How Much Is Enough?
Prevailing Revenue Volatility & State Rainy Day Funds
It doesn't have to be this way, Minnesota

By Kevin Goodno and Jay Kiedrowski
POSTED: 01/25/2009 12:01:00 AM CST

MINNPOST
Minnesota's rainy day fund is drained, and now we're in a budget storm

By Sharon Schmickle | 02/15/10

The New York Times
Minnesota Government Shuts in Budget Fight

By MONICA DAVEY | JUNE 30, 2011

THE WALL STREET JOURNAL
Fitch Cuts Minnesota From Triple-A

By KELLY NOLAN | July 7, 2011

Minnesota's bond rating downgraded

By rachelst | SEPTEMBER 23, 2011 — 7:58PM
MINNPOST
November forecast brings good news for Minnesota — but proceed with caution
By Christina Wessel | 12/08/13

StarTribune
No reason not to support a higher Minnesota budget reserve
The required level of cushion hasn’t been updated since 2001, even as the general fund has grown by 59 percent.
By Richard Cohen | MARCH 10, 2014

StarTribune
A healthy budget reserve is state's shock absorber
"Give it back" sounds good — until revenues drop.
By Editorial Board Star Tribune | MARCH 28, 2014

StarTribune
Minnesota puts money in the bank, raising reserves to highest level ever
Blog post by Rachel E. Stussneger | JULY 1, 2014

StarTribune
Keep building state's reserve fund
Economic news is good, but state revenues remain volatile.
By Editorial Board Star Tribune | JULY 16, 2014

MPRnews
S&P: Minnesota's fiscal picture brightening, top debt rating may return
MPR News Staff | Aug 5, 2015

StarTribune
Wyoming looks to Minnesota in setting its rainy-day fund
By Ricardo Lopez | SEPTEMBER 29, 2015
How Much Is Enough?
Prevailing Revenue Volatility & State Rainy Day Funds

- Most state governments (incl. Minnesota) use rainy day funds (RDFs) to cushion against fiscal stress caused by changing economic conditions and tax policy preferences.

- Yet public finance literature offers little guidance on the amount of RDF savings a state needs.

- Our method provides a comprehensive empirical method for estimating an appropriate size RDF based on prevailing cyclical volatility of a state’s revenue system.
We draw on the motivation that state RDFs are not a one-size-fits-all solution.

Instead:

• Changing economic conditions and tax policy choices are unique among states.

• Growth, volatility, and diversity characteristics underlying state revenue streams are inherently different.

• Appropriate state RDF considerations require state-specific focus in a comprehensive and time-varying manner.
We construct a normal probability density function of state general fund revenues.

- Scale parameter $\sigma$ is estimated using a time-varying portfolio formula. This integrates dynamic measures of composition, diversification, and volatility for detailed revenue components:

$$
\sigma_{P,t} = \sqrt{\sum_{i=1}^{N} \sum_{j=1}^{N} w_{i,t} w_{j,t} \rho_{ij,t} \sigma_{i,t} \sigma_{j,t}}
$$

- Systematic changes in portfolio $\sigma$ are quantified in four steps.
1. Design
   – Empirical Considerations
     • Time Period
     • Measuring Techniques
   – Minnesota’s Tax System
     • Description
     • Data Sources

2. Process & Results
   – Step 1: Detach Cyclical Deviation from Long-term Trend Growth Rate
     Method: Hodrick-Prescott filter
   – Step 2: Measure Time-Varying Cyclical Volatility.
     Method: Integrated Generalized Autoregressive Conditional Heteroskedasticity (IGARCH) model
   – Step 3: Measure Time-Varying Covariation between Components
     Method: Integrated form of Dynamic Conditional Correlation (DCC) model
   – Step 4: Quantify System-Wide Volatility Over Time
     Method: Portfolio Standard Deviation Formula

3. Compute Appropriate Size Rainy Day Fund
• Analyze 50-year period: 1963 to 2013

• Values are in nominal dollars
  – Most of the state’s tax provisions are based on current dollar values of income, profits, and goods and services
  – Converted to growth rates using log-differences (stationary)

• Examine tax base (not revenues)
  – Difficult to obtain a series of state revenue data uninfluenced by changes to tax law over time
  – Key objective is to provide guidance on policy options available to mitigate major responses to most economic disturbances

• Use national data (not state)
  – Availability of detailed state-level economic data is limited
  – National data serve as an appropriate proxy for state activity
Major Sources of Revenue:

1. **Individual Income Tax**
   Analyze 6 different personal taxable income types (before deductions) from IRS’s *Statistics of Income (SOI)*
   - Salaries and wages
   - Taxable interest
   - Ordinary dividends
   - Net capital gains
   - Business-related income
   - All other taxable income

2. **General Sales Tax**
   Analyze 5 purchase categories from the *National Income and Product Accounts (NIPAs)* of the Bureau of Economic Analysis (BEA)
   - Consumer spending on non-auto durable goods
   - Non-durable goods subject to tax
   - Investment and government consumption
   - Household operation services
   - Other services subject to tax

3. **Corporate Income Tax** - Pre-tax domestic corporate profits from the BEA *NIPAs*

4. **Statewide Property Tax** - Implicit price deflator for state and local government consumption expenditures and gross investment from the BEA *NIPAs*

5. **Other Revenue & Tax Portfolio Shares** – Derived from U.S. Census Bureau’s State Government Finance statistics (adjusted for major changes in tax rates and bases).
Empirical Strategy & Results
Step 1: Detach Cyclical Deviations from Long-Term Trend
Method: Hodrick-Prescott Filter

Growth Characteristics of Components in Minnesota's Tax Base: 1963 to 2013

- Individual Income Tax Base; Salaries & Wages
  - Growth Rate: 2.8%

- General Sales Tax Base; Non-Auto Durable Goods
  - Growth Rate: 2.2%

- Corporate Franchise Tax Base; Corporate Profits
  - Growth Rate: 4.7%

- General Sales Tax Base; Non-Durable Goods Subject to Tax
  - Growth Rate: 3.3%

- Individual Income Tax Base; Net Capital Gains
  - Growth Rate: -3.4%

- Price Index for S&L Purchases
  - Growth Rate: 2.3%

Sample of Results:
Empirical Strategy & Results

Step 2: Construct a Time-Varying Measure of Cyclical Volatility
Method: Integrated Generalized Autoregressive Conditional Heteroskedasticity (IGARCH) model

Volatility Characteristics of Components in Minnesota's Tax Base: 1963 to 2013

- Absolute Value of Cyclical Deviations (CYC)
  (Black = Positive Deviation; Gray = Negative Deviation)
  - Individual Income Tax Base; Salaries & Wages
    - Prevailing (2013) Conditional $\sigma_t$
  - General Sales Tax Base; Non-Durable Goods Subject to Tax
  - Corporate Franchise Tax Base; Corporate Profits
  - Property Tax Base; Price Index for S&L Purchases

- Conditional Standard Deviation ($\sigma$)
  - Individual Income Tax Base; Net Capital Gains
  - General Sales Tax Base; Non-Auto Durable Goods

Sample of Results:
Empirical Strategy & Results

Step 3: Measure Time-Varying Covariation between Components

Method: Integrated form of Dynamic Conditional Correlation (INT-DCC) model

Conditional Correlation between Components in Minnesota's Tax Base: 1963 to 2013

**Product of Standardized Residuals; Left Axis**

**Conditional Correlation (ρ); Right Axis**

---

**Sample of Results:**

- **IND x SALES**
  - Degree of Covariation: -15% to 15%
  - 1963-2013
  - Conditional ρ: +0.86

- **CORP x SALES**
  - Degree of Covariation: -4% to 4%
  - 1963-2013
  - Conditional ρ: -0.04

- **CORP x PROP**
  - Degree of Covariation: -10% to 10%
  - 1963-2013
  - Conditional ρ: -0.38

- **IND x PROP**
  - Degree of Covariation: -12% to 12%
  - 1963-2013
  - Conditional ρ: +0.39

- **CORP x IND**
  - Degree of Covariation: -1% to 1%
  - 1963-2013
  - Conditional ρ: +0.04

- **PROP x SALES**
  - Degree of Covariation: -12% to 12%
  - 1963-2013
  - Conditional ρ: +0.52
Empirical Strategy & Results

Step 4: Quantify System-Wide Volatility Over Time

Method: Portfolio Standard Deviation Formula

Time-Varying $\sigma$ of Major Components in Minnesota's General Fund Tax Base: 1963 to 2013

- Individual Income (IND)
- General Sales (SALES)
- Corporate Income (CORP)
- Property (PROP)
- Other Revenues (OREV)

Volatility

- Prevailing $\sigma_t$ (2013)
- $10.9\%$
- $5.0\%$
- $4.8\%$
- $3.3\%$
- $1.5\%$

'65 '70 '75 '80 '85 '90 '95 '00 '05 '10
Empirical Strategy & Results
Step 4: Quantify System-Wide Volatility Over Time
Method: Portfolio Standard Deviation Formula

Volatility Characteristics of Minnesota's Total General Fund Tax Base Portfolio: 1963 to 2013

- Absolute Value of Cyclical Deviations (CYC)
  (Black = Positive Deviation; Gray = Negative Deviation)
- Time-Varying Standard Deviation ($\sigma$)

*Calculated as the weighted sum of log differences less the weighted sum of trend growth rates.
Appropriate Size Rainy Day Fund?

Over time, an increasingly volatile tax base can have meaningful implications for long-term state budget planning. To protect against the prevailing level of risk, an appropriate size RDF can be calculated:

1. Convert estimated tax base volatility ($\sigma = 3.5\%$) to revenue volatility ($\sigma = 4.2\%$)
   Reason: Progressivity in MN’s individual income tax; elasticity w/ respect to tax base $\approx 1.27$

2. Choose confidence level: % of outcomes RDF protects against shock (e.g. 95%)

3. Multiply prevailing volatility measure by critical $z$-value ($4.2\% \times 1.645 = 6.9\%$)
   Note: One-tailed critical $z$-value for 95% confidence level (normal distribution) = 1.645

4. Scale for number of years: $\sigma \sqrt{\text{years}}$ ($6.9\% \sqrt{2} = 9.8\%$ of annual revenues)
   Note: MN budgets on a two-year basis

Method demonstrates that a state RDF of $9.8\%$ of annual revenues will sufficiently protect against cyclical risk—w/ 95% confidence—during most recent two-year budget period.
• Consider role of revenue volatility in context of state RDFs
• Estimate appropriate RDF size for Minnesota by constructing a normal pdf of unexpected shocks to state revenues:
  – Scale parameter estimated using a portfolio $\sigma$
  – Integrates measures of volatility, diversification, and composition
  – Examine detailed components of state’s tax base

• Evaluate portfolio $\sigma$ in the dynamic context of time (1963-2013):
  – Annual measures of portfolio $\sigma$ are quantified in 4 steps, including IGARCH process
  – Consideration of state RDF size can then be based on prevailing conditions

• Results:
  – Minnesota’s tax base has grown more volatile since the late 1990s.
  – Attributable to increasingly unstable components, such as wages, forms of individual investment income, and corporate income. The changing composition and less short-run diversification are also contributing factors.
  – State rainy day reserve of 9.8% of annual revenues would adequately protect against cyclical economic risk.
Thank You

MATTHEW SCHOEPPNER
651.201.8048 | MATTHEW.SCHOEPPNER@STATE.MN.US
ECONOMIST | MINNESOTA MANAGEMENT & BUDGET

THOMAS F. STINSON
612.625.1217 | TSTINSON@UMN.EDU
PROFESSOR | DEPARTMENT OF APPLIED ECONOMICS
UNIVERSITY OF MINNESOTA
Supplemental Charts/Data

Time Varying $\sigma$ of Minnesota's Individual Income Tax Base Components: 1963 to 2013

Volatility

- Salaries & Wages (IWS)
- Taxable Interest (IINT)
- Ordinary Dividends (IDIV)
- Net Capital Gains (ICG)
- Business-Related Income (IBUS)
- All Other Taxable Income (IO)

Prevailing (2013) Conditional $\sigma_i$

- 39.3%
- 17.4%
- 12.6%
- 7.1%
- 5.0%
- 3.2%
Supplemental Charts/Data

Volatility Characteristics of Minnesota's Individual Income Tax Base Portfolio: 1963 to 2013

Absolute Value of Cyclical Deviations (CYC)
(Black = Positive Deviation; Gray = Negative Deviation)

Time-Varying Standard Deviation ($\sigma$)

Prevailing $\sigma_t$ (2013)
4.8%
Supplemental Charts/Data

Time Varying $\sigma$ of Minnesota's General Sales Tax Base Components: 1963 to 2013

- Non-Auto Durable Goods (SDXMV)
- Non-Durable Goods Subject to Tax (SNDO)
- Household Operation Services (SSVH)
- Other Services Subject to Tax (SSVO)
- Business & Government (SINV)

Volatility

- Prevailing (2013) Conditional $\sigma_t$
  - $6.7\%$
  - $3.3\%$
  - $3.0\%$
  - $2.4\%$
  - $1.6\%$
Volatility Characteristics of Minnesota's General Sales Tax Base Portfolio: 1963 to 2013

Absolute Value of Cyclical Deviations (CYC)
(Black = Positive Deviation; Gray = Negative Deviation)

Time-Varying Standard Deviation ($\sigma$)

Prevailing $\sigma_t$ (2013)

3.3%
Supplemental Charts/Data

Growth Characteristics of Supplementary Variables: 1963 to 2013

- **First Difference of the Log (TAX)**
- **Trend Growth Rate (g)**

**Other Variables (Tax-Exempt); Food Products**
- 2.9%

**Other Variables (Tax-Exempt); Pharmaceutical Products**
- 5.4%

**Other Variables (Dedicated Tax); Motor Vehicles**
- 2.9%

**Other Variables (Tax-Exempt); Clothing and Shoes**
- 2.1%

**Other Variables (Dedicated Tax); Gasoline and Other Motor Fuels**
- 3.0%

**Other Variables; Price Index for PCE**
- 1.6%

*Prevailing \( g_t \) (2013)*
Supplemental Charts/Data

Volatility Characteristics of Supplementary Variables: 1963 to 2013

- Absolute Value of Cyclical Deviations (CYC)
  - Black = Positive Deviation; Gray = Negative Deviation
- Conditional Standard Deviation (\(\sigma\))

Other Variables (Tax-Exempt); Food Products
- 1.9%

Other Variables (Tax-Exempt); Pharmaceutical Products
- 2.1%

Other Variables (Dedicated Tax); Motor Vehicles
- 7.6%

Other Variables (Dedicated Tax); Gasoline and Other Motor Fuels
- 15.3%

Other Variables (Dedicated Tax); Clothing and Shoes
- 3.0%

Other Variables; Price Index for PCE
- 1.0%

Prevailing (2013) Conditional \(\sigma_t\)