Rainy Day Funds

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Introduction

Unlike the federal government, nearly every state has some type of balanced budget requirement[1]; despite the differences in the structure of these requirements across the states, the balance budget requirements still impose constraints upon state governments from which the federal government does not suffer. Because of the cyclical nature of state revenue collections, the amount of revenue state governments collect naturally declines during economic downturns. The decline in revenue that occurs during an economic downturn, coupled with a balanced budget requirement, potentially necessitates tax increases and/or spending cuts. During the Great Recession, 42 states cut their spending in 2009, 39 states made mid-year budget cuts in 2010, and 38 states enacted revenue increases in 2010.[2] As the name implies, a rainy-day fund (RDF's) (also known as budget stabilization funds) gives states a mechanism through which to accumulate a stock of savings that can be used to mitigate tax increases/spending cuts that might otherwise result as revenue declines during economic contractions. An important question for states is how much savings they should accumulate to avoid tax increases and/or spending cuts during an economic downturn.

In this essay, we follow the methodology introduced by Wagner and Elder (2007) to estimate state-specific business cycle characteristics (the length and severity of economic expansions and contractions), and then use these estimates to accomplish a number of goals. First, we construct a probability distribution of revenue shortfalls for each state. The distribution relates the probabilities an economic contraction lasts a certain number of periods along with the corresponding revenue shortfall.[3] A state does not know with certainty how much savings they should accumulate to weather a revenue shortfall associated with a recession since the duration and severity of the business cycle phases are unknown beforehand. Therefore, how much revenue declines during an economic contraction is not characterized by a SINGLE number, but instead, it is characterized by a distribution of possible outcomes associated with the probabilities that each one of those outcomes actually occurs. Knowing the distribution of potential revenue shortfalls allows policymakers to make more informed decisions concerning the likelihood that a given stock of accumulated savings will allow a state to weather the next recession without increasing taxes and/or reducing government spending. As mentioned, the distribution for each state depends on the state-specific business cycle characteristics. With this distribution, it is possible to make statements concerning the average revenue shortfall a state may experience, the median shortfall a state may experience, as well as other potential revenue shortfalls based on various confidence levels. Once the distributions are established, we use data concerning how much each state has currently accumulated to assess their ability to weather a recession. Additionally, policymakers can use these results to make informed decisions concerning how much more they may need to save to weather a certain proportion, such as 75% or 90%, of all possible recessions they are likely to face, and hence can be that confident they have sufficient savings to avoid tax increases/spending decreases during the next recession.

In addition to calculating the probability distributions for potential revenue shortfall for each state, we also use the parameter estimates to estimate the amount each state would need to save during economic

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[1] Vermont being the only exception
[2] *Fiscal Survey of States*, fall 2010
[3] Using monthly data, T = 360

expansions in order to be confident in accumulating a sufficient amount of savings to weather a certain proportion of potential recessions. Clearly it is important for legislators to know how likely they are to avoid the fiscal stress brought on by declining revenues during a recession, but in our opinion, it is at least equally important to give policymakers a roadmap to accumulating the desired savings goals which is why the calculation of savings RATES is useful and important.

Prior to the Great Recession, states had accumulated savings equal to 11.5% of their total 2006 expenditures.[4] Despite the fact that this amount was almost double the historical average, the severity of the Great Recession virtually wiped out the savings that states had accumulated. The total amount that states had accumulated by 2019 is nearly 14% of their expenditures.[5] Based on the number of states that enacted spending cuts/tax increases during the Great Recession, the amount of savings states had accumulated was clearly insufficient to buffer against the ensuing revenue declines. By many metrics, the Great Recession was the worst recession the country had experienced since the Great Depression, and as such, it is unlikely that the US will experience another recession of such severity in the foreseeable future. Nonetheless, questions remain concerning the sufficiency of the new, higher level of accumulated savings in terms of just how severe a recession the current level of accumulated savings is capable of buffering; how severe a recession is the current, higher level of savings sufficient for?

Though the states in aggregate have accumulated such a large stock of savings, these aggregated numbers obviously do not tell the complete story. In both 2006 and 2019, the distribution of accumulated savings across the states is quite large. In 2006, nineteen states had savings of ten percent or less of their expenditures while only nine states had savings greater than twenty percent of their expenditures. Currently, a dozen states have accumulated savings of ten percent or less of their expenditures while a dozen states have over accumulated savings greater than twenty percent of their expenditures. In addition to vast differences across states in terms of their accumulated savings, there are also large differences across states in terms of their business cycles with respect to how long expansions and contractions generally last as well as how much states expand and contract during their business cycles.

Therefore, one relevant question is whether the states that are saving more than others are actually the states that NEED to be saving more than the others based on their state-specific business cycle characteristics. Obviously, it could be the case that the states are saving enough as a group to weather a mild recession but when the numbers are disaggregated and we look at each state separately, some of them have accumulated enough savings to weather a severe recession while others have not saved enough to weather even a very mild recession.

Brief Summary of Results

Based on the results presented below, we find that the average amount states need to save to weather an average economic downturn is 11% of revenue, but this amount varies considerably from state to state. Interestingly, the distribution is severely skewed to the right so much so that for many states, the average revenue shortfall is very similar to the 75th percentile revenue shortfall.

The following sections review the previous literature on the appropriate size of a RDF, offer a brief description of how the distribution of potential shortfalls and savings rates are calculated, a discussion of the data and statistical methodology, a discussion of the results, and concluding remarks.

Previous Literature

[4] This total includes amounts in RDF's as well as general fund balances
[5] *Fiscal Survey of States*, fall 2019

The issue of how large a RDF should be has attracted much attention. In 1983, the National Conference of State Legislators issued a report recommending a balance of 5% of revenue. This recommendation is problematic for a number of reasons. First, as mentioned above, as a group, states had accumulated savings over double this amount, and it proved insufficient during the Great Recession. Granted, the Great Recession was the most severe recession since the Great Depression, but the 5% recommendation is also problematic because it prescribes the same goal for all states despite the fact that each state has differing tax bases and tax structures, and hence each state will likely experience differing revenue declines during a recession so a one-size-fits-all approach clearly is not informative to state legislators.[6] More recently, in 2009, the Government Finance Officers Administration suggested states accumulate savings equal to 2 months of their operating revenues. Even though this target was much larger than the 5% target, it is still a one-size-fits-all approach.

The early academic literature on the appropriate size of a RDF, such as Pollock and Suyderhoud (1986), Sobel and Holcombe (1996), and Navin and Navin (1997), have estimated how much a state might need to save by estimating the deviations of revenue collections from a trend during economic downturns, but these studies were for single states. Additionally, only single point estimates of the budget shortfalls are reported. This is important because it makes it difficult to assess how prepared a given state might be with their current stock of savings. Cornia and Nelson (2003) overcome this issue by using a value-at-risk approach to estimate a distribution of potential shortfalls for Utah. One problem with this approach is that it estimates the potential shortfalls over some fixed period of time such as one year instead of over an economic downturn or over a complete business cycle.

All of the studies mentioned above use actual revenue data. The problem with using actual revenue data is that it contains policy changes that quite likely obscures the statistical inferences. Zhao (2014) corrects this problem by adjusting the reported revenue collections by the estimated effect that the policy changes have on the revenue collections. Multiple problems exist with the approach of Zhao. First, the data in the analysis is annual revenue collections making is very likely that at least some of the fluctuations in the revenue series are being smoothed out since it is highly unlikely that revenue fluctuations follow the calendar or fiscal year. Furthermore, Zhao only reports the mean and median shortfalls, again, making it difficult for policymakers to make meaningful inferences concerning how prepared their state might be with their current stock of savings.

We believe the approach taken in this paper overcomes all of the above-mentioned shortcomings. First, we provide a much more thorough description of the distribution of revenue shortfalls by providing the 10^{th}, 25^{th} 50^{th}, 75^{th}, and 90^{th} percentiles (along with the expected value). Additionally, we estimate the cyclical characteristics for each state based on the coincident index developed by Crone (2002) and reported by the Philadelphia Federal Reserve.[7] Once the cyclical characteristics for each state are estimated, we scale the expansion and contraction growth rates by the elasticity of a state's total revenue with respect to economic activity. This approach ensures that the estimates of the cyclical characteristics of revenue are not influenced by policy changes. Finally, the coincident indices are reported monthly resulting in more accurate measures of the cyclical characteristics because they are not being smoothed out as a result of using lower frequency data.

Distribution of Revenue Shortfalls and Savings Rates

Although both government spending and revenue collections are both influenced by the phases of the business cycle, in the analysis below, we focus on the volatility of revenue collections. Revenue collections are procyclical, increasing during the expansionary phase of the business cycle and declining during the

[6] Owyang, Piger, Wall (2005) estimate business cycle characteristics for each state.

[7] The data are from 1979:09 to 2019:12

contractionary phases of the business cycle. In the analysis below, we assume the economic activity (and hence government revenue collections) is in one of two possible phases; it is either expanding or contracting. When the economy is in an expansionary phase of the business cycle, it expands at a rate of μ_H; when the economy is in a contractionary phase of the business cycle it grows at a rate of μ_L (generally, $\mu_L < 0$). If the economy is in an expansionary phase then there is some probability, P_{HH}, that it remains in an expansionary phase, and the probability it switches to a contractionary phase the following period is denoted P_{HL} (where $P_{HL} = 1 - P_{HH}$). Likewise, if the economy is currently in a contractionary phase then there is some probability P_{LL} that it remains in a contractionary phase next period, P_{LL}, and there is some probability, P_{LH}, that it switches to an expansionary phase the following period.[8] It can be shown that the probability a contraction lasts for exactly t_L period is $P(t_L) = P_{LL}^{t_L-1} - P_{LL}^{t_L}$. As previously mentioned, we assume that the pattern of revenue collections follows the pattern of economic activity with revenue collections increasing when the economy expands and revenue collections decreasing when the economy contracts. Depending upon the specific tax structure of a state, tax collections may be more or less volatile than overall economic activity. The parameter φ denotes the sensitivity of tax collections to economic activity so tax collections grow at rate g_H ($=\varphi*\mu_H$) when the economy is expanding and grow at rate g_H ($=\varphi*\mu_H$) when the economy is contracting.[9] The total revenue shortfall, relative to pre-contraction revenue, associated with an economic contraction can be shown to be $\pi(t_L) = t_L - \sum_{i=1}^{t_L}(1+g_L)^i$. Therefore, the distribution of revenue shortfalls shows the likelihood an economic contraction lasts 1 period along with the revenue shortfall that would occur if an economic contraction lasts 1 period, the likelihood an economic contraction lasts 2 periods along with the revenue shortfall that would occur if the economic contractions lasts 2 periods, and so on.

The distribution of savings rates is calculated in a similar fashion but is slightly more complicated than the revenue-shortfall distribution because the savings rate depends on how long both the expansionary phase of the business cycle lasts as well as how long the contractionary phase lasts (whereas the revenue-shortfall distribution only depends on how long the contraction lasts. Suppose we knew that an expansion was going to last t_H periods and it would be followed by a contraction lasting exactly t_L periods. The question is what fraction of revenue a state should save each expansionary period in order to accumulate enough savings to cover the entire revenue shortfall during the contractionary periods. For example, suppose an expansion lasts 1 period and is followed by a 1 period contraction. If we assume revenue is R_0 before the expansion, then revenue grows to $R_0(1+g_H)$ during the one expansionary period. If the state saves a fraction s of their revenue then the amount of revenue available to finance spending during the one expansionary period is $(1-s)R_0(1+g_H)$ and their accumulated savings is $sR_0(1+g_H)$. During the contraction, actual revenue falls to $R_0(1+g_H)(1+g_L)$. If the state desires to avoid tax increases or spending reductions, the revenue shortfall is the difference between the amount of revenue available to finance spending after the first period and the actual amount of revenue in the contractionary period, $(1-s)R_0(1+g_H) - R_0(1+g_H)(1+g_L)$. The savings rate that is necessary to finance this revenue shortfall is the s that solves $sR_0(1+g_H) = (1-s)R_0(1+g_H) - R_0(1+g_H)(1+g_L)$; solving for s yields

$$s = {(1+g_H)(-g_L)}\Big/{2(1+g_H)}$$

As an example, suppose $R_0 = 100$, $g_H = .05$, and $g_L = -.03$. Using the formula for s, the savings rate is .015. Total revenue in the first period is 105, total savings is .015*105 = 1.575, and the amount available to finance spending in the first period is 103.425. In the second period, revenue declines by 3% so total revenue is 100*1.05*0.97 = 101.85. Relative to the amount available to finance spending in the first period, the revenue shortfall in the second period is 103.425 – 101.85 = 1.575 so the amount saved in the first period is sufficient to make up the revenue shortfall in the second period. By a similar argument, it is possible to

[8] In technical terms, we are assuming the growth rate of economic activity follows a first-order Markov process.

[9] If $\varphi > 1$ then tax collections are more volatile than overall economic activity and if $\varphi < 1$ then tax collections are less volatile than overall economic activity.

solve for the savings rate necessary to equate the total amount saved during t_H expansionary periods to finance the revenue shortfall that would occur in t_L contractionary periods.

The likelihood than an expansion lasts exactly t_H periods is $P(t_H) = P_{HH}^{t_H - 1} - P_{HH}^{t_H}$, so therefore, an expansion lasting t_H periods followed by a contraction lasting t_L periods occurs with probability $P(t_H)*P(t_L)$. Once the savings rates are calculated for every (reasonable) combination of t_H and t_L, the probability distribution for the savings rate is completed by sorting the saving rates from lowest to highest. Finally, a cumulative density function is calculated by summing the probabilities associated with all savings rates that are lower than a given amount. The cumulative density function is of central importance because it reports the cumulative probability of a savings rate being less than or equal to some amount. For example, the 75th percentile savings rate is the savings rate that is greater than or equal to 75% of all possible savings rates. Therefore, if the 75th percentile savings rate is 2.5% for a particular state then if that state saves 2.5% of its annual revenue during expansionary periods then they will accumulate a sufficient amount of savings to weather the resulting revenue shortfall in 75% of all possible expansion-contraction combinations.

The parameter estimates necessary to estimate the distributions of revenue-shortfalls and savings rates are P_{HH}, P_{LL}, μ_H, μ_L, and φ for each state. The first four are estimated using the regime-switching model popularized by Hamilton (1989). The elasticity is estimated for each state by regressing the log difference in (annual) total revenue on a constant and the log difference in (annual) state GDP.

Results

Regression Estimates

The results from estimating the Markov Switching regression are presented below. As mentioned above, a one-size-fits-all recommendation for the size of an RDF makes no sense because of the potential differences among states in terms of their business cycle characteristics. Some states grow faster during expansions than others, some states have longer expansions or contractions, and some states have significantly more overall volatility in their business cycles. These differences can be seen by looking at the parameter estimates of the business cycle characteristics in Table 1. As can be seen, the parameter estimates for the high and low-regime growth rates as well as the transition parameters vary considerably. This is strong evidence against the one-size-fits-all approach for the appropriate size since the cyclical characteristics are very state-specific. For the high-growth regime, the average growth rate is 0.286, but it varies from a maximum of 0.437 (Alaska) to a minimum of 0.114 (Louisiana). For the low-growth regime, the average growth rate is -0.45; four states actually have a positive growth rate whereas three states have low-growth regime growth rates over 1% (per month!!) with Louisiana at -4.6 and West Virginia at -2.4. The transition probabilities, P_{HH} and P_{LL}, also differ considerably across the states. The transition probabilities determine the expected length of the economic expansions and contractions.[10] The average duration of an expansion is 72 months and the average contraction lasts 10.5 months, but again, there is considerable variation across the states. Louisiana has both the longest average expansion AND the shortest average contraction. Fifteen states have an average expansion of at least 83 months, but 16 states have an average expansion of 60 months or less. Calculating the average growth rate for each state, again, there is considerable differences amongst the states with 12 states having an average growth rate of 0.25% (per month) led by Nevada, Arizona, and Utah with average growth rates over 0.30% while 8 states have average growth rates below 0.15% with Michigan, West Virginia, and Louisiana all below 0.10%. Finally, in terms of the volatility of the business cycle, there is are enormous differences between the states. The most states with the most volatile business cycle, Michigan, Louisiana, and West Virginia, have a volatility approximately 5 times that of the least volatile states, Arkansas, Nebraska, and Georgia. Interestingly, in general, the states that have more (less) volatile business cycles tend to the ones with the

[10] The expected duration, $E(t_i) = (1-P_{ii})^{-1}$ for i=H and L

lowest (highest) average growth rates; in other words, there is a strongly negative correlation, -0.51, between the average growth rate and the variance of their growth. Texas, Colorado, and Florida are both in the top 10 in average growth rate AND have one of the top 10 with the lowest volatility. On the flip side, Montana, Kentucky, Michigan, Louisiana, and West Virginia are all in the bottom 10 in terms of their average growth rate AND have one of the tope 10 highest volatility measures.

Shortfall Results

After the discussion in the previous section, it should not be surprising that the revenue shortfalls significantly differ across the states. The shortfall results in Table 2 are expressed as a percentage of pre-contraction annual revenue. For example, the expected revenue shortfall for Kentucky is 7.24% meaning that if Kentucky accumulates 7.24% of their current annual revenue they would have a sufficient amount of savings to weather an average economic contraction without needing to raise taxes or cut their spending when their economy contracts and revenue collections decrease. Because the duration of an economic contraction is unknown with certainty before it starts, the revenue shortfall that may occur is necessarily characterized by a distribution of possibly outcomes (along with the associated probabilities each of those outcomes actually occurs). Table 2 reports four points along that distribution along with the expected value. The four points that are reported are the 25th, 50th, 75th, and 90th percentiles. The 75th percentile revenue shortfall for Arizona is 5.13% meaning that when Arizona experiences an economic contraction and associated revenue shortfall, their total revenue shortfall will be 5.13% or LESS in seventy five percent of all possible economic contractions they might experience, given their estimated business cycle characteristics. In general, it might be useful to think of the 25th percentile numbers as representative of a very mild recession whereas the 90th percentile numbers might be thought of as a relatively severe economic contraction.

A first interesting point is that the expected revenue shortfall (which can be thought of as the average revenue shortfall) is much larger than the MEDIAN shortfall. The median shortfall is the 50/50 split of revenue shortfalls; half the possible economic contractions are more severe than this and half are less severe than this. The reason for this is because the estimated P_{LL}'s (the likelihood of remaining in an economic contraction) are so high. The average P_{LL} is 0.891. Table 1 demonstrates the distribution of potential revenue shortfalls.[11] Based on this number, the likelihood than an economic contraction lasts 6 months or less is 50%. If the contraction lasts for 6 months or less, then the total revenue shortfall will be relatively small. Using the average low-growth regime growth rate of -0.45 and the average elasticity of revenue to economic activity of 1.75, if a contraction lasts 6 months then the total revenue shortfall is only 1.36% of pre-contraction revenue (so there is a fifty percent chance the revenue shortfall will be 1.36% or less). Alternatively, there is only a twenty five percent chance the economic contraction lasts more than 12 months, but the revenue shortfall associated with an economic contraction lasting 12 months is almost five percent and every period the contraction lasts, the additional revenue shortfall associated with an additional period of economic contraction gets larger and larger. Therefore, even though long recessions (such as one lasting 12 months or longer) are relatively rare, the revenue shortfalls associated with these longer recessions are very severe. In fact, the median revenue shortfall is generally approximately equal to 75th percentile revenue shortfall for most states.

Thirty-six states have an average revenue shortfall of five percent or less indicating that the 5% recommendation from the NCSL may have been appropriate for those states. Alternatively, 3 states have an average shortfall of 10% or more. If legislators want to be more cautious by accumulating more savings, thus avoiding tax increases or spending cuts during recessions, then they may want to accumulate a savings level equal to (or greater than) the 90th percentile numbers. For this level of savings, 21 states have potential revenue shortfalls of 10% or more with 7 states having 90th percentile revenue shortfalls in excess of 20 percent.

[11] Based on the average low-growth regime growth rate and average elasticity.

One additional point to note are the four states that have a positive low-growth regime growth rate. Based on our methodology, these states do not need to accumulate any savings because a revenue shortfall is not possible. This conclusion for these states is very likely unrealistic and is completely due to the methodology used to calculate revenue shortfall. In our methodology, we use the *point* estimate for the low-growth regime growth rate to calculate the potential revenue shortfalls. An alternative strategy for computing the potential revenue shortfalls would be to pull values for the low-growth regime growth rate from the distribution of the estimate. Although more technically correct, the cost of using this methodology is the ability to offer an intuitive explanation of the results is diminished. Therefore, although the results presented in Table 2 suggest these four states do not need to accumulate much savings, they should take this as a recommendation that they do not need to accumulate very much in savings.

Ability to Weather Recession

Most states have accumulated savings in their RDF. Table 3 reports the accumulated savings in RDF's as of 2019.[12] Wyoming has the largest RDF (as a percentage of their annual revenue) by far with a fund size of 122%. The average state has accumulated savings of 11.2% of revenue, but taking Wyoming out reduces this number to 8.9% and if the number two state, Alaska, is also exempted reduces the average to 7.3%; the median among all the states is 7.1%. Fifteen states have accumulated savings of 10% or more while fifteen states have accumulated savings less than 5% with 5 states that have less than 2% accumulated savings in their RDF. As mentioned above though, the question naturally arises whether the states that have accumulated a significant amount of savings actually the states that need to do so.

In order to calculate how ready states are to weather an economic contraction, it is possible to compare the amount that each state has accumulated in their RDF with that state's distribution of revenue shortfalls. For example, Hawaii has accumulated 4.8% of their current annual revenue in their RDF. Their 75th percentile revenue shortfall is 2.2% while their 90th percentile revenue shortfall is 5.8%. Therefore, they can clearly weather somewhere between 75 and 90 percent of all revenue shortfalls they may experience. Based on their complete distribution of revenue shortfalls, Hawaii can weather 87.5% of all possible revenue shortfalls they may experience. Specifically, based on the methodology used in this essay, Hawaii has a sufficient amount of savings to weather an economic contraction lasting 15 months or less. Overall, 26 states have accumulated a sufficient amount of savings to cover 90% or more of all the possible revenue shortfalls they may experience. On the other hand, six states have accumulated savings sufficient to cover *less than* 50% of their possible revenue shortfalls, and 12 states have insufficient funds to cover the revenue shortfall associated with an *average* economic contraction.

Savings Rates

Knowing HOW MUCH savings to accumulate is obviously useful to legislators, but an additional piece of information that would be helpful is the savings *rate* that would be necessary to achieve the desired level of total accumulated savings. The determination of the appropriate savings rate is more difficult than the formation of the distribution of potential revenue shortfalls because the distribution of revenue shortfalls only depends on the economic contraction characteristics, g_L and P_{LL} whereas the savings rate additionally depends on the economic expansion characteristics, g_H and P_{HH}. Therefore, the savings rate depends on how fast a state's economy expands as well as the duration of an economic expansion for that state. Table 4 reports the distribution of savings rates. Interpreting the numbers in Table 4 is best explained by an example. The median savings rate for Louisiana, 1.25%, is the rate of savings which if followed, would allow Louisiana to accumulate a sufficient amount of savings during an expansion to weather the following economic contraction. In other words, if Louisiana saves 1.25% of their revenue

[12] Based on the *Fiscal Survey of States*, Spring 2020 from the National Association of State Budget Officers.

while the state is expanding then they will accumulate a sufficient amount of savings to avoid tax increases or spending cuts when revenue declines during their contraction. At a savings rate of 1.25%, this will be true in 50 percent of all possible combinations of expansion-contraction durations. If a state follows the savings rates listed in the Expected Value column, then on average, the state will accumulate enough savings during an expansion to finance its revenue shortfall during the following economic contraction.

Obviously, there will be business cycles with shorter expansions and longer contractions for which the amount of accumulated savings is not sufficient, but there will also be expansions that are longer and contractions that are shorter for which the state will "over-save". On average, the over-saving will cancel out the insufficient savings. Again though, the *average* savings rate can be very different than the *median* savings rate because of the skewness of the distribution of potential shortfalls. In general, the median state needs to save at a rate of 0.65% of revenue each expansionary period in order to accumulate enough savings on average, but this number varies from less than 0.5% for 19 states to over 1% for 16 states and even over 2% for 3 states, West Virginia, Michigan, and Montana. States that tend to have lower expansion growth rates or shorter expansions tend to have to save a larger fraction of their revenue. Similarly, states that contract more significantly during economic contractions or have economic contractions that last longer also tend to have higher required savings rates.

Even though the "Expected Value" savings rate is the rate of savings that will, on average, allow a state to accumulate a sufficient amount of savings to avoid tax increases or spending cuts during an economic contraction, Table 4 also reports various points along the savings rate distribution. If the legislators in a state had as their objective to really avoid tax increases or spending reductions during economic contractions, then they could choose to save at a higher rate such as the 75th percentile or 90th percentile savings rates because, as mentioned, even though the Expected Value savings rate is sufficient on average, there will be business cycles in which the expansion was shorter than expected or the contraction longer than expected in which case the savings accumulated during an expansion will prove to be insufficient to keep spending constant during the economic contraction. For example, if legislators in Illinois wanted to be more sure of avoiding tax increases or spending reductions, they could save at the 75th percentile savings rate of 1.56% during expansionary periods. At this rate, they would accumulate a sufficient amount of savings in 75% of all expansion-contraction duration combinations, or in other words, in 75% of all business cycles, they would accumulate enough savings to keep their spending (and tax rates) constant during a recession.

Conclusion

Since the revenue that states collect is procyclical, it is virtually inevitable that revenue will decline during periods of economic contraction. If states do not have any savings, or an insufficient amount of savings, then, since most states have some form of balanced budget requirement, they will be forced to either increase tax rates or reduce spending during an economic contraction. Rainy day funds are commonly used to accumulate savings during expansions. The basic problem for legislators though is because the severity and duration of the phases of the business cycle are unknown beforehand, it is impossible to know how much to save. Furthermore, since every state has different business cycle characteristics (expansion and contraction growth rates as well as durations) and different tax bases and tax structures (making the sensitivity of revenue collections to economic activity different in each state), a one-size-fits-all approach simply makes no sense. Furthermore, deriving point estimates of how much of a revenue shortfall a state may experience is not necessarily very useful since, again, the duration and severity of the business cycle phases are unknown beforehand. In this essay, we have accomplished a number of tasks. First, we have calculated the distribution of revenue shortfalls for each state based on their state-specific business cycle characteristics. This distribution is useful because when combined with their current level of savings, tells legislators how prepared they are currently. Additionally, this distribution can inform them of savings goals based on their own preferences for avoiding tax increases or spending reductions during an economic contraction. Furthermore, we have assessed how prepared each state is currently by comparing the distribution of potential revenue shortfalls with each state's accumulated savings in their RDF. Finally, we have laid out a roadmap concerning the rate at which each state could save to accumulate a sufficient amount of savings which may be at least of equal importance relative to just having goals for total accumulated savings.

Table 1: Markov Switching Regression Estimated Parameters and Estimated Elasticity

State	μ_H	μ_L	P_{HH}	P_{LL}	$E(t_H)$	$E(t_L)$	**Elasticity**
Alabama	-0.681	0.273	0.987	0.883	-0.681	0.273	2.03
Alaska	0.082	0.437	0.868	0.98	0.082	0.437	4.32
Arizona	-0.267	0.435	0.982	0.912	-0.267	0.435	1.74
Arkansas	-0.006	0.222	0.988	0.91	-0.006	0.222	0.89
California	-0.094	0.355	0.984	0.93	-0.094	0.355	2.26
Colorado	0.025	0.34	0.984	0.933	0.025	0.34	1.91
Connecticut	-0.142	0.282	0.978	0.936	-0.142	0.282	1.45
Delaware	-0.819	0.245	0.992	0.832	-0.819	0.245	0.99
Florida	-0.005	0.335	0.985	0.929	-0.005	0.335	2.39
Georgia	0.062	0.31	0.98	0.873	0.062	0.31	1.48
Hawaii	-0.321	0.252	0.979	0.878	-0.321	0.252	1.29
Idaho	-0.292	0.318	0.989	0.873	-0.292	0.318	2.06
Illinois	-0.401	0.237	0.985	0.902	-0.401	0.237	1.78
Indiana	-0.353	0.25	0.987	0.906	-0.353	0.25	0.99
Iowa	-0.641	0.21	0.991	0.85	-0.641	0.21	1.05
Kansas	-0.565	0.226	0.988	0.871	-0.565	0.226	1.09
Kentucky	-0.742	0.287	0.982	0.882	-0.742	0.287	1.79
Louisiana	-4.616	0.114	0.996	0.749	-4.616	0.114	2.27
Maine	-0.601	0.238	0.986	0.854	-0.601	0.238	0.59
Maryland	-0.467	0.317	0.983	0.888	-0.467	0.317	2.17
Massachusetts	-0.323	0.357	0.985	0.932	-0.323	0.357	1.91
Michigan	-1.251	0.254	0.981	0.838	-1.251	0.254	2.21
Minnesota	-0.365	0.281	0.988	0.886	-0.365	0.281	1.58
Mississippi	-0.182	0.195	0.98	0.873	-0.182	0.195	1.82
Missouri	-0.235	0.215	0.982	0.889	-0.235	0.215	1.34
Montana	-0.51	0.251	0.984	0.899	-0.51	0.251	3.37
Nebraska	-0.023	0.23	0.985	0.896	-0.023	0.23	1.53
Nevada	-0.245	0.401	0.988	0.912	-0.245	0.401	1.57
New Hampshire	-0.235	0.347	0.986	0.902	-0.235	0.347	0.72
New Jersey	-0.109	0.233	0.983	0.908	-0.109	0.233	1.54
New Mexico	-0.323	0.273	0.988	0.88	-0.323	0.273	2.03
New York	-0.21	0.236	0.98	0.903	-0.21	0.236	2.21
North Carolina	-0.071	0.297	0.984	0.903	-0.071	0.297	1.60
North Dakota	-0.151	0.341	0.97	0.891	-0.151	0.341	1.99
Ohio	-0.451	0.211	0.986	0.883	-0.451	0.211	2.73
Oklahoma	-0.305	0.237	0.983	0.855	-0.305	0.237	1.99
Oregon	-0.346	0.323	0.986	0.873	-0.346	0.323	3.41
Pennsylvania	-0.366	0.217	0.987	0.895	-0.366	0.217	1.56
Rhode Island	-0.411	0.266	0.988	0.928	-0.411	0.266	1.36
South Carolina	-0.379	0.33	0.982	0.876	-0.379	0.33	2.13
South Dakota	-0.668	0.294	0.991	0.868	-0.668	0.294	0.56
Tennessee	-0.439	0.363	0.977	0.887	-0.439	0.363	1.92
Texas	0.014	0.323	0.987	0.919	0.014	0.323	1.51
Utah	-0.077	0.368	0.987	0.909	-0.077	0.368	1.75
Vermont	-0.387	0.288	0.988	0.896	-0.387	0.288	1.12
Virginia	-0.039	0.293	0.984	0.93	-0.039	0.293	2.45
Washington	-0.199	0.342	0.985	0.909	-0.199	0.342	0.77
West Virginia	-2.359	0.306	0.988	0.868	-2.359	0.306	0.94
Wisconsin	-0.366	0.24	0.988	0.887	-0.366	0.24	1.04
Wyoming	-0.652	0.22	0.988	0.867	-0.652	0.22	2.20
Mean	-0.45	0.28	0.98	0.891	-0.45	0.28	1.75
Median	-0.32	0.28	0.99	0.89	-0.32	0.28	1.74
Max	0.08	0.44	1.00	0.98	0.08	0.44	4.32
Min	-4.62	0.11	0.87	0.75	-4.62	0.11	0.56

Table 2: Estimated Revenue Shortfalls

State	Exp. Value	25%	50%	75%	90%
Alabama	7.61	0.68	2.36	8.53	20.14
Alaska	0.00	0.00	0.00	0.00	0.00
Arizona	4.76	0.38	1.38	5.13	12.10
Arkansas	0.05	0.00	0.02	0.05	0.14
California	3.51	0.18	0.97	3.66	9.13
Colorado	0.00	0.00	0.00	0.00	0.00
Connecticut	4.07	0.26	1.13	3.92	10.58
Delaware	2.31	0.20	0.67	2.39	5.97
Florida	0.20	0.01	0.05	0.19	0.52
Georgia	0.00	0.00	0.00	0.00	0.00
Hawaii	2.25	0.21	0.72	2.25	5.76
Idaho	2.98	0.30	1.04	3.24	7.41
Illinois	5.80	0.35	1.64	6.04	15.55
Indiana	3.19	0.17	1.04	3.44	8.52
Iowa	2.40	0.17	0.83	2.48	6.53
Kansas	2.96	0.31	1.07	3.32	7.61
Kentucky	7.24	0.66	2.28	8.24	19.47
Louisiana	10.54	0.87	4.87	11.38	24.80
Maine	1.35	0.09	0.44	1.31	3.48
Maryland	6.24	0.50	1.75	6.35	16.66
Massachusetts	10.25	0.76	2.77	10.38	27.02
Michigan	7.67	0.68	2.24	7.77	21.49
Minnesota	3.54	0.29	1.00	3.67	9.73
Mississippi	1.67	0.17	0.58	1.80	4.15
Missouri	2.08	0.16	0.55	2.02	5.40
Montana	12.17	0.85	3.87	13.97	32.22
Nebraska	0.27	0.02	0.08	0.27	0.68
Nevada	3.98	0.32	1.14	4.27	10.09
New Hampshire	1.44	0.08	0.39	1.47	3.83
New Jersey	1.63	0.08	0.50	1.67	4.15
New Mexico	3.63	0.33	1.14	3.53	10.00
New York	3.93	0.23	1.07	3.97	10.30
North Carolina	0.99	0.06	0.26	0.99	2.58
North Dakota	2.06	0.15	0.70	2.25	5.16
Ohio	6.86	0.61	2.11	7.66	18.14
Oklahoma	2.32	0.15	0.75	2.24	5.89
Oregon	5.64	0.59	2.03	6.25	14.15
Pennsylvania	4.10	0.28	1.31	4.22	10.55
Rhode Island	8.37	0.46	2.52	8.55	21.83
South Carolina	4.13	0.40	1.39	4.31	10.97
South Dakota	1.76	0.19	0.47	1.70	4.70
Tennessee	5.15	0.42	1.45	5.30	13.96
Texas	0.00	0.00	0.00	0.00	0.00
Utah	1.33	0.11	0.40	1.34	3.60
Vermont	3.23	0.22	1.01	3.24	8.13
Virginia	1.60	0.08	0.44	1.66	4.16
Washington	1.52	0.13	0.46	1.52	4.10
West Virginia	9.28	1.10	2.70	9.54	25.26
Wisconsin	2.40	0.19	0.66	2.43	6.48
Wyoming	6.17	0.71	1.76	6.29	16.93
Mean	3.73	0.30	1.16	3.92	9.80
Median	3.09	0.21	1.00	3.28	7.87
Max	12.17	1.10	4.87	13.97	32.22
Min	0.00	0.00	0.00	0.00	0.00

Table 3: Rainy Day Fund Balances and Ability to Weather a Revenue Shortfall

State	RDF Size	% of Potential Shortfalls
Alabama	9.1	77.5
Alaska	86.9	99.9
Arizona	4.1	72.5
Arkansas	2.6	100.0
California	15.2	94.9
Colorado	9.1	100.0
Connecticut	12.8	91.9
Delaware	5.2	89.0
Florida	4.3	99.9
Georgia	11.0	100.0
Hawaii	4.8	87.5
Idaho	11.3	94.2
Illinois	0.0	9.8
Indiana	8.6	90.6
Iowa	9.7	94.6
Kansas	0.0	0.0
Kentucky	1.1	39.5
Louisiana	4.0	43.9
Maine	8.0	97.3
Maryland	4.8	69.5
Massachusetts	9.9	73.8
Michigan	10.8	79.6
Minnesota	10.3	91.1
Mississippi	5.9	93.4
Missouri	6.8	92.5
Montana	2.3	41.3
Nebraska	6.8	99.9
Nevada	7.1	84.2
New Hampshire	7.1	95.9
New Jersey	1.1	68.6
New Mexico	13.8	94.0
New York	2.9	67.4
North Carolina	5.1	96.2
North Dakota	5.9	91.1
Ohio	8.0	77.5
Oklahoma	10.5	95.6
Oregon	11.1	85.1
Pennsylvania	0.1	10.5
Rhode Island	5.1	64.9
South Carolina	6.0	82.1
South Dakota	10.4	97.1
Tennessee	5.7	76.3
Texas	18.8	100.0
Utah	9.2	97.8
Vermont	13.3	94.8
Virginia	3.7	88.7
Washington	7.3	95.7
West Virginia	15.8	84.1
Wisconsin	3.7	83.4
Wyoming	122.2	99.9
Mean	11.18	81.11
Median	7.09	90.88
Max	122.24	100.00
Min	0.00	0.00

Table 4: Savings Rates

State	Exp. Value	25%	50%	75%	90%
Alabama	1.74	0.16	0.65	2.14	5.20
Alaska	0.00	0.00	0.00	0.00	0.00
Arizona	1.09	0.11	0.45	1.38	3.02
Arkansas	0.01	0.00	0.00	0.01	0.03
California	0.67	0.07	0.28	0.87	1.89
Colorado	0.00	0.00	0.00	0.00	0.00
Connecticut	0.79	0.09	0.35	1.04	2.18
Delaware	0.46	0.04	0.16	0.61	2.24
Florida	0.04	0.00	0.02	0.05	0.10
Georgia	0.00	0.00	0.00	0.00	0.00
Hawaii	0.63	0.06	0.24	0.77	1.76
Idaho	0.66	0.06	0.24	0.82	2.12
Illinois	1.26	0.12	0.48	1.56	3.63
Indiana	0.62	0.05	0.22	0.75	1.86
Iowa	0.48	0.04	0.16	0.61	1.92
Kansas	0.65	0.05	0.22	0.77	2.00
Kentucky	1.92	0.19	0.75	2.37	5.39
Louisiana	1.57	0.30	1.25	16.63	0.00
Maine	0.34	0.03	0.11	0.38	0.98
Maryland	1.59	0.16	0.62	1.98	4.47
Massachusetts	1.88	0.19	0.79	2.47	5.36
Michigan	2.50	0.27	0.96	3.00	6.93
Minnesota	0.75	0.07	0.27	0.92	2.32
Mississippi	0.47	0.05	0.17	0.56	1.31
Missouri	0.51	0.05	0.19	0.62	1.44
Montana	2.94	0.31	1.23	3.78	8.33
Nebraska	0.06	0.01	0.02	0.07	0.17
Nevada	0.76	0.07	0.29	0.97	2.32
New Hampshire	0.30	0.02	0.10	0.36	0.87
New Jersey	0.36	0.03	0.13	0.44	1.00
New Mexico	0.80	0.07	0.29	0.98	2.47
New York	0.97	0.10	0.39	1.21	2.69
North Carolina	0.22	0.02	0.08	0.27	0.62
North Dakota	0.64	0.08	0.28	0.83	1.74
Ohio	1.63	0.16	0.62	2.01	4.76
Oklahoma	0.66	0.06	0.24	0.77	1.84
Oregon	1.49	0.15	0.59	1.85	4.28
Pennsylvania	0.86	0.07	0.30	1.05	2.56
Rhode Island	1.39	0.12	0.54	1.80	4.28
South Carolina	1.14	0.12	0.44	1.39	3.18
South Dakota	0.33	0.03	0.11	0.42	1.31
Tennessee	1.49	0.16	0.62	1.88	4.10
Texas	0.00	0.00	0.00	0.00	0.00
Utah	0.27	0.02	0.10	0.34	0.79
Vermont	0.64	0.05	0.23	0.79	1.98
Virginia	0.30	0.03	0.12	0.39	0.85
Washington	0.31	0.03	0.11	0.38	0.89
West Virginia	2.10	0.19	0.74	2.56	6.50
Wisconsin	0.49	0.04	0.17	0.59	1.53
Wyoming	1.43	0.13	0.51	1.74	4.39
Mean	0.84	0.08	0.34	1.34	2.39
Median	0.65	0.06	0.24	0.80	1.95
Max	2.94	0.31	1.25	16.63	8.33
Min	0.00	0.00	0.00	0.00	0.00