Seasonal Adjustment of the Quarterly Summary of State and Local Government Tax Revenue (QTax)

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Disclaimer: Any views expressed are those of the authors and not necessarily those of the U.S. Census Bureau.

Qtax Survey

- Quarterly
  - National (State and Local)
  - State (Total and by state and type)
- State
  - Census
- Local
  - Probability samples
  - National minus State

Qtax Survey

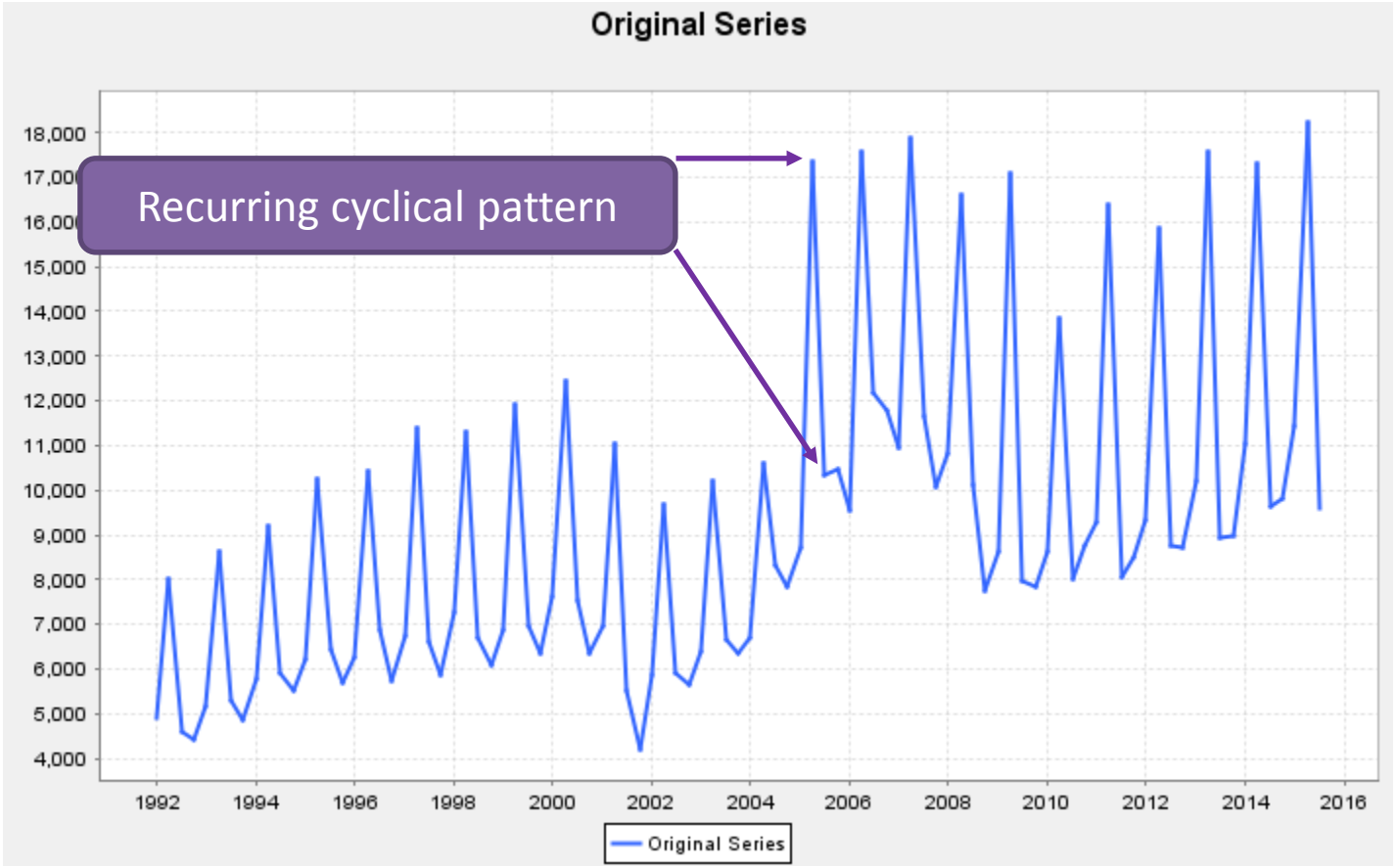
- Four Taxes
  - Property (T01)
  - General Sales and Gross Receipts (T09)
  - Individual Income (T40)
  - Corporation Net Income (T41)

- 12 time series

- Cyclical Pattern

- Seasonal Adjustment
  - Remove cyclical pattern (internal request)

Corporate Net Income Tax (T41)



Seasonal Adjustment Background

- Seasonality can obscure the quarter-to-quarter changes in the series

- Seasonal adjustment removes the repeated seasonal pattern to reveal underlying movement in the series

- General Principle
  - Adjust series **only if** it appears to have a seasonal pattern
  - Residual seasonality should not be present in adjusted series

Seasonal Adjustment

- Decomposition
  - Trend-Cycle component (C)
  - Seasonal Component (S)
  - Irregular Component (I)
- Equation for Multiplicative Decomposition
  - $Y = S \times C \times I$
  - Seasonally Adjusted Series: $A = C \times I = Y/S$

Seasonal Adjustment in X-13ARIMA-SEATS

- RegARIMA Model
  - Model calendar effects
  - Adjust for outliers
  - Forecast the series for seasonal adjustment purposes
- X11/SEATS
  - Perform the seasonal adjustment
- Diagnostics that help make adjustment decisions
  - Check for presence of seasonality in the original series
  - Determine adequacy of the model
  - Measure stability of the seasonal adjustment
  - Check for presence of residual seasonality in the adjusted series

Research Questions

- Are the series seasonal?
- If yes, can we provide quality seasonal adjustments?
- Do the seasonally adjusted series provide additional information?
  - The original series still will be published
  - Can data users gain from having the additional series?

Research Questions Related to Seasonal Adjustment

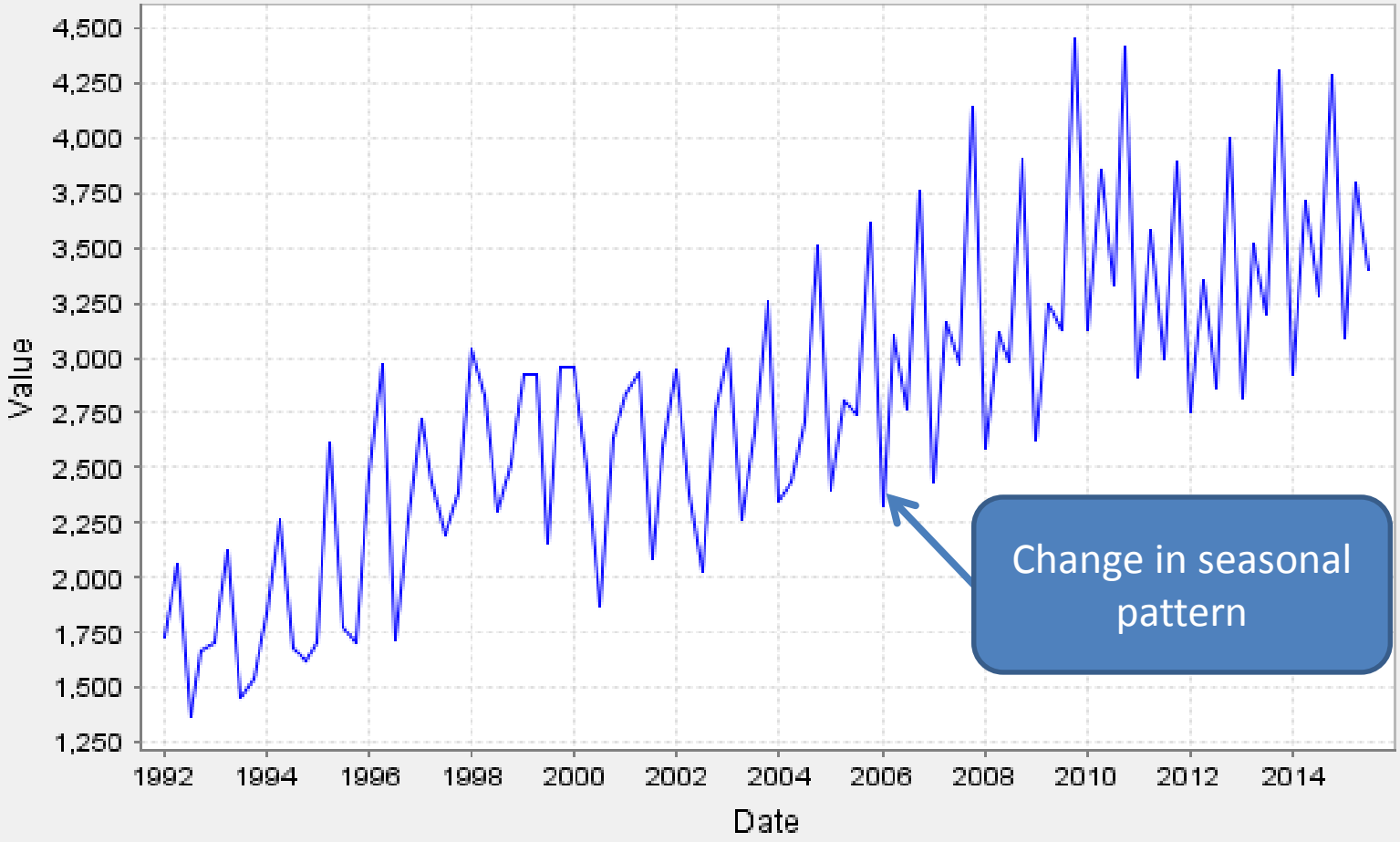
- What method of adjustment should we use:
  - X-11
  - SEATS

- Is it better to
  - Adjust National and State series directly?
  - Adjust State and Local series directly?
    - Indirect adjustment of National series

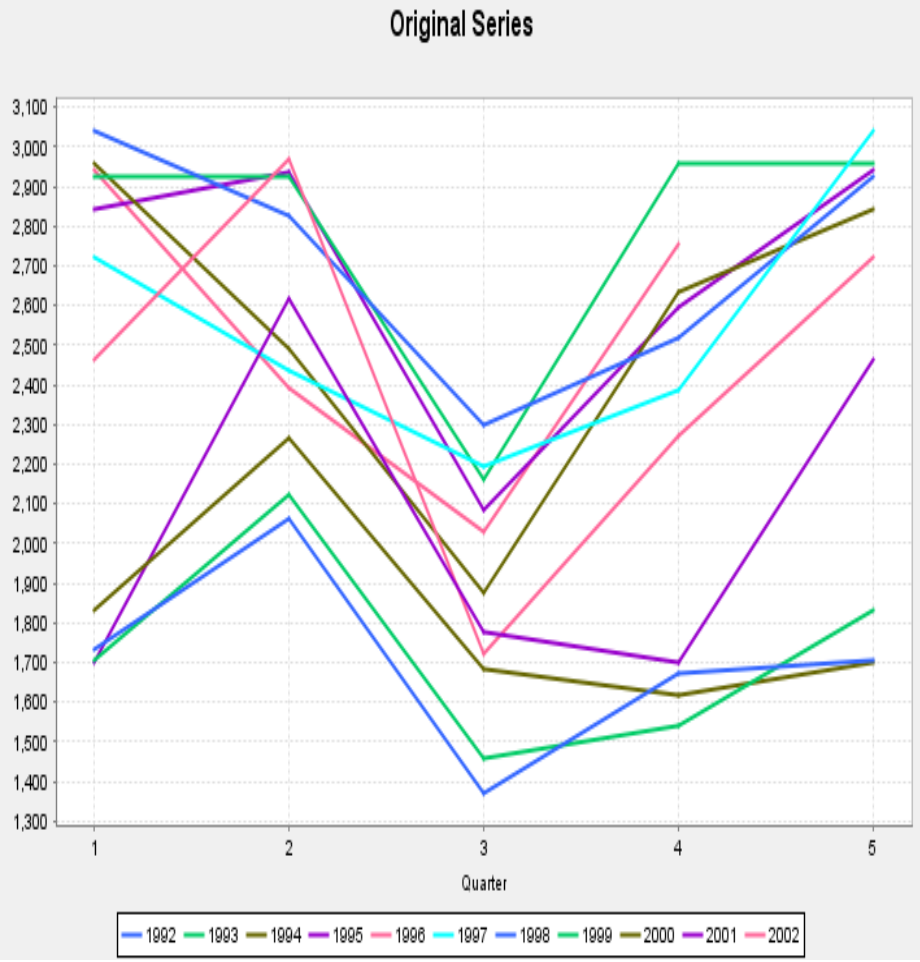
Preliminary Decisions
Length of Series

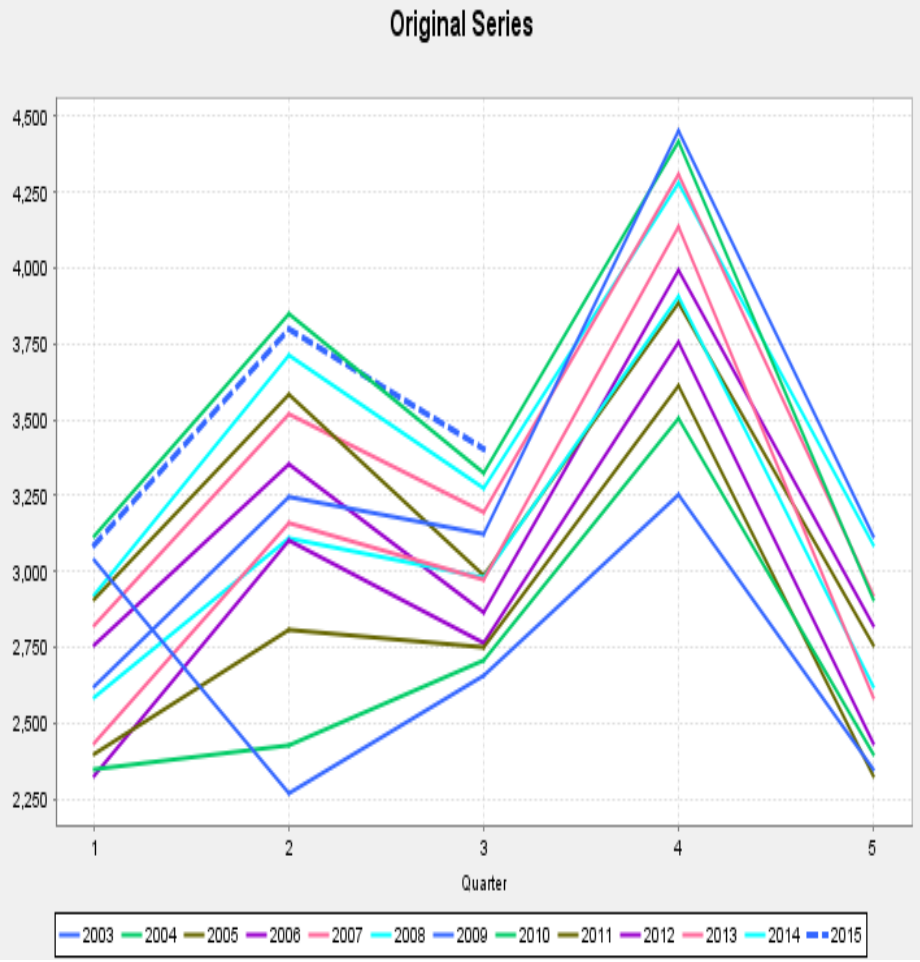
- Series available starting at 1992
- State series
  - Collection changes
- Local series
  - 2008 redesign to probability sample, implemented in 2009
  - Change in questionnaire in 2013
  - estimation changes

Property Tax (T01) - State

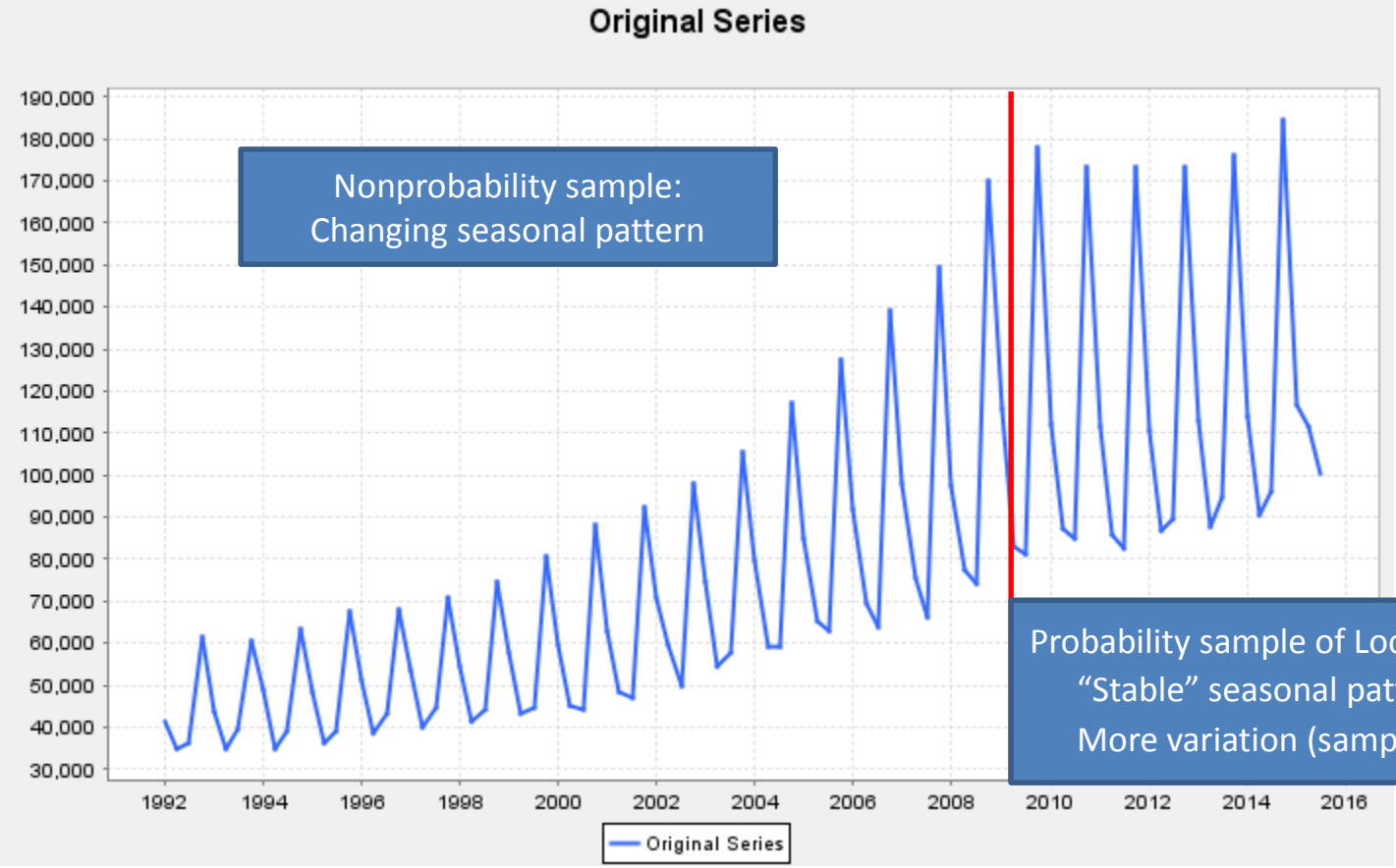


State T01 – 1992–2002 vs. 2003–2015





Property Tax (T01) - National



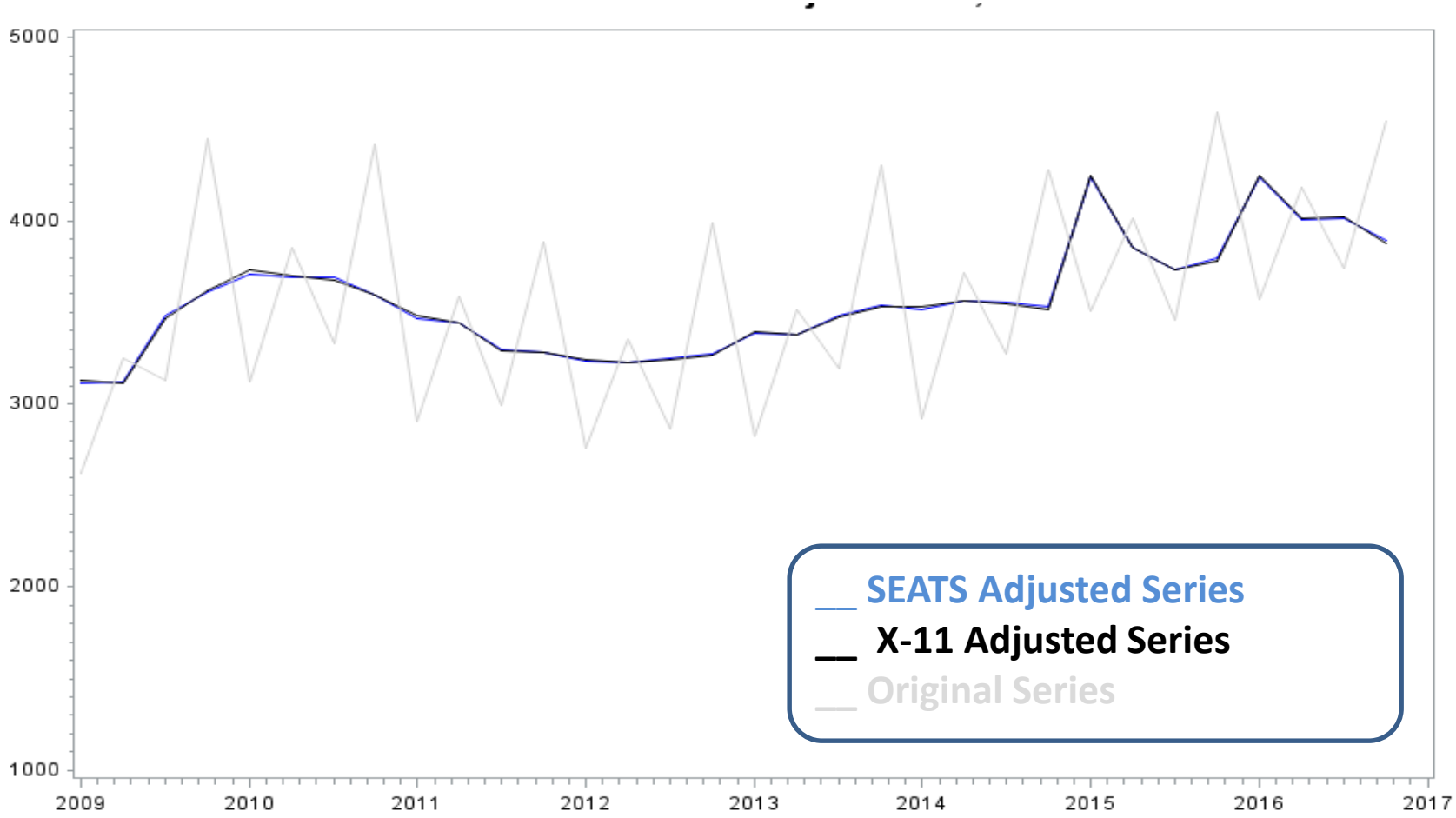
Model and Adjustment Options

- Adjust starting 2009Q1 through 2015Q4
  - Limits the standard diagnostics
  - Refit the series models
- Trading day
  - Captures the effect of the weekday composition of each month
  - Full span
    - State and National T09 (6-coefficient trading day effect)
    - State and National T41 (1-coefficient trading day effect)
  - Short span
    - State T01 (1-coefficient trading day effect)

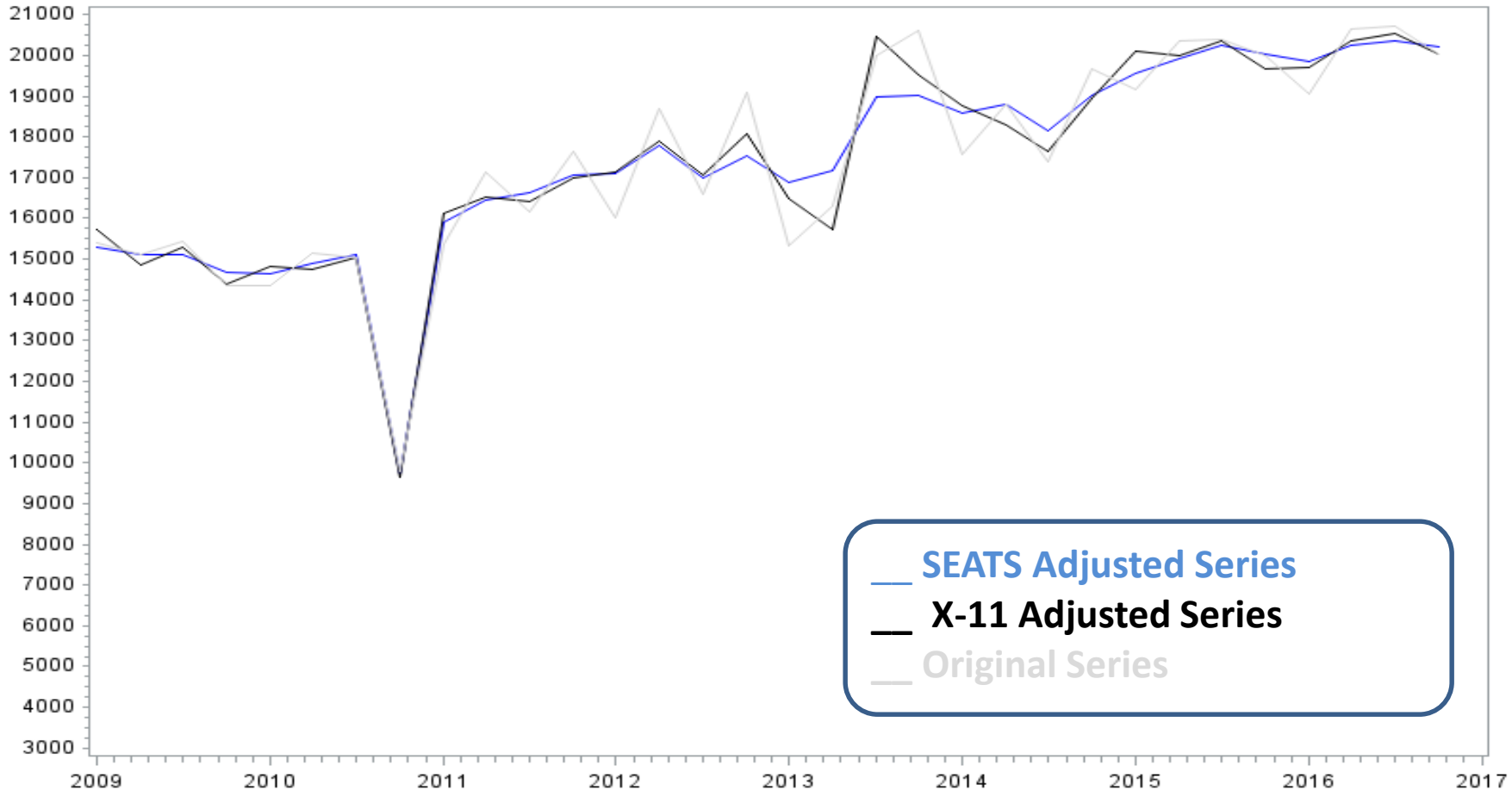
Which Seasonal Adjustment Method?

- X-11
  - All published seasonal adjustments from the U.S. Census Bureau are from X-11
  - Iterates between estimating the trend and seasonal factors
  - Seasonal and trend moving-average filters
- SEATS = Signal Extraction in ARIMA Time Series
  - ARIMA model-based seasonal adjustment
  - Developed at the Bank of Spain and implemented at Eurostat, the Bureau of Labor Statistics, among other organizations

Property Tax (T01) – State Series



General Sales and Gross Receipts (T09) – Local Series



Preliminary Recommendations

Series		RegARIMA Model/SEATS	X-11 Filters
Local	T01	(0 0 0)(0 1 0) + constant	3x5 3x5 3x3 3x5
State		(0 1 1)(0 1 1) + TD(1coef) + LS2009.3 + TC2015.1	3x5 3x5 3x3 3x5
National		(0 0 0)(0 1 0) + constant	3x5 3x5 3x3 3x5
Local	T09	(0 1 1)(1 0 0) + AO2010.4	3x3
State		(0 1 1)(0 1 1)	3x3
National		(0 1 1)(0 1 1) + AO2010.4	3x3 3x3 3x5 3x5
Local	T40	(0 1 1)(0 1 1) + LS2011.1	3x3
State		(1 0 0)(0 1 1) + constant	3x3
National		(0 1 0)(0 1 1)	3x3
Local	T41	(1 0 0)(1 1 0) + constant + TC2010.1	3x5
State		(0 0 0)(1 1 0) + constant + TC2009.2	3x5
National		(1 0 0)(1 1 0) + constant	3x5

Monitoring Phase

- Monitor the seasonal adjustment for a while (one year?)
- For each new quarter, run and compare the X-11 and SEATS adjustments
- Make final recommendation
  - X-11 or SEATS
  - Direct or indirect adjustment (National)

Monitoring the Adjustments

- Monitoring Phase
  - Short series/last published 1994
  - Reevaluate models/adjustments
- What we reviewed
  - All four quarters of 2016 = 12 series
  - Gathered diagnostics to check whether the selected model continued to work well
  - Examined the changes in the model parameters and regression coefficient estimates
  - Looked at whether new outliers were selected

Monitoring the Adjustments

- Checked whether the previous month's forecasted value was close to the true value
- Read the seasonally adjusted series and compared it with that of previous quarters to see how much previous estimates were changing when new values were added
- Compared the corresponding X-11 and SEATS adjustments
- Compared the direct and indirect adjustments of the national series

RegARIMA Models

- ARIMA models
  - Majority stayed the same - 1 change
- Outliers
  - State T01 - TC2016.1 (4.1859)
  - State T41 – LS2015.4 (-7.806)
- Trading Day
  - Remained significant for State T01
  - t-value = -3.76

Seasonal Adjustment Diagnostics

- Diagnostics
  - QS Tests (Residual Seasonality)

    - National series
  - Sliding Spans

    - Local series (T09, T40, T41)
  - Revisions
- X-11 vs SEATS
  - S.A. / Q-Q revisions

SA Method with Smallest Revisions

Series		Average Seasonal Adjustment Percent Change	Average Q-to-Q Percent Change
T01	Local	SEATS	SEATS
	State	tie	SEATS
	National	Direct SEATS Indirect SEATS	SEATS
T09	Local	X-11	SEATS
	State	X-11	SEATS
	National	Direct SEATS Indirect X-11	SEATS
T40	Local	SEATS	SEATS
	State	SEATS	SEATS
	National	Direct SEATS Indirect SEATS	SEATS
T41	Local	SEATS	SEATS
	State	tie	SEATS
	National	Direct X-11 Indirect SEATS	SEATS

RegARIMA Models 2017

- ARIMA Models
  - No changes
- Outliers
  - Local T09 - LS2013.3 (Only for 2017Q2)
  - State T01 - TC2016.1 dropped out
    - Less potential outliers
  - State T41 – LS2015 (-8.474), AO2017.1 (-9.607)
    - Less potential outliers
  - National T41 – AO2017.1(-7.218)
- Trading Day
  - Remained significant for State T01, but less so
  - t-value = -2.93

Seasonal Adjustment Diagnostics 2017

- Diagnostics
  - Residual Seasonality
  - Stable Seasonality

    - Local series (T09, T40, T41)
  - Larger Revisions

    - SEATS outperformed X-11

Direct Versus Indirect of National

- Tended to favor SEATS adjustments
- Difficult to find stable adjustments for the local series
- Census does not publish local estimates
- Direct preferred
  - Can obtain stable adjustments for national and state series
  - Derive (unpublished) local series by subtraction

Conclusion

- Seasonally adjusted series can complement original series
- Presently, the direct method works best for national Qtax series
- Over time, the adjustments might become more stable, which could make the indirect method preferable
- Census should investigate the use of SEATS for seasonal adjustments

Thank You

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