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A New Approach to Measuring Winter Weather Effects in GDP

Unusually harsh winter weather affects different parts of the economy in different ways. Unusually heavy snowfall reduces some types of activity, like construction and shopping, and boosts other types of activity, like clearing roads and parking lots. Unusually cold temperatures raise consumption of gas and electric utilities. We have found in past work that the net effect of harsh winter weather on GDP is typically negative, but we have never estimated the offsetting effects separately. In this Macro Focus, we introduce a new measure of winter weather effects by estimating key positive and negative effects separately and combining them into a single measure. We estimate that unusual winter weather through February (temperatures and snowfall) boosted fourth-quarter GDP growth by 0.2 percentage point and will shave 0.1 percentage point from first-quarter GDP growth.

Background

Our approach to estimating the effects of unusual winter weather on GDP growth has always been in the context of regression analysis, with aggregate GDP growth explained as a function of, among other things, markers of unusual winter weather. Before we had available to us our population-weighted measure of unusual snowfall, we used unusual heating degree days as a marker for unusual winter weather.[1] When we introduced unusual snowfall into our analysis, we found that a strong correlation between unusually cold temperatures and unusually heavy snowfall prevented us from identifying independent roles for both, so we included only unusual snowfall in our regression analysis.[2,3]

Outlined in this Macro Focus is a new approach to estimating winter-weather effects in which we separate GDP growth into two portions: one that we expect is influenced by unusual temperatures and another that we expect is influenced by unusual snowfall. We estimate these two effects separately, then combine them into a single measure of unusual winter-weather effects.

Analysis

The first column of Table 1 demonstrates the problem we have had in the past of identifying independent roles for unusual temperatures and unusual snowfall in a single regression. The dependent variable in this regression is the one-month percent change of monthly GDP. "Snowfall" is the one-month change of our population-weighted measure of unusual weekday snowfall.[4] "Heating degree days" is the one-month change in unusual heating degree days, where unusual heating degree days are defined as the difference between heating degree days for a month and the five-year

[1] See, for example, "A Winter Chill in Q1 GDP and a Spring Thaw in Q2: Follow-Up," *Macroeconomic Advisers' Macro Musing*, March 3, 2014.

[2] To the extent that unusual temperatures are correlated with unusual snowfall, including only snowfall captures the effects of both. But this is less than ideal, as unusual snowfall and unusual temperatures are not perfectly correlated.

[3] The methodology underlying our current approach to estimating the effect unusual winter weather on GDP growth was introduced in our April 14, 2014 *Macro Focus* titled "Elevated Snowfall Reduced Q1 GDP Growth 1.4 Percentage Points," volume 9, number 4, and subsequently updated in our May 15, 2015 *Macro Focus* titled "Residual Seasonality in GDP Growth Rates – Part 2: Residual Seasonality and Weather Effects Together Lowered Q1 by More Than 3 Percentage Points," volume 10, number 6 and in our November 29, 2016 *Macro Focus* titled "Updating MA's Snowfall GDP Tracking Methodology."

[4] See our February 22, 2016 *Macro Focus* titled "Economic Impact of Weekday versus Weekend Snowfall."

Table 1: Winter Weather Effects in GDP

Sample: August 2005 - December 2018

	(1)	(2)	(3)	(4)	(5)
	Monthly GDP	Elec & gas utilities (cont.)	Other MGDP (cont.)	Elec & gas utilities (cont.)	Other MGDP (cont.)
Intercept	0.19 ***	0.00	0.19 ***		0.19 ***
Recession dummy	-0.43 ***	0.00	-0.43 ***		-0.44 ***
Snowfall	-0.15 ***	0.01 *	-0.16 ***		-0.14 ***
Heating degree days	0.00135 *	0.00076 ***	0.00061	0.00083 ***	
Cooling degree days	0.00191	0.00136 ***	0.00068	0.00136 ***	
MA(1) error term	-0.43 ***	-0.93 ***	-0.41 ***	-0.89 ***	-0.43 ***
R-squared	0.25	0.83	0.23	0.82	0.22
Durbin-Watson	1.96	1.90	1.96	1.96	1.96

Notes: In column (1), the dependent variable is the 1-month percent change of real monthly GDP (MGDP). In columns (2) and (4), the dependent variable is the contribution of PCE on electric and gas utilities to the 1-month percent change of MGDP. In columns (3) and (5), the dependent variable is the contribution of MGDP excluding PCE on electric and gas utilities to the 1-month percent change of MGDP. "Snowfall" is the 1-month change of population-weighted unusual weekday snowfall. "Heating degree days" is the 1-month change of heating degree days for a month expressed as a difference from the trailing 5-year average for that month. "Cooling degree days" is analogous. *** indicates significance at 1%, ** indicates significance at 5%, and * indicates signficance at 10%.

trailing average for that same month. "Cooling degree days" are defined analogously. Also included in the regression are a constant and a recession dummy, which takes a value of unity for recession months and zero otherwise. The error term is modeled as a first-order moving average error process.

While unusual heating and cooling degree days are surely important drivers of consumption of electric and gas utilities—an important component of GDP—heating degree days is barely significant in the regression and cooling degree days is not significant at all.[5] Meanwhile, unusual weekday snowfall is quite significant. The near insignificance of the heating-degree-days term likely reflects its correlation with the snowfall term, which is 0.47 in this sample.

To address this, we decompose growth of monthly GDP into two series: contributions from consumption of electric and gas utilities and contributions from all other GDP. The contribution from consumption of electric and gas utilities is calculated as the product of its one-month percent change and its once-lagged nominal share. We calculated the contribution from all other monthly GDP analogously after first calculating real monthly GDP excluding consumption of electric and gas utilities.[6] The second and third columns of Table 1 report the results of regressing these contribution series on the same independent variables as in the aggregate regression from column 1.

It is evident in column 2 of the table that both unusual heating degree days and unusual cooling degree days

[5] The change in unusual heating degree days is significantly different from zero at the 10% level of significance.

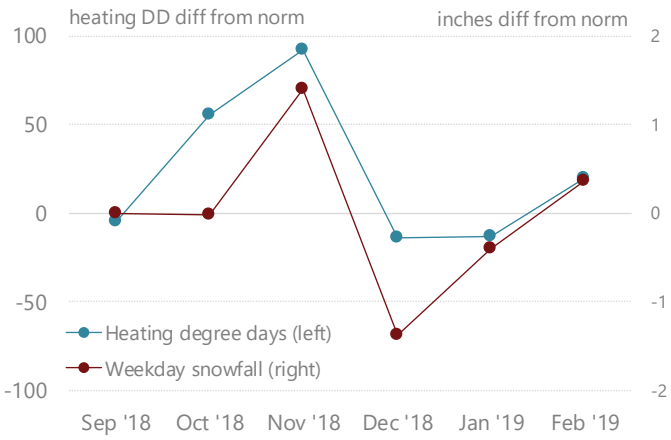
[6] This was achieved by first Fisher subtracting consumption of electric and gas utilities from total consumption and then Fisher aggregating the result with all other components of monthly GDP. Alternatively, we could have simply subtracted the contributions from electric and gas utilities from total monthly GDP growth. These two methods give very nearly the same results.

are quite significant in explaining consumption of electric and gas utilities. Unusual snowfall does maintain some marginal significance, but the point estimate is small. Furthermore, the estimated intercept term and coefficient on the recession dummy indicate that consumption of electric and gas utilities is essentially trendless over this sample and did not weaken materially during the Great Recession.

Column 3 of the table indicates that unusual temperatures have no significant bearing on GDP outside of electric and gas utilities, but that unusual snowfall has a significant and negative impact.[7] To be sure, the regressions in columns 2 and 3 are potentially subject to the same issues of correlated independent variables as in the aggregate regression of column 1. However, separating growth of monthly GDP this way provides both unusual temperatures and unusual snowfall significant channels through with to explain variation in monthly GDP (and with the expected signs). Therefore, we are comfortable that the point estimates from these regressions provide meaningful estimates of the impact of unusual temperatures and unusual snowfall in GDP.

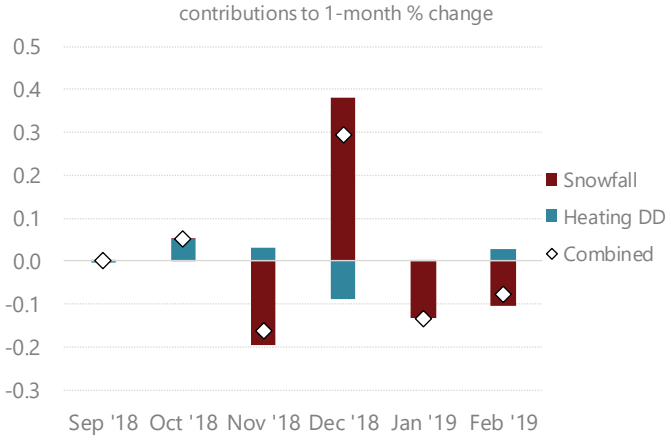
Columns 4 and 5 of table 1 remove insignificant terms and fully separate the effects of unusual temperatures and unusual snowfall into different parts of GDP.[8] Unusual temperatures (unusual heating and cooling degree days) are allowed to effect consumption of electric and gas utilities, while unusual snowfall is allowed to affect all other GDP. Because the dependent variables are contributions to monthly GDP growth, the contributions from unusual temperatures (from regression 4) and unusual snowfall (from regression 5) are additive. We define the contribution from unusual *winter* weather to monthly GDP growth as the sum of the contribution from unusual *heating degree days* (from regression 4) and the contribution from unusual snowfall (from regression 5).[9]

Figure 1: Unusual winter weather



Source: Macroeconomic Advisers by IHS Markit

Figure 2: Winter weather effects in monthly GDP growth



Source: Macroeconomic Advisers by IHS Markit

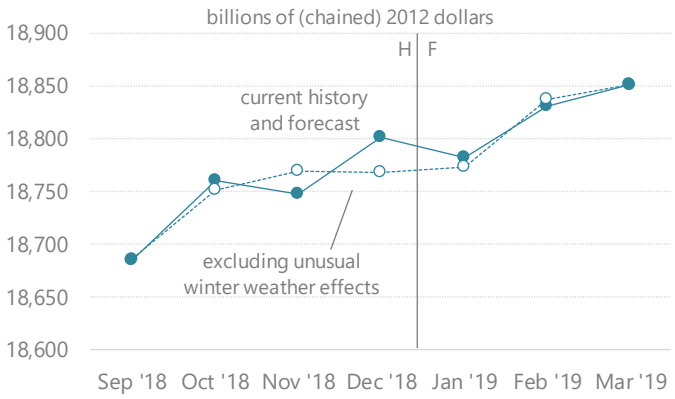
Figure 1 shows the levels of the measures of unusual winter weather that enter our regressions (as first differences) for recent months. Figure 2 shows the contributions from these measures to the one-month percent change of monthly GDP so far this season as estimated by equations 4 and 5 along with the combined effect. October was unusually cool, as heating degree days rose above the recent norm. This boosted PCE on electric and gas utilities, suggesting a boost to GDP growth then. Snowfall was not in play. In November, temperatures turned even cooler relative to the norm,

[7] The other terms indicate trend growth during expansion months in the sample (0.19% per month) as well as the average rate of decline of monthly GDP during the Great Recession (-0.24% per month).

[8] Because unusual snowfall is only marginally significant in electric and gas utilities, we left it out of the final regression in column 4.

[9] Unusual cooling degree days are a summer phenomenon, so we do not include their contributions in our measure of unusual winter weather effects.

Figure 3: Monthly GDP including & excluding unusual winter weather effects



Source: Macroeconomic Advisers by IHS Markit

as snowfall turned unusually heavy, the former boosting utilities PCE further, but the latter subtracting from GDP outside of utilities. The latter was the larger effect, so monthly GDP growth was reduced by nearly 0.2 percentage point. Conditions reversed in December, as temperatures turned mild and snowfall was unusually light. The boost to GDP growth from the switch from heavy to light snowfall was partially offset by the subtraction from utilities consumption from the switch from cool to mild temperatures. Over January and February, snowfall rose relative to the norm, subtracting from monthly GDP growth over both months. In February, temperatures turned unusually cool, boosting PCE utilities (our estimate).

Figure 3 shows the effect of unusual winter weather on the level of monthly GDP.[10] The solid line shows the actual data on real monthly GDP through December along with the assumptions implicit in our current forecast of 1.2% growth in the first quarter. The dotted line shows the level of monthly GDP excluding unusual winter weather effects. Notice that unusually dry conditions in December were primarily responsible for raising monthly GDP above the normal-weather baseline, setting up the first quarter for unfavorable momentum. Using these levels (and prior levels not charted), we calculate that quarterly GDP growth was boosted by unusual winter weather conditions in the fourth quarter by 0.2 percentage point, and we project that unusual winter weather through February (and assuming normal weather for March) will shave 0.1 percentage point from first-quarter GDP growth.

Concluding Thoughts

In this analysis, we combine the generally countervailing effects of unusual snowfall and unusual temperatures into a single measure of the effects of unusual winter weather. With this new tool in hand, we will eventually be replacing our "Snowfall GDP Tracking" with "Winter-Weather GDP Tracking," or something to this effect. In future work, we will also be drilling down into non-utilities GDP to determine which detailed components of monthly GDP are most affected by unusual snowfall and we will be enhancing our GDP tracking system to better account for these effects.

[10] The regressions give us contributions to the growth of monthly GDP, not the level. To get the level effects, we first constructed a counterfactual level of monthly GDP whose growth rate is given by actual growth less the estimated winter weather effects and whose starting level is arbitrary. We then adjusted the starting level of this counterfactual series so that the sum of the resulting level effects over the entire sample is zero.

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