**Informed Decision-Making Through Forecasting: Your Guide to Better Revenue Analysis**

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Effective Forecast Process, Pitfalls, and a Possible Path Forward

Josh Harwood, City Economist
City of Portland, Oregon

May 22, 2017
Focus on Process

- Need to constantly reflect on *not* just accuracy of forecast, but on *how* the forecast was reached
  - Understand what you can control and recognize/describe what you can’t.
Accept Uncertainty

- Your forecast will be wrong...
- ...so accept uncertainty and plan for it

"All models are wrong, but some are useful."
Polish Up Your Data

- Garbage in, Garbage Out

- Invest in data cleaning
  - Find and adjust outliers and anomalies
  - Correct for accounting idiosyncrasies
  - Consider seasonality
  - Build a forecasting database
State of the Economy

- Will economy help or hinder recovery?
  - Provide context to financial strategy development
- Take stock of key national & regional indicators
- Gather qualitative evidence from community
State/Federal Budget Situation

- Changes in service policies
  - Shifting responsibility to local government?
- Changes in revenue sharing policies
  - Reductions or re-directions?
- Increasing state taxes?
  - Taxpayers then less receptive to local taxes?
Get More Perspectives

- Quantitative
  - Use more than one forecasting technique

- Judgmental
  - Widen the circle
  - Manage the team carefully

- Think like a fox
Show a Clear set of Assumptions

- Show a set of assumptions that tell a story about forecast expectations
- Highlight wildcards
Test and Validate

- Use hold out test to see what model would have said for prior year
- Calculate measures of accuracy and bias
- Compare to benchmarks
Watch Out for Land Mines

- How sophisticated is your forecast model?
  - Is it disaggregated in many component parts?

- “Relentlessly” investigate
  - Talk to people close to the action

- Be aware of skewed risks
  - Income taxes often fall much faster than they grow
How to (Maybe) Be More Accurate

- Adopting highly sophisticated forecasting methods are probably not the answer
  - Inherited a model that is poorly documented
  - Overreaches on what it tries to accomplish

- Understand sensitivity of individual assumptions
  - Maybe certain forecast inputs don’t deserve lengthy consideration
Too Conservative Forecasting?

- Doesn’t necessarily mean every component of the forecast is conservative...can hedge one forecast for another.
  - Hedge volatile forecasts with conservative estimates of more stable revenue sources.

- For component forecasts, be careful about aggregating bias.
Aggregation Bias Example

- Prison Population Forecast
  - Forecasting prosecutions by crime type, because different crimes have different sentencing lengths
  - Note trends: crime generally decreasing
  - Model will likely result in each component slightly decreasing
Aggregation Bias Example

- When total is “built up” from components, it will be overly biased low because general trend may be down, but individual components will move in either direction.

- Solution – Model the total as well
  - Take advantage of the god of offsetting errors
Portland’s Five-Year Balancing

- Attempt to ensure that budget is sustainable by only funding ongoing programs that forecast shows enough revenue to fund in each of the next five years

  - Five-Year forecasts for revenue streams vs. existing ongoing programs “inflated” each of the next five years plus other expected increases (e.g., pension costs)
Important Concepts

- Ongoing programs vs. One-time funded
  - Programs funded with one-time include limited-term FTE funded only through the end of the fiscal year

- Do not adopt a budget on “hope”
  - If cuts are needed in out-years of the forecast, fund a portion of the existing budget on a one-time basis in expectation of not having enough revenue in the next year to fund it.
Scenario: Revenue Expansion, but...
Don’t Re-base Expense Trajectory

Forecast Year (0 = Current Year)

- Forecasted Expenses
- Forecasted Revenues
- Re-based Expenses
Enough Revenue to Cover Ongoing Spending Creates “One-Time” Resources

Forecast Year (0 = Current Year)

- Forecasted Expenses
- Forecasted Revenues
- Adjusted Ongoing Expenses

Ongoing expenses in budget year less than revenue. "Excess" revenue treated as "one-time"
Some Benefits

- Maintain reserves for true emergencies (e.g., natural disasters, occupy protests, etc.)
  - Supports credit rating

- Limits year-to-year volatility and “flexibility” for policy makers

- Makes clear distinction of what parts of the budget are sustainable and what parts will have to cease should the forecast hold
Some Drawbacks

- When coupled with conservative forecasting, can produce “serial” one-time funds
- Significant number of limited-term positions, lowering workforce and/or program stability
- May “overcut” budgets if overly conservative revenue forecast
Take the time to set up a forecast process that is comprehensive and specifically tailored to account for blind spots

- Constantly appraise it’s effectiveness in identifying adverse forecast outcomes

Evaluate proper forecast structure and communication in order to best manage government resources
Contact Information

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A TALE OF TWO CITIES

...and two forecasts

May 22, 2017
GILBERT, ARIZONA

2015 POPULATION 242,857

Retail
Sales tax
Property tax

Restaurants
Sales tax
Property tax

Industry
Property tax
High wage employment

* Sources: Town of Gilbert; PCMag
PARADISE VALLEY, ARIZONA

2015 POPULATION 13,673

Resorts
- Sales Tax
- Bed Tax

Residential
- No property tax
- State-shared revenue based on population

Resort Residential
- No property tax
- State-shared revenue based on population

* Sources: Montelucia, Sanctuary, Nicholas McConnell
STEP 1 – DEFINE THE PROBLEM:

- Focus
- Growth
- Size & Volatility
- Politics

Focus
GILBERT, ARIZONA

2015 POPULATION 242,857

Retail
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STEP 1 – DEFINE THE PROBLEM:
IMPACT, VOLATILITY, GROWTH, & POLITICS
PARADISE VALLEY, ARIZONA

2015 POPULATION 13,673

Paradise Valley GF Revenues

- FY 2010
- FY 2011
- FY 2012
- FY 2013
- FY 2014
- FY 2015
- FY 2016

Resorts
Sales Tax
Bed Tax

Residential
No property tax
State-shared revenue based on population

STEP 1 – DEFINE THE PROBLEM:
IMPACT, VOLATILITY, GROWTH, & POLITICS
STEP 2 – GATHER INFORMATION

Know your revenues
- Mental models, diagrams, checklists
- Historical revenue
- One-time vs ongoing
- Subject experts
- Other communities
- Universities & state agencies

Know the financial and economic environment
- Law of large numbers
- Macro vs micro
- Specific local industry
- Multiple perspectives
- Beyond the spreadsheet

Know special events and emerging trends
- STEEP
  - Social
  - Technological
  - Economic
  - Ecological
  - Political

Optimize & adjust data
- Policy changes
- Number of transaction days
- Changes in tax base
- Local idiosyncrasies
STEP 2 – GATHER INFORMATION

• Know your revenues
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• Optimize & adjust data
  • Policy changes
  • Number of transaction days
  • Changes in tax base
  • Local idiosyncrasies
STEP 3 – EXPLORATORY ANALYSIS

Data Visualization

Descriptive Statistics

Disaggregation - Break it down

* Source: pin2pin
STEP 4 – SELECT FORECASTING METHODS

• No single best forecasting technique for all situations
• Results of steps 1 through 3 help to determine best method
  • For each revenue type
  • For each government entity
  • At different times
WARNING: **DO TRY THIS AT HOME**

- Apply historic actual revenue data as though you were forecasting prior year
  - E.g. use FY 2011 through FY 2015 data to “forecast” FY 2016
- Apply different methodologies
  - Linear regression
  - Simple moving average
  - Seasonal decomposition
- Adjust for special events
- For each major revenue type, which methodology calculated the closest result?
LOOKING TOWARD THE FUTURE
TOWN OF PARADISE VALLEY
BUDGET FORECASTING
LINEAR REGRESSION

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>$13,993,737</td>
<td>$16,310,141</td>
<td>$18,507,893</td>
<td>$20,171,944</td>
<td>$22,517,586</td>
</tr>
</tbody>
</table>

\[ y = 2 \times 10^6 x - 4 \times 10^9 \]
### 2015 Forecasted vs. Actual Values Using Linear Regression

<table>
<thead>
<tr>
<th>Account Name</th>
<th>2015 Forecasted</th>
<th>2015 Actual</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Sales Tax</td>
<td>$12,098,147</td>
<td>10,978,886</td>
<td>$(1,119,261)</td>
</tr>
<tr>
<td>Local Bed Tax</td>
<td>$3,008,330</td>
<td>3,117,450</td>
<td>109,120</td>
</tr>
<tr>
<td>State-Shared Income Tax</td>
<td>$1,409,057</td>
<td>1,551,940</td>
<td>142,883</td>
</tr>
<tr>
<td>State-Shared Sales Tax</td>
<td>$1,113,739</td>
<td>1,171,604</td>
<td>57,865</td>
</tr>
<tr>
<td>Court Fines</td>
<td>$813,627</td>
<td>1,118,688</td>
<td>305,061</td>
</tr>
<tr>
<td>Building Permit</td>
<td>$650,783</td>
<td>613,269</td>
<td>$(37,514)</td>
</tr>
</tbody>
</table>
SIMPLE MOVING AVERAGE

- Calculated by adding revenues and dividing by number of periods
  - An average over a chosen time period

\[ SMA = \frac{p_1 + p_2 + \cdots + p_n}{n} \]
# 2015 Forecasted vs. Actual Values Using Simple Moving Average

<table>
<thead>
<tr>
<th></th>
<th>FY 2015</th>
<th>FY 2015 Simple Moving Average</th>
<th>Actual-Forecasted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Sales Tax</td>
<td>10,978,886</td>
<td>8,063,452</td>
<td>2,915,434</td>
</tr>
<tr>
<td>Local Bed Tax</td>
<td>3,117,450</td>
<td>2,617,239</td>
<td>500,211</td>
</tr>
<tr>
<td>State-Shared Income</td>
<td>1,551,940</td>
<td>1,292,457</td>
<td>259,483</td>
</tr>
<tr>
<td>State-Shared Sales</td>
<td>1,171,604</td>
<td>1,055,156</td>
<td>116,447</td>
</tr>
<tr>
<td>Court Fines</td>
<td>1,118,688</td>
<td>887,828</td>
<td>230,861</td>
</tr>
<tr>
<td>Building Permit</td>
<td>613,269</td>
<td>505,498</td>
<td>107,770</td>
</tr>
</tbody>
</table>
SEASONAL DECOMPOSITION

• Look at revenues in different seasons or months of year

• Look for a trend over a period of time
  • Time frame for PV is 4 years FY 2012-2015
Informed Decision-Making Through Forecasting:
A Practitioner’s Guide to Government Revenue Analysis
Shayne C. Kavanagh and Daniel W. Williams
Government Finance Officers Association
Forecasting Under Extreme Uncertainty

Bob Eichem
Chief Financial Advisor
Boulder, Colorado
Who are we? A sustainable resilient community. What do we do? Use forecasts to ensure today’s decisions are sustainable into the future.
Legal - January 1, 2014
Why Be Concerned?

Between 200,000 and 50,000 Population

Percent of observations

Mean Absolute Percentage Error is 7.4%
Where Do You Start?

• Too many variables!
  – Which are the most important
• How do we mitigate risk
  Integrate it into the decision making process
• No historical data
• Charged political environment
• Used many of the techniques in
  Informed Decision-Making Through Forecasting:
  A Practitioner’s Guide to Government Revenue Analysis
Being the First – What Did We Know?

- No empirical information
- Lots of community advice will be the magic bullet
- Convince everyone we needed to cover new expenditures first
- Can’t let it hijack the regular budget process
- What does GFOA have on such situations
  – Timing was great for this bullet -
What Are the Best Practices?

1. Find a reference point if no historical data
2. Engage subject matter experts about RMJ in the forecast
3. Organize the info into a model
4. Disaggregate the analysis; aggregate the forecast
5. Acknowledge the uncertainty in the forecast
6. Design the public forum appropriately
7. Establish an environment for good decisions
Find a Reference Point & SMEs

• Gathering Input and Data
  – Manager of Licensing – Medical
  – Best in the Medical MJ Business
    • How many will switch to MJ
    • Export out of COB
    • Higher taxes will people switch
  – Shayne and the Influence Diagram
Data for the Model – S/U Tax

Each entity decides if they will allow or not

- City Regular Sales and Use Tax Rate  3.56%
- City RMJ Tax Rate  3.50%
- Total COB  7.06%
- State tax rate  12.90%
- Total State and City Tax Rate  19.96%

State share back of 10.0% of sales pro rata/sales
Data for the Model - Excise Tax Rate

City - Five percent on the average market rate of unprocessed recreational marijuana that is sold or transferred from a recreational marijuana cultivation facility.

State  15.0%
COB    5.0%
Total  20.0%
As a rule of thumb, the forecaster should always seek to apply some quantitative technique, and before relying solely on expert judgement for a forecast.
<table>
<thead>
<tr>
<th>Description</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated recreational sales</td>
<td>$24,000,000</td>
<td>$36,000,000</td>
</tr>
<tr>
<td>New state sales tax rate on recreational RMJ</td>
<td>10.00%</td>
<td></td>
</tr>
<tr>
<td>City share back from state</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td><strong>Total sales tax received by the city from state share back</strong></td>
<td><strong>$360,000</strong></td>
<td><strong>$540,000</strong></td>
</tr>
<tr>
<td>Incremental non-medical amount if projections are met</td>
<td>$1,680,000</td>
<td>$2,520,000</td>
</tr>
</tbody>
</table>
Acknowledge the Uncertainty & Design the Public Forum

• Your credibility is on trial – years to gain it seconds to lose it
  – Review what you have done to mitigate risk
    • Consolidated in General Fund
  – Do not let RMJ hijack the regular budget process
  – It had already been spent multiple times
    • Basic rule of budgeting did not change
      – You only get to spend it once!
Establish an Environment for Good Decisions

• Proposed and accepted: treat as one-time money until the number of states reach critical political mass
• Built-in several contingencies due to multiple unknowns
  – Youth education
  – Unknown expenditures at time of appropriations
  – Revenue: Not a high degree of confidence
Mini Budget Process
Supplemental Appropriation

• So it did not hijack the regular budget process
  
• So it was transparent and not buried
  
• So new expenditures were vetted
  – everyone knew why something was being proposed
  – It worked well
Results

• First year – set the projection between the anchors for incremental tax at $2 million.
• Actual collected - $2,040,000
  – The base is now part of the regular business cycle
  – The incremental on RMJ is still separate
  – Longer term felt would be 4% of GF revenue
  – In 4th year – so far it has worked!
It Has Been A Learning Experience

Standard is:
• What you know

• What you don’t know

• What you don’t know that you don’t know

Added: What you wish you had known when you started down this path