Weather Matters

The Impact of Climate, Weather and Seasons on Economic Activity

Michael P. Niemira

Weather is a powerful force effecting the economy. No doubt about it. Abnormal weather conditions can shift the timing of purchases or it can result in a total loss of demand. But, to be meaningful to a geographically diverse country such as the United States, the impact has to widespread.

Weather is a risk factor for business and government. Retailers often talk about how adverse weather impacts their sales and/or earnings. Witness, for example, the July 6, 2005, statement on second-quarter earnings by Peter Harris, CEO of West Marine, who said of his company's sales: "As one would expect, continuing poor weather in April and May on both coasts dampened second quarter sales, especially when compared to the great spring weather we enjoyed last year. Unlike last year, many boats in our Northeast region, from the mid-Atlantic up through the northeastern seaboard and across to the Great Lakes, remained in storage until June. Although sales picked up along with better weather in June, we still had a disappointing second quarter."

But weather matters to more than just retailers, and it can have secondary or indirect impacts on consumer spending. On March 14, 1978, Raymond Scheppach of the Congressional Budget Office testified before Congress:

> Weather is an uncontrollable variable that directly and indirectly affects the federal budget. . . . The effects of weather on various budget accounts can be classified according to the type of weather sensitivity as follows: direct, indirect, and timing. Direct effects are those in which outlays and, at times, budget authority are affected directly by weather. Disaster payments to farmers for crop losses and unemployment compensation paid to workers who have been laid off because of a weather-related shortage of natural gas are examples. An indirect impact is one that changes budget outlays through the inflation rate as generally reflected in the Consumer Price Index (CPI). For example, a crop loss causes food prices to increase, which in turn increases the overall CPI. Ultimately, such a change in the inflation rate is reflected in the federal budget through the various indexed entitlement programs, such as social security, railroad retirement, etc. The final kind of weather-induced budget effects are those that affect the timing, but not the total level, of expenditures. These are primarily construction-related accounts in which bad weather restricts construction activity and federal outlays, but generally the activity and outlays are made up when the weather improves. Prime examples of this type of activity would be highway construction and the Environmental Protection Agency waste water treatment construction program.

Scheppach's perspective on the direct, indirect and timing impacts of weather on the budget also is helpful in understanding how weather impacts consumer spending.

THREE WEATHER IMPACTS

In assessing weather effects on consumer and business activity, there are three basic aspects to consider: (1) "weather as noise" and its role in shifting the timing of purchases or production (temporary impact); (2) "weather as a seasonal shock" and the possibility of a permanent impact on demand and output; and (3) "weather cycles" and a potentially causal relationship with macroeconomic activity.

In all three cases, it is not surprising that weather impacts economic activity—even if most economists do not explicitly consider that impact significant. Nonetheless, Nobel Prize winner Clive Granger (1978) wrote: "… actual changes in temperature, rainfall, and other weather variables have direct effects on various economic series, such as those concerned with agricultural production, construction, and transportation, and consequent indirect effects on other series. It could be argued that this cause is the true seasonal, being itself a consequence of the annual movement of the earth's axis which leads to the seasons." It may be more surprising, however, that for the United States—which is geographically diverse—there is a macroeconomic impact

from adverse weather, especially given that the U.S. Department of Commerce concluded in 1965 that its own "study attempted to isolate the impact of weather conditions on the irregular factor of retail sales but the geographic dispersion was too great and no practical application was possible."

However, theory, data and empirical studies have come a long way. Robert Barsky and Jeffrey Miron (1989) suggest, for example, that **the true macroeconomic link is from *abnormal weather* to the *seasonal cycle* to the *business cycle.*** Those researchers further found that "seasonal fluctuations are an important source of variation in all macroeconomic quantity variables, including consumption, investment, government purchases, employment and the money stock. On the other hand, seasonal fluctuations are small or absent on both real and nominal price variables. . . . We suspect that the weather plays an important role in the [process]." The significance of this linkage should not be understated, as Barsky and Miron observed that "the similarity of the seasonal cycle and the business cycle presents a challenge because it suggests the possibility of a unified explanation of both business cycles and seasonal cycles."

Box 6-1

WHY WEATHER MATTERS

1. Weather can cause shifts in the *timing* of purchases.
2. Weather can cause purchases that might not otherwise occur, or weather can cause a permanent loss of demand.
3. Weather can be responsible for lost or increased production—especially in agriculture, construction and energy areas.
4. Weather is one cause of seasonality, and the seasonal cycle is intertwined with the dynamic of the business cycle.
5. To the extent that longer-run weather patterns persist, those influences could result in a non-neutral, longer-run impact on the business cycle.

ARE WEATHER INFLUENCES TRANSITORY OR PERMANENT?

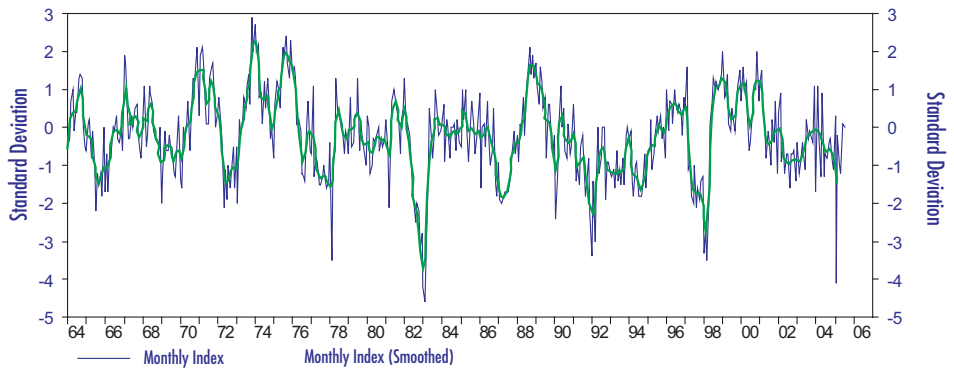
In Nobel Prize winner Milton Friedman's permanent income hypothesis, he posits that consumption and income can be segmented into two parts: a permanent component and a transitory component. Friedman wrote that the transitory component could be the result of, among other things, "unusually good or bad weather." But the basis of this theory and other consumption theories following a similar line of reasoning is that if income—either permanent or transitory—does not change, then any increase or decrease in transitory consumption associated with abnormal weather will be reversed in the subsequent period or periods.

Yet, still, there is a debate within the economics literature as to whether lost output or sales due to a shock is "permanent" or "transitory." No truer is this concern evident when unseasonable weather impacts consumer spending. Are retail sales permanently lost or do they simply shift into some future date?

Fabian Linden (1962) observed that those retail sales can be permanently lost due to unseasonable weather. Moreover, his study concluded that "weather has a powerful effect on demand." Martha Starr-McCluer (2000) also points out that weather affects non-market activities (such as shopping or recreation time); yet, in the end, she concluded that the weather's impact on retail sales "tends to wash out at a quarterly frequency." While the Starr-McCluer conclusion is traditional, it may be too simplistic. In a series of papers by Barsky and Miron, Miron, and Beaulieu and Miron, the authors found that the seasonal cycle displays similar characteristics to the business cycle in the United States and internationally. Barsky and Miron (1989) concluded that "weather plays an important role in the [seasonal] recovery of [national output] from the first to the second quarter." The assumption is that the seasonal cycle has reasonably fixed attributes, such as with the timing of holidays, weather patterns, factory shutdown periods, auto model production changeover schedules, and so on. In most cases, this is a reasonable assumption when it comes to holidays such as Christmas, but it is not true

Chart 6-1

SOUTHERN OSCILLATION INDEX
A MEASURE USED TO TRACK ENSO CYCLES



Source: U.S. Department of Commerce.

when it comes to other holidays such as Easter. The retail industry has long observed that the earlier in the year Easter occurs, the smaller the sales impact; in many cases, *the seasonal cycle is not neutral* over the year.

CLIMATE CYCLES

One reason to believe that abnormal weather can have a lingering effect on the economy is the building scientific evidence that an El Niño (EN) or the Southern Oscillation (SO)—often referred to as "ENSO"—is a *multi-year cycle of interaction* between the atmosphere and the ocean, which produces a large-scale abnormal warming in sea surface temperatures found primarily in the tropical Pacific (see Chart 6-1). During ENSO periods, abnormal weather patterns may develop around the world. Similarly, a La Niña is a multi-year period when there is a cooling in sea temperatures, which can result with the opposite effects from the ENSO. Table 6-1 presents the El Niño periods. The most severe El Niño on record occurred in 1982–1983, and was associated directly with $1.3 billion in flood damage in the United States alone. The 1994–1995 El Niño was mild, on the other hand, and was associated with one of the warmest winters in the United States on record and unusually wet conditions in the West (especially in California).

What does the presence of an El Niño mean for retailers and other weather-sensitive businesses? The record qualitatively shows that overall U.S. consumer spending tends to be stronger in the early stages of an El Niño. This may be due partly to, and initially from, less nondiscretionary spending on energy, for example, and more spending on other discretionary items. Moreover, it takes about 9–12 months for the impact of the warming in the Pacific Ocean (as reflected by the Southern Oscillation Index) to show up as abnormally wet weather over a widespread area of the United States.

The sunspot cycle might be another reason for expecting longer-run impacts climate on the economy. Galileo was credited with discovering sunspots around 1610. Ever since that time, there has been a debate, which at times has been intense, on the effect of solar activity on man, weather, agriculture and the whole economy. The cycle in sunspot activity, however, was not fully appreciated until Heinrich Schwabe published a paper on the subject in 1844 and concluded that there was a reasonably periodic cycle in sunspot activity. Hence, the sunspot cycle is often dubbed the *Schwabe cycle*. Based on a thorough review of the scientific literature on the sun and its impact on weather, John Herman and Richard Goldberg (1978) concluded: (1) "the amount

Table 6-1

WARM EPISODE YEARS

El Niño or the Southern Oscillation,
Years Beginning, 1951 – 2005

Year
1951
1957
1963
1965
1968
1972
1976
1982
1986
1991
1993
1994
1997
2002
2004

Source: U.S. Department of Commerce.

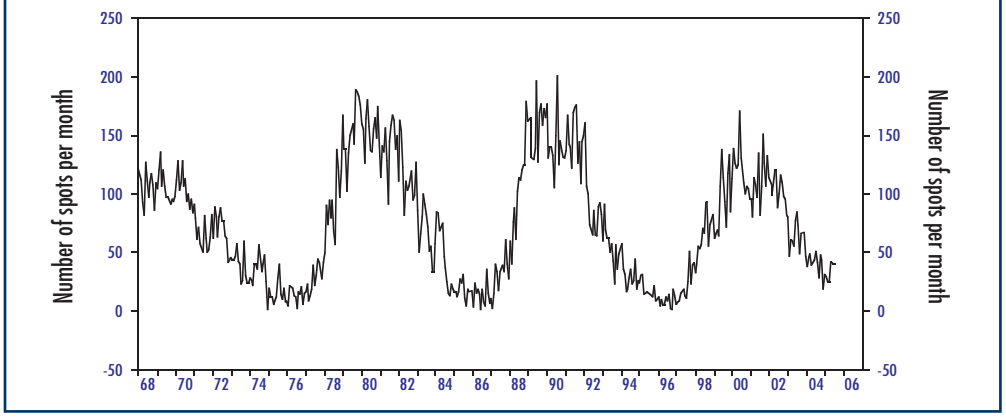
of annual rainfall . . . exhibits a dependence on the 11 year sunspot cycle in many land areas of the world"; (2) "long-term variations in surface temperature show some relationship with [the] sunspot cycle"; and (3) "sunspots are either a barometer for changes in solar [activity] or reflect direct processes related to solar activity which interact with the Earth's atmosphere to affect weather and climate." Moreover, Herman and Goldberg suggest that the consensus of spectral analysis studies (a cycle-length determining statistical technique) has found that the major periodicities in sunspots are at average cycle durations of 5.5, 8.1, 9.7, 11.2, 100 and 180 years.

An early comprehensive attempt to incorporate the Schwabe cycle into a business-cycle framework was suggested by William Stanley Jevons (1835–1882), who early in his career was a practicing meteorologist. In Jevons' *Investigations in Currency and Finance*, he discussed economic fluctuations and isolated three components of economic activity: seasonal fluctuation, business cycles and trends. Jevons attempted to statistically link the business cycle with fluctuations in sunspot activity. There was additional research by Jevons' son, H.S. Jevons, who further observed that "among other meteorological cycles, there exists a three-and-one-half-year period in solar radiation and barometric pressure," which might help to explain the shorter-term business cycle. But despite the ongoing scientific research on sunspots, the economics profession has generally dismissed sunspots as a factor influencing the business cycle, largely because of some statistical problems with Jevons' early study.

Nonetheless, the cycle in sunspots is often linked to a climatic cycle, which has four major phases: warm-wet, warm-dry, cold-wet and cold-dry. Between the mid-1930s and mid-1950s, Raymond H. Wheeler, who was a professor of psychology at the University of Kansas, examined the role that those climatic phases had on human activities, including business activity. Michael Zahorchak (1983) summarized the Wheeler evidence as follows: While the causes of the business cycle vary, the common thread throughout all of the cycles is weather, and that no economic theory is complete without a weather component that can contribute a stimulating and debilitating effect on the economy. Wheeler did *not* advocate weather as the *only* cause of the business cycle—rather as a significant contributing factor. Wheeler's work is an extension of earlier research by Ellsworth Huntington (1919), who suggested that variations in health caused the business cycle. Huntington felt that weather and solar radiation had critical influences on health. Wheeler and Huntington downplayed the weather/agricultural cycle connection with the economy and argued instead that "weather trends affect people directly, and [people are affected] only incidentally through crops." The sunspot cycle is shown in Chart 6-2.

Chart 6-2

THE SUNSPOT CYCLE



Source: U.S. Department of Commerce.

In the final analysis, Edward Dewey (1968) summarized the empirical research on the relationship between sunspots and the economic cycle when he wrote: ". . . in spite of numerous allegations and widespread folklore, there is, as yet, no conclusive evidence that the dominant 11-year sunspot cycle, or the double sunspot cycle of 22 years, or any of the subsidiary solar cycles that have been alleged, have any economic or sociological repercussions." *And that is where the evidence largely still stands.*

WEATHER DOES MATTER

This article reviewed the literature on shifts in weather, climate and the seasons, as well as their potential impact on consumer spending and, more generally, the economy. Although the empirical evidence for longer-term climate or weather cycles affecting consumer spending is still inconclusive, there are plenty of reasons to expect that there is some relationship between abnormal weather and changes in typical consumer spending behavior.

REFERENCES

Barsky, Robert B., and Jeffrey A. Miron. "The Seasonal Cycle and the Business Cycle," *Journal of Political Economy.* Vol. 97 (No. 3), 1989, pp. 503–534.

Beaulieu, J. J., J. K. MacKie-Mason, and J. A. Miron. "Why Do Countries and Industries With Large Seasonal Cycles Also Have Large Business Cycles?," National Bureau of Economic Research, Working Paper No. 3635, February 1991.

Beaulieu, J. J., and J. A. Miron. "Seasonal Unit Roots in Aggregate U.S. Data," manuscript, January 1991.

Beaulieu, J. J., and J. A. Miron. "A Cross Country Comparison of Seasonal Cycles and Business Cycles," National Bureau of Economic Research, Working Paper No. 3459, October 1990.

Beaulieu, J. J., and J. A. Miron. "The Seasonal Cycle in U.S. Manufacturing," National Bureau of Economic Research, Working Paper No. 3450, September 1990.

Dewey, Edward R. "Economic and Sociological Phenomena Related to Solar Activity and Influences," *Cycles*, September 1968; reprinted May/June 1990, pp. 151–162.

Estey, James Arthur. *Business Cycles: Their Nature, Cause, and Control,* 3rd Edition. Prentice Hall, Englewood Cliffs, N.J., 1956.

Garcia-Mata, C., and F. I. Shaffner. "Solar and Economic Relationships," *Quarterly Journal of Economics,* Vol. 49, November 1934.

Granger, Clive. "Seasonality: Causality, Interpretation, and Implications," in *Seasonal Analysis of Economic Time Series,* Economic Research Report, ER-1, Arnold Zellner, ed., U.S. Department of Commerce, December 1978.

Hall, Robert E. *Booms and Recessions in a Noisy Economy*. Yale University Press, New Haven, Conn., 1991.

Herman, John R., and Richard A. Goldberg. *Sun, Weather, and Climate.* Dover Publications, Mineola, N.Y., 1985.

Kallek, Shirley. "An Overview of the Objectives and Framework of Seasonal Adjustment," in *Seasonal Analysis of Economic Time Series,* Arnold Zellner, ed., U.S. Department of Commerce, December 1978.

Leffler, Robert J., Henry E. Warren, and Jerry Sullivan. "National Weather Indices and Economic Indicators: A New U.S. Weather Assessment Approach." Conference on the Human Consequences of 1985's Climate, American Meteorological Society, Boston, Mass., 1986.

Linden, Fabian. "Weather in Business," *The Conference Board Business Record.* Vol. 16, 1959, pp. 90–94.

Linden, Fabian. "Consumer Markets: Merchandising Weather," *The Conference Board Business Record.* Vol. 19 (No. 6), 1962, pp. 15–16.

Maunder, W. J. *The Uncertainty Business.* Methuen & Co., London, 1986.

Maunder, W. J. "National Economic Indicators: The Importance of the Weather," in Heenan, L.D.B., and Kearsley, G. W. (eds.), *Essays in Honour of Ronald Lister,* Dunedin, New Zealand, University of Tago, 1982, pp. 41–60.

Maunder, W. J. "Weekly Weather and Economic Activities on a National Scale: An Example Using United States Retail Trade Data," *Weather,* Vol. 28, 1973, pp. 2–18.

Miron, Jeffrey A. "The Economics of Seasonal Cycles," National Bureau of Economic Research, Working Paper No. 3522, November 1990.

Miron, Jeffrey A. *The Economics of Seasonal Cycles.* MIT Press, Cambridge, Mass., 1996.

Osborn, Denise R. "A Survey of Seasonality in UK Macroeconomic Variables," *International Journal of Forecasting,* Vol. 6, 1990, pp. 327–336.

Osborn, Denise R. and Jeremy P. Smith. "The Performance of Periodic Autoregressive Models in Forecasting Seasonal U.K. Consumption," *Journal of Business and Economic Statistics,* January 1989, pp. 117–127.

Palutikof, Jean. "The Impact of Weather and Climate on Industrial Production in Great Britain," *Journal of Climatology,* Vol. 3, 1983, pp. 65–79.

Petty, Mary T. "Weather and Consumer Sales," *Bulletin of the American Meteorological Society,* Vol. 44 (No. 2), February 1963, pp. 68–71.

Starr-McCluer, Martha. "The Effects of Weather on Retail Sales," Federal Reserve Board of Governors, Washington, D.C., January 2000.

Steele, A. T. "Weather's Effect on the Sales of a Department Store" *Journal of Marketing,* Vol. 15, 1951, pp. 436–443.

Zahorchak, Michael. Climate: *The Key to Understanding Business Cycles.* Tide Press, Linden, N.J., 1983.

This article was written by Michael Niemira, Vice President, Director of Research and Chief Economist at ICSC.