Understanding the Relationship Between the Seasonal Regression Model-Based F Test and a Diagnosis of Residual Seasonality

Kathleen McDonald-Johnson and Demetra Lytras
U.S. Census Bureau

Seasonal Adjustment Practitioners Workshop

November 20, 2019

Disclaimer: Any views expressed are those of the authors and not necessarily those of the Census Bureau. The Census Bureau has reviewed this data product for unauthorized disclosure of confidential information. (Approval ID: CBDRB-FY19-ESMD-B00021)

United States Census Bureau

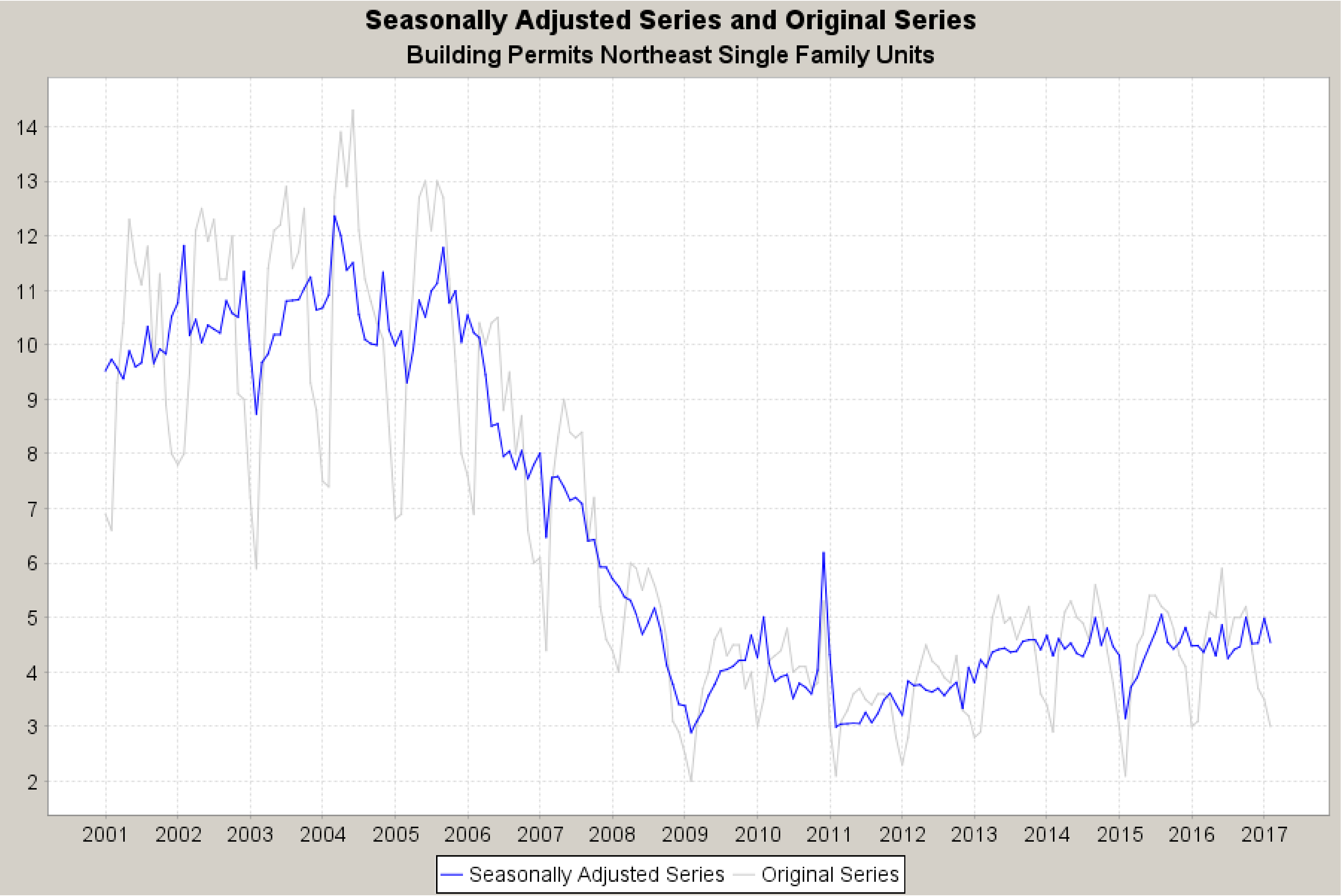
U.S. Department of Commerce
Economics and Statistics Administration
U.S. CENSUS BUREAU
census.gov

Background and motivation

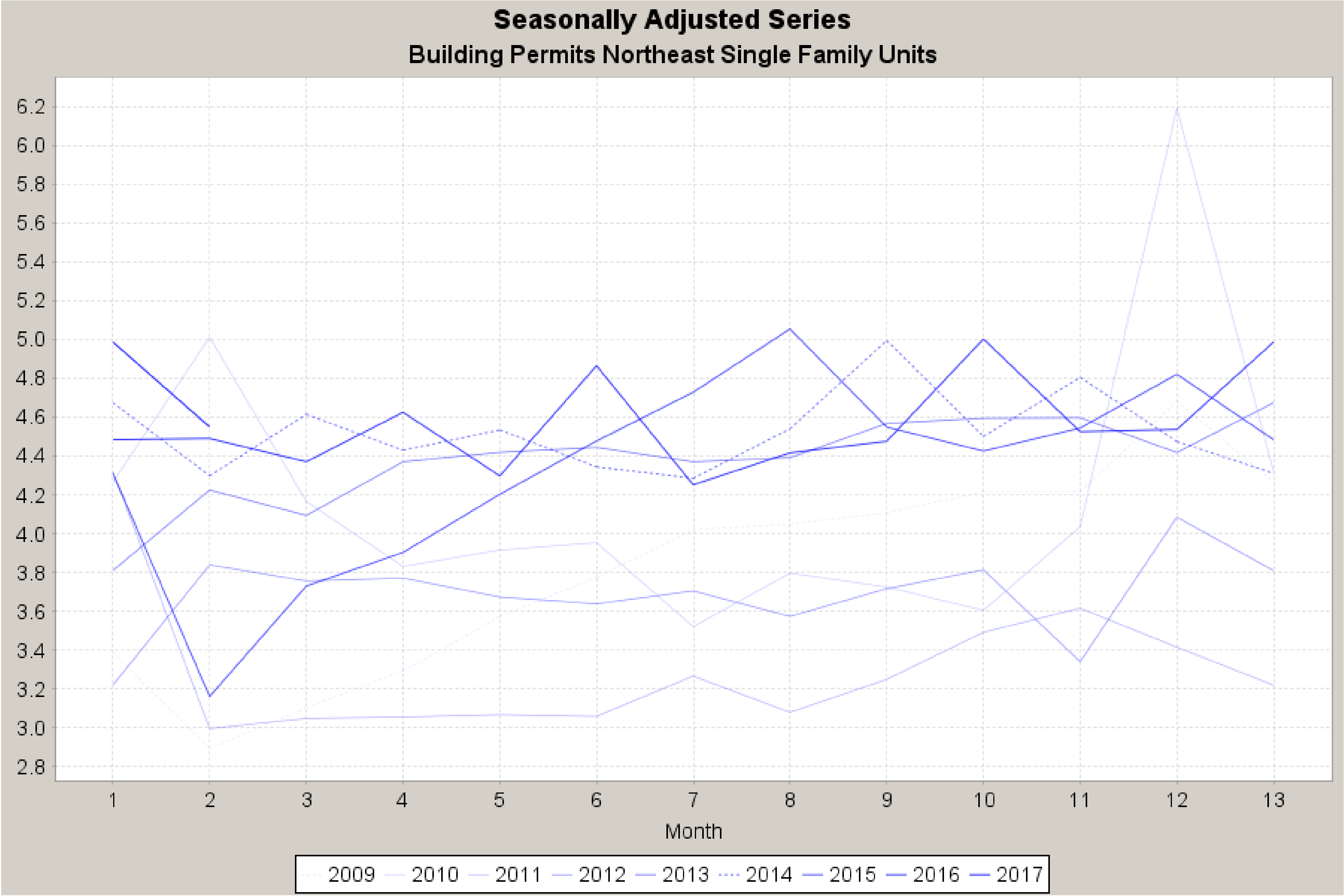
- Residual seasonality is an identifiable seasonal effect that remains in a seasonally adjusted series
  - Long-time concern
- Recent scrutiny of GDP heightened the focus on this problem
- Research has shown the model-based F test from the seasonal regressors is a promising diagnostic for identifying seasonality
  - Lytras, Feldpausch, and Bell 2007 – it performed well in size and power, compared to other diagnostics
  - Findley, Lytras, and McElroy 2017 – it can measure stable residual seasonality over an appropriate subspan of the series
- In practice, the F test can give conflicting results
- Can we determine a way to fit the regressors appropriately to see the best results?

Example: New Single-Family Units Authorized by Building Permit in Permit-Issuing Places, Northeast

- Estimates are subject to sampling and nonsampling error; more information about data collection and estimation is available at https://www.census.gov/construction/bps/how_the_data_are_collected/
- We tested for seasonality in the seasonally adjusted series
  - Shorter model span, eight years at the end of the series
  - Fit a model with the seasonal regressors
- Note: the adjustment might differ from the published adjustment because of choices of span, model, and rounding of the original series. The adjustment is for purposes of example only.



Source: Original series from U.S. Census Bureau, www.census.gov, seasonally adjusted series from X-13ARIMA-SEATS seasonal adjustment.



Source: Original series from U.S. Census Bureau, www.census.gov, seasonally adjusted series from X-13ARIMA-SEATS seasonal adjustment.

Test from seasonal regressors, with automatic modeling

ARIMA (1 1 0)(0 0 1) with three additional outliers

F Tests for Seasonal Regressors		
Degrees of Freedom	F Statistic	*P*-Value
11, 80	4.12	**0.00**

Test from seasonal regressors, modifying the model from the adjustment

ARIMA (1 1 0) with no new outliers

F Tests for Seasonal Regressors		
Degrees of Freedom	F Statistic	*P*-Value
11, 83	0.13	**1.00**

Methods

- Simulated monthly series from the airline model (0 1 1)(0 1 1)
  - Lengths 120 and 240 (10 and 20 years)
  - Nonseasonal theta θ of (0.3, 0.8) and Seasonal Theta Θ of (0.3, 0.5, 0.8)
- Seasonally adjusted with X-13ARIMA-SEATS using SEATS and X11 specifications
  - Automatic modeling, no set model, no fixed coefficients
- Compared F test significance of seasonal regressors fit to the seasonally adjusted series
  - Various model settings
  - Subspans of the original lengths

Notes on comparisons

- Most settings (series length, theta and Theta values) did not show a big difference
- Presence of a seasonal moving average parameter DID stand out (as did automatic modeling results)

Adjustment Method	Model Approach in Conjunction With Seasonal Regression	Percent of Series With Significant F Test		Number of Series
		.05 level	.01 level	
SEATS	(0 1 1) and constant	0.1%	0.0%	2377
SEATS	(1 1 0) and constant	0.5%	0.3%	2377
SEATS	(0 1 1)(1 0 0)12 and constant	1.6%	1.0%	2377
SEATS	(0 1 1)(0 0 1)12 and constant	43.8%	32.2%	2377
SEATS	AutoMdl Allowing Seasonal ARMA	31.7%	24.0%	2268
SEATS	AutoMdl With No Seasonal ARMA	2.4%	1.7%	2239

Source: Significance testing of seasonal regressors fit to seasonally adjusted simulated time series.

Adjustment Method	Model Approach in Conjunction With Seasonal Regression	Percent of Series With Significant F Test		Number of Series
		.05 level	.01 level	
X-11	(0 1 1) and constant	0.3%	0.2%	2399
X-11	(1 1 0) and constant	0.8%	0.4%	2399
X-11	(0 1 1)(1 0 0)12 and constant	5.0%	2.6%	2399
X-11	(0 1 1)(0 0 1)12 and constant	72.9%	64.6%	2399
X-11	AutoMdl Allowing Seasonal ARMA	45.2%	40.5%	2272
X-11	AutoMdl With No Seasonal ARMA	3.9%	2.9%	2232

Source: Significance testing of seasonal regressors fit to seasonally adjusted simulated time series.

Summary

- Results for use of the regression model-based F test are less promising than we had hoped
- More study might help
- ARIMA model choice greatly influences the result of the regression model-based F test for seasonality; other settings (ARMA coefficients of simulations, series length) did not have much effect.

More steps

- We are continuing the investigation into using the seasonal regressors to test for residual seasonality
- We plan to
  - Fit the regressors to different subspans
  - Compare the results of the regression model-based F test to other, possibly new diagnostics
  - Maybe expand simulation models and the models used in test runs

- Any suggestions for us?

Acknowledgments

- We are extremely indebted to Amy Newman-Smith, Bill Bell, Katherine Jenny Thompson, Osbert Pang, Carol Caldwell, Lynn Imel, Nikki Czaplicki (all U.S. Census Bureau), and Professor Robinson Kruse-Becher (University of Cologne) for their careful reviews and helpful comments

References

- Findley, D.F., Lytras, D.P., and McElroy, T.S. (2017). "Detecting Seasonality in Seasonally Adjusted Monthly Time Series." Census Bureau Research Report: RRS2017/03, https://www.census.gov/srd/papers/pdf/RRS2017-03.pdf.
- Lytras, D.P., Feldpausch, R.M., and Bell, W.R. (2007). "Determining Seasonality: A Comparison of Diagnostics From X-12-ARIMA." Proceedings of the Third International Conference on Establishment Surveys, https://www.census.gov/ts/papers/ices2007dpl.pdf.

Thank you for your kind attention!

Questions or comments?

Kathleen.M.McDonald.Johnson@census.gov

Demetra.P.Lytras@census.gov