Tracking Revenues with Daily Targets in Massachusetts

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by

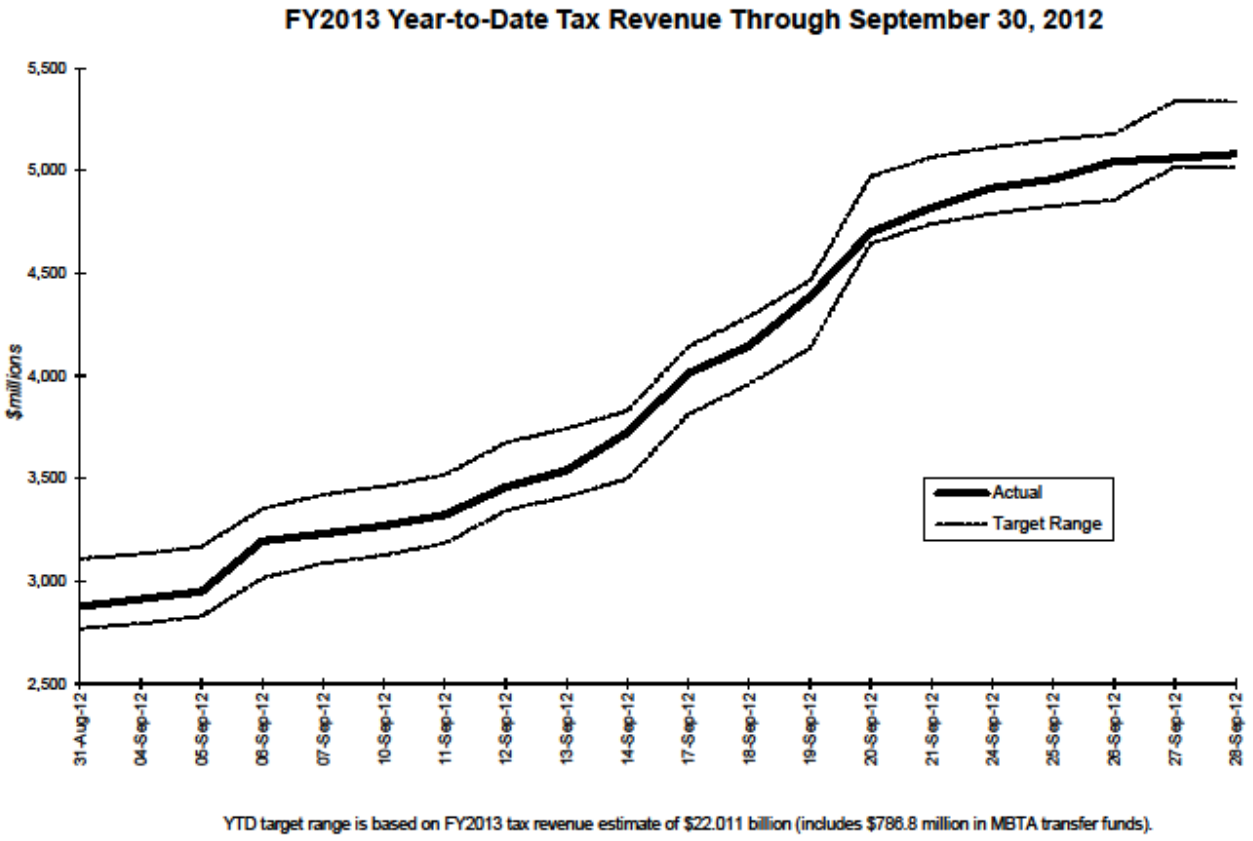
Alan Clayton-Matthews

Northeastern University

Why create a daily revenue forecast?

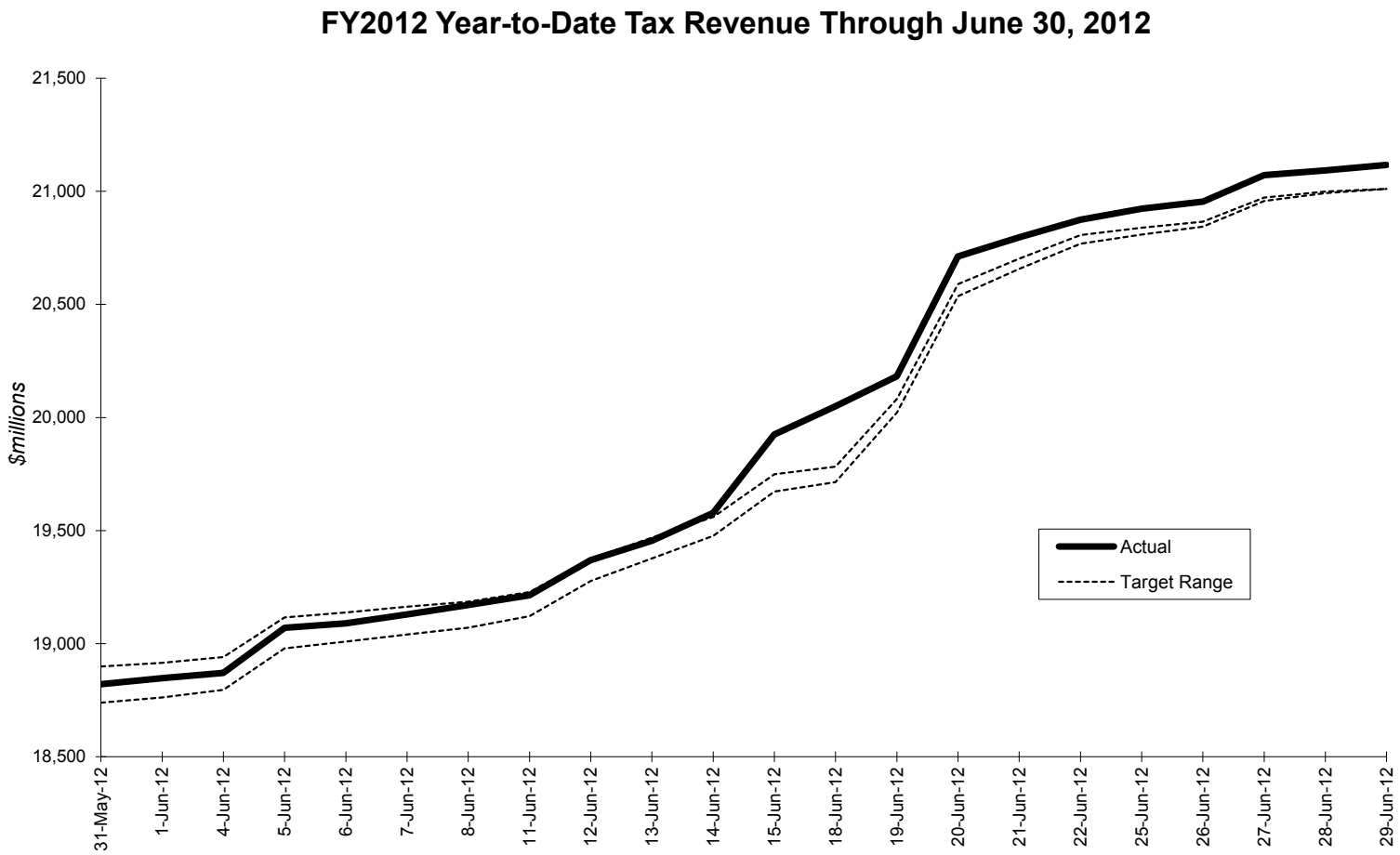
- There is a need to be able to compare revenues to expectations on a daily basis.
- Comparisons to last year (for example, month-to-date or fiscal year-to-date) are subject to last year's "deviation" as well as this year's "deviation".
- Daily expected revenues do not grow at a continuous rate but exhibit marked seasonality (intra-month as well as inter-month).

Examples from Massachusetts



YTD target range is based on FY2013 tax revenue estimate of $22.011 billion (includes $786.8 million in MBTA transfer funds).

Examples, continued

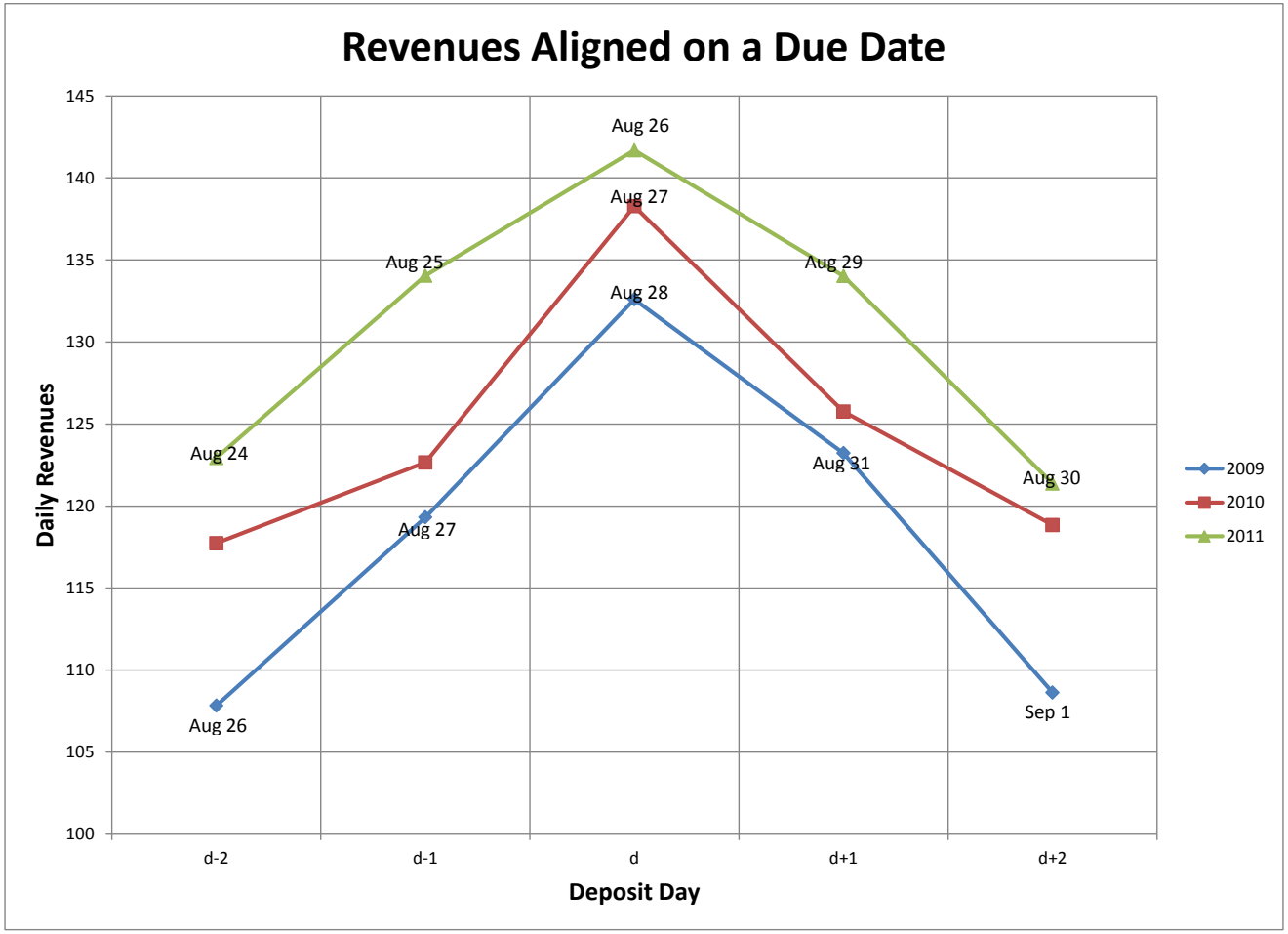


YTD target range is based on FY2012 tax revenue estimate of $21.010 billion (includes $779.1 million in MBTA transfer funds).

Steps in Creating Daily Forecast Targets

1. Form daily seasonal adjustments by decomposing daily tax revenues over history into its trend, seasonal, and irregular components: $R{\downarrow}y.d = T{\downarrow}y.d + S{\downarrow}y.d + I{\downarrow}y.d$. Do this and the following steps for each tax type, after adjusting for changes in tax law and taking out "one-time" revenue effects.
2. Project the trend component using the annual, quarterly, or monthly forecast.
3. Apply the seasonal component (or a projection of the seasonal component) to the projected trend to get the projected daily revenues.

Step 1a: Form a calendar of deposit days aligned on "big event" days, e.g., due dates.



Step 1a, continued

There will be a few days in between the “big event” days that don’t line up when there are a different number of deposit days between the “big event” days in different years.

Options:

1. Leave out the extra days. Assign the seasonal factor from adjoining days.
2. Assign the missing days a revenue amount equal to the average of adjoining days.

Step 1b: Two Strategies

1. Use an X-11 type seasonal adjustment procedure. This will involve an iterative process of:
   - Estimating the trend, T.
   - Estimating the seasonal factors, S.
2. Use a structural time series estimator (unobserved components model, state space model).

Step 1b: Trend estimation, first time

Estimate the trend, T, as a centered 1-year moving average of daily revenues.

Step 1b: Seasonal factor estimation.

- Calculate the S+I component: $S{\downarrow}y.d + I{\downarrow}y.d = R{\downarrow}y.d - T{\downarrow}y.d \equiv SI{\downarrow}y.d$
- Model the seasonal component for each day using one of the standard simple seasonal filters: 3x3, 3x5, etc. E.g., a 3x3:

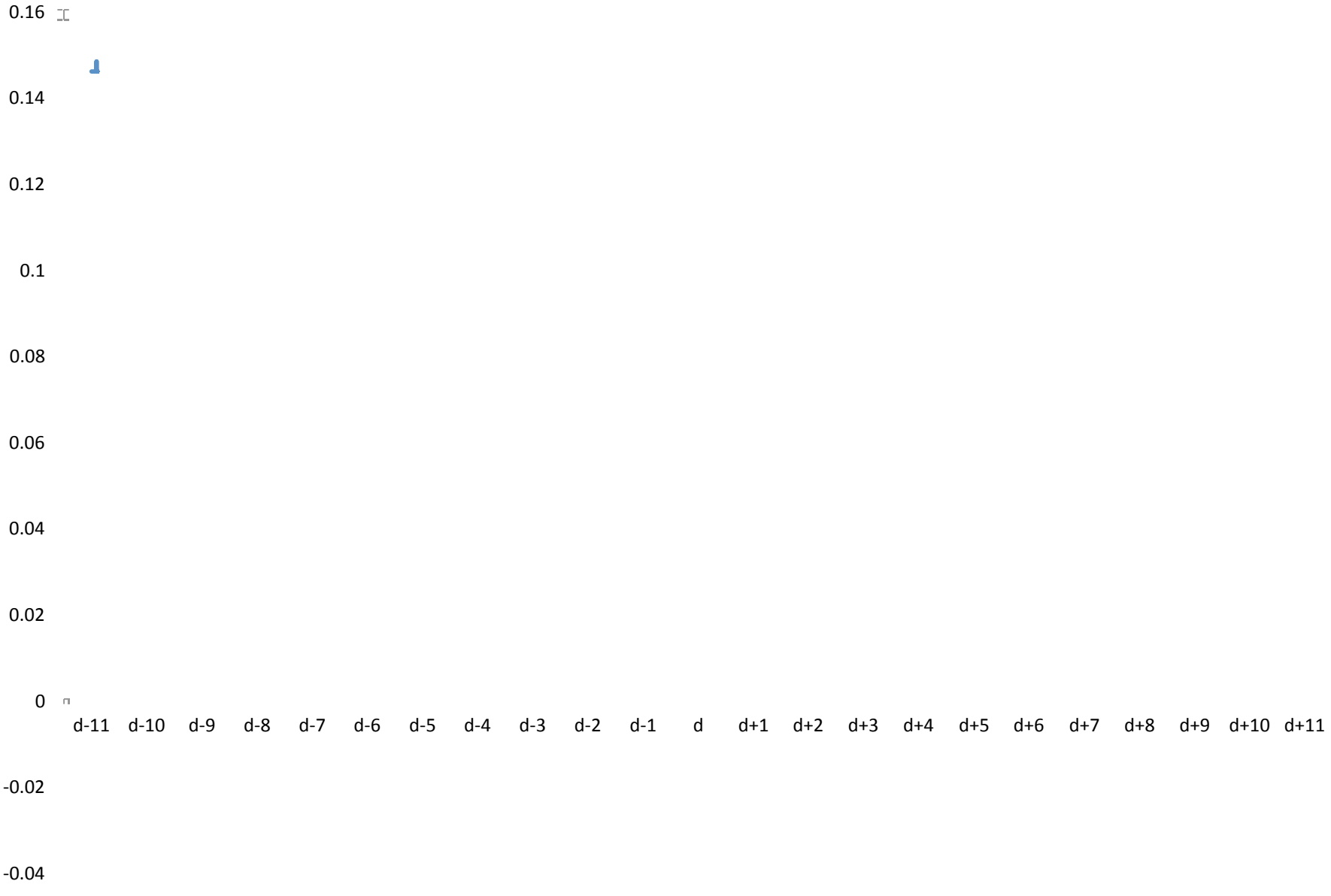
$$S{\downarrow}y.d = (SI{\downarrow}y{-}2.d + 2SI{\downarrow}y{-}1.d + 3SI{\downarrow}y.d + 2SI{\downarrow}y{+}1.d + SI{\downarrow}y{+}2.d)/9.$$

- If needed, calculate $I{\downarrow}y.d = SI{\downarrow}y.d - S{\downarrow}y.d$.

Step 1b: Trend estimation, second (and later) time(s).

- Deseasonalize revenues: $R{\downarrow}y.d - S{\downarrow}y.d$
- Re-estimate the trend, $T{\downarrow}s.d$, by applying a more sophisticated filter to the deseasonalized revenues, e.g., a Henderson filter of appropriate length (about a year).
- Derive the filter using a procedure, or interpolate from an existing shorter filter.
- Options for the beginning and ending periods of history:
  - Use one-sided Henderson filters;
  - Forecast and backcast deseasonalized revenues;
  - Drop beginning and ending periods from the analysis.

Henderson 23-Term Filter



Step 1b: Iteration and additional options.

- Re-estimate the seasonal (and irregular) components using the new trend.
- Re-estimate the trend. Continue iterating estimation of trend and seasonal components until satisfied.
- Optionally, form more sophisticated models for the seasonal factors:
  - "Tone down" extreme irregulars.
  - Estimate effect of the number of "trading days" on the size of the S+I component.
  - Use criteria to decide which seasonal filter to use, e.g., the $MSR = I/S$.

Steps 2 and 3: Forecast the trend and apply the seasonal factors (simple).

2. Project the trend using the annual, quarterly, or monthly forecast, growing the trend by the growth rate from the same period, prior year: $T{\downarrow}y{+}1.d = T{\downarrow}y.d\ (1+r)$.
3. Project the daily revenues by applying the seasonal factor (or its forecast by a time series model) to the trend projection: $E(R{\downarrow}y{+}1.d\ ) = T{\downarrow}y{+}1.d + S{\downarrow}y{+}1.d$.

Sources

- Gray, Alistair; and Thomson, Peter. (February 7, 1997). Design of moving-average trend filters using fidelity, smoothness and minimum revisions criteria. Statistical Research Report Series No. RR96/01. Washington, D.C.: U.S. Census Bureau, Statistical Research Division. (Contains methodology for constructing Henderson and other filters.)
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