The Effect of the Pandemic on the Seasonal Adjustment of BLS Labor Force Estimates

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Outline

- Normal approach to current SA and outlier detection for national and metro area labor force estimates
- Outlier Regression Model
- Sequence outlier option for real time outlier detection
- Seasonal adjustment of national labor force series using additive outlier sequence (AOS)
- Seasonal adjustment of metro labor force series using level shift outlier sequence (LSS)
- Unemployment Insurance Initial Claims
- Summary

Seasonal Adjustment of BLS Labor Force Estimates

- BLS uses the Census X-13A-SEATS program to seasonally adjust national and Metropolitan Statistical Area (MSA) estimates
- Normal policy is to use all relevant data as it becomes available each month to seasonally adjust the latest observation in each series (concurrent adjustment) with the following restrictions
  - models, parameters, outliers fixed during the year
  - no revisions until the end of the year
  - if needed, new outliers will be added but only at the end of the year
    - infrequent
    - relatively small in magnitude
    - usually, no prior information

Seasonal Adjustment of BLS Labor Force Estimates

- Covid-19 required an immediate change to real time outlier identification and estimation
  - large magnitude unprecedented
  - widespread over large number of series
  - Knowledge of cause & time of occurrence

Outlier Regression Model (RegARIMA)

- $y_t = U_t + O_t,$

  U_t is a seasonal ARIMA series

  $O_{t_0+r} = \sum_{i=0}^{r} \beta_i x_{i,t_0+i}$ outlier effect

  $x_{i,t}$ -- exogenous variables (e.g. 0's & 1's)

  β_i -- i^{th} outlier effect

  - $y_t - O_t = U_t,$ series purged of outliers
  - Seasonally adjust U_t, yields seasonal factors, S_U, free of distortions
  - Individual outlier effects, $\beta_i x_{i,t}$, allocated to either trend-cycle or irregular component

Pre-Specified Outliers in X-13A-S

Type	Description	Component
Additive	Abrupt change affects only one observation	Irregular
Level Shift	Abrupt change to a new level	Trend-cycle
Temporary change	Abrupt change followed by exponential decay to normal	Irregular

Default Outlier Selection Option

- When adjusting many series, common approach is to use the default automated procedures available in X-13-A-S (U.S. Census Bureau, 2020
  - **Iterative Stepwise Approach** (default in Outlier spec)
    - Capable of following complicated patterns by mixing & sequencing 3 simple types of outliers (AO, TC, LS)
    - Intensive search process
      - Forward addition of one outlier regressor at a time with the most significant t-stat, repeat until no significant regressors remain.
      - Backward deletion of 1 regressor at a time until only significant regressors remain
    - Most effective for identifying outliers towards middle of series, less effective towards end of series

Outlier selection at the end of the series

- At the end of a series all outliers look alike—sudden change in level
  - Lack of additional data precludes effective use of the stepwise outlier option
- **Sequence Outliers** (Lytras & Bell, 2013)
  - available in the Regression spec
  - much less intensive automatic testing process, useful towards the end of series
  - prespecifies the type of outlier using one of two options:
    - **AOS—sequence of additive outliers**
    - **LSS—sequence of level shift outliers**

Sequence of Successive Simple Outliers

- Outlier Effect $(t_o, t_o + r)$:

$$O_{t_0+r} = \sum_{i=0}^{r} \beta_i x_{i,t_0+i} = \begin{cases} \beta_r & if\ AOS \\ \sum_{i=0}^{r} \beta_i & if\ LSS \end{cases}$$

  - $x_{i,t}$ appropriately defined zero-one regressor variables
  - AOS : non-overlapping, no accumulation of previous effects
  - LSS : overlapping effects accumulate over time
  - Each period, add new regressor & retain previous regressors with significant t-values

Difference between outlier sequence options

- AOS more conservative since it tends to use less information from the pandemic period
  - At each time point, assumes duration of outlier effect is one period, to maintain protection must add additional outliers each period
  - Useful when pattern uncertain, estimated sequence of AO's may give clues in suggesting how to model
  - If an unbroken sequence of AO outliers were added in real time during 2020 it would be equivalent to excluding pandemic data from the seasonal adjustment process (not concurrent SA)
    - equivalent to the seasonal factor projection method, an old practice commonly used in the early years of slow mainframe computers
    - with advent of modern computers this approach was largely abandoned in favor of concurrent SA

Difference between outlier sequence options

- LSS is less conservative in its use of pandemic data
  - Cleans data without zeroing it all out, allows use of concurrent SA in the interim period as new data accumulate,
  - Especially useful if level or rate of change in series stabilizes or experiences discrete shifts
  - During the steep recovery period, deterministic LS reflecting extreme values in 2020, may drive trends in additive models to unrealistic low levels towards the end of 2020. Requires careful monitoring and ultimate modification to diminish the effects to zero.

Which outlier sequence option should be used?

- Not clear since little information at the start
  - Either approach can effectively insulate SA from serious distortion by pandemic effects during the early stages of gathering additional information from new data
- SA of National LF estimates from CPS used AOS approach
- SA of Metro LF estimates from the LAUS program used LSS approach.
  - At end of 2020, a special study using AICC criterion to assess different approaches was made for the metro data

Seasonal Adjustment of Metro Areas

- Started with LSS
- At end of year, with benefit of hindsight, tested alternatives, using minimum AICC criterion (**ARIMA model fixed**) to select the most parsimonious combination of outliers.

Seasonal Adjustment of National CPS LF estimates

- Started with AOS
- At end of year, with benefit of hindsight, tested alternatives, using minimum AICC criterion (**ARIMA model fixed**) to select the most parsimonious combination of outliers.

Multiplicative vs Additive when large level shifts occur

- Multiplicative SA, by exaggerating seasonal variation series when there is a sudden large shift in level, may obscure rather than reveal underlying movements in the series
- May lead to exaggerated downward adjustment in SA series during periods of normally high seasonality and upward adjustment during periods of low seasonality
- For additive seasonal adjustment, magnitude of seasonal variation will be much smaller relative to the level of the series
  - resulting SA series will be very close to NSA series, reflecting obvious fact that seasonality no longer obscures the level of the series

Reassessment at end of year

- LAUS Unemployment series for 421 metro areas
  - base period for RegArima models -- 2000-2019
  - span for outlier detection -- Mar-Dec 2020
  - T-test critical value = 3.16
- Four options for selecting outlier sets:

AOS	Regression spec for Sequence of AO's
LSS	Regression spec for Sequence of LS's
LS_TC_AO	Automatic detection of AO's, LS's & TC's
LS_AO	Automatic detection of LS & AO's

Minimum AICC criterion for Outlier Model Selection

$$AICC_N = \underbrace{-2L_N + 2n_p}_{AIC} + \frac{2n_p(n_p+1)}{N - n_p - 1}$$

L_N = estimated maximum value of the exact log likelihood function

n_p = number of estimated parameters in the model

N = effective number of observations

- 1st AIC term -- “information loss” from fitting RegArima model, where ARIMA part & historic outliers from pre-pandemic data are fixed across all pandemic outlier options
- 2nd AIC term – “penalty for complexity” due to additional parms required in the outlier spec (3rd term small sample correction)
- Min AICC picks parsimonious outlier combination that balances minimizing loss in fit with increased model size due to the outlier spec

Figure 1: CPS National Unemployment Rate

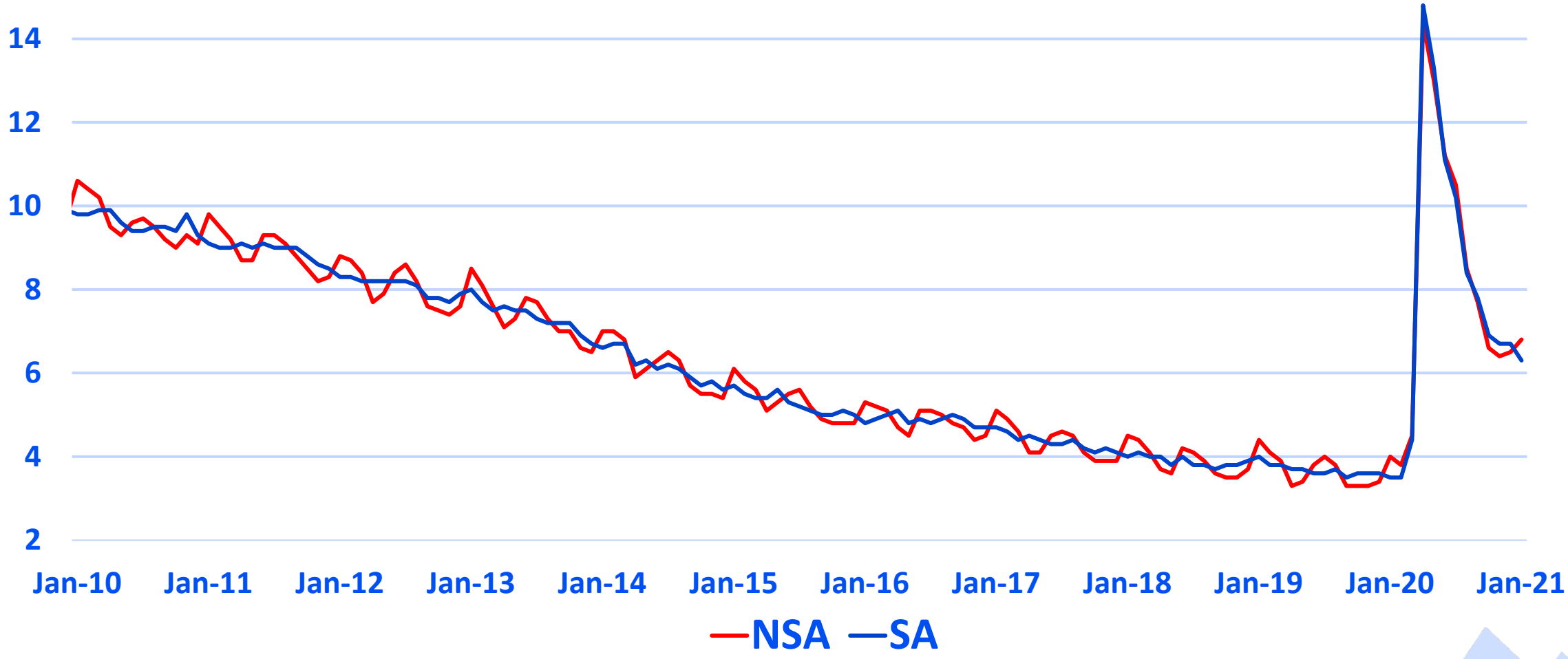


Figure 2: Percent of Metro Area Unemployment series with Minimum AICC

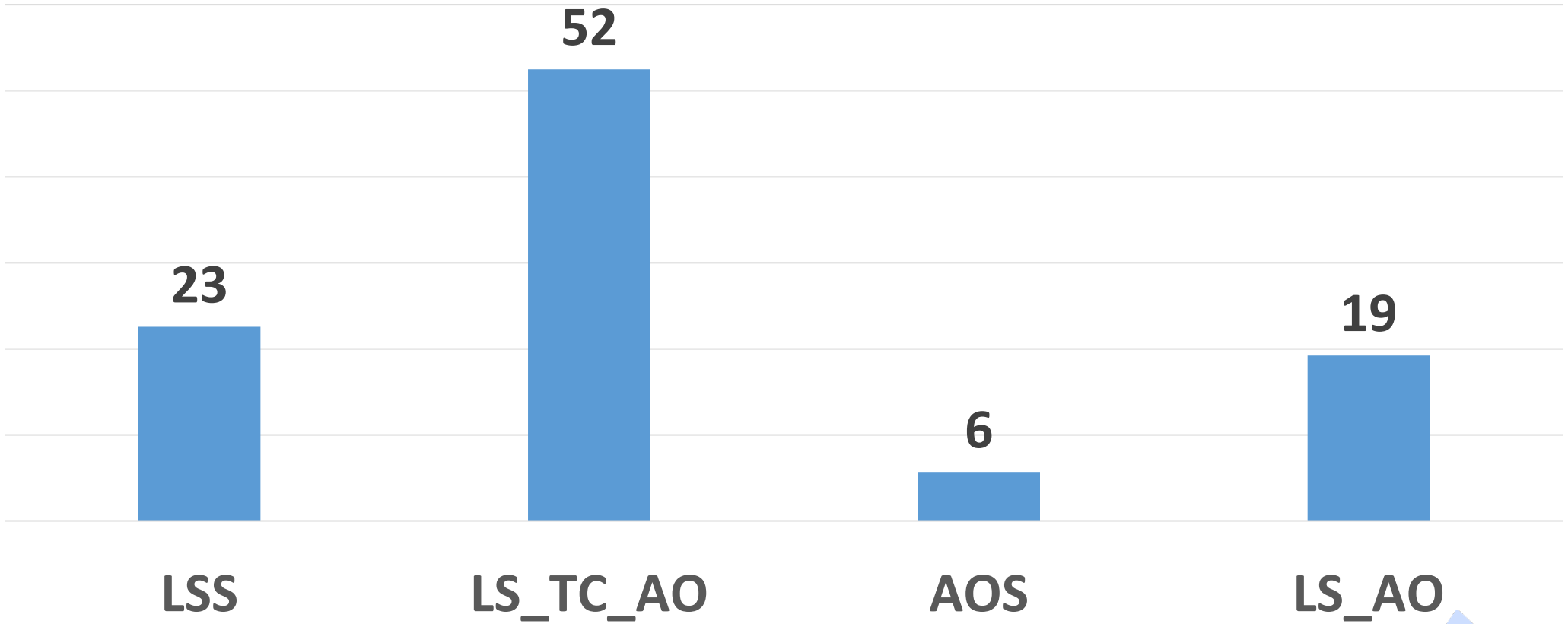


Figure 3: Average Number of Outliers Per Area by Option

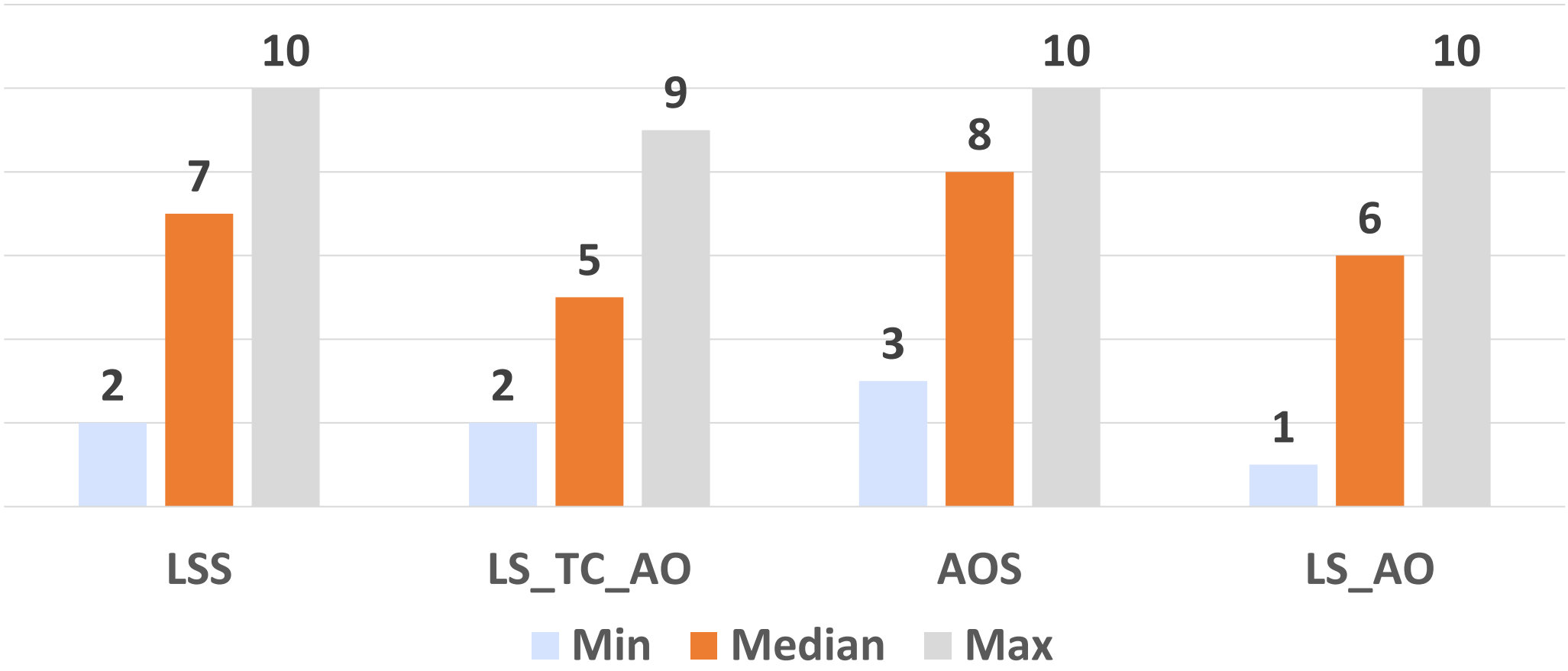
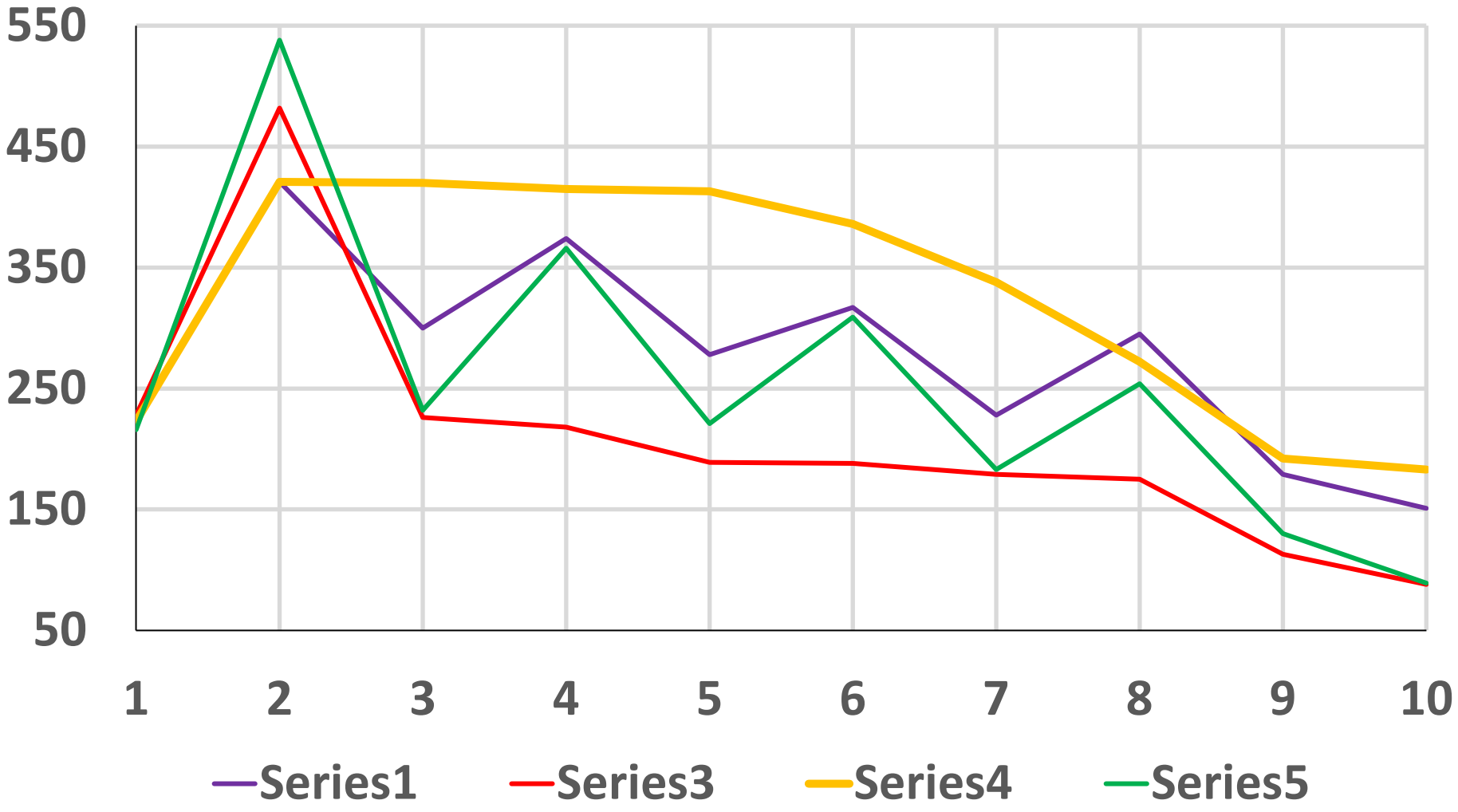


Figure 4: Number of Outliers in Each Month of Pandemic



UI Initial Claims

- A roughly 30x increase in the first four weeks of the pandemic
- So, we had immediate concerns about using multiplicative adjustments
- Unfortunately, the MoveReg program was written in Fortran and did not allow for additive adjustments or LS/TC outliers
- No ability to properly detect outliers automatically at first for weekly data
- BLS uses projected seasonal factors for UI series so a special intervention was needed in the summer of 2020
- Every week was an AO for months without using LS's and TC's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Summary

- After accumulating 10 observations in the pandemic period, the AOS method, which heavily discounts the pandemic data, is least parsimonious for most series
- Overall pattern is an eventual return towards normal or new normal where pandemic data provides useful information for seasonal adjustment.
- Care must be taken to ultimately turn off pandemic LS's that outlive their usefulness

References

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U.S. Census Bureau (2022) “X-13ARIMA Reference Manual, Version 1.1,” Time Series Research Staff, Center for Statistical Research and Methodology, Washington, DC, available at https://www.census.gov/data/software/x13as.html

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