Estimating Tax Base Volatility in Minnesota

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Tax Base Volatility

• Volatility measures the variation between expected (trend) growth and actual growth
• The traditional measure of volatility is the standard deviation ($\sigma$)
• In a normal distribution, 68% of values fall within $\pm 1 \sigma$ of the mean and 95% fall inside $\pm 2 \sigma$’s
Why Is Volatility Important?

• More volatile (higher $\sigma$) tax systems will have larger surpluses and deficits
• Tax system volatility helps determine how large a budget reserve is needed
• Volatility can be adjusted by changing either the proportion of revenue derived from each tax or the volatility of individual taxes

How We Measured Volatility

• Focused on tax base, not revenues
• Analyzed growth rates, not $\$ \text{ amounts}$
• Computed yearly deviations from trend growth for components of the tax base
• Combined volatilities for each component of the tax base to produce an estimate of the system-wide volatility
• Covariances taken into account
Questions

1) How volatile is Minnesota’s tax system?
2) Has the volatility of MN’s tax system changed over time?
3) Can volatility be reduced by re-weighting the tax mix towards less volatile revenue sources or by changing the volatility of existing revenue sources?
4) How large a budget reserve is needed?
Measuring Growth and Volatility
Example: U.S. Capital Gains

Measuring a Trend Growth Rate
Example: U.S. Capital Gains
Measuring a Trend Growth Rate
Example: U.S. Capital Gains

Hodrick Prescott Filter uses a trend component and a cyclical component to obtain a smoothed non-linear representation of the long term trend growth rate of a data-series.

Measuring Volatility
Example: U.S. Capital Gains

5-Year Moving Average of Standard Deviation
**Measuring Volatility**

**Example: U.S. Capital Gains**

![Graph showing time-variant measure of dispersion from trend (GARCH σ) with trend growth rate (H-P Filter) and annual % change.]

**GARCH Model** is a time variant measure of statistical dispersion (σ) based on the assumption that volatility changes over time. The model captures both short-term high-frequency volatility as well as long-term influences.

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**Measuring Growth & Volatility**

**Example: Wages and Salaries**

![Graph showing annual % change over time from 1960 to 2005.]

Annual % Change
Measuring Growth & Volatility
Example: Wages and Salaries

Trend Growth Rate (H-P Filter)

Annual % Change

0.9%
2.3%

Variation from Trend (GARCH σ)
Volatility Calculation Summary

– H-P Filter estimates trend growth rate
– GARCH model estimates volatility ($\sigma$) from trend growth rate over time
– Markowitz’s modern portfolio theory (MPT) used in volatility estimate
  • Portfolio Trend Growth Rate: weighted sum of the individual component’s growth rates
  • Portfolio Volatility: weighted sum of the variances and covariances of the individual components
MN Tax Portfolio Data: 4 Major Revenues

- Individual Income Tax: 7 income types (Source: IRS SOI)
- General Sales Tax: 19 purchase types (Source: BEA NIPA tables)
- Corporate Income Tax: domestic profits (Source: BEA NIPA tables)
- Other Taxes and Non-Tax Revenue (Source: U.S. Census)
2.3% 3.3% 6.0% 12.3% 15.2% 27.3%
Salaries & Wages
Taxable Interest
Ordinary Dividends
Taxable Pensions, Annuities, & IRA Distributions
NFI Capital Gains
Business Partnership & S-Corp, & Farm Income

Individual Income Tax Base Portfolio

0% 5% 10% 15% 20% 25% 30%

3.1%

2005-2007 Trend Growth Rate of MN’s GF Tax Base

<table>
<thead>
<tr>
<th>Tax Base</th>
<th>Growth Rate</th>
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<tbody>
<tr>
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<td>FY07-07 Proportion of MN’s General Fund Tax Revenues</td>
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MN’s General Fund Tax Base Volatility by Major Source (5YMA)

2005-2007 Trend Growth Rate of MN’s GF Tax Base

- Individual Income Tax Base: 5.4%
- Corporate Income Tax Base: 14.9%
- MN Sales Tax Base: 5.2%

FY05-07 Proportion of MN’s General Fund Tax Revenues

- Individual Income Tax Base: 48.1%
- Corporate Income Tax Base: 31.2%
- MN Sales Tax Base: 7.4%

Inflation: 2.6%
MN's General Fund Tax Base Volatility by Major Source (5YMA)

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| Total MN Tax Base Portfolio | 6.5%       |

Inflation 2.6%

FY05-07 Proportion of MN's General Fund Tax Revenues

Individual Income Tax Base 31.2%
Corporate Income Tax Base 48.1%
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Portfolio Theory Suggests Using a Tax System that Minimizes Volatility for a Given Growth Rate

- Given the trend growth rate, variance, and covariance of each major tax, an Efficiency Frontier Line (EFL) can be estimated
  - The EFL shows combinations of taxes that provide the lowest volatility for each growth rate
  - Points below the frontier are suboptimal.
**Actual vs. Efficient MN One-Year Tax-Mix Given the Current Trend Growth Rate**

<table>
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<th>Actual FY 2005-2007 Portfolio</th>
<th>Efficient Tax Mix Portfolio</th>
<th>Percent Change</th>
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<tr>
<td>Trend Growth Rate</td>
<td>7.70%</td>
<td>7.70%</td>
<td>-</td>
</tr>
<tr>
<td>Volatility (Standard Deviation)</td>
<td>3.26%</td>
<td>3.09%</td>
<td>-5.2%</td>
</tr>
<tr>
<td>Share of Total Tax Revenue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Sales</td>
<td>31.2%</td>
<td>60.3%</td>
<td>+93.3%</td>
</tr>
<tr>
<td>Corporate Income</td>
<td>7.4%</td>
<td>13.1%</td>
<td>+77.0%</td>
</tr>
<tr>
<td>Individual Income</td>
<td>48.1%</td>
<td>9.2%</td>
<td>-80.9%</td>
</tr>
<tr>
<td>Other Revenues</td>
<td>13.3%</td>
<td>17.4%</td>
<td>+30.8%</td>
</tr>
<tr>
<td>Total</td>
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Calculating the Appropriate Size for Minnesota’s Budget Reserve

• Convert annual estimated tax base volatility (σ = 2.6%) to General Fund revenue volatility (σ = 3.03%)

• Choose failure rate: Percent of time deficit exceeds budget reserve (1 in 20, 5%)

• Multiply annual revenue volatility estimate by the critical failure rate value (3.03%*1.645 = 4.98%)  
  (critical value for a 5% one tail z test = 1.645)

• MN budgets on a 2 year basis. Biennial reserve found using the same procedure but for two years.

Results

• Budget reserve based on trend forecast:  
  – 5.0% ($870M of FY06) for first (one) year  
  – 4.1% ($1.4B of FY06-07) for biennium

• Biennial estimates vary depending on treatment of successive events (years)

• Average volatility may understate potential shortfalls in economic downturns

• Budget reserve depends on history of forecast errors and failure rate chosen
Conclusions

• Minnesota’s tax base has grown more volatile
• Tax base volatility appears to increase during economic downturns
• Modest reductions in tax system volatility could be obtained, but dramatic tax rate changes would be required
• At current levels of volatility a biennial budget reserve of 4.1% ($1.4B of FY06-07 revenues) would be appropriate

Thank You

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