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Special Commentary

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A Re-Assessment of Residual Seasonality in GDP

Executive Summary

First-quarter GDP growth has been weak relative to the other three quarters in recent years (Figure 1). Even after the Bureau of Economic Analysis (BEA) published revised GDP estimates in July (the agency calculates substantial "benchmark" revisions to economic data every five years), average Q1 GDP growth remained 0.74 percentage points below the Q2 to Q3 average in the 2010-2017 period (Figure 2). Consistent weakness in Q1 growth has led to questions about whether residual seasonality exists in seasonally-adjusted (SA) GDP data. Using GDP data published before benchmark revisions, the BEA itself has found statistical evidence to support residual seasonality.[1] In this report, we conduct a re-assessment using the most recent GDP data from before and after benchmark revisions.

Our statistical analysis rejects the hypothesis of residual seasonality in revised GDP data in all of the sample periods we examine. This implies that analysts should look for other reasons to explain weak growth, and forecasters should not expect Q1 GDP growth to be weak in future years based on seasonality alone.

The Backdrop: Weak Q1 GDP Growth

Q1 GDP growth has been consistently weak relative to growth in the year as a whole.

In recent years, Q1 GDP growth has been consistently weak relative to growth in the year as a whole. This comes despite the fact that the BEA publishes SA GDP data. Seasonal adjustment is meant to capture the underlying trend in data by using statistical techniques to remove the influence of predictable fluctuations from calendar, holiday and weather effects.

Figure 1

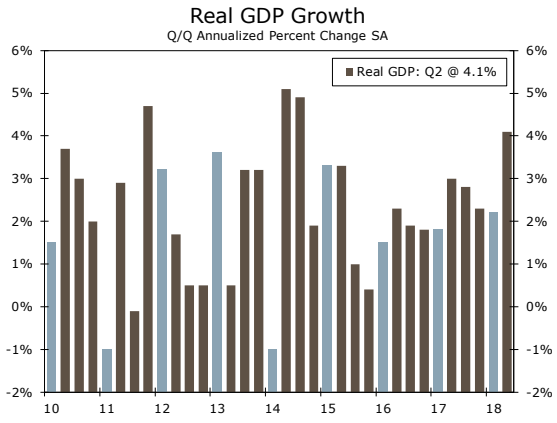
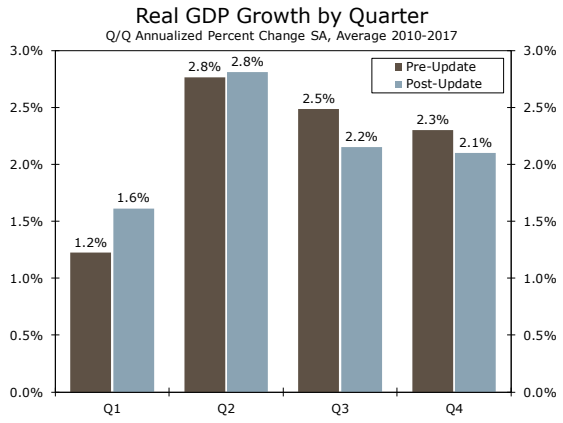


Figure 2



Source: U.S. Department of Commerce and Wells Fargo Securities

[1] **Brent R. Moulton & Benjamin D. Cowan. "Residual Seasonality in GDP and GDP: Findings and Next Steps," *Bureau of Economic Analysis*, July 2016.**

Persistent softness in Q1 GDP has led to questions about whether "residual seasonality" (lingering seasonal effects after adjustment) remains in the BEA's estimates of GDP. A 2016 review by the BEA found statistically significant residual seasonality in headline real GDP and several subcomponents of real GDP, including nonresidential structures, exports of goods and government spending.[2] The BEA derives SA headline GDP by rolling up SA components to the headline, which means that any residual seasonality in line items would flow through to the aggregate estimates. However, with the publication of its 2018 benchmark GDP revisions in July, the BEA implemented changes to its estimation process, including applying new seasonal adjustment procedures to historical data.

The BEA's benchmark revisions bumped up Q1 GDP growth.

The BEA's benchmark revisions bumped up Q1 GDP growth, particularly in the past several years. Does this mean that residual seasonality has been eliminated? Average Q1 GDP growth remains 0.74 percentage points below the Q2 to Q4 average over the course of the current expansion (2010-2017), which could suggest that some residual seasonality remains. However, just the observation that Q1 GDP growth remains relatively weak is not enough to prove residual seasonality, as other factors could be at play (e.g., unusually harsh winter weather or political election cycles). Therefore, we apply statistical tests on various sample periods to assess whether or not residual seasonality remains.

Testing for Residual Seasonality

We test for residual seasonality using the Census Bureau's X-13 ARIMA seasonal adjustment program. This is a common technique for identifying residual seasonality, and was used by the BEA in its 2016 assessment of GPD data.[3] We apply diagnostic tests from the Census Bureau on real GDP data for the 2002-2017 sample period, the 2010-2017 period (to cover the current expansion) and the 2006-2015 period originally analyzed by the BEA.

As shown in Table 1, we examine three GDP series and their associated major subcomponents for residual seasonality. These series are: SA GDP before revisions, SA GDP after revisions, and not seasonally-adjusted (NSA) GDP after revisions (we seasonally adjust this series using the X-13 ARIMA before applying diagnostic tests). The BEA's NSA series, after our seasonal adjustment, is used as a benchmark for analysis.[4] Highlighted cells in Table 1 are those in which statistical tests indicate residual seasonality, based on thresholds identified by the Census Bureau.[5]

Table 1. Tests for Residual Seasonality of Real Gross Domestic Product (GDP)

	2002 to 2017						2010 to 2017						2006 to 2015					
	Post-Update		Pre-Update		X-13 SA		Post-Update		Pre-Update		X-13 SA		Post-Update		Pre-Update		X-13 SA	
	M7	F	M7	F	M7	F	M7	F	M7	F	M7	F	M7	F	M7	F	M7	F
Gross domestic product	1.5	3.0	1.0	6.4	1.4	2.4	2.6	1.0	1.3	3.6	3.0	0.2	1.1	5.0	0.8	10.3	2.1	1.3
Personal consumption exp.	2.5	1.1	3.0	0.6	3.0	0.0	2.4	1.2	1.1	4.6	3.0	0.2	3.0	0.3	3.0	0.2	1.5	2.8
Goods	3.0	0.2	3.0	0.3	3.0	0.2	1.7	1.7	1.5	2.3	2.8	0.4	1.4	2.6	2.5	0.7	3.0	0.3
Services	1.2	3.4	1.3	2.9	3.0	0.0	2.4	1.0	1.6	2.0	3.0	0.0	2.1	1.1	1.3	3.0	3.0	0.1
Gross private domestic invest.	1.7	2.0	1.4	2.9	2.6	0.8	2.0	1.9	1.9	1.8	3.0	0.6	1.1	4.3	0.9	6.6	1.8	1.8
Fixed investment	1.0	10.0	1.2	5.0	3.0	0.1	3.0	0.5	2.9	1.0	2.0	1.3	0.9	10.0	1.0	6.3	3.0	0.1
Nonresidential	0.6	11.5	0.7	9.9	3.0	0.0	1.2	3.8	1.6	1.6	2.2	1.0	0.7	13.5	0.9	6.4	2.7	0.4
Residential	3.0	0.1	3.0	0.1	3.0	0.0	2.2	1.4	1.6	2.8	3.0	0.1	1.7	2.7	1.8	2.4	2.4	1.0
Change in private inventories	3.0	0.5	1.7	1.9	3.0	0.2	3.0	0.6	2.5	0.9	1.7	1.6	2.9	0.5	2.0	1.3	2.7	0.2
Net exports of goods and services	3.0	0.4	3.0	0.3	3.0	0.1	3.0	0.4	2.6	1.0	2.6	1.3	1.6	2.1	1.4	2.7	2.4	0.9
Goods	1.5	3.1	1.2	4.2	3.0	0.1	1.5	2.6	1.6	2.3	2.8	0.3	0.8	10.4	0.7	11.5	1.3	3.5
Services	2.2	1.0	2.3	0.9	2.4	1.7	3.0	0.3	2.3	1.1	2.3	0.9	1.1	4.3	2.8	0.7	1.3	5.0
Gov. consumption exp. and gross invest.	1.5	2.0	0.5	18.9	3.0	0.1	2.0	1.0	1.1	5.3	3.0	0.5	0.8	6.4	0.4	26.6	3.0	0.3

Note: Cells highlighted when null hypothesis of seasonality rejected: M7 <1.0, F>7.0
F Statistical test for stable seasonality
M7 Statistical diagnostic for identifiable seasonality

Source: Wells Fargo Securities

[2] Ibid.
[3] Ibid.
[4] The SA subcomponents used as inputs by the BEA are typically seasonally adjusted, using various methodologies, by the respective agency that collects the raw data (and some subcomponents are not seasonally adjusted at all). Therefore, applying the X-13 ARIMA to the BEA's NSA series provides a comparison series that is seasonally adjusted with consistent methodology.
[5] Demetra P. Lytras, Roxanne M. Feldpausch & William R. Bell. "Determining Seasonality: A Comparison of Diagnostics from X-12 ARIMA," *Census Bureau*, 2007.

We do not find evidence of residual seasonality in the revised estimates of headline GDP for any of the three sample periods in our analysis. However, we identify residual seasonality in pre-update GDP for the 2006-2015 period, matching the findings of the BEA. The analysis is sensitive to the sample period chosen, as we do not identify residual seasonality in either pre- or post-update GDP data for the 2002-2017 or 2010-2017 periods.

We do not find evidence of residual seasonality in the revised estimates of headline GDP.

Depending on the sample period, some subcomponents of GDP show evidence of residual seasonality, even after revisions. Specifically, our analysis finds remaining residual seasonality in nonresidential fixed investment for the 2002-2017 period. Goods exports and government spending also exhibit some evidence of residual seasonality, as measured by the M7 statistical diagnostic for the 2006-2015 period. However, our criteria require that the values of the M7 and F tests both cross their respective critical thresholds to establish residual seasonality for a given series in a given period, and this is not met for export and government spending data post-update. We note that our benchmark series (the BEA's NSA series after our seasonal adjustment) does not exhibit seasonality during any period of analysis. This suggests that there may still be some issues with residual seasonality in the GDP subcomponents used by the BEA. However, subcomponent residual seasonality has been reduced enough post-update that it no longer produces identifiable seasonality in aggregate GDP, according to our analysis.

Conclusion

Residual seasonality is important to identify because of its implications for interpreting economic data and forecasting future economic trends. Our analysis, using statistical methods, does not find evidence of residual seasonality in GDP. This suggests that analysts should look for other explanations behind a recent trend of relatively slow Q1 GDP growth. In addition, forecasters should not expect Q1 GDP growth to remain weak in coming years on the basis of seasonality alone. Finally, a soft Q1 GDP print in the future, should it occur, may be evidence of underlying weakening rather than residual seasonality, an important distinction.

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