Final Thoughts

Seasonal Adjustment With X-13ARIMA-SEATS

2019

Economic Statistical Methods Division

U.S. Census Bureau

United States Census Bureau

U.S. Department of Commerce
Economics and Statistics Administration
U.S. CENSUS BUREAU
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Objectives

- **At the end of this unit, you should know –**
  - Some suggested practices in seasonal adjustment
    - Tips for unusual situations
  - Where to learn more

U.S. Census Bureau Approach

- Always use X-13ARIMA-SEATS for seasonal adjustment
  - Use regARIMA models, forecasts whenever possible (need very strong reasons *not* to model and forecast)
- Review models, filters, etc. annually
  - Keep the same spec file with no changes during the production year except adding newly identified outliers

U.S. Census Bureau Approach, continued

- Use concurrent adjustment, not projected factors
  - One big exception at the Census Bureau
- Publish the original series and the seasonally adjusted series
  - Could publish trend-cycle as well, but we do not – trends tend to have large revisions
  - (Other statistical agencies around the world do publish trends)

Annual Review

- Written into policy: review spec files annually and change them only during that annual review
  - Producing Estimates from Models – (Index A – Z… Q… Quality Standards… Statistical Quality Standards… D2) https://www.census.gov/about/policies/quality/standards/standardd2.html
- Advantages
  - Higher quality adjustments
  - Reproducible results

Annual Review but Concurrent Adjustment

- Every month/quarter, when a new observation is available, run the new series using the same spec file
  - Same model (in form) but re-estimate parameters

Example Production Spec File

```
metadata {keys="analyst" values="Ice Bear" }
series {span = (1992.1,)
    modelspan = (1995.1,)
    file='sales.dat' format='datevalue'
}
spectrum {savelog=all}
transform {function=log}
regression {variables=(td ao2000.sep ls2016.dec)}
arima {model=(0 1 1)(0 1 1)}
outlier {types=(ao ls) critical=3.8 span=(2016.1,)}
forecast {maxlead=24}
check {print=all savelog=all}
estimate {print=all}
X11 {seasonalma = s3x5
    sigmalim = (1.8 2.8)
    savelog=all
}
```

Concurrent Seasonal Adjustment

- Each month/quarter uses the most up-to-date information for seasonal adjustment
- Benefits
  - Ensures that the seasonal factors are current
  - Smaller revisions each month rather than all at once when estimates are updated

Revisions to the Seasonally Adjusted Series

- Revisions occur because of
  - Changes in the original series
    - Late respondents
    - Historical corrections
  - Method or classification/definition changes in the original series
  - Adding new observations
    - New values mean new model parameters, new forecasts, maybe new extreme values, new seasonal and trend filter values

Revisions From New Observations

- New observations cause revisions to *past estimates*

- Usually new observations affect the last 3 to 4 years of the series, depending on the settings
  - Longer filters reach further into the past to cause revisions but have smaller weights so revisions might be smaller at any given time

Publishing Revisions

- Revise the adjustment for each original value that changes
- Suggestion: revise into the past beyond where the original series has changed
- Can revise the entire series
  - Consider how the regression estimation (TD, moving holidays, etc.) might change

Each Month/Quarter: Revisions

- Suggestion: revise one or two previous values beyond where the original series has changed
- Suggestion: revise the same month/quarter a year ago (and one more?)
  - Can compare month-to-month (quarter-to-quarter) changes of last year and this year

Annually: Revisions

- Suggestion: revise at least five years into the past
  - Consider how long the seasonal filters are when deciding how far back to revise

~~Quick~~ Tips

Unusual Events

- The default outlier critical value is greater than 2 because of multiple comparisons
  - Greta Ljung (1993)
- If we know something happened that is likely to affect the series (*a priori* knowledge), we can use a |t statistic| of 1.96 (or 2)
  - Find outlier t statistics in *.fts file

  or
  - Model the outlier and check the t statistic
  - (These will differ slightly)

Retail Car Sales, September 2001

Outlier	Param.	SE	t value
AO2001.Sep	-0.0609	0.029	-2.11
Automatically Selected			
AO2001.Oct	0.1732	0.029	6.02
AO2005.Jul	0.1186	0.027	4.40

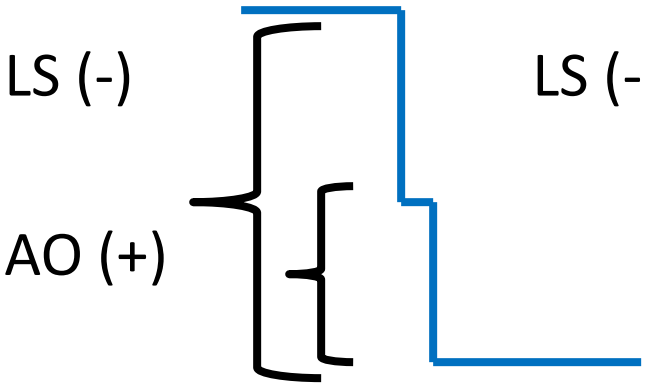
Argument for Flow/Stock

- X-13ARIMA-SEATS users can specify **`type=stock`** or **`type=flow`**
  - **`series{} or composite{}`** spec
  - Prevents using the wrong kind of regressors

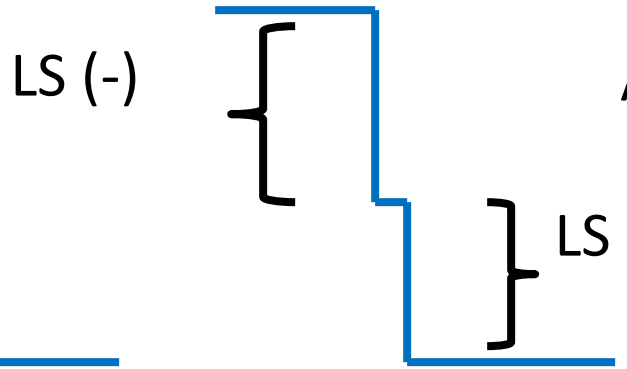
- **Vitally important to understand the series concepts, estimation, and behavior**
  - For example, Single Family VIP is flow in concept (construction spending over the month) but has unusual estimation that alters the weekday measurement, so we don't use regular trading day regressors
  - Keep an eye out for unusual results like leap year February outliers or extreme values

Simultaneous or Consecutive Outliers

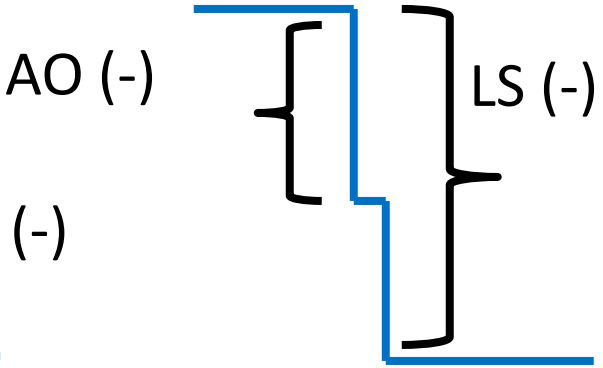
AO, LS at same time



Consecutive LS, LS

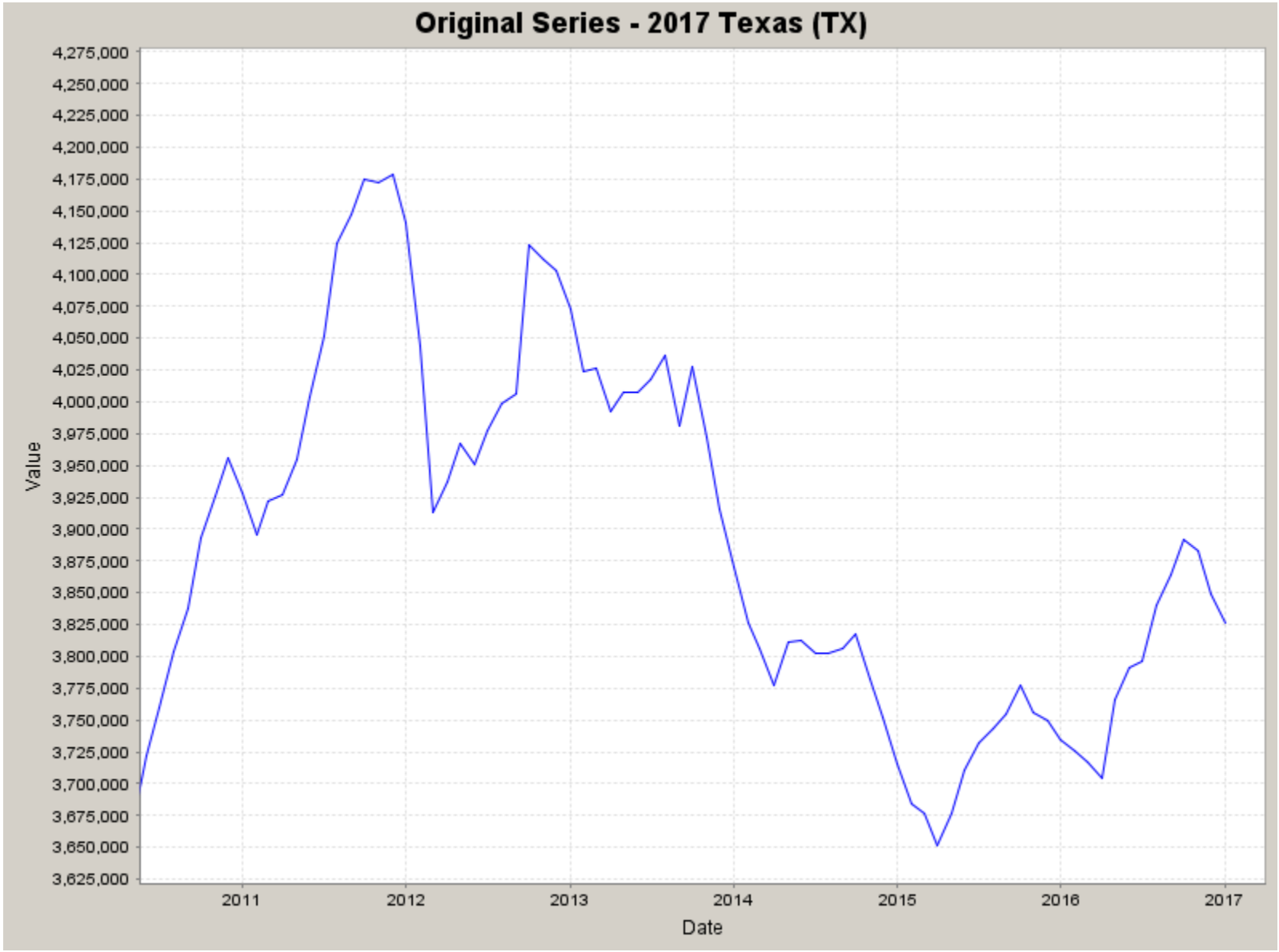


Consecutive AO, LS

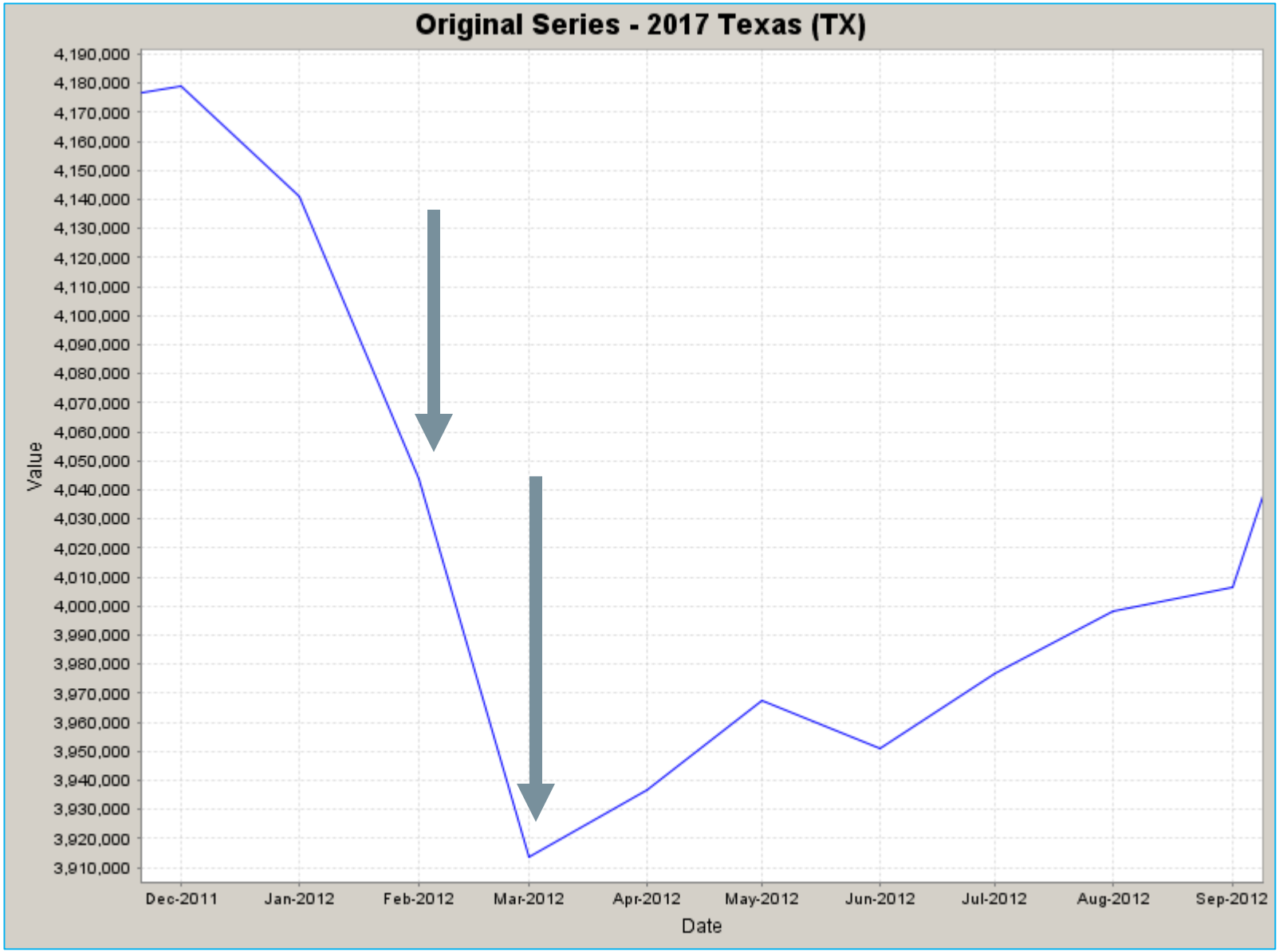


These outliers are equivalent (for most of our purposes)

Texas SNAP Original Series



Closer Look, 2 Consecutive LS



Consecutive Level Shift Regressors

Regressor	Coefficient	Std Error	t value
LS2012.Feb	-0.0254	0.00562	-4.51
LS2012.Mar	-0.0435	0.00531	-8.19

SNAP = Supplemental Nutrition Assistance Program, formerly known as food stamps

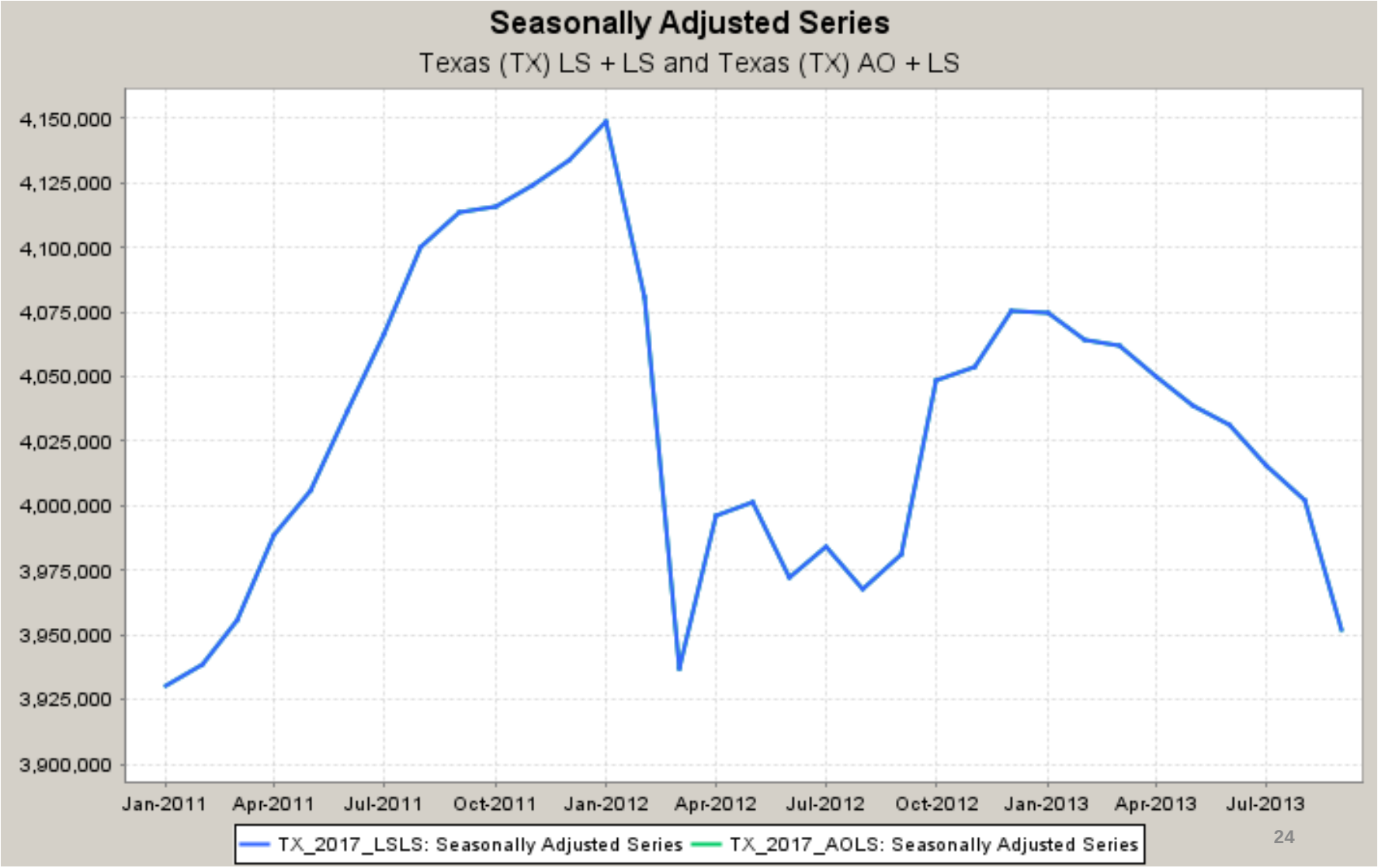
Additive Outlier Followed by a Level Shift

Regressor	Coefficient	Std Error	t value
AO2012.Feb	-0.0254	0.00562	-4.51
LS2012.Mar	-0.0689	0.00904	-7.61

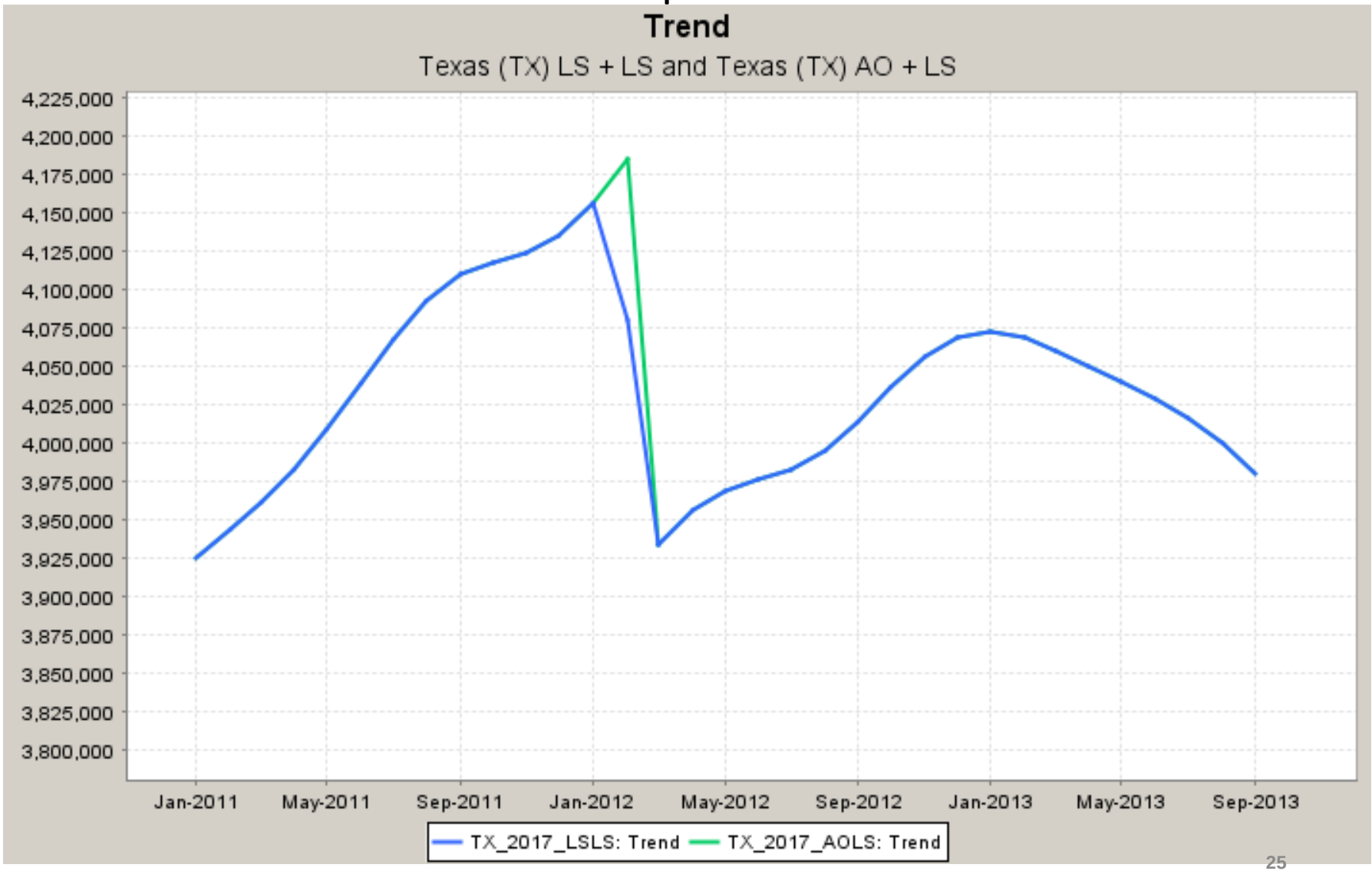
AO + LS or LS + LS?

- Outlier sets give the same seasonal adjustment!
  - Usually it won't matter, but if publishing the trend, decide which outlier types make the most sense
    - AO: assigned to the irregular (I)
    - LS: assigned to the trend (C)
  - Diagnostics based on the trend or irregular will be different

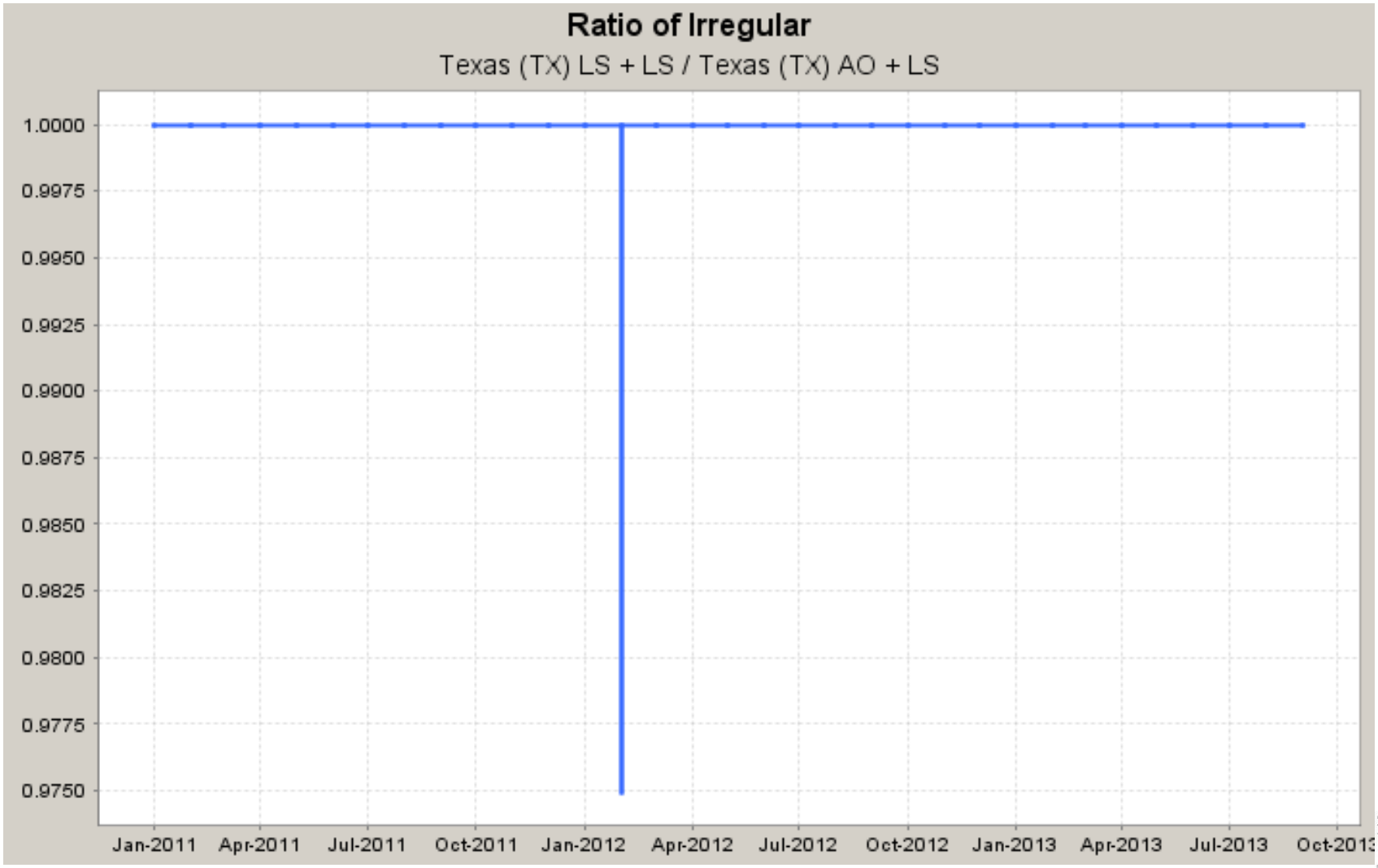
Same Seasonally Adjusted Series



Texas SNAP Trend Comparison



Texas SNAP Irregular Comparison



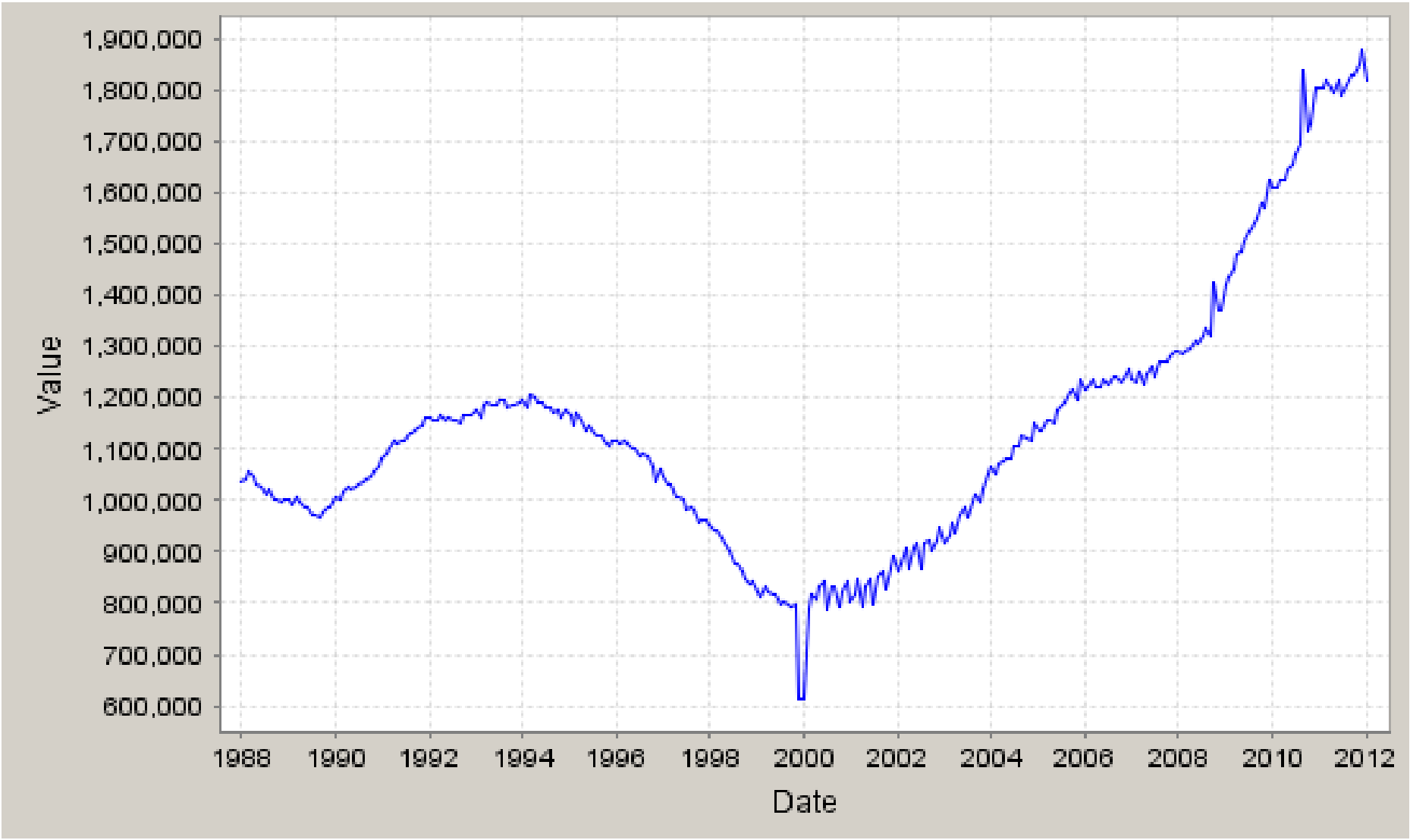
Canceling Level Shifts

- Two (or more) level shifts in opposite directions might cancel
- We can replace them with AOs or a temporary level shift (tLS)

Example: Illinois SNAP Recipients

- 2 very low values, December 1999 and January 2000
- Possibly reporting problems, y2k issues?

Illinois SNAP Original Series



Illinois SNAP: Automatically Identified Outliers

Variable	Parameter Estimate	Standard Error	t-value
AO1996.Nov	-0.0208	0.00499	-4.17
LS1999.Dec	-0.2729	0.00668	-40.87
LS2000.Feb	0.2546	0.00764	33.33
AO2004.Jan	0.0274	0.00529	5.18

+ more outliers not shown here

Test the Level Shifts for Cancellation

- Use the **`LSrun`** argument
  - Value indicates how many level shifts to test for cancellation, set to 2, 3, 4, or 5

```
outlier {. . .
    lsrun=2
. . .}
```

Criteria for Replacements

- Span is “short”
  - “Short” is determined by the user, perhaps not longer than half a year?
    - Depends on circumstances!
- Sum of LS effects is not significantly different from 0

  $|t| < 1.96$ (or 2)

Cancellation Test in the Output

Tests for Cancellation of Level Shifts

Dates of LS Sets	Span	t-value
1999.Dec+2000.Feb	2	-1.28

- Span is 2 months (short)
- | t statistic | is 1.28, so the sum is not significantly different from zero; in other words, these level shifts cancel each other

Replace the Level Shifts With Additive Outliers

Replace

LS1999.Dec and LS2000.Feb

with

AO1999.Dec and **AO2000.Jan**

At 2000.Feb, the level shifted back to the previous usual level; 1999.Dec and 2000.Jan are the unusual values

Illinois SNAP: New Outlier Set

Variable	Parameter Estimate	Standard Error	t-value
AO1996.Nov	-0.0207	0.00505	-4.11
AO1999.Dec	-0.2672	0.00572	-46.76
AO2000.Jan	-0.2621	0.00613	-42.76
AO2004.Jan	0.0266	0.00532	5.00

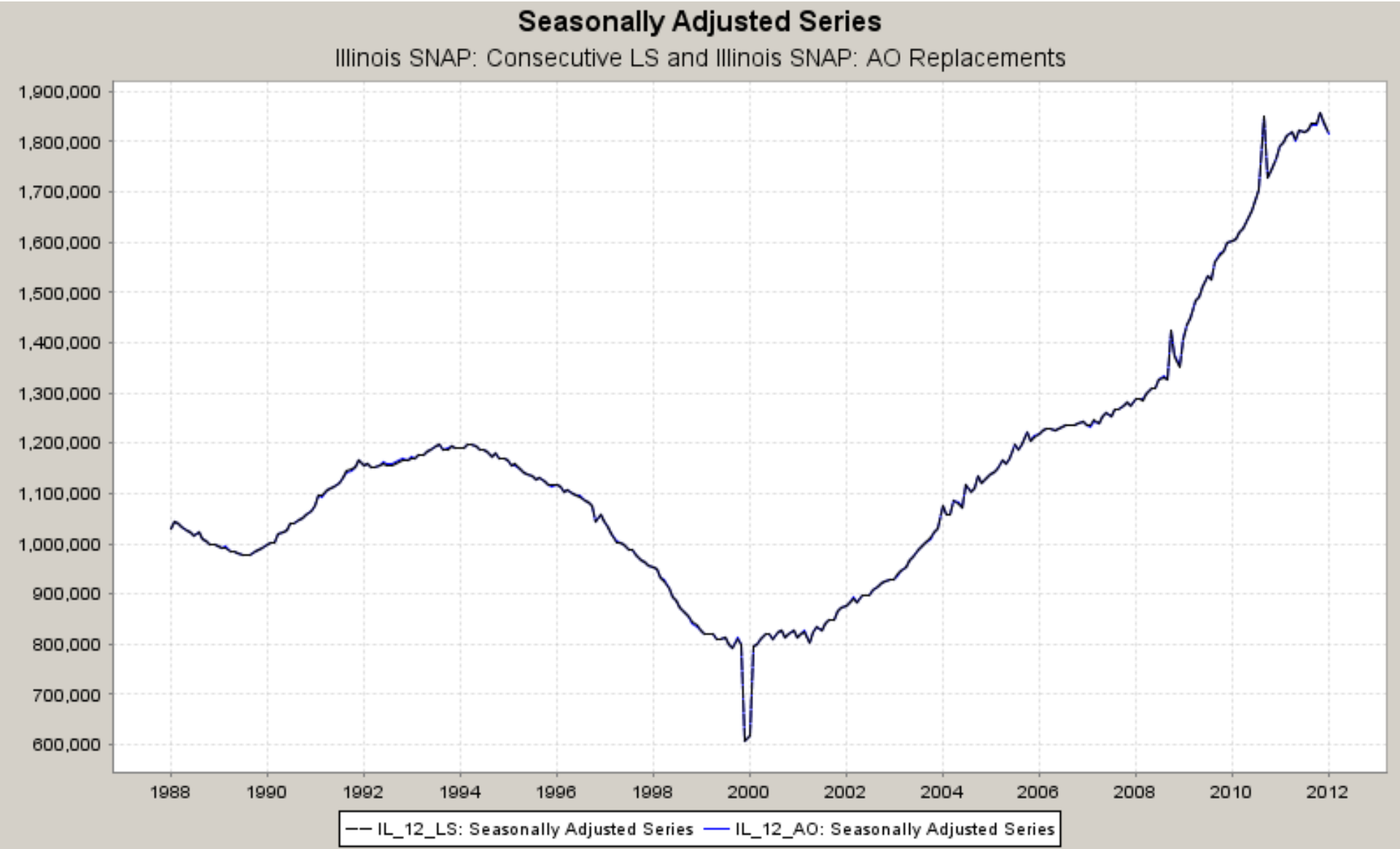
+ additional outliers

New outlier set could be fairly different from before

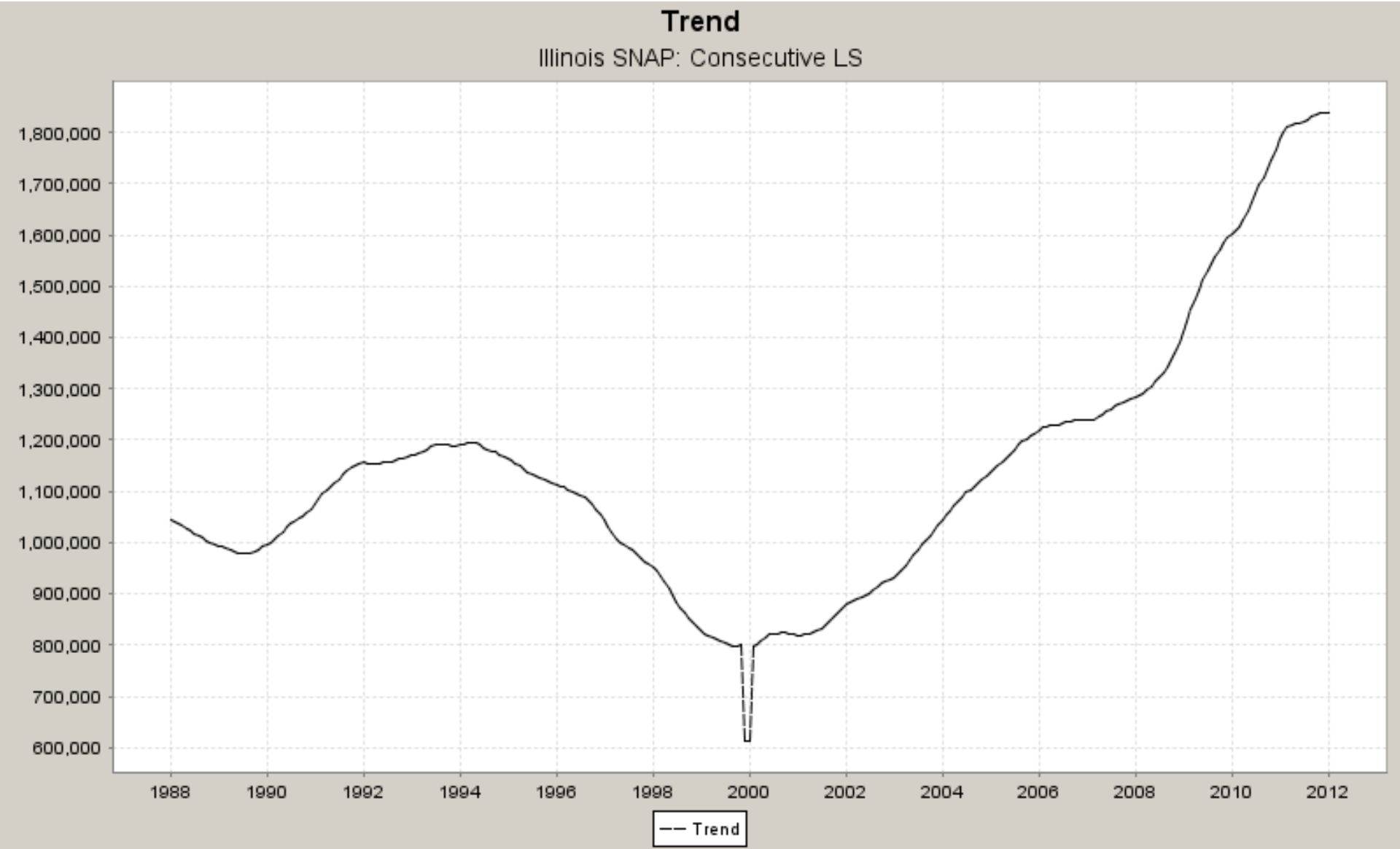
Why Replace the Level Shifts?

- If we publish the trend-cycle or irregular component (or use those for analysis), we can ensure the outlier types make sense for the series
  - Sudden and short-term bumps often make more sense as irregular effects, might be undesirable as trend effects

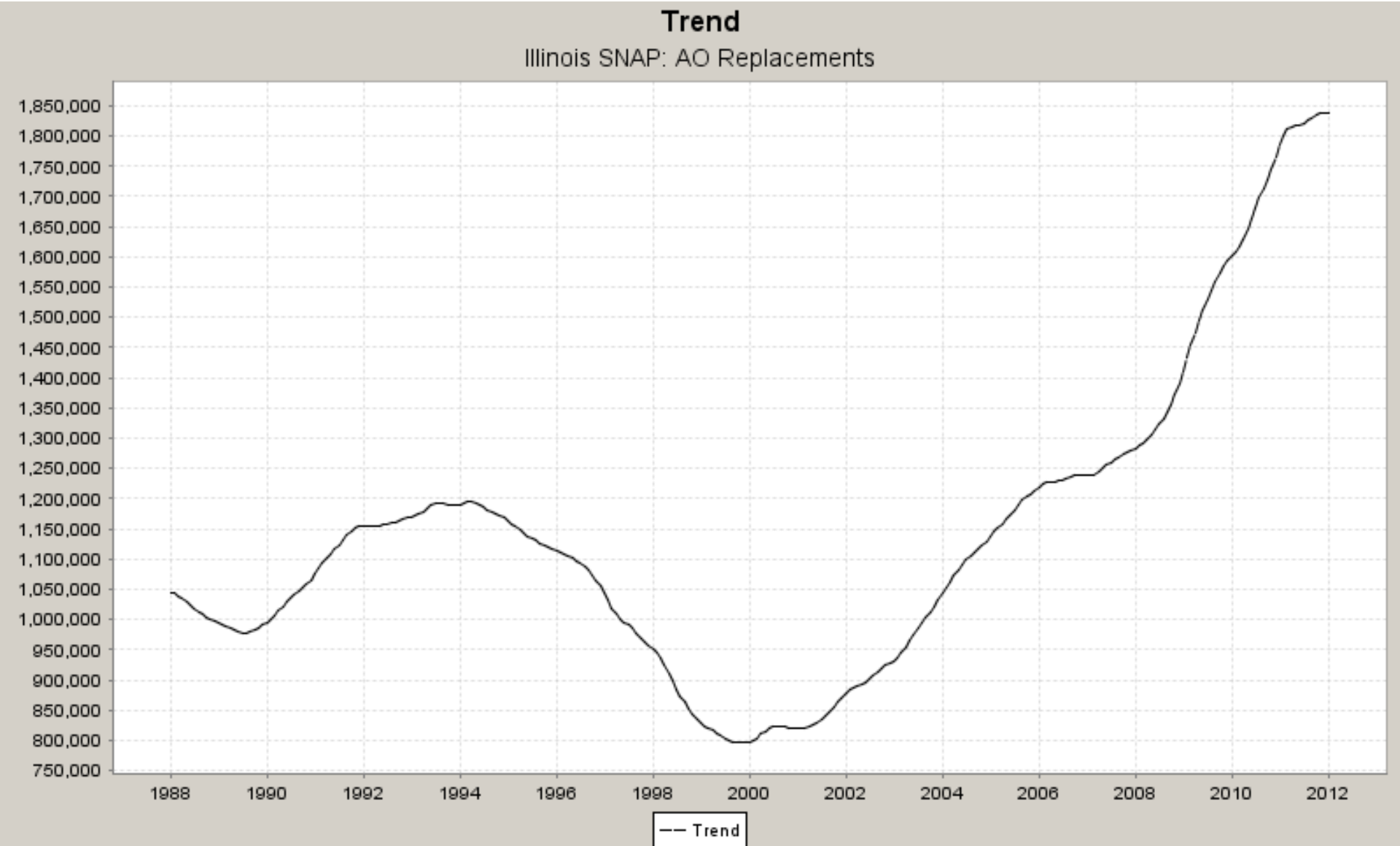
Seasonally Adjusted Series: Nearly the Same



Trend With Consecutive LS



Trend With AO Replacements



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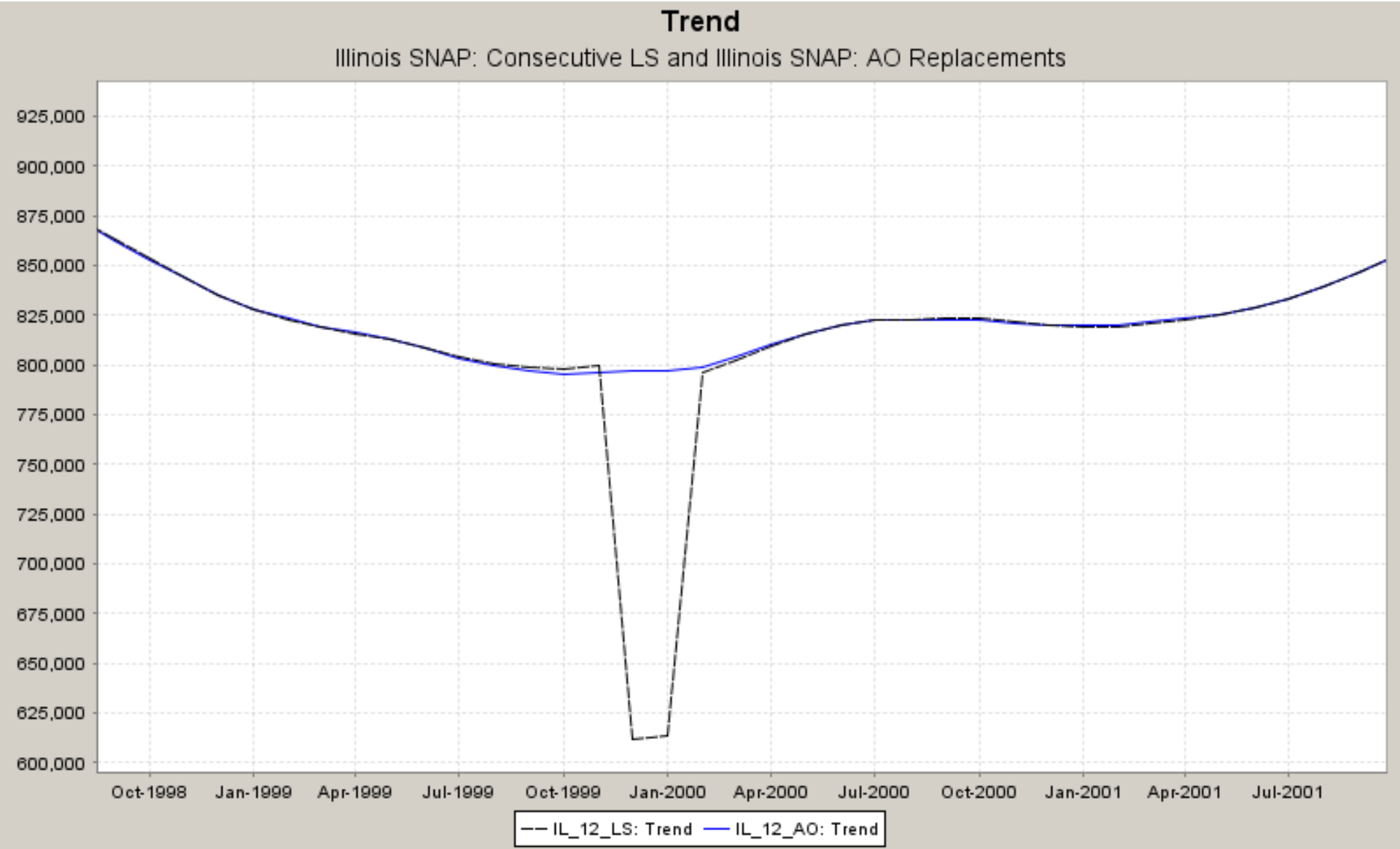

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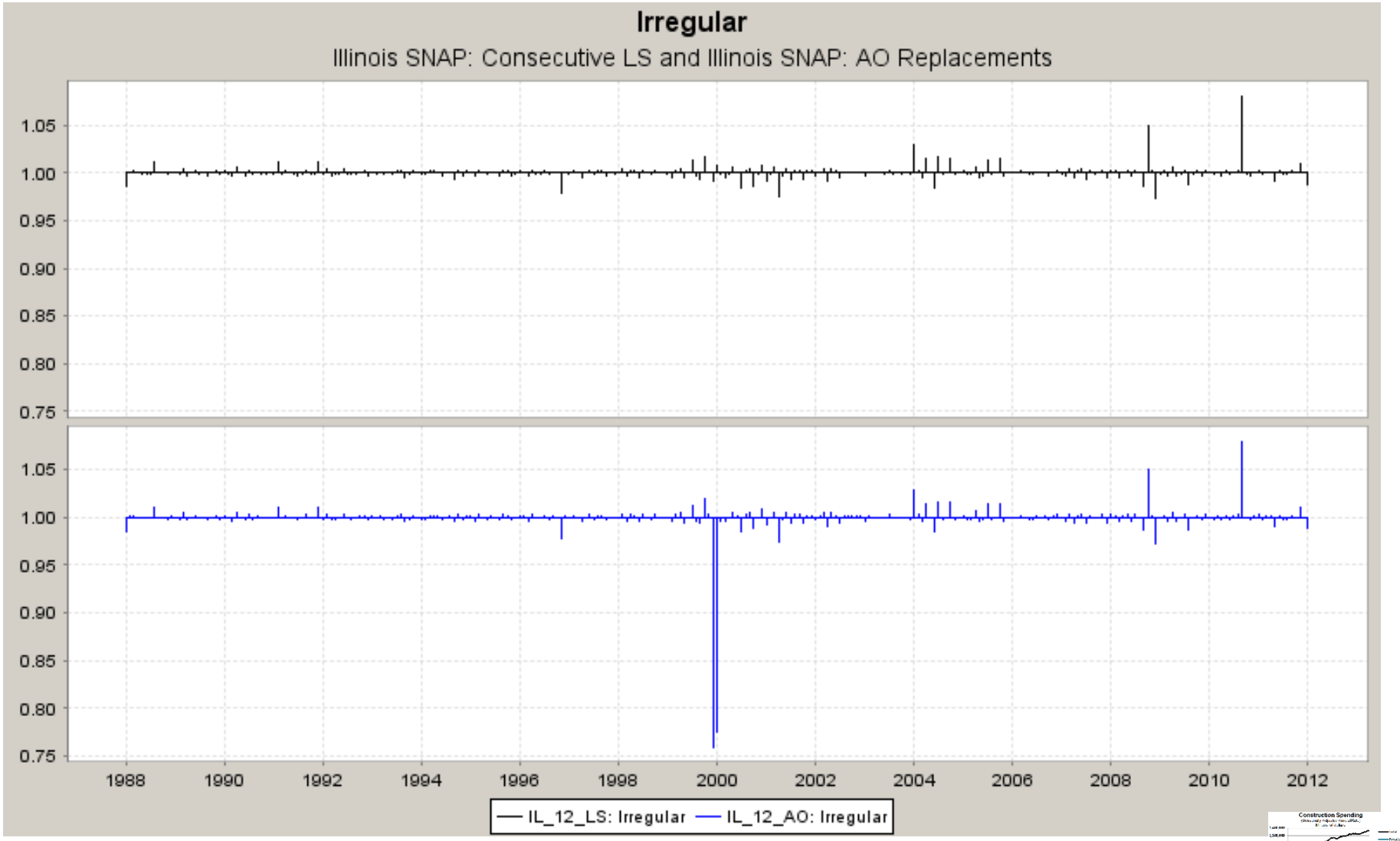
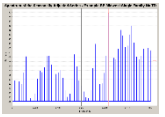


Problem? ARIMA (p d q)(1 1 0)

- Sometimes almost miraculously clears up problems in ACF/PACF and/or spectrum of model residuals, but if it does not fit well, the forecasts can cause problems

- Avoid using this ARIMA model unless both the AICC and out-of-sample forecast error plot prefer it over (p d q)(0 1 1)



When Discouraged, Remember Clive Granger's Statement

- 2003 Nobel Prize in Economics

"The criteria I suggested have been shown to be impossible to achieve in practice, and thus, should be replaced by achievable criteria. However, I am at a loss to know what these criteria should be.

There seems to be no ideal process of evaluating a method of adjustment…."

1978, "Seasonality: Causation, Interpretation, and Implications“ (response to comments)

Available on the Census Bureau website

www.census.gov/ts/papers/Conference1978/Granger1978.pdf

Future of Seasonal Adjustment

- Model-based Adjustment
  - The future is now

- SEATS, developed by Agustín Maravall at the Bank of Spain
- REGCMPT, developed by Bill Bell at the Census Bureau

REGCMPT

- Advantages
  - Methods for seasonal heteroskedasticity
  - Can build very flexible regARIMA models
- Disadvantages
  - Not quite ready; Bill works on the program when he has time

How to Learn More?

- Experiment with series that you know well
  - Try different models, filters, other settings
- Read agency standards and guidelines
- Papers, books, Internet
  - Papers often have the best information on new developments!

Census Bureau's Website

www.census.gov/srd/www/x13as/

- Glossary
- Papers for New Users
- Manual, Quick Reference
- Census Bureau Standards and Guidelines
- References
- Links to other resources

Springer Lecture Notes in Statistics

- Ladiray and Quenneville (2001) *Seasonal Adjustment With the X-11 Method* (#158)
  - Spanish and French translations available on the X-13 website

- Dagum and Cholette (2006) *Benchmarking, Temporal Distribution, and Reconciliation Methods for Time Series* (#186)

Thank You!

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- If links to papers change, try www.census.gov then choose “Index A-Z” (in tiny font at the top of the page) then choose X