assessment of how prepared each state is for an economic downturn and the resulting decline in tax revenues.

INTRODUCTION

The revenue that US states collect is often highly dependent upon personal income taxes and sales taxes; as such, it is highly cyclical.[2] Most states have borrowing constraints, so in response to an economic downturn and the resulting decline in revenue, states have limited options for dealing with the budget shortfalls and the fiscal stress that are associated with the economic downturn. Increasing tax rates or reducing government spending are both procyclical polices that can exacerbate the underlying problem of business cycle volatility. A rainy day fund (RDF), sometimes referred to as a budget stabilization fund, is a tool used by almost all the states in the United States as a way to help mitigate fiscal stress during economic downturns by helping the states to smooth their spending and tax collections.[3]

One problem is that states have not historically accumulated a sufficient amount of savings in RDFs to weather the potential revenue declines associated with economic downturns. In 2006, states had a 30-year historically high balance (combined general fund balance and budget stabilization fund balance) of 11.5 percent of expenditures, much higher than the 30-year average balance of 5.7 percent.[4] But even these historically high RDFs were not sufficient to cover the decline in revenues that states experienced during the Great Recession. Instead, 41 states resorted to midyear budget cuts in 2009 and 39 states made midyear budget cuts in 2010.[5] In addition to these budget cuts, states collectively enacted tax increases that resulted in almost $24 billion in tax revenue in 2010 alone. As an additional example of their insufficient size, the total amount of savings in RDFs was approximately $60 billion in 2008, but these funds were completely wiped out during the Great Recession. The total shortfall that states experienced in 2009 alone was $117 billion (Urahn and Ettlinger, 2014). Since in many ways the Great Recession was the most severe economic downturn since the Great Depression, it may not be surprising that the budget gaps associated with the Great Recession far surpassed the savings in RDFs.[6] Therefore, one issue associated with RDFs is how much savings states should accumulate in order to weather the revenue declines associated with an economic downturn.

The ability to deal with the fiscal stress associated with economic downturns is based on how much savings states have in their RDFs relative to an estimated probability distribution of potential revenue shortfalls. For example, if it is known that for an “average” economic downturn, the total revenue shortfall over the entire economic downturn will be an amount equal to 15 percent of a state’s current annual revenue and that state has accumulated reserves equal to 15 percent of the current revenues, then the state has accumulated a sufficient amount of savings to weather an average economic downturn, hence avoiding any tax increases or spending cuts. If a state has accumulated reserves less than 15 percent of the current revenues, then there is a good chance that during the next economic downturn, some form of tax increases or spending reductions may be necessary.

The advantage of having a distribution of potential revenue shortfalls is that it allows an assessment of states’ abilities to weather budget shortfalls caused by economic downturns of various severities. For example, even though saving an amount equal to 15 percent of revenues may be sufficient to buffer against revenue shortfalls during an average recession, it may require accumulated savings equal to 25 percent of current revenue to weather 90 percent of all possible budget shortfalls that may occur due to an economic downturn. The methodology discussed below allows legislators to understand how choices they make concerning the accumulation of savings will affect their states in terms of their ability to manage the fiscal stress caused by economic downturns of varying degrees without significant changes in tax or spending policies.

The distribution of potential revenue shortfalls for a particular state depends on how fast that state’s economy declines during an economic downturn (severity) and how long the economic downturn lasts (duration). For each state there is a distribution of potential revenue shortfalls because both the severity and duration of economic downturns is uncertain. How fast economic activity (and hence state revenue) declines, as well as how long an economic downturn will likely persist, vary among states. Everything else being equal, a state that is more likely to experience a rapid decline in economic activity during an economic downturn will need to accumulate more savings in an RDF than a state that has a lower expected rate of decline in order to achieve a similar confidence level to be prepared for an economic downturn. Additionally, again everything else being equal, a state that is more likely to experience a longer economic downturn needs to accumulate more savings than a state with a shorter expected downturn. Estimating a distribution of revenue shortfalls for each state, and then comparing each state’s actual accumulated savings to their distribution of revenue shortfalls, is one component of this paper. The estimation of the distribution of potential revenue shortfalls uses parameter estimates from a switching regression model and follows the methodology of Wagner and Elder (2007a, b). In this paper, states are ranked with respect to their current ability to weather the revenue declines associated with an economic downturn.

The following sections contain a brief literature review, a discussion of how the distribution of potential revenue shortfalls is calculated, an explanation of the data and methodology used to estimate the distribution of revenue shortfalls, a discussion of the empirical results and rankings, and concluding remarks.

PREVIOUS LITERATURE

Various researchers have attempted to quantify the fiscal stress caused by economic downturns and prescribe how much states should accumulate in savings in order to avoid tax or spending changes. Some rule-of-thumb estimates have suggested a common savings amount for all states ranging from 5 percent to 16.7 percent of spending or revenue.[7] These guidelines may be acceptable for some states, but as Owyang, Piger, Wall (2005) have shown, state business cycles differ with respect to their duration and severity so a one-size-fits-all solution does not seem reasonable. Other researchers, such as Pollock and Suyderhoud (1986), Sobel and Holcombe (1996), Navin and Navin (1997), and Mitchell and Stansel (2015), have examined state-specific fiscal stress using a linear trend method, where the point estimate of the budget shortfall is determined as the cumulative sum of deviations of spending and revenue from an estimated linear trend. One problem with this approach is that the researchers use the actual revenue and spending data, which include various policy changes and hence cloud the inferences concerning the level of potential fiscal stress.

More recently, Zhao (2014) has calculated a point estimate of the fiscal stress for each state using a newly constructed data series that is potentially free of policy changes. The point estimates are calculated for each period when revenues were fiscally stressed, that is, when revenues fell below their long-term trend; maximum and median results are reported. One potential problem with this data series is that the effects of policy changes are based on surveys of state budget officers' opinions concerning the effects on actual revenue of various policy changes. Additionally, the data Zhao (2014) used are only reported annually; therefore, it is likely that some of the business cycle movements are smoothed out, potentially missing some interesting shorter-term dynamics. The advantage the current approach has is that it can develop a complete distribution of possible budget shortfalls as opposed to the relatively small number of periods over the past 25 years when states have experienced fiscal stress. Additionally, the data used in the current paper are monthly, which should capture more accurate business cycle movements.

CALCULATION OF REVENUE SHORTFALLS

Although influences on both the spending and revenue side of the budget vary over the business cycle, and hence add to the fiscal stress that states experience during economic downturns, Holcombe and Sobel (1997), as well as Crain (2003), find that the primary cause of fiscal stress is the cyclical variability of revenue. Additionally, Kusko and Rubin (1993) find that revenue is much more sensitive than spending to business cycle movements. Therefore, for simplicity, when measuring the fiscal stress caused by economic downturns, this paper focuses on the revenue side of the budget. The revenue shortfalls estimated below can be considered lower bounds of the actual shortfalls that states may experience without any policy changes such as revenue increases or spending cuts.

Following the methodology Wagner and Elder (2007a,b) developed, the first step in assessing each state's ability to weather a future economic downturn is the calculation of a distribution of potential revenue shortfalls each state may experience. To calculate that distribution, it is necessary to know two pieces of information: how likely it is that an economic contraction will last a specific number of periods and how large the associated revenue shortfall is if the economic contraction lasts for a specific number of periods. If a state is currently in an economic contraction, there is some probability that the economic contraction will persist into the following period; let this probability be denoted by P_{LL} (the notation is described in more detail in the Methodology and Data section). If this probability is independent of the number of periods the contraction has been going on, then the probability that a contraction lasts exactly t_L periods is given by $P_L(t_L) = P_{LL}^{t_L - 1} - P_{LL}^{t_L}$. Therefore, it is possible to calculate the probability an economic contraction will last for exactly one period, exactly two periods, or for any (and every) possible duration.[8]

The next step in the formation of the revenue-shortfall distribution is the calculation of the revenue shortfalls associated with contractions lasting various durations. It is assumed that each state's revenue collections follow the same pattern as the economic activity of the state. This assumption seems reasonable since, as mentioned above, nearly 50 percent of states' revenues come from income and sales taxes, both of which vary with economic activity. Furthermore, it is assumed that there are two possible regimes that describe the growth of economic activity for a state: a high-growth regime (economic expansion) and a low-growth regime (economic contraction). Therefore, a state's economy—and hence its revenue collections—is either expanding or contracting. If the economy is in the high-growth regime, then economic activity grows at rate μ_H, and correspondingly, the state's revenue grows at $g_H = \varphi\ \mu_H$ where φ measures the sensitivity of revenue collections to changes in economic activity.[9] Alternatively, if the economy is in a low-growth regime, then economic activity grows at rate μ_L (likely a negative number) and correspondingly, the state's revenue grows at $g_L = \varphi\ \mu_L$.

The revenue shortfall during a low-growth regime then depends on how fast revenue (including funds withdrawn from the RDF) grows. It is assumed that each state has a target stream of revenue (including withdrawals from the RDF) that is available to finance their spending. Letting λ denote an amplitude parameter indicating the desired growth of revenue (again, including funds withdrawn from the RDF) during an economic contraction, a reasonable range for λ may be $[0,g_H]$. Setting $\lambda = 0$ corresponds to a constant level of revenue during an economic contraction, and setting $\lambda = g_H$ corresponds to revenue growing at the same rate during the contraction as it does during an expansionary phase of the business cycle.

To calculate the shortfall of actual revenue collections relative to the desired target of revenue (including withdrawals from the RDF) for a contraction lasting t_L periods, first think about the revenue shortfall for a contraction lasting one period. If actual revenue is R_0 before the contraction, then actual revenue in the first period of the contraction is $R_0(1 + g_L)$, whereas the desired level of revenue is $R_0(1 + \lambda)$, so the revenue shortfall is $R_0[(1+\lambda)-(1+g_L)]$; relative to precontraction revenue, the shortfall is simply $(1+\lambda)-(1+g_L)$. If the contraction lasts two periods, the desired level of revenue in the second period is $(1+\lambda)^2$ whereas actual revenue in the second period is $(1+g_L)^2$, so the revenue shortfall in the second period is $(1+\lambda)^2-(1+g_L)^2$ and the cumulative shortfall is $(1+\lambda)-(1+g_L)+(1+\lambda)^2-(1+g_L)^2$. For a contraction lasting exactly t_L periods, the revenue shortfall is $\varsigma(t_L)=\sum_{i=1}^{t_L}\left[(1+\lambda)^i-(1+g_L)^i\right]$. Setting $\lambda = 0$, calculating all of the possible revenue shortfalls, and combining those shortfalls with the associated probabilities, results in a distribution of "constant-revenue shortfalls" whereas setting $\lambda = g_H$, calculating all of the possible revenue shortfalls, and combining the shortfalls with the associated probabilities results in a distribution of "expansion-revenue shortfalls."

METHODOLOGY AND DATA

Based on the discussion in the previous section, in order to calculate an estimated distribution of revenue shortfalls, it is necessary to have estimates of P_{LL}, μ_H, and μ_L. These are estimated using a Markov switching model. The state-level measure of economic activity is the monthly coincident index (1979:09–2014:12) described by Crone and Clayton-Matthews (2005) and published by the Philadelphia Federal Reserve.[10]

Each state's economic activity is modeled as a two-state Markov switching model in the spirit of Hamilton (1989). A Markov-switching model is a statistical technique wherein the data-generating process of a data series is assumed to undergo unknown, periodic changes between two regimes. Hamilton demonstrated how a switching model very accurately predicted expansion and contraction turning points as dated by the National Bureau of Economic Research for the US economy. More recently, Owyang, *et. al.* (2005) used a switching regression to model the business cycle movements for each of the US states using Crone and Clayton-Matthews's monthly coincident index of state-level economic activity.

Specifically, a Markov switching model assumes the growth rate of a series, $\dot{y}_t$, which can be modeled as $\dot{y}_t = \mu_0 + \mu_1 S_t + \varepsilon_t$, where $\mu_1 > 0$ and ε_t is a normally distributed random error with variance σ_ε^2. Of particular interest is the variable S_t, which is an unobservable regime variable that can take on a value of either 0 or 1. When $S_t = 0$ (low-growth regime), the growth rate of economic activity is assumed to be generated by a normal distribution with a mean of μ_0, and when $S_t = 1$ (high-growth regime), the growth rate of economic activity is assumed to be generated by a normal distribution with a mean of $\mu_0 + \mu_1$. Furthermore, the regime variable S_t occasionally switches between values of 1 and 0; although the switches are unobservable, they are assumed to follow a first-order Markov process where $P_{LL} = P(S_t = 0|S_{t-1} = 0)$ and $P_{HH} = P(S_t = 1|S_{t-1} = 1)$. Therefore, P_{LL} is the probability that, if economic activity was in a low-growth regime in period $t - 1$, it will be in a low-growth regime again in period t. P_{HH} is the probability that, if economic activity was in a high-growth regime in period $t - 1$, it will be in a high-growth regime in period t. The likelihood of switching from a high-growth regime to a low-growth regime is P_{HL}, and the likelihood of switching from a low-growth regime to a high-growth regime is P_{LH}.[11]

In summary, a state's economy is either expanding or contracting each period. If the economy is expanding—or in the high-growth regime—it grows by μ_H ($= \mu_0 + \mu_1$). If the economy is contracting—or in the low-growth regime, it grows by μ_L ($= \mu_0$), which will likely be a negative number. The probability P_{ij} describes the likelihood of moving from regime i to regime j. The estimated values of the transition probabilities are denoted by $\hat{P}_{i,j}$ for i,j = 0,1, and the estimated low- and high-regime growth rates are denoted by $\hat{\mu}_L = \hat{\mu}_0, \hat{\mu}_H = \hat{\mu}_0 + \hat{\mu}_1$.[12]

EMPIRICAL RESULTS AND RANKINGS

Descriptive statistics for each state are presented in Table 1.

TABLE 1
STATES' DESCRIPTIVE STATISTICS

	Positive growth period's average	Negative growth period's average	Maximum positive growth rate	Minimum negative growth rate	Percentage of positive periods	Positive growth followed by positive growth	Negative growth followed by negative growth
Alabama	0.276	−0.245	0.83	−0.98	0.772	0.927	0.750
Alaska	0.300	−0.265	1.69	−1.55	0.605	0.833	0.743
Arizona	0.431	−0.317	1.36	−1.34	0.776	0.915	0.702
Arkansas	0.265	−0.191	0.86	−0.58	0.805	0.962	0.829
California	0.291	−0.160	0.63	−0.72	0.824	0.946	0.743
Colorado	0.347	−0.232	0.73	−0.80	0.802	0.985	0.940
Connecticut	0.302	−0.221	0.86	−0.65	0.772	0.988	0.958
Delaware	0.309	−0.206	0.85	−0.79	0.784	0.940	0.780
Florida	0.328	−0.314	0.92	−1.24	0.838	0.963	0.809
Georgia	0.373	−0.255	1.17	−0.93	0.819	0.943	0.737
Hawaii	0.273	−0.203	0.89	−0.92	0.656	0.871	0.752
Idaho	0.415	−0.454	0.89	−1.14	0.788	0.985	0.933
Illinois	0.304	−0.286	0.71	−1.04	0.732	0.936	0.814
Indiana	0.347	−0.430	0.97	−1.54	0.781	0.976	0.902
Iowa	0.269	−0.284	0.73	−1.25	0.767	0.972	0.898
Kansas	0.291	−0.277	0.80	−1.22	0.727	0.877	0.661
Kentucky	0.305	−0.337	0.95	−1.11	0.788	0.982	0.921
Louisiana	0.303	−0.361	0.79	−1.96	0.668	0.842	0.686
Maine	0.399	−0.293	1.14	−1.37	0.654	0.856	0.719
Maryland	0.289	−0.259	0.97	−0.74	0.784	0.949	0.813
Massachusetts	0.336	−0.254	1.04	−0.75	0.795	0.962	0.849
Michigan	0.501	−0.625	3.22	−2.95	0.696	0.902	0.766
Minnesota	0.276	−0.227	0.75	−0.66	0.856	0.989	0.933
Mississippi	0.294	−0.258	0.83	−0.94	0.725	0.968	0.905
Missouri	0.268	−0.238	0.89	−0.87	0.741	0.959	0.872
Montana	0.338	−0.385	1.04	−1.21	0.687	0.962	0.909
Nebraska	0.249	−0.218	0.82	−0.68	0.824	0.980	0.905
Nevada	0.495	−0.489	1.12	−1.83	0.776	0.979	0.926
New Hampshire	0.369	−0.308	1.17	−0.88	0.854	0.981	0.885
New Jersey	0.283	−0.215	0.87	−0.78	0.793	0.979	0.920
New Mexico	0.273	−0.200	0.77	−0.92	0.835	0.972	0.855
New York	0.226	−0.191	0.57	−0.59	0.816	0.977	0.896
North Carolina	0.335	−0.269	0.91	−1.02	0.809	0.983	0.925
North Dakota	0.269	−0.144	1.28	−0.74	0.809	0.968	0.850
Ohio	0.363	−0.480	1.34	−1.66	0.755	0.972	0.903
Oklahoma	0.284	−0.315	0.90	−1.15	0.725	0.877	0.681

Oregon	0.416	−0.545	1.04	−1.66	0.826	0.977	0.890
Pennsylvania	0.258	−0.242	0.76	−0.84	0.744	0.883	0.657
Rhode Island	0.333	−0.359	1.17	−1.23	0.765	0.966	0.879
South Carolina	0.355	−0.324	1.10	−1.29	0.793	0.953	0.816
South Dakota	0.281	−0.212	0.81	−0.87	0.791	0.979	0.909
Tennessee	0.298	−0.264	0.85	−0.90	0.828	0.986	0.917
Texas	0.329	−0.249	0.71	−0.67	0.826	0.989	0.945
Utah	0.344	−0.203	0.76	−0.85	0.831	0.989	0.944
Vermont	0.373	−0.321	1.10	−1.23	0.758	0.870	0.588
Virginia	0.289	−0.188	0.74	−0.69	0.779	0.970	0.903
Washington	0.278	−0.228	0.67	−0.71	0.849	0.981	0.889
West Virginia	0.277	−0.318	0.81	−1.18	0.814	0.971	0.872
Wisconsin	0.464	−0.656	1.70	−5.71	0.673	0.850	0.688
Wyoming	0.337	−0.619	1.21	−2.08	0.746	0.972	0.916
Mean	**0.324**	**−0.303**	**0.994**	**−1.188**	**0.773**	**0.948**	**0.838**
Median	**0.303**	**−0.264**	**0.889**	**−0.958**	**0.784**	**0.968**	**0.875**
Maximum	**0.501**	**−0.144**	**3.215**	**−0.585**	**0.856**	**0.989**	**0.958**
Minimum	**0.226**	**−0.656**	**0.569**	**−5.708**	**0.605**	**0.833**	**0.588**

The first column reports the average of the positive growth rates; the second column reports the average of the negative growth rates; columns 3 and 4 report the maximum positive and minimum negative growth rates; column 5 reports the percentage of times each state experienced a positive growth rate; column 6 reports the percentage of times that a state had a positive growth rate in one period and a positive growth rate in the following period (estimated by $\hat{P}_{HH}$); and column 7 reports the percentage of times that a state had a negative growth rate in one period and a negative growth rate in the following period (estimated by $\hat{P}_{LL}$). The median state has an average positive growth rate of 0.303 and an average negative growth rate of−0.264. Furthermore, the median state experiences positive growth periods 78.4 percent of the time (and therefore negative growth periods 21.6 percent of the time). Finally, for the median state, a positive growth period is followed by another positive growth period 96.8 percent of the time whereas a negative growth period is followed by a negative growth period 87.5 percent of the time.

The results of the Markov switching regression for each state are presented in Table 2.

TABLE 2
MARKOV SWITCHING PARAMETER ESTIMATES FOR EACH STATE

	$\hat{\mu}_0 + \hat{\mu}_1$	$\hat{\mu}_0$	$\hat{P}_{HH}$	$\hat{P}_{LL}$	$\hat{\sigma}^2_\varepsilon$	$E[t_H]$	$E[t_L]$	$E[t_H] + E[t_L]$
Alabama	0.267	−0.249	0.986	0.935	0.043	73.8	15.4	89.1
Alaska	0.141	−1.085	0.995	0.907	0.129	203.5	10.7	214.2
Arizona	0.595	−0.017	0.978	0.975	0.095	46.0	39.7	85.7
Arkansas	0.307	−0.075	0.983	0.955	0.031	57.6	22.0	79.6
California	0.329	−0.059	0.980	0.948	0.025	50.6	19.4	70.0
Colorado	0.357	−0.195	0.984	0.939	0.035	63.1	16.5	79.6
Connecticut	0.312	−0.189	0.984	0.949	0.035	64.1	19.7	83.8
Delaware	0.371	−0.074	0.981	0.960	0.042	53.2	24.9	78.0
Florida	0.312	−0.399	0.989	0.917	0.049	94.7	12.0	106.8
Georgia	0.398	−0.153	0.982	0.936	0.054	55.6	15.6	71.2
Hawaii	0.294	−0.144	0.979	0.967	0.045	46.9	30.0	76.9
Idaho	0.403	−0.489	0.986	0.921	0.064	70.6	12.6	83.2
Illinois	0.304	−0.269	0.987	0.953	0.043	77.0	21.1	98.1
Indiana	0.319	−0.564	0.986	0.910	0.068	73.8	11.1	84.8
Iowa	0.244	−0.377	0.988	0.918	0.046	80.4	12.2	92.6
Kansas	0.240	−0.396	0.988	0.922	0.057	80.7	12.8	93.4
Kentucky	0.287	−0.406	0.985	0.910	0.049	67.7	11.1	78.8
Louisiana	0.214	−0.637	0.986	0.920	0.074	72.3	12.6	84.9
Maine	0.619	−0.043	0.973	0.982	0.112	37.6	56.3	93.9

Maryland	0.270	−0.309	0.986	0.926	0.047	73.5	13.5	86.9
Massachusetts	0.349	−0.204	0.985	0.946	0.040	65.5	18.4	83.9
Michigan	0.391	−0.937	0.981	0.895	0.211	53.1	9.5	62.6
Minnesota	0.307	−0.097	0.988	0.950	0.029	82.6	20.0	102.6
Mississippi	0.302	−0.226	0.973	0.925	0.047	36.8	13.4	50.2
Missouri	0.277	−0.202	0.986	0.955	0.039	73.9	22.1	96.0
Montana	0.294	−0.484	0.982	0.927	0.074	55.9	13.7	69.6
Nebraska	0.257	−0.177	0.986	0.929	0.032	71.9	14.0	85.9
Nevada	0.473	−0.556	0.985	0.930	0.109	66.4	14.4	80.8
New Hampshire	0.384	−0.223	0.983	0.923	0.059	60.0	12.9	73.0
New Jersey	0.311	−0.130	0.979	0.947	0.040	47.2	18.9	66.2
New Mexico	0.307	−0.078	0.984	0.949	0.039	63.7	19.5	83.2
New York	0.226	−0.187	0.984	0.925	0.022	63.3	13.3	76.6
North Carolina	0.351	−0.211	0.984	0.934	0.039	64.3	15.2	79.5
North Dakota	0.664	0.134	0.935	0.988	0.046	15.3	82.3	97.6
Ohio	0.308	−0.768	0.987	0.898	0.091	74.1	9.8	83.9
Oklahoma	0.243	−0.413	0.986	0.933	0.059	69.1	14.8	83.9
Oregon	0.400	−0.631	0.984	0.902	0.072	62.6	10.2	72.8
Pennsylvania	0.216	−0.349	0.985	0.904	0.041	68.0	10.4	78.4
Rhode Island	0.316	−0.404	0.988	0.936	0.060	86.2	15.7	102.0
South Carolina	0.361	−0.278	0.981	0.925	0.058	53.1	13.4	66.5
South Dakota	0.290	−0.174	0.984	0.934	0.036	62.4	15.1	77.5
Tennessee	0.298	−0.256	0.985	0.911	0.033	67.4	11.2	78.7
Texas	0.334	−0.225	0.986	0.932	0.030	69.3	14.7	84.0
Utah	0.380	−0.101	0.984	0.942	0.033	63.9	17.3	81.2
Vermont	0.353	−0.266	0.980	0.928	0.094	50.9	13.9	64.7
Virginia	0.377	−0.032	0.975	0.969	0.035	40.7	31.9	72.6
Washington	0.289	−0.166	0.986	0.932	0.028	70.6	14.7	85.4
West Virginia	0.259	−0.387	0.986	0.907	0.044	72.5	10.7	83.2
Wisconsin	0.273	−1.636	0.987	0.875	0.257	77.2	8.0	85.2
Wyoming	0.252	−1.505	0.990	0.895	0.087	99.3	9.5	108.9
Mean	**0.329**	**−0.346**	**0.983**	**0.932**	**0.061**	**67.001**	**17.963**	**84.964**
Median	**0.308**	**−0.237**	**0.985**	**0.931**	**0.046**	**65.949**	**14.518**	**83.225**
Maximum	**0.664**	**0.134**	**0.995**	**0.988**	**0.257**	**203.464**	**82.288**	**214.187**
Minimum	**0.141**	**−1.636**	**0.935**	**0.875**	**0.022**	**15.275**	**7.983**	**50.164**

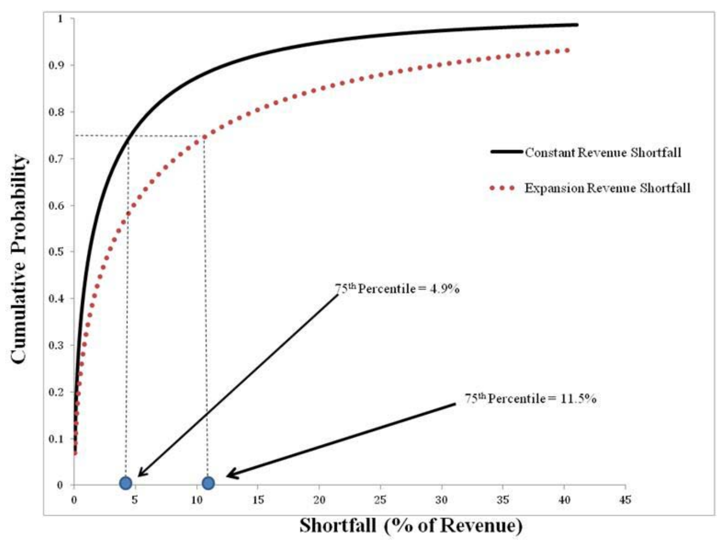
Notes: $\hat{\mu}_0 + \hat{\mu}_1$ is the estimated monthly high-growth regime growth rate; $\hat{\mu}_0$ is the estimated monthly low-growth regime growth rate; $\hat{P}_{HH}$ is the probability of remaining in a high-growth regime; $\hat{P}_{LL}$ is the probability of remaining in a low-growth regime; $E[t_H]$ is the expected duration of an expansion; $E[t_L]$ is the expected duration of a contraction; $E[t_H] + E[t_L]$ is the expected duration of a complete business cycle; and $\hat{\sigma}_{\varepsilon}^2$ is the estimated standard error.

The expansion and contraction growth rates are listed in the first two columns. The median expansion and contraction growth rates over the fifty states are 0.308 and −0.237, respectively (which are very similar to the estimates from the raw data mentioned above). The expansion growth rates range from 0.664 (North Dakota) to 0.141 (Alaska). In general, the expansion growth rates show relatively little variation with 39 of the expansion growth rates being between 0.25 and 0.45. There is considerably more variation in the contraction growth rates that range from 0.134 (North Dakota) to −1.636 (Wisconsin); the largest variations are seen in Alaska, Wisconsin and Wyoming which all have contraction growth rates in excess of −1.0 per month. Compared to the pre–Great Recession results Wagner and Elder (2007b) estimated, the estimated expansion growth rates are smaller for all but five states and the contraction growth rates are larger for all but nine states.

The estimated transition probabilities, P_{HH} and P_{LL}, listed in the third and fourth columns of Table 2, demonstrate how persistent the business cycle phases are for the states. For the median state, given that the state is in expansion in the current period, the probability is 0.985 that the state will be in an expansion the following period; if the state is currently in a contraction, the probability is 0.931 that the state will be in a contraction the following period. These probabilities imply that for the median state, the expected expansion will last 67 months while the expected duration of a contraction is almost 18 months.[13] The highest P_{HH} is for Alaska (0.995) followed by Wyoming (0.990) and Florida (0.989) while the lowest values are for North Dakota (0.935) and for Mississippi and Maine (0.973). The highest P_{LL} is associated with North Dakota (0.988) while the lowest is associated with Wisconsin (0.875). Compared to the pre–Great Recession results reported by Wagner and Elder (2007b) presented, the persistency of the business cycle phases has increased for most states. The estimated P_{HH}'s are larger for 39 states and the estimated P_{LL}'s are larger for 30 states when data through 2014 is included in the sample compared with data through only 2006.

As mentioned above, the estimated parameters of the Markov switching regression can be used to estimate a distribution of possible shortfalls for each state. Using the median values in Table 2 (and elasticity of 1.2), Figure 1 illustrates the cumulative distributions for a constant-revenue shortfall and an expansion-revenue shortfall.

FIGURE 1
CUMULATIVE DISTRIBUTIONS FOR A CONSTANT-REVENUE SHORTFALL AND AN EXPANSION-REVENUE SHORTFALL



The cumulative distributions are initially very steep because the estimated transition probabilities are so high. In fact, based on the median P_{LL} of 0.931, the likelihood of a low-growth regime lasting 6 or fewer months is 35 percent while the probability of a low-growth regime lasting 12 months or fewer is nearly 60 percent.

To calculate the estimated shortfalls for each state, the estimated revenue elasticities reported by Kodrzycki (2014) are used (the elasticitites are shown in Table 3).[14]

TABLE 3
STATES' ELASTICITY OF REVENUE TO ECONOMIC CONDITIONS

State	Elasticity	State	Elasticity
Alabama	2.026	Montana	3.369
Alaska	4.317	Nebraska	1.532
Arizona	1.736	Nevada	1.568
Arkansas	0.891	New Hampshire	0.718
California	2.256	New Jersey	1.542
Colorado	1.909	New Mexico	2.033
Connecticut	1.452	New York	2.205
Delaware	0.992	North Carolina	1.595
Florida	1.483	North Dakota	1.992
Georgia	2.388	Ohio	2.732
Hawaii	1.290	Oklahoma	1.986
Idaho	2.056	Oregon	3.414
Illinois	1.775	Pennsylvania	1.555
Indiana	0.991	Rhode Island	1.358
Iowa	1.051	South Carolina	2.126
Kansas	1.091	South Dakota	0.563
Kentucky	1.793	Tennessee	1.915
Louisiana	2.265	Texas	1.509
Maine	0.588	Utah	1.745
Maryland	2.172	Vermont	1.123
Massachusetts	1.909	Virginia	2.448
Michigan	2.207	Washington	0.771
Minnesota	1.579	West Virginia	0.943
Mississippi	1.818	Wisconsin	1.036
Missouri	1.340	Wyoming	2.195

Source: Yolanda K. Kodrzycki, "Smoothing State Tax Revenues over the Business Cycle: Gauging Fiscal Needs and Opportunities" (Working Paper No. 14-11, Federal Reserve Bank of Boston, 2014); Table A1 in this paper.

The estimated shortfall results for all of the states appear in Tables 4 and 5.

TABLE 4
CONSTANT-REVENUE SHORTFALL DISTRIBUTIONS OF STATE REVENUE CONTRACTIONS (% OF PRECONTRACTION ANNUAL REVENUE)

	Expected	10%	25%	50%	75%	90%
Alabama	9.2	0.1	0.6	2.7	9.4	25.0
Alaska	30.8	1.2	2.3	12.6	38.0	84.0
Arizona	3.8	0.0	0.2	1.0	3.7	10.0
Arkansas	2.7	0.0	0.2	0.7	2.6	7.1
California	4.1	0.0	0.2	1.2	4.2	10.8
Colorado	8.0	0.1	0.5	2.4	8.3	20.8
Connecticut	8.4	0.1	0.5	2.4	8.4	22.7
Delaware	3.7	0.0	0.2	0.9	3.6	10.0
Florida	6.7	0.1	0.5	2.2	7.3	17.7
Georgia	7.0	0.1	0.5	2.0	6.9	18.4
Hawaii	13.2	0.2	0.7	3.5	13.0	34.8
Idaho	12.0	0.3	0.8	3.7	12.2	31.1
Illinois	16.2	0.2	0.8	4.7	16.6	43.5
Indiana	5.4	0.1	0.5	1.7	5.4	14.5
Iowa	4.7	0.1	0.3	1.5	4.9	12.1
Kansas	5.6	0.1	0.4	1.6	5.4	15.0
Kentucky	7.0	0.2	0.6	2.1	7.0	18.6
Louisiana	16.2	0.4	1.2	5.2	17.1	43.0

Maine	6.6	0.0	0.3	1.6	6.5	17.5
Maryland	9.4	0.2	0.6	2.5	9.2	24.4
Massachusetts	10.3	0.1	0.7	2.9	10.2	27.8
Michigan	13.3	0.2	1.0	4.6	14.4	34.8
Minnesota	5.0	0.1	0.3	1.3	5.1	12.9
Mississippi	5.8	0.1	0.3	1.5	5.7	15.3
Missouri	10.4	0.1	0.6	2.7	10.2	27.5
Montana	21.1	0.4	1.3	7.1	23.5	57.6
Nebraska	4.3	0.1	0.2	1.2	4.2	11.6
Nevada	13.4	0.2	0.7	3.9	14.4	35.1
New Hampshire	2.2	0.0	0.1	0.6	2.3	5.7
New Jersey	5.8	0.1	0.4	1.5	5.8	15.4
New Mexico	4.9	0.0	0.3	1.4	5.0	12.9
New York	5.8	0.1	0.3	1.5	5.7	15.4
North Carolina	6.2	0.1	0.4	1.8	6.3	16.1
North Dakota	0.0	0.0	0.0	0.0	0.0	0.0
Ohio	14.2	0.2	1.0	4.7	14.7	38.4
Oklahoma	13.5	0.2	1.0	3.7	13.6	35.2
Oregon	15.7	0.5	1.1	4.8	17.2	42.5
Pennsylvania	4.6	0.1	0.3	1.3	4.6	12.0
Rhode Island	10.5	0.1	0.7	3.0	11.1	28.6
South Carolina	8.2	0.1	0.5	2.2	8.1	21.6
South Dakota	1.8	0.0	0.1	0.5	1.9	4.8
Tennessee	4.9	0.1	0.4	1.5	4.8	12.8
Texas	5.8	0.1	0.4	1.5	5.8	15.3
Utah	4.3	0.0	0.2	1.1	4.4	11.2
Vermont	4.6	0.1	0.2	1.4	4.6	12.0
Virginia	6.4	0.1	0.4	1.6	6.3	17.1
Washington	2.3	0.0	0.2	0.6	2.2	5.9
West Virginia	3.4	0.1	0.2	1.1	3.6	8.9
Wisconsin	8.0	0.1	0.8	2.9	8.8	22.0
Wyoming	19.5	0.3	1.6	7.2	22.0	51.6
Mean	**8.3**	**0.2**	**0.6**	**2.5**	**8.7**	**22.2**
Median	**6.5**	**0.1**	**0.4**	**1.7**	**6.4**	**17.3**
Maximum	**30.8**	**1.2**	**2.3**	**12.6**	**38.0**	**84.0**
Minimum	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table 4 contains the results for constant-revenue shortfalls, which are small because it is assumed that states want only to maintain a constant level of available revenue to finance their spending during a low-growth regime. Therefore Table 4 sets the lowest targets for states by giving them an absolute minimum level of savings that they must accumulate in order to weather economic downturns while avoiding the need to raise taxes or reduce spending.

By contrast, Table 5 contains the results for expansion-revenue shortfalls. These are larger shortfalls because they are calculated based on the assumption that states want the revenue available to finance spending to grow during a low-growth regime at the same rate as it does during an economic expansion.

Tables 4 and 5 present six sets of revenue shortfall numbers for each state; the numbers are expressed as a percentage of precontraction annual revenue. The first column head in each table is "Expected," which is the average-size shortfall that each state could expect to experience based on their particular business cycle characteristics. The next five columns present specific points along each state's shortfall distribution: the 10th, 25th, 50th, 75th, and 90th percentile shortfall amounts. These results can be interpreted as follows: The 75th percentile shortfall is the shortfall amount that is greater than 75 percent of all possible shortfalls that a state could experience.

TABLE 5
EXPANSION-REVENUE SHORTFALL DISTRIBUTIONS OF STATE REVENUE CONTRACTIONS (% OF PRECONTRACTION ANNUAL REVENUE)

	Expected	10%	25%	50%	75%	90%
Alabama	20.8	0.3	1.3	5.8	20.2	55.3
Alaska	37.0	1.3	2.6	14.5	44.2	100.0
Arizona	229.7	1.3	7.2	39.4	164.6	513.0
Arkansas	14.4	0.2	0.8	3.4	13.5	37.4
California	31.1	0.2	1.5	7.9	29.1	79.1
Colorado	25.3	0.3	1.3	6.9	24.8	64.2
Connecticut	24.5	0.4	1.3	6.4	23.3	64.6
Delaware	24.5	0.2	1.3	5.7	22.6	64.4
Florida	12.6	0.3	0.9	3.9	13.4	32.9
Georgia	29.3	0.3	1.7	7.4	26.3	74.1
Hawaii	45.2	0.5	2.1	11.0	41.7	115.8
Idaho	24.1	0.5	1.5	6.8	23.2	61.3
Illinois	38.6	0.5	1.8	10.2	37.1	101.1
Indiana	8.7	0.2	0.7	2.6	8.6	23.2
Iowa	8.0	0.2	0.5	2.4	8.3	20.3
Kansas	9.2	0.2	0.6	2.6	8.8	24.8
Kentucky	12.6	0.3	1.0	3.7	12.3	33.1
Louisiana	23.0	0.5	1.6	7.1	23.4	60.2
Maine	126.8	0.7	5.1	26.4	109.4	316.6
Maryland	18.9	0.3	1.0	4.7	17.9	48.5
Massachusetts	31.6	0.3	1.9	8.1	29.2	82.8
Michigan	20.4	0.2	1.5	6.7	21.2	52.4
Minnesota	22.8	0.3	1.1	5.7	22.3	57.9
Mississippi	14.6	0.2	0.8	3.6	13.8	37.7
Missouri	26.9	0.3	1.5	6.4	25.1	69.5
Montana	38.9	0.7	2.2	11.8	40.1	102.9
Nebraska	11.1	0.2	0.6	3.1	10.6	29.7
Nevada	27.6	0.4	1.3	7.4	28.0	70.4
New Hampshire	6.2	0.1	0.4	1.6	6.3	16.0
New Jersey	21.5	0.2	1.2	5.2	20.4	56.0
New Mexico	27.2	0.2	1.4	7.0	25.7	69.3
New York	13.6	0.2	0.8	3.4	13.1	35.7
North Carolina	17.9	0.2	1.1	5.0	17.5	45.6
North Dakota	4,770.3	4.1	29.9	198.0	1,105.2	4,960.2
Ohio	21.5	0.2	1.5	6.7	21.3	57.2
Oklahoma	23.0	0.3	1.6	5.9	22.4	59.0
Oregon	29.3	0.9	1.8	8.1	29.9	77.3
Pennsylvania	7.8	0.2	0.4	2.0	7.6	19.9
Rhode Island	19.9	0.2	1.2	5.4	20.5	53.7
South Carolina	21.0	0.3	1.1	5.1	19.6	53.7
South Dakota	5.0	0.1	0.3	1.4	5.0	13.0
Tennessee	11.3	0.3	0.9	3.2	10.6	28.9
Texas	15.5	0.2	1.1	3.9	14.9	40.2
Utah	22.7	0.2	1.1	5.6	21.8	58.1
Vermont	11.3	0.2	0.6	3.2	11.1	29.0
Virginia	116.0	0.8	4.7	22.4	93.6	279.4
Washington	6.5	0.1	0.4	1.6	6.2	16.6
West Virginia	5.8	0.2	0.3	1.8	6.1	15.1
Wisconsin	9.6	0.2	1.0	3.4	10.4	26.1
Wyoming	23.9	0.3	1.9	8.5	26.3	62.6
Mean	**123.3**	**0.4**	**2.0**	**10.8**	**47.6**	**169.3**
Median	**21.5**	**0.3**	**1.2**	**5.7**	**21.2**	**56.6**
Maximum	**4,770.3**	**4.1**	**29.9**	**198.0**	**1,105.2**	**4,960.2**
Minimum	**5.0**	**0.1**	**0.3**	**1.4**	**5.0**	**13.0**

Using the median estimates for the high- and low-growth rates and transition probabilities presented in Table 2, Figure 1 demonstrates that the 75th percentile constant-revenue shortfall is 4.9 percent of revenue while the 75th percentile expansion-revenue shortfall is 11.5 percent of current revenue. As an additional example, based on the results in Table 4, if Illinois had accumulated savings equal to 16.6 percent of its current annual revenue, then it would be able to maintain a constant level of revenue available to finance spending in 75 percent of all possible economic contractions that it could experience (Table 4, column 5). Based on the numbers in Table 4, the median 75th percentile constant-revenue shortfall is 6.4 percent.

If instead of maintaining a constant level of revenue during an economic downturn, states wanted to maintain a constant growth of spending equal to the growth during an expansion, those results are presented in Table 5. If Illinois wanted to maintain an expansion level of revenue growth during an economic downturn then it would need accumulated savings of 37.1 percent of its current annual revenue to weather 75 percent of all possible economic contractions (Table 5, column 5). If Illinois wanted to maintain a constant growth of revenue during an economic downturn and had accumulated savings equal to 10 percent of the current annual revenues, then based on the numbers in Table 5, it would be able to weather just under half of all possible economic downturns (because its 50th percentile shortfall amount is 10.2 percent). The median state would need to have accumulated savings of 21.5 percent of its current annual revenue to weather an average economic downturn without raising taxes or reducing spending (Table 5, column 1).

In order to compare the results in the current paper with those reported by Wagner and Elder, Tables A1 and A2 in the appendix allow a comparison of the results including post-2007 data with the results of Wagner and Elder (2007b). These tables report the shortfall results based on the assumption that states have a goal of maintaining a constant level of revenue (Table A1) and a constant (expansion) growth rate of revenue (Table A2). Both Table A1 and A2 use a constant elasticity of 1.2 instead of state-specific elasticities as are used in Tables 4 and 5. The estimated shortfalls are generally larger with the inclusion of post-2007 data. For example, the expected shortfall results reported in Table A1 are larger for 45 states than the comparable set of results Wagner and Elder (2007b) reported.

Four states in Table 5 have significantly higher thresholds than the other states: Arizona, Maine, North Dakota, and Virginia. The reason these states have significantly higher results than other states is that the expansion growth rates are relatively high in combination with a high P_{LL}. The high expansion growth rates require that revenue grow very fast if the state wants to maintain the expansion growth rate of revenue during an economic contraction. Additionally, the high value for P_{LL} means that there is a higher probability of a contraction lasting for a longer duration.

Two important questions for states are (1) what level of savings should states target as a buffer against future economic downturns and (2) how prepared are states to weather any economic contraction? To answer the first question, states should look at "expected" shortfalls, not the median shortfall. At first glance, the median (or 50th percentile) shortfall numbers of either Table 4 or Table 5 may seem like a reasonable level of savings for states to target because half of the shortfalls they may experience are greater than this amount and half are less than this amount. However, for all of the states, the "expected" shortfall is higher than the median shortfall. This is because, as mentioned above, there is a very high probability that of all the shortfalls a state could possibly experience, the duration will be very short-lived. For example, if $P_{LL} = 0.931$ (the median value from Table 2), 35 percent of all economic contractions that a state could experience will last less than six months. Another way to think about this is that the distributions are highly skewed to the right, meaning that even though longer-lasting (and hence larger) revenue shortfalls are less likely, they can be very large when they do occur. For this reason, if states target the median (or 50th percentile) revenue shortfall, then on average, they will not have a sufficient amount of savings. In order for states to have, on average, a sufficient amount of savings, they would need to target the "expected" shortfall level for accumulating savings.

Interestingly, because the distributions are skewed to the extent they are, the expected shortfall amount is approximately equal to the 75th percentile savings level. Therefore, if states were to target this level of accumulated savings, they would not only have sufficient savings to weather three out of every four recessions, but they would also be saving a sufficient amount on average. In other words, over a large number of economic contractions, they will have a sufficient amount of savings.

As a simple example, suppose that for a particular state there are only four possible durations, one, two, three, or four periods. Additionally, suppose that the associated shortfalls are 5, 10, 15, and 30 and all are equally likely (so there is a 25 percent chance of each occurring). This distribution has similar properties to those reported for the states in terms of being skewed to the right. The median shortfall is 10, the 75th percentile shortfall is 15, and the expected shortfall is 15. Additionally, assume that this state faces four revenue shortfalls in the future that exactly follow the distribution described above, with the first shortfall equal to 5, the second equal to 10, the third equal to 15, and the fourth shortfall equal to 30. If a state with this distribution of shortfalls were to target the median shortfall, it would have an excess amount of savings after the first shortfall equal to 5, and it would have precisely the correct amount of savings during the second shortfall, but its savings would be insufficient during the third shortfall by 5, and it would have insufficient savings for the fourth by 15. Overall, the state's savings would be sufficient half the time and insufficient half the time, but overall, its savings would be insufficient by 15. If alternatively the state were to target the expected, or average, shortfall amount of 15, which is also equal to the 75th percentile shortfall amount, then it would have sufficient savings in three out of four economic contractions. On average, the state's savings would be on target, saving and having 10 less than necessary during the first shortfall, 5 less than necessary in the second shortfall, the correct amount in the third shortfall, and 15 more than necessary in the fourth shortfall. For this reason, the "Expected" shortfall may be more representative of what states should expect and attempt to target than the median shortfall level.

To answer the second question concerning how prepared states are to weather any economic contraction, it is necessary to know how much states have accumulated in their RDFs as well as the size of their general fund surplus (since these funds could be used in combination as a buffer against a future revenue shortfall). The amount of funds that states have available in their RDFs alone and also in combination with their general fund balance is reported by the National Association of State Budget Officers in the semi-annual *Fiscal Survey of States*. The actual amounts for 2015 are reported in Table 6.

TABLE 6
STATES' 2015 ACTUAL BALANCES OF RAINY DAY FUNDS (RDFS) AND GENERAL FUNDS (GFS)

State	RDF balance ($ millions)	% of 2014 actual revenue	RDF + GF balance ($ millions)	% of 2014 actual revenue
Alabama	412	5.3	627	8.0
Alaska	10084	455.1	7365	332.4
Arizona	457	5.1	748	8.4
Arkansas	0	0.0	0	0.0
California	3058	2.7	5481	4.9
Colorado	577	5.9	753	7.7
Connecticut	448	2.6	377	2.2
Delaware	213	5.4	548	13.9
Florida	1139	4.1	3491	12.5
Georgia	1246	6.1	1834	9.0
Hawaii	90	1.4	918	14.0
Idaho	190	6.4	232	7.8
Illinois	276	0.9	350	1.1
Indiana	1254	8.3	2141	14.1
Iowa	696	10.3	1060	15.7
Kansas	0	0.0	76	1.3
Kentucky	77	0.8	298	3.0
Louisiana	470	5.5	470	5.5
Maine	128	3.8	154	4.6
Maryland	766	4.8	1086	6.8
Massachusetts	1179	3.1	1416	3.7
Michigan	498	4.8	668	6.4
Minnesota	994	5.0	1754	8.8
Mississippi	395	7.1	461	8.3

Missouri	270	3.1	548	6.3
Montana	0	0.0	455	20.7
Nebraska	728	16.9	1460	33.9
Nevada	0	0.0	146	4.5
New Hampshire	9	0.6	83	5.9
New Jersey	0	0.0	627	1.9
New Mexico	634	10.0	630	10.0
New York	1798	2.6	7617	11.2
North Carolina	652	2.9	1516	6.8
North Dakota	573	24.3	1303	55.4
Ohio	1478	4.7	3190	10.1
Oklahoma	385	6.0	434	6.7
Oregon	391	4.6	868	10.2
Pennsylvania	0	0.0	9	0.0
Rhode Island	185	5.1	351	9.6
South Carolina	447	6.4	1221	17.5
South Dakota	149	10.8	171	12.4
Tennessee	492	3.8	1311	10.1
Texas	7500	14.3	15838	30.1
Utah	491	8.1	895	14.8
Vermont	76	5.3	76	5.3
Virginia	468	2.6	715	4.0
Washington	513	3.0	1379	8.0
West Virginia	869	20.7	1289	30.7
Wisconsin	280	1.9	416	2.9
Wyoming	960	54.1	960	54.1

Source: National Association of State Budget Officers, *The Fiscal Survey of States, Fall 2015* (Washington, DC, 2015)

Comparing the numbers in Table 6 with those in Tables 4 and 5 allows the calculation of the percentage of revenue shortfalls each state can currently weather without any increases in taxes or reductions in spending.

Tables 7 and 8 report two ways to measure the amount of savings that a state is able to use as a buffer against revenue shortfalls. Table 7 contains the results using only the money that is in a state's RDF.

TABLE 7
STATES' ABILITY TO WEATHER AN ECONOMIC CONTRACTION
(USING ONLY THE STATES' RAINY DAY FUNDS)

	Constant-revenue	Expansion-revenue	Each state's average	Rank
Alaska	99.9	99.7	99.8	1
West Virginia	97.3	93.5	95.4	2
South Dakota	97.0	87.2	92.1	3
Wyoming	90.2	87.8	89.0	4
Nebraska	94.0	83.1	88.5	5
Iowa	87.2	80.4	83.8	6
Texas	88.8	73.8	81.3	7
Indiana	81.9	73.5	77.7	8
New Mexico	86.5	57.0	71.8	9
Utah	86.0	56.6	71.3	10
Washington	80.1	59.9	70.0	11
Mississippi	78.9	60.7	69.8	12
Vermont	77.6	59.3	68.4	13
Delaware	81.4	48.1	64.8	14
Minnesota	75.0	48.7	61.8	15
Tennessee	70.2	52.6	61.4	16
South Carolina	68.7	53.9	61.3	17
North Dakota	98.8	22.6	60.7	18
Colorado	69.5	49.7	59.6	19

Florida	64.6	54.1	59.4	20
Georgia	71.6	45.0	58.3	21
Alabama	63.6	49.0	56.3	22
Idaho	62.9	48.3	55.6	23
Maryland	60.4	50.1	55.3	24
Rhode Island	60.1	48.1	54.1	25
Oklahoma	56.7	50.3	53.5	26
North Carolina	61.4	42.0	51.7	27
New York	60.9	42.1	51.5	28
Arizona	80.5	22.5	51.5	29
California	67.1	34.5	50.8	30
Louisiana	52.6	44.1	48.3	31
Michigan	53.9	42.5	48.2	32
Missouri	52.3	37.0	44.6	33
Ohio	47.6	41.6	44.6	34
Maine	65.2	22.2	43.7	35
Oregon	46.1	40.2	43.2	36
Connecticut	51.8	34.1	42.9	37
New Hampshire	51.6	33.1	42.4	38
Massachusetts	51.6	32.4	42.0	39
Wisconsin	41.5	41.5	41.5	40
Virginia	59.0	20.0	39.5	41
Kentucky	31.4	24.6	28.0	42
Hawaii	33.4	21.1	27.3	43
Illinois	25.3	17.7	21.5	44
Arkansas	0.0	0.0	0.0	45
Kansas	0.0	0.0	0.0	45
Montana	0.0	0.0	0.0	45
Nevada	0.0	0.0	0.0	45
New Jersey	0.0	0.0	0.0	45
Pennsylvania	0.0	0.0	0.0	45
States' Median	**59.6**	**43.7**		
States' Average	**63.2**	**44.5**		

Table 8 shows the RDF balance in combination with a projected general fund balance.

TABLE 8
STATES' ABILITY TO WEATHER AN ECONOMIC CONTRACTION
(USING THE COMBINED RAINY DAY FUND AND GENERAL FUND)

	Constant-revenue	Expansion-revenue	Each state's average	Rank
Alaska	99.7	99.2	99.4	1
West Virginia	98.8	96.4	97.6	2
Nebraska	98.3	91.9	95.1	3
South Dakota	97.7	89.6	93.7	4
Texas	96.1	86.1	91.1	5
Iowa	92.3	86.1	89.2	6
Wyoming	90.2	87.8	89.0	7
Indiana	89.7	83.5	86.6	8
Washington	93.1	78.7	85.9	9
New Hampshire	90.3	74.6	82.4	10
Utah	92.8	67.8	80.3	11
Florida	85.1	75.0	80.1	12
Tennessee	87.1	72.9	80.0	13
South Carolina	86.7	73.2	79.9	14
Delaware	93.6	65.6	79.6	15
New York	85.8	71.4	78.6	16

Mississippi	80.5	63.6	72.0	17
New Mexico	86.5	57.0	71.8	18
Minnesota	84.2	58.2	71.2	19
Vermont	77.6	59.3	68.4	20
Montana	72.4	62.7	67.5	21
Georgia	79.6	54.9	67.3	22
Rhode Island	73.1	60.1	66.6	23
North Carolina	76.1	55.8	65.9	24
North Dakota	98.8	32.4	65.6	25
Alabama	72.2	58.3	65.2	26
Hawaii	75.9	54.1	65.0	27
Colorado	74.7	52.8	63.8	28
Ohio	65.9	57.7	61.8	29
California	78.4	44.1	61.3	30
Maryland	68.6	53.8	61.2	31
Idaho	65.8	52.4	59.1	32
Oregon	64.3	51.4	57.8	33
Arizona	88.0	26.4	57.2	34
Missouri	65.5	47.6	56.6	35
Oklahoma	59.7	50.3	55.0	36
Michigan	58.7	48.5	53.6	37
Kentucky	57.1	48.2	52.7	38
Wisconsin	48.8	48.8	48.8	39
Louisiana	52.6	44.1	48.3	40
Maine	68.8	24.9	46.9	41
Nevada	51.4	39.7	45.5	42
Virginia	66.1	24.9	45.5	43
Massachusetts	54.2	36.0	45.1	44
New Jersey	53.2	31.6	42.4	45
Kansas	43.5	38.7	41.1	46
Connecticut	49.2	30.6	39.9	47
Illinois	25.3	17.7	21.5	48
Arkansas	0.0	0.0	0.0	49
Pennsylvania	0.0	0.0	0.0	49
States' Median	**72.3**	**55.7**		
States' Average	**76.0**	**55.4**		

Based on the actual 2015 RDF balances shown in Table 6, if states want to maintain a constant level of spending during an economic contraction, they would be able to weather an average of 63.2 percent of possible economic contractions (Table 7, column 1) with the current stock of savings in their RDFs. Alternatively, if states want to maintain a constant growth of revenue available to finance their spending, they have sufficient savings in their RDFs to weather an average of 43.7 percent of possible economic contractions (Table 7, column 2).

There is a large amount of variability in the results in Tables 7 and 8. With the goal of just keeping available revenue constant (Table 7, column 1), 17 states have accumulated sufficient savings in their RDF alone to weather 75 percent of possible revenue shortfalls; 12 states have not accumulated sufficient savings in their RDF alone to meet the median revenue shortfall, meaning that there is a better than 50/50 chance that these 12 states have insufficient RDFs to weather the next revenue shortfall. If states want to maintain a constant growth of available revenue using only rainy day funds during the next economic contraction (Table 7, column 2), only 6 states (Alaska, Iowa, Nebraska, South Dakota, West Virginia, and Wyoming) have a sufficient amount of savings to weather 75 percent or more of all possible economic contractions (which, based on the earlier discussion is similar to the "average" economic contraction) that may occur, whereas 32 states have savings that are less than the corresponding median shortfalls reported in Table 5.

Table 7 also shows the states' rankings based on their ability to weather an economic contraction using only the accumulated savings in the RDFs. Averaging the numbers for each state from the first two columns gives a simple measure against which to assign a ranking for each state's ability to weather an economic contraction. This average is shown in the third column of Table 7, and the ranking based on these averages is shown in column 4. Under this ranking, Nebraska is 5th (top 10 percent) with an average ability to weather an economic downturn of 88.5 percent. To be in the top quartile (Mississippi is ranked 12th), it is necessary to have an average ability of 69.8 percent, and to be in the top half (Rhode Island is ranked 25th), it is necessary to have an average ability of 54.1 percent.

The second way to measure the buffer against revenue shortfalls is based on combining the state's rainy day fund with any general fund balance (Table 8). Using the accumulated savings in the RDF along with the 2015 actual general fund balance as a measure of the accumulated savings states have to buffer against spending cuts or tax increases during economic downturns, 26 states can maintain a constant level of spending in 75 percent of possible economic downturns (column 1); only 6 states (Connecticut, Wisconsin, Kansas, Illinois, Arkansas, and Pennsylvania) have accumulated savings that are insufficient to weather at least 50 percent of all possible economic downturns.[15] If states want to maintain a constant growth of spending during an economic downturn (column 2), there are 10 states that have a sufficient amount of savings in their RDF and general fund surplus to accomplish this goal in 75 percent of all economic downturns, whereas 18 states can accomplish this goal in less than half of all possible economic downturns without cutting spending or increasing taxes.

As in Table 7, column 3 of Table 8 is the average of columns 1 and 2; it measures the average ability to weather economic downturns using the combined resources in an RDF and the general fund surplus. To be in the top 10 percent (Texas), it is necessary to have an average ability to weather economic downturns of at least 91.1 percent, an ability of 80.1 percent to be in the top quartile (Florida), and an ability of 65.6 percent to be in the top half (North Dakota). These rankings are shown in column 4 of Table 8. Generally, the rankings using the two different measures are within four or five spots of each other. Exceptions are Florida, New York, Hawaii, and Montana, which improve 8 or more spots (due to very low rainy day fund balances and relatively high general fund surpluses), and Connecticut, Oklahoma, Colorado, Idaho, Louisiana, and New Mexico which significantly decline 9 or more places due to low general fund balances that do not add much to their ability to weather economic downturns.[16]

CONCLUSION

Rainy day funds are a common tool used by most states to reduce, or possibly eliminate, the need to lower spending or increase taxes during periods of fiscal stress caused by economic contractions. The problem is that most states, on average, do not currently have a sufficient amount of savings to offset revenue shortfalls during periods of fiscal stress. This paper uses a switching regression to estimate the parameters necessary to form a distribution of potential revenue shortfalls, and then compares this information to the current level of accumulated savings for each state. The results makes it evident that very few states have a sufficient amount of savings in their RDF to weather an average revenue shortfall (which is approximately equal to the 75th percentile recession) if the goal is to maintain a constant growth of revenue available to finance spending.

The choices that state legislators make with regard to their state's accumulated savings have obvious implications for the potential need to change spending or raise taxes during an economic downturn. The results presented in this paper indicate how prepared states currently are, but they should also give legislators an idea of what goals they could set in terms of savings if they would like to decrease potential spending reductions or tax increases during the next economic contraction. Additionally, the results give state legislators an idea of their state's position with respect to best practices and in terms of how prepared they are relative to other states.

ENDNOTES

1. I would like to thank the Mercatus Center at George Mason University for its financial support and Gary Wagner for many valuable comments and suggestions. Any errors are my responsibility.

2. In 2013, sales and gross receipt taxes accounted for \$393.8 billion and income taxes accounted for \$354.5 billion. Together, these revenues accounted for 88.3 percent of the taxes that states collected. (Lee 2015)
3. All but three states have a functional RDF; the exceptions are Colorado, Kansas, and Montana.
4. *Fiscal Survey of States*, National Association of State Budget Officers, Fall 2007.
5. Ibid.
6. Similarly, by many metrics, the economic downturn associated with the 2001 recession was relatively mild. Yet the median state budget gap in 2002 was nearly \$400 million, which was significantly greater than the median accumulated savings in RDFs of nearly \$100 million.
7. Bond rating agencies and the Fiscal Affairs and Oversight Committee of the National Conference of State Legislatures have previously recommended 5 percent savings thresholds while the Government Finance Officers Association suggests two months' worth or spending or revenues which equates to savings of 16.7 percent of annual spending or revenue (Zhao, 2014).
8. The probability that a contraction lasts for exactly t_L periods declines as t_L increases, $P_L(t_L) > P_L(t_{L-1})$ for any t_L, and so $P_L(t_L)$ becomes infinitesimally small for very large t_L. Therefore, the maximum t_L considered is 360; since monthly data is used in the estimation process, this corresponds to a contraction lasting 20 years.
9. Following the methodology developed by Wagner and Elder (2007b), two reasonable values for φ are assumed: 1.2 and 1.5.
10. An abbreviated explanation of the construction of the coincident index is provided in this paper; for an expanded explanation, interested readers should see Wagner and Elder (2007b). The coincident index is the result of a dynamic factor model combining four labor market variables: the unemployment rate, payroll employment, average weekly manufacturing hours, and real wage and salary disbursements.
11. Note that $P_{LH} = P(S_t = 1|S_{t-1} = 0) = 1 - P_{LL}$ and $P_{HL} = P(S_t = 0|S_{t-1} = 1) = 1 - P(S_t = 1|S_{t-1} = 1)$.
12. The parameters of the model are estimated using the Bayesian Gibbs-sampling approach for Markov switching models developed by Kim and Nelson (1998). I acknowledge the use of the computer routines described in Chang-Kim and Nelson (1999).
13. The expected length of a business cycle phase is $(1\text{-}P_{ii})^{-1}$ for i-H,L.
14. Appendix Table A1, 2000–2012.
15. Arkansas has a unique method of budgeting, so the results reported in this paper concerning their ability to use RDF and general fund surpluses to weather a recession may not be an accurate representation. More information concerning Arkansas's budgeting process can be found in "The Revenue Stabilization Act," Encyclopedia of Arkansas History & Culture, http://www.encyclopediaofarkansas.net/encyclopedia/entry-detail.aspx?entryID=7840. Additional information can be found in Jordan (2006).
16. New Hampshire improves more than 28 places but this is primarily due to the low elasticity resulting in relatively low shortfalls.

REFERENCES

Crain, W. Mark (2003). *Volatile States: Institutions, Policy, and the Performance of American State Economies*. Ann Arbor: University of Michigan Press.

Crone, Theodore M. and Alan Clayton-Matthews (2005). Consistent Economic Indexes for the 50 States. *Review of Economics and Statistics*, 87: 593–603.

Hamilton, James (1989). A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle. *Econometrica*, 57(2), 357-84.

Holcombe, Randall G. and Sobel, Russell S. (1997). *Growth and Variability in State Tax Revenue: An Anatomy of State Fiscal Crises*. Westport, CT: Greenwood Press.

Jordan, Meagan M. (2006). Arkansas Revenue Stabilization Act: Stabilizing Programmatic Impact through Prioritized Revenue Distribution. *State and Local Government Review*, 38, no. 2: 104–11.

Kim, Chang-Jin and Charles R. Nelson (1998). Business Cycle Turning Points, A New Coincident Index, and Tests of Duration Dependence Based on a Dynamic Factor Model with Regime-Switching. *The Review of Economics and Statistics* 80(2), 188-201.

Kim, Chang-Jin and Charles R. Nelson (1999). *State-Space Models with Regime Switching: Classical and Gibbs Sampling Approaches with Applications*, Cambridge: MIT Press.

Kodrzycki, Yolanda K. (2014). Smoothing State Tax Revenues Over the Business Cycle: Gauging Fiscal Needs and Opportunities. Federal Reserve Bank of Boston Working Paper No. 14-11.
Kusko, Andrea L. and Laura Rubin (1993). Measuring the Aggregate High-Employment Budget for State and Local Governments. *National Tax Journal*, 46(4), 411-423.
Lee, Cheryl H., Tereese Dyson, Matthew Park, Calvin Handy, and Marquita Buchanan Reynolds (2015). *State Government Finances Summary: 2013*, U.S. Census Bureau, February 3.
Mitchell, David T. and Dean Stansel (2015). State Fiscal Crises: States' Abilities to Withstand Recessions. Mercatus Working Paper, Mercatus Center at George Mason University, Arlington, VA, January.
National Association of State Budget Officers (2007). *The Fiscal Survey of the States: Fall 2007*, Washington, DC.
Navin, John and Leo Navin (1997). The Optimal Size of Countercyclical Budget Stabilization Funds: A Case Study of Ohio. *Public Budgeting and Finance*, 17(2), 114-27.
Owyang, Michael, Jeremy Piger, and Howard Wall (2005). Business Cycle Phases in U.S. States. *The Review of Economics and Statistics*, 87(4), 604-616.
Pollock, Richard, and Jack Suyderhoud (1986). The Role of Rainy Day Funds in Achieving Fiscal Stability. *National Tax Journal*, 39(4), 485-497.
Sobel, Russell, and Randall Holcombe (1996). The Impact of State Rainy Day Funds in Easing State Fiscal Crises During the 1990-1991 Recession. *Public Budgeting and Finance*, 16(3), 28-48.
State Rainy Day Fund Regulations (2013). Tax Policy Center, http://www.taxpolicycenter.org/taxfacts/Content/PDF/state_rainy_day.pdf.
Urahn, Susan and Michael Ettlinger (2014). Building State Rainy Day Funds. Pew Charitable Trusts.
Wagner, Gary A. and Erick M. Elder. (2005). The Role of Budget Stabilization Funds in Smoothing Government Expenditures Over the Business Cycle. *Public Finance Review*, 33(4), 439-465.
Wagner, Gary A. and Erick M. Elder (2007a). How Well are the 8th District States Prepared for the Next Recession. *Regional Economic Development*, 3(2), November 2007, pp. 75-87.
Wagner, Gary A. and Erick M. Elder (2007b). Revenue Cycles and the Distribution of Shortfalls in U.S. States: Implications for an 'Optimal' Rainy-Day Fund. *National Tax Journal*, 60(4), 2008, pp. 727-742.
Zhao, Bo (2014). Saving for a Rainy Day: Estimating the Appropriate Size of U.S. Budget Stabilization Funds. Working Paper, Federal Reserve Bank of Boston.

APPENDIX

TABLE A1
CONSTANT-REVENUE SHORTFALL DISTRIBUTIONS OF STATE REVENUE CONTRACTIONS, 2000–2012 (% OF REVENUE)

	Revenue elasticity = 1.2					
	Expected	10%	25%	50%	75%	90%
Alabama	5.6	0.07	0.37	1.63	5.6	15.2
Alaska	11.1	0.32	0.65	3.79	12.3	29.5
Arizona	2.6	0.03	0.13	0.68	2.6	6.9
Arkansas	3.6	0.05	0.21	0.90	3.5	9.5
California	2.2	0.02	0.12	0.62	2.2	5.8
Colorado	5.1	0.06	0.29	1.51	5.3	13.3
Connecticut	7.0	0.11	0.40	1.96	7.0	18.9
Delaware	4.5	0.04	0.27	1.13	4.4	12.1
Florida	5.5	0.12	0.40	1.77	6.0	14.5
Georgia	3.6	0.05	0.23	1.00	3.5	9.4
Hawaii	12.3	0.14	0.64	3.28	12.1	32.5
Idaho	7.3	0.15	0.49	2.17	7.3	18.8
Illinois	11.2	0.16	0.56	3.18	11.3	30.1
Indiana	6.4	0.17	0.56	2.00	6.6	17.4
Iowa	5.3	0.11	0.38	1.68	5.6	13.7
Kansas	6.1	0.12	0.39	1.76	5.9	16.5
Kentucky	4.8	0.12	0.40	1.45	4.8	12.7
Louisiana	9.2	0.19	0.63	2.81	9.4	24.2
Maine	12.7	0.09	0.66	3.34	13.1	35.4
Maryland	5.4	0.09	0.31	1.38	5.2	13.9
Massachusetts	6.6	0.06	0.43	1.84	6.5	17.8
Michigan	7.8	0.09	0.56	2.56	8.2	20.1
Minnesota	3.8	0.06	0.20	1.02	3.9	9.9
Mississippi	3.9	0.07	0.23	1.01	3.8	10.2
Missouri	9.4	0.12	0.56	2.39	9.2	24.7
Montana	8.5	0.15	0.48	2.62	8.9	22.7
Nebraska	3.4	0.05	0.18	0.97	3.3	9.1
Nevada	10.5	0.17	0.55	3.00	11.2	27.4
New Hampshire	3.6	0.07	0.22	0.99	3.7	9.4
New Jersey	4.5	0.04	0.27	1.18	4.5	12.1
New Mexico	2.9	0.02	0.16	0.82	2.9	7.7
New York	3.2	0.06	0.19	0.84	3.2	8.5
North Carolina	4.7	0.06	0.32	1.38	4.8	12.2
North Dakota	0.0	0.00	0.00	0.00	0.0	0.0
Ohio	6.8	0.08	0.46	2.11	6.7	18.2
Oklahoma	8.5	0.12	0.62	2.24	8.4	22.0
Oregon	6.2	0.19	0.38	1.74	6.4	16.5
Pennsylvania	3.6	0.10	0.21	0.97	3.6	9.3
Rhode Island	9.3	0.12	0.60	2.62	9.9	25.4
South Carolina	4.8	0.08	0.28	1.24	4.7	12.5
South Dakota	3.8	0.05	0.26	1.14	4.0	10.1
Tennessee	3.1	0.08	0.26	0.91	3.0	8.1
Texas	4.7	0.07	0.34	1.23	4.6	12.3
Utah	3.0	0.03	0.15	0.79	3.0	7.8
Vermont	4.9	0.08	0.27	1.45	5.0	12.8
Virginia	3.2	0.03	0.17	0.80	3.1	8.4
Washington	3.5	0.05	0.25	0.91	3.4	9.1
West Virginia	4.3	0.12	0.23	1.38	4.5	11.2
Wisconsin	9.2	0.16	0.97	3.33	10.1	25.1
Wyoming	11.9	0.15	0.89	4.07	12.8	30.9
Mean	**5.9**	**0.09**	**0.38**	**1.71**	**6.0**	**15.6**
Median	**5.0**	**0.08**	**0.33**	**1.45**	**5.1**	**13.0**
Maximum	**12.7**	**0.32**	**0.97**	**4.07**	**13.1**	**35.4**
Minimum	**0.0**	**0.00**	**0.00**	**0.00**	**0.0**	**0.0**

TABLE A2
EXPANSION-REVENUE SHORTFALL DISTRIBUTIONS OF STATE REVENUE CONTRACTIONS, 2000-2012 (% OF REVENUE)

	Revenue elasticity = 1.2					
	Expected	10%	25%	50%	75%	90%
Alabama	12.2	0.15	0.77	3.41	11.9	32.6
Alaska	12.7	0.37	0.73	4.30	14.0	33.8
Arizona	130.5	0.93	4.89	26.46	107.1	319.0
Arkansas	19.7	0.23	1.08	4.65	18.3	51.0
California	15.6	0.12	0.82	4.13	15.1	40.3
Colorado	15.5	0.17	0.83	4.34	15.5	39.8
Connecticut	20.1	0.30	1.06	5.30	19.2	53.1
Delaware	30.2	0.27	1.62	6.95	27.6	78.9
Florida	10.2	0.21	0.71	3.19	10.8	26.7
Georgia	14.0	0.17	0.83	3.67	13.0	35.9
Hawaii	41.8	0.44	1.98	10.25	38.7	107.3
Idaho	14.1	0.27	0.89	4.00	13.6	35.9
Illinois	25.8	0.34	1.20	6.89	25.0	68.0
Indiana	10.5	0.26	0.88	3.15	10.4	28.0
Iowa	9.1	0.19	0.62	2.78	9.4	23.2
Kansas	10.1	0.19	0.63	2.85	9.6	27.2
Kentucky	8.5	0.21	0.69	2.49	8.3	22.3
Louisiana	12.7	0.26	0.85	3.78	12.7	33.1
Maine	309.8	1.41	10.52	56.54	246.2	767.0
Maryland	10.5	0.17	0.58	2.61	9.9	26.9
Massachusetts	19.4	0.17	1.16	5.06	18.2	51.2
Michigan	11.5	0.13	0.79	3.67	11.8	29.4
Minnesota	17.0	0.24	0.85	4.29	16.8	43.5
Mississippi	9.5	0.16	0.53	2.38	9.1	24.8
Missouri	24.0	0.29	1.34	5.77	22.5	62.1
Montana	14.2	0.23	0.78	4.25	14.6	37.8
Nebraska	8.6	0.13	0.43	2.39	8.3	23.2
Nevada	21.1	0.31	1.03	5.64	21.5	53.9
New Hampshire	10.4	0.18	0.61	2.75	10.5	26.9
New Jersey	16.5	0.13	0.93	4.06	15.8	43.1
New Mexico	15.4	0.12	0.81	4.10	14.9	39.8
New York	7.4	0.12	0.41	1.86	7.1	19.3
North Carolina	13.3	0.17	0.84	3.73	13.1	34.1
North Dakota	608.2	2.45	17.13	105.23	507.7	1,828.6
Ohio	9.9	0.11	0.64	2.98	9.6	26.2
Oklahoma	14.1	0.20	0.98	3.59	13.6	36.1
Oregon	10.5	0.31	0.62	2.87	10.7	27.9
Pennsylvania	6.0	0.17	0.34	1.58	5.9	15.4
Rhode Island	17.6	0.22	1.08	4.74	18.1	47.5
South Carolina	11.7	0.19	0.64	2.88	11.0	30.0
South Dakota	10.8	0.14	0.70	3.07	10.8	28.0
Tennessee	7.0	0.17	0.55	2.00	6.7	18.1
Texas	12.3	0.17	0.84	3.09	11.8	31.8
Utah	15.2	0.14	0.72	3.80	14.8	39.2
Vermont	12.1	0.19	0.62	3.42	11.8	31.1
Virginia	47.8	0.41	2.28	10.64	43.0	122.3
Washington	10.1	0.14	0.68	2.52	9.7	26.0
West Virginia	7.4	0.19	0.39	2.32	7.7	19.2
Wisconsin	11.0	0.19	1.13	3.90	11.9	29.9
Wyoming	14.2	0.18	1.04	4.78	15.1	36.9
Mean	**35.0**	**0.29**	**1.46**	**7.50**	**30.8**	**94.7**
Median	**13.0**	**0.19**	**0.82**	**3.75**	**13.0**	**33.9**
Maximum	**608.2**	**2.45**	**17.13**	**105.23**	**507.7**	**1,828.6**
Minimum	**6.0**	**0.11**	**0.34**	**1.58**	**5.9**	**15.4**