Special Report / Viewpoint

Rainy Day Funds and Value at Risk

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This report and the other special report this week were prepared for a conference on "State Fiscal Crises: Causes, Consequences, and Solutions," held by the Urban Institute and Brookings Institution's Tax Policy Center and Northwestern University's Kellogg School of Management and Institute for Policy Research; the conference was held on April 3 in Washington. (For a report on this conference, see State Tax Notes*, Apr. 14, 2003, p. 150;* 2003 STT 66-1*; or* Doc 2003-8738 (2 original pages)*.)*

Reports from the fiscal crisis conference that appear here may also be found at http://www.taxpolicycenter.org.

Introduction

The most recent economic slowdown has painfully exposed the inadequacy of rainy day funds (RDFs). Even with these reserve funds, revenue shortfalls have forced state governments to patch together tax increases and spending cuts in order to balance budgets. The revenue declines reveal the need for more formal methodology that can prescribe the size of RDFs better than simplistic application of rules of thumb. As an alternative to heuristics, established and proven methodologies exist for similar risk-management problems encountered in private enterprise. As yet, however, such methodologies have not been applied to the complex problems encountered in public management.

This report first enumerates the fiscal uncertainties inherent in state budgeting. Subsequent review of the tax policy and risk-management literature contributes a methodology applicable for determining the RDF's size. This procedure is finally illustrated using current state fiscal situations.

Fiscal Uncertainties in State Budgeting

Because states differ, RDF design requires customized attention. States derive revenues from a variety of sources. Major revenue categories include sales, personal income, corporate franchise, motor fuels, severance, and other miscellaneous taxes, fees, and assessments. The dominance of income and sales taxes in the portfolio mix is well-known. The business cycle plays a prominent role in the growth and stability of these taxes. The business cycle also influences a state's expenditure demands. This is true in the case of all the major spending categories: education, welfare, health care, corrections, and highways. Medicaid, unemployment compensation, and welfare are examples of state outlays that vary significantly with the business cycle. Because of the heterogeneity among state economic conditions and tax codes, a one-size-fits-all RDF model may not result in valuable management insights.

Possible Strategies for Budget Deficits

Because of either legal requirements or political expediency, most state governments must balance their budgets at the conclusion of each fiscal year. In most states, constitutional or statutory provisions mandate that collected revenues equal or exceed actual expenditures. In addition to legal requirements, political survival can depend on a balanced budget. Few governors or individual legislators can successfully run for reelection against the background of a deficit.

When unexpected shortfalls develop, states must take immediate steps to achieve a balanced outcome. Shortfalls are generally discovered well after the fiscal year has begun and opportunities to recall the legislature are limited. When confronted with unexpected revenue shortfalls, states can respond by using three basic approaches. First, they may increase tax revenue. Because of both timing and politics, however, the alternative of raising taxes is often impossible. Even in favorable situations, a decision to increase taxes is fraught with explosive political land mines that undermine virtually every effort.

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Second, states can impose across-the-board cuts. This alternative causes almost as many difficulties as raising taxes. Often a high percentage of a state's expenditures is associated with personnel costs and is thus difficult to reduce on short notice. Neither expenditures nor programs protected by court mandates or legislated code allow any promise for fiscal relief. In cases in which states do find excess funds, the agency from which the funds will be taken and/or the clients served by the agency vigorously resist the perceived raid on their resources.

Finally, states can seek temporary solutions. They can borrow from external or internal accounts. A common practice has been to change accounting procedures to allow the recording

of expenditures in the subsequent fiscal year or to book next year's revenue during the current year. Changing the assumptions on long-term funding of pensions has also been used to reduce the annual contributions going into the retirement corpus and provide a one-time budget savings (Alt and Lowery, 1994). Another short-run avenue to cope with shortfalls prompts state governments to postpone capital expenditures, restructure long-term debt repayment schedules, impose hiring freezes, and limit out-of-state travel.

Rainy Day Fund Dimensions

None of the above reactions to fiscal crises would be identified in a list of best-practice management techniques. Rather, they are characterized by a sense of crisis management, minimization of conflict, or desperation (Moore, 1995). The crisis nature of unexpected fiscal mismatches leads directly to the advantages of RDFs. Using RDF funds to offset the shortfall in revenue or shore up proposed spending mitigates some of the problems associated with a budget deficit. The availability of RDF resources allows a state to respond to situations in a timely fashion and avoid unwise and shortsighted decisions.

The RDF's operating characteristics must remain politically feasible and anticipate potential political consequences for elected and administrative officials. They must also avoid unintended outcomes. For example, the existence of a sizable RDF may create a moral hazard because bureaucrats may be less inclined to worry about careful budget preparation. They may simply assume that differences between planned and actual revenues will be made up and thus careful expenditure planning is unnecessary.

A major policy issue is the size of RDFs relative to state expenditures. Aside from politics, there is also a concern about allowing public funds to sit idle in an insurance account. The opportunity cost of a bloated RDF may be substantial. In general, the larger the shortfall as a percent of proposed expenditures, the larger the level of disutility. When shortfalls turn into surpluses, they are initially perceived as a positive. As the surplus gets larger, however, disutility begins to be manifest. Exactly how large a surplus needs to be before disutility begins to arise is unclear.

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In the past, ad hoc calculations have often established rule-of-thumb limitations on RDFs. A majority of states limit the size of their RDFs to less than 10 percent of the planned expenditures (28 of 46 states). The most common cap is 5 percent (21 of 46 states). The 5 percent rule is advocated by the National Conference of State Legislatures (NCSL) and is recommended in an ad hoc manner by "Wall Street." The 5 percent rule is now being considered by local governments in the United States (Tyer, 1993) and is part of policy recommendations offered by the World Bank to emerging and transitional countries. Joyce (2001), among others, questions the adoption of a 5 percent standard.

Previous Rainy Day Fund Research

The reported research on the optimal size of RDFs has been based on ex post analysis of the fiscal consequences of economic downturns. The analysis usually starts by estimating the long-term trends of both expenditures and tax revenues in a specific state. The standard assumption is that if a downturn does not occur, then revenue and expenditure trends should continue. When a downturn does materialize, the deviations are measured and the resulting expenditure reductions or tax increases are assumed to represent the shortfall that a an RDF could be expected to offset.

Using this analysis in specific states has found that the current levels of existing RDFs are inadequate. Relying on data from Indiana, Pollock and Suyderhoud (1986) estimate the RDF needed to prevent an expenditure reduction or tax increase during the period 1969 to 1983. They conclude that the RDF in Indiana needed to be as high as 13 percent to avoid a change in state expenditure and revenue patterns. They also determine withdrawals from the RDFs would have been required in 31 out of 59 quarters.

Vasche and Williams (1987) use California data to examine the required size of the state's RDF. Their analysis focuses on the error margins associated with the revenue forecasts over the period 1973-74 and 1984-85. They center attention on the error margins associated with personal income forecasts because of their historical importance in revenue forecasting accuracy. They find that a 1 percent error in the personal income forecast increases the error in the sales and income tax forecast by about 2 percent. They conclude that an RDF of approximately 10 percent would insure California against a serious downturn in the economy. They also find that a reserve fund of approximately 3 percent would offer forecasting protection. They thus recommend a reserve fund of 5 percent.

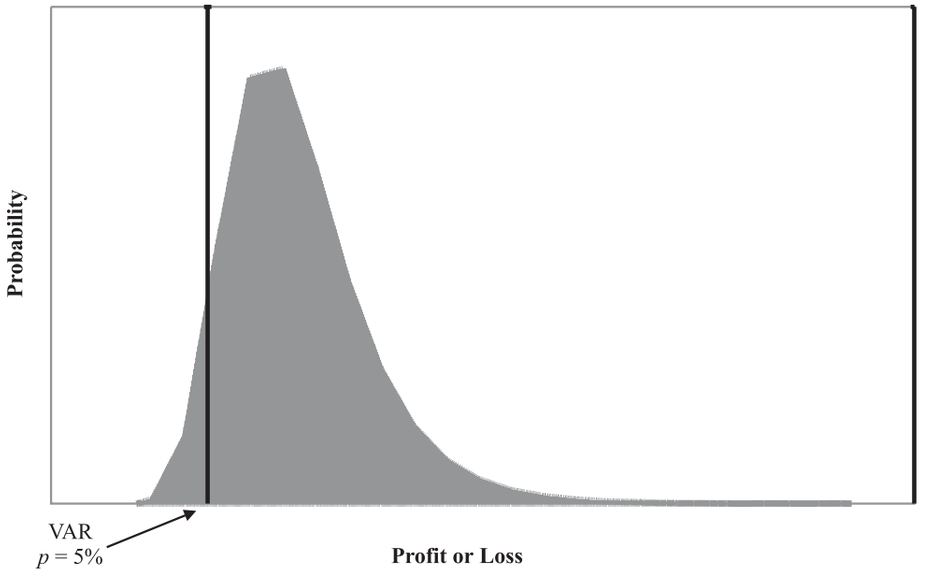
Sobel and Holcombe (1996) calculate the required size of an RDF that would have been needed in 1988 to allow each state to survive the downturns that occurred in the period 1989-1992. On average, they estimate that states should have reserved 30 percent of their 1988 expenditures. For some states, the RDF could have been 5 percent or less. For many states, however, the size of the fund was well in excess of 50 percent. They suggest that if states pooled their surplus funds, they could reduce the RDF required size to 16.7 percent of 1988 expenditure levels.

Navin and Navin (1997) estimate the optimal size of an RDF for Ohio using data for the period 1985 to 1995. As with the analysis of Indiana and California, they set out to determine the optimal size of the RDF based on the ability of the state to continue operating on consistent expenditure and revenue trends. They find that the Ohio RDF would need to be greater than 11 percent of the previous year's appropriations in order to avoid disruptive expenditure decisions or tax increases. Sjoquist (1998) uses a similar methodology to estimate that Georgia needs an RDF over 27 percent.

Fiscal Uncertainty and the Business Cycle

Because no two states share identical political or economic characteristics, it is hardly surprising that states experience differential responses to upturns or downturns in the economy. Michigan, for example, is closely linked to the automobile and light manufacturing industries, Hawaii to travel and tourist spending, and Texas to energy. Changes in the general economy differentially affect each of these states. The national business cycle may not be the most accurate representation of a given state's economic situation.

Figure 1
Value at Risk



States also differ in their degree of dependence on specific taxes. Some states rely heavily on income taxes, others heavily on sales taxes. In the states where there are substantial differences in the relative importance of taxes, it is reasonable to expect varying responses to economic changes. Different outcomes even occur in states with evenly balanced income tax, sales tax, and miscellaneous revenues (Suyderhoud, 1994). Some states have adopted progressive income tax systems, and the result is an income tax that is quite buoyant, rapidly increasing or decreasing as the economy declines or grows. Other states imposed an income tax with a single flat rate and the result is a relatively unresponsive income tax system. The difference in the elasticity or responsiveness of state income taxes is substantial (Dye and McGuire, 1999). Similar observations can be made about sales taxes. Some states have broad sales tax bases and lower rates and a resulting inelastic source of revenue. Others have narrow sales tax bases and high rates and a resulting responsive revenue source.

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The importance of the business cycle on RDFs may not be correctly perceived by some public officials. Their sensitivity to the size needed for an RDF could be counterintuitive depending on the phase of the business cycle. After a period of prolonged economic expansion, for example, policymakers may not correctly anticipate the benefits of an adequate RDF. A likely outcome in a mature expansion is a significant, possibly lengthy, contraction in the economy. In this situation, a sizable RDF may be needed most. Policymakers accustomed to growth, however, would be less likely to fund the RDF. Conversely, following a sustained slowdown or a trough, the economy would likely be characterized by positive and accelerating growth rates. In this case, a smaller RDF would be appropriate given the assumption of economic recovery and growth. In such situations, because of the experiences of the immediate past, policymakers would be inclined to react by proposing a larger RDF.

Value at Risk

In response to risk exposures to exchange rates, interest rates, and commodity prices, analysts and decision-makers have developed many new tools for risk management. Although the ability to model the risk and return of a portfolio using the simplifications to the Markowitz (1959) framework outlined by Sharpe (1963) represents a significant advancement, the development of financial derivatives initiated a need to summarize risk based on a probability distribution function (PDF). In response to decisionmakers' desires for summary measures, analysts developed the statistic known as value at risk (VAR).

A substantial literature such as Dowd (1998) and Crouhy, Galai, and Mark (2001) documents the VAR concept. Jorion (2001) states that "VAR summaries the worst loss over a target horizon with a given level of confidence. More formally, VAR describes the quartile of the forecasted PDF of gains and losses over the target horizon. If 1-p is the selected confidence level, VAR corresponds to the p lower-tail level." In Figure 1, the graph identifies the VAR as the value that leaves probability p in the lower-tail. This means that there is only probability p that a loss will exceed the VAR value.

VAR Application to Rainy Day Funds

Because a budget deficit or surplus is defined as revenues minus expenses, risk naturally originates from uncertainty in both monetary inflows and outflows. Significant studies investigate the revenue uncertainty and lay the foundation for characterizing the PDFs of revenues. Relatively less research focuses on expenditure risk, which makes it much more difficult to establish an empirical base to quantify this uncertainty.

Revenue Uncertainty

Holcombe and Sobel (1997) lay the groundwork for quantitatively integrating revenue risk into the RDF problem. They astutely establish the need "to measure variability related to the

business cycle, rather than variability in general." They do this by focusing on elasticities that measure the percentage change in revenue relative to the percentage change in economic aggregates such as personal income.

The concept of a revenue elasticity is very similar to the beta coefficient of Sharpe's single index model (1963). He quantifies the risk of financial market portfolios by focusing on the covariance of an individual common stock's return with the return on the market portfolio. The beta for a given stock is like an elasticity because it is the ratio of the percentage change in the equity price relative to the percentage change in the market portfolio. When a stock's beta equals 1, then the stock systematically follows the market portfolio. This means that when equity markets increase by 1 percent, then the return on the stock also increases by 1 percent. When a stock's beta exceeds 1, the stock is more volatile than the market portfolio. When a stock's beta is less than 1, then the stock is more conservative than the market portfolio.

Another analytical advantage of the Sharpe model is that it allows decomposition of total risk into systematic and unsystematic categories. Because the beta coefficient is estimated by regressing an individual stock's excess return on the excess return of the market portfolio, an analysis of variance reports the standard partition of total variance into explained and unexplained components. The explained variance, the deviations due to the market, is known as systematic or market risk. The unexplained portion of the variance is the nonsystematic, idiosyncratic, or company-specific risk.

Because the business cycle causes most tax revenues to move together over time, considering individual revenue sources as components in a portfolio of taxes allows adaptation of the financial market methodology. Parameter values for tax elasticities, as prescribed by Holcombe and Sobel (1997), are estimated by regressing appropriate growth rates of individual taxes on similar growth rates for macroeconomic aggregates. This subdivides the total revenue risk of each tax into systematic risk, that attributable to the business cycle, and unsystematic risk, or that uncertainty that is specific to the individual tax source.

Expenditure Uncertainty

A very simplistic model categorizes annual changes in expenditures into those associated with the base budget and those costs related to the business cycle. This works well with Medicaid and unemployment benefits because they correlate more strongly with the business cycle than other expenditures.

Because research similar to the well-developed tax revenue methodology has not yet occurred for the expenditure side of the fiscal ledger, untested methodology and data scarcity require recourse to human judgment. This lack of established procedures forces reliance on subjective assessment of expenditure uncertainty. Morgan and Henrion (1990) assert that "when the value of an uncertain quantity is needed in policy analysis, and limits in data or understanding preclude the use of conventional statistical techniques to produce probabilistic estimates, about the only remaining option is to ask experts for their best professional judgment." A rich literature from Kahneman, Slovic, and Tversky (1982) gives background useful for such constructs.

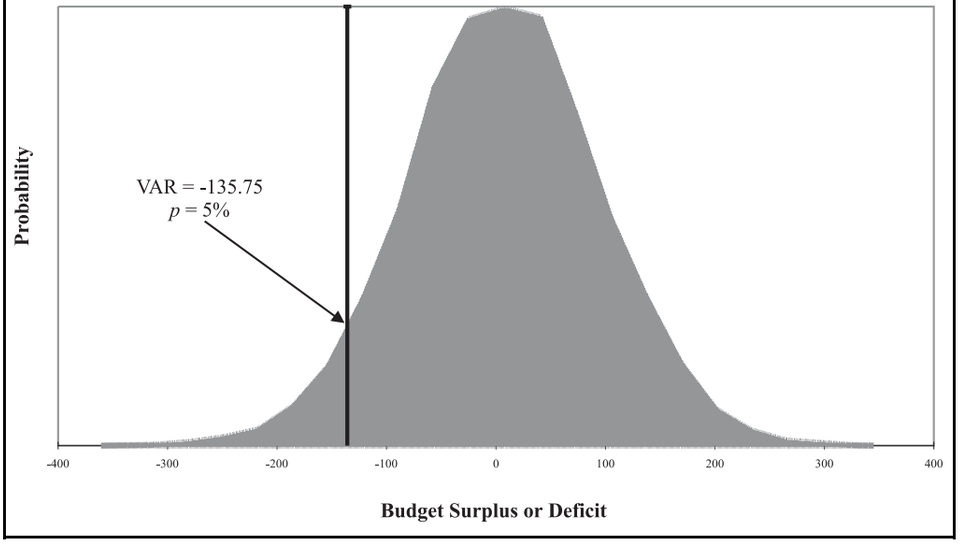
Simulation

Uncertainty measurement and risk management often use historical and/or Monte Carlo simulation to analyze situations and generate insights. Simulations that are based on historical business cycle data have many distinct advantages. Most important, modeling of the business cycle is unnecessary. Although historical simulation offers a deep study of outcomes during known business cycles, the low frequency of business cycle downturns gives few data points for investigation. Given the variety among business cycle patterns, historical simulations also lack the ability to stress test the outcomes to alternative macroeconomic circumstances.

The need to model the business cycle in Monte Carlo simulations rates as both a disadvantage and an advantage. The disadvantage is that it introduces the possibility of modeling error. The advantage is that it allows stress-testing the size of the RDF against a wide variety of assumptions. When utilizing a model capable of identifying VAR, it is natural to inquire about its sensitivity to underlying model parameters and states of the world. Model validation and stress-testing foster understanding and provide such insights. Jorion (2001) emphasizes that stress-testing attempts to identify situations that could cause extraordinary negative outcomes.

The management literature once again delivers a wide array of tested techniques and accepted methodologies that allow application of the proposed model to RDFs. Law and Kelton (2000) give guidance on Monte Carlo simulation methods.

Figure 2
VAR for Utah in FY 2003



Vose (2000) details the simulation implementation of risk problems using readily available spreadsheet software. This makes the currently proposed analysis accessible to state fiscal budgeting officials and analysts.

Although a wide variety of taxes and fees make up a state's portfolio of revenue sources, for simplicity in exposition, the present illustration only considers sales, income, and corporate franchise taxes. The simulation of net revenues occurs using the Palisade (2002) spreadsheet add-in @RISK®. Approximately 10,000 simulated values for the budget surplus/deficit for the state of Utah for fiscal 2003 gives the PDF depicted in Figure 2 and results in the reported VAR. The procedure calculates a 5 percent chance that a deficit of $135.75 million or more might occur. Therefore, an RDF of $135.75 million would give the state adequate revenue to match planned and mandated expenditures 95 percent of the time. Of course, reducing the level of confidence would correspondingly decrease the size of the RDF, but increase the chance that inadequate funding would be available.

Conclusions

The proposed methodology for evaluating RDFs eclectically draws from the extensive tax policy and risk management literatures. Significant and extensive research investigates tax revenue elasticities and equity volatiles or beta coefficients. Because these two problems are conceptually similar, it allows a productive application of capital asset pricing model concepts to the RDF analysis. Especially valuable is the ability to decompose revenue uncertainty into systematic and unsystematic risk components. Because the systematic risk corresponds to the correlated revenues observed each year due to the business cycle, this construct effectively models the observed high interrelatedness of the portfolio of various tax resources.

The VAR application to RDFs also benefits from the significant resources invested by financial researchers and firms in developing software and methodology that apply risk management methodology. The standardization achieved by J.P. Morgan and its spinoff company, Riskmetrics (http://www.riskmetrics.com/), validates the concepts of VAR and enterprise risk management. It also gives credibility to the proposed application in the arena of public management.

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