

Federal Reserve Bank of Cleveland

# Forecasts and Sunspots: Looking Back for a Better Future

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Some would argue that economic forecasts are about as accurate as soothsayers and weather forecasts. Yet central banks all around the world make such forecasts and use them when conducting monetary policy. In fact, countries with inflation targets (Canada, New Zealand, and the United Kingdom, for example) all base their policy actions on inflation forecasts. As Federal Reserve Chairman Alan Greenspan recently commented: “Implicit in any monetary policy action or inaction is an expectation of how the future will unfold, that is, a forecast.”<sup>1</sup>

The recent funds rate increase in the United States is evidence that such forecasts are used. Although there were few signs that current inflation was increasing, interest rates were raised at the August Federal Open Market Committee meeting because it was feared that higher future inflation might very well be in the offing.<sup>2</sup> Most accept that the monetary authority must be proactive to keep inflation from increasing. This *Economic Commentary* discusses why such a policy may be destabilizing.

The reasons to use forecasts are in some sense obvious. Because the monetary authority’s actions will affect the future, it seems wise to have an idea of what the future is likely to be in the absence of (and in response to) its actions. After all, if you want to arrive at some destination, you need to have a good idea of where you’re heading. Before driving from Cleveland to Atlanta, you consult a map. If the goal of monetary policy is to stabilize the inflation rate, then the monetary authority’s natural course of action is to look ahead and respond to what inflation is expected to be.

The alternative course of action is to respond only to what has already taken place. This is a bit like trying to make the drive to Atlanta by looking out of the rearview mirror the entire way. Such an approach seems doomed to fail. If the monetary authority decided to stabilize inflation with this approach, it would try to maintain an inflation objective by responding only to past inflation. Because a policy that responds to past inflation reacts not only to shocks that have a lasting impact but also to those with no bearing on future inflation, the result would be large swings in prices.

Despite the fact that a “rearview” approach can never deliver price stability, some continue to argue against using forecasts when conducting monetary policy. Milton Friedman warned that attempts to fine-tune output or even inflation by acting preemptively would usually make matters worse. Because it takes long and variable amounts of time for changes in the money supply to affect prices, he argued that forward-looking monetary policy was futile and proposed instead to let money growth expand at a constant rate.

To many, however, this argument rings hollow. While forecasts are not perfect, conducting monetary policy without them would be foolish, akin to deciding to carry an umbrella without consulting the local weather channel. Surely, even a bad weather forecast is better than none. Despite this cogent reasoning, this *Economic Commentary* argues that the use of such forecasts has a serious downside in that basing monetary policy decisions on forecasts may lead to excessive volatility in prices. This occurs not just

**To head off inflation before it gets started, central banks must use forecasts. But using forecasts to determine monetary policy actions introduces the possibility that inflation will increase just because the public expects it to. This *Economic Commentary* explains how random events—sunspots—can affect economic systems and lead to volatility in prices. The authors suggest that sunspots can be avoided with an approach that responds predominantly to past, rather than predicted, inflation.**

because the monetary authority may respond to bad forecasts but also because the use of forecasts makes the economy vulnerable to a pernicious type of event known as a *sunspot*.

## ■ Sunspots and Lack of Coordination

The difference between comparing monetary policy actions with one’s decision to carry an umbrella is that one’s decision to carry an umbrella will not affect whether it rains. This is not necessarily true in economics. Monetary policy can be conducted in such a way that decisions depend on what the public is expected to do, and the public bases its behavior on current monetary policy actions. This can lead to a well-known problem of “infinite regress,” in which the public’s behavior and monetary policy affect each other in turn, and there is nothing objective on which to “pin down” either. Once the cycle gets going,

no matter what the cause, there is nothing to check it. Thus, even random events, which would otherwise have no effect, can affect economic variables (such as inflation) if only the public expects them to.

The term *sunspots* was first introduced into economics by Jevons in 1884. He argued that actual sunspots—cooler regions on the Sun which fluctuate in number—mattered to economic activity because their attendant climate changes would affect agricultural productivity. This effect proved to be quantitatively irrelevant. More recently, the term has come to symbolize something quite different. An event is called a sunspot if it affects some economic variable only because the public *believes* it does. A sunspot is therefore purely extraneous information that leads to a circle of self-fulfilling expectations. If the public expects prices to be higher today, it sets in motion a series of forces that actually causes prices to be higher.

Perhaps the most obvious example of sunspot behavior was the bank runs during the Great Depression. Because of the first-come-first-served rule for bank depositors, it was in their best interest to withdraw their money whenever they thought the bank might be in financial jeopardy. But here is the rub. If everyone thought the bank was in financial trouble, the ensuing run on the bank would, in and of itself, cause this trouble. The reason is that much of a bank's portfolio is tied up in assets that cannot be easily liquidated, so that a bank run or even the rumor of one would be a self-fulfilling prophecy. Deposit insurance was instituted to eliminate this particular sunspot behavior.

Many economists dispute the notion that sunspots are an important source of shocks to the economy. They contend that the circumstances in which expectations may actually be self-fulfilling are rare. Yet there is one case in which sunspots become much more likely, and that is when the actions of multiple players depend on each other, but coordination among the parties is not possible.

Suppose Chuck's decision whether or not to attend a party depends on Tim's decision and that Tim's decision, in turn, depends on Chuck's. Further suppose that they prefer to attend these parties if only both attend. If coordination is not possible, then two different self-fulfilling

prophecies are possible. If Tim expects that Chuck will not attend, he will decide to miss the party, too. It doesn't matter how Tim arrives at his expectation. When Chuck hears Tim isn't going, he'll definitely decide not to attend, which confirms Tim's initial expectation. Of course, the same thing occurs in reverse if Tim initially thinks Chuck *is going*. Now suppose that Tim believes that Chuck will never go to a party if it rains in Tahiti. Tim's belief will be self-fulfilling: if it rains in Tahiti, Tim will not go to the party (because he expects Chuck not to), and neither will Chuck (because Tim isn't going).

The key to this example and the hallmark of sunspot behavior is the presence of the self-fulfilling circle of expectations. Sunspots can't disturb the system without this circle. Rain in Tahiti can affect whether Tim and Chuck attend parties only because Tim believes it affects Chuck, and each of their decisions is based on the other's decision.

Lack of coordination was also a factor in the bank-run problem. Notice that the possibility of a disastrous run on an otherwise healthy bank would have been eliminated if all the bank's customers could have coordinated their actions before deciding whether to clean out their accounts. Knowing that others were contemplating withdrawals only out of fear that everyone else would do so would have removed depositors' need to withdraw their funds.

### ■ Sunspots and Monetary Policy

In monetary policy, the two parties that can be involved in self-fulfilling prophecies are the monetary authority and the public. Self-fulfilling prophecies become much more likely when central banks target interest rates. Central banks all around the world have found it best to do so (in this country, we target the federal funds rate). Because of this, the money supply (the primary determinant of inflation) is no longer directly controlled by the monetary authority. It is supplied at whatever level is necessary to achieve the interest-rate target. The potential problem with this approach is that changes in public expectations will indirectly influence money growth, which directly impacts (and possibly even justifies) these expectations.

Consider the case of a pure funds-rate peg, and suppose prices today increase.

This lowers real money balances and puts upward pressure on nominal interest rates. In order to keep interest rates constant, the monetary authority increases the money supply to accommodate the increase in prices. But at the end of this cycle, real money balances and, hence, interest rates are back where they started.<sup>3</sup>

With a pure funds-rate peg, therefore, the money supply and prices would be vulnerable to random sunspot events. Although the term sunspots reflects the fact that the triggers that set such a cycle in motion are purely extraneous events that cannot be predicted ahead of time, they could just as easily be based on the release of some economic variable. Whatever the trigger, the result is that prices could, in principle, be quite volatile.

One possible way to avoid sunspots is to control money directly and let interest rates do what they will. This draconian solution would allow sharp spikes in interest rates from predictable spikes in money demand. Indeed, the Federal Reserve was founded in part to smooth out the sharp spike in interest rates that used to occur with every spring planting. To this day, the Fed continues to keep interest rates from increasing during spring and the Christmas season by expanding the money supply to satisfy the public's increased demand for cash.

### ■ Looking Back to the Future

Of course, the Federal Reserve does not maintain a pure funds-rate peg. Instead, the funds rate is allowed to vary in response to changes in either past or expected inflation. The question is whether it is best to be proactive and use a forward-looking rule, increasing the funds rate when inflation appears to be increasing, or to adopt a backward-looking rule and wait until prices actually start to rise before responding. With both approaches, the monetary authority responds to inflation (whether past or future), irrespective of why inflation changed (whether because of a fundamental or a sunspot shock). In either case, the money supply responds to maintain the central bank's interest-rate target.

Having the funds rate respond to expected inflation results in a situation similar to the pure funds-rate-peg scenario just described. There, the circle was completed when the sunspot-driven price increase was accommodated by the

central bank: The bank increased the money supply, which resulted in a price increase. With a forward-looking rule, the story is slightly more complicated. Unlike the case of a pure funds-rate peg, where prices were assumed to be perfectly flexible, this example assumes that firms choose their prices one period in advance. This “sticky price” assumption allows sunspots to affect not just today’s prices but expected inflation as well. This causes real variables also to be affected by sunspot events.

Suppose there is a sunspot-driven increase in the prices firms are planning for tomorrow. Since today’s prices are fixed (having been set one period earlier), this increases expected inflation (the price-level movement between today and tomorrow). The monetary policy rule implies that today’s funds rate must increase in response. To achieve this, the monetary authority lowers today’s money growth, thus driving down real money balances. Given this monetary contraction, when tomorrow comes, firms’ preset prices will be too high. That is, real money balances will be too low. But low real-money balances put upward pressure on interest rates, implying that the monetary authority must increase tomorrow’s money supply so that the funds rate returns to normal. As with an interest-rate peg, the increase in expected inflation sets in motion a future increase in the money supply that is ultimately inflationary. Thus, a forward-looking rule opens the door to sunspot-induced behavior.<sup>4</sup>

This simple example also suggests how sunspots could get started in the first place. Sunspots might arise if the factors that cause inflation are not well understood. Suppose that either the public or the monetary authority falsely believes that capacity utilization in and of itself causes future inflation.<sup>5</sup> Even if changes in capacity utilization have no direct impact on expected inflation, they will set in motion a chain of events that cause expected inflation to rise. Over time, the belief that there is a direct causal connection between the two will become entrenched because inflation will generally increase following high capacity-utilization numbers.

The problem with a proactive agenda is that money growth is responding to market-determined variables. Remarkably, a backward-looking interest-rate rule can potentially eliminate sunspots.<sup>6</sup>

Such a rule commits the central bank to moving *future* funds rates in response to *today’s* price movements. This timing difference mitigates the coordination problem because the monetary authority does not “move” until long after the public has moved.<sup>7</sup>

Sunspots seem possible even with a backward-looking rule. But if interest rates respond to past inflation aggressively enough, sunspots will never get started because the expectations that start the ball rolling will never be fulfilled.

To see why this is so, suppose *current* (call it period  $t$ ) inflation increases. The monetary authority must increase money growth today to keep nominal interest rates constant (being based on yesterday’s inflation). Why does this not become a self-fulfilling prophecy? With a backward-looking monetary policy rule, higher current inflation means that tomorrow’s nominal interest rate must also increase. How can this be accomplished? Decreasing money growth tomorrow ( $t + 1$ ) will not work because it would lower prices in  $t + 1$  and hence decrease expected inflation and nominal interest rates in  $t$ . The monetary authority can only increase nominal interest rates in  $t + 1$  by increasing money growth in  $t + 2$ . But the story doesn’t end there. Faster money growth and hence higher prices in period  $t + 2$  imply that nominal interest rates must increase in  $t + 3$ . If interest rates respond aggressively enough, then this process would lead to a cascading series of events in which nominal interest rates and inflation move progressively higher, culminating in hyperinflation.<sup>8</sup>

Like a debtor borrowing money today to pay off yesterday’s loan, such an approach is not sustainable. Nobody would ever extend the first loan if they knew the debtor’s approach to finances. With a backward-looking rule, the monetary authority would always have to use future (not today’s) money growth to satisfy its interest-rate objective. Knowing that this could only continue so far before collapsing like a house of cards, no one would allow the sunspot to get started.<sup>9</sup>

There are, of course, shocks other than sunspots that buffet the economy. Inflation increases that are based on market fundamentals would never lead to a hyperinflationary outcome. Sunspots influence prices directly, while fundamental shocks affect both prices and

interest rates. Interest rates and prices will always respond to fundamental shocks such that these hyperinflationary outcomes never occur.

## ■ Conclusion

A fundamental contribution of economic research over the last three decades is the discovery that private-sector expectations have an enormous influence on the business cycle and on the effect of changes in government policy. This *Economic Commentary* illustrates a natural corollary. If monetary policy is based on expected inflation, and expected inflation is influenced by monetary policy, then there is a very real danger that a forward-looking policy will make matters worse by introducing additional volatility into the economy.

To avoid doing this harm, the central bank has (at least) two possibilities. One option is to commit to a Friedman-style constant-money-growth rule and thus eliminate one player from the coordination game: Tim announces that he is always going to the party. The disadvantage of such a rule in monetary policy is that it leads to a great deal of volatility in nominal interest rates because of underlying movements in money demand. For example, without Fed action, there would be a larger seasonal component in the nominal interest rate, driven by seasonal movements in the demand for cash.

A second method of avoiding self-fulfilling expectations is for the central bank to target the nominal rate but base these movements on past movements in the inflation rate. As long as this link between current interest rates and past inflation is aggressive enough, the central bank can eliminate the possibility of sunspots.

For illustrative purposes, this *Economic Commentary* analyzed two polar extremes: a pure forward-looking rule and a pure backward-looking rule. In reality, the monetary authority is likely to use both of these options to varying degrees. Research on these more complicated but realistic rules suggests that to avoid producing a fertile environment for sunspots, the monetary authority must respond aggressively to inflation and that, while it can look forward, the weight of the response should always be from past movements in inflation. A mixed rule of this type allows one to respond to movements in future expected inflation, thus helping to minimize inflation variability.

## ■ Footnotes

1. Alan Greenspan, quoted in Sir Alan Budd, "Economic Policy, with and without Forecasts," Bank of England, *Quarterly Bulletin*, November 1998.

2. To quote the FOMC minutes: "While key measures of prices did not at this point suggest any upturn in inflation, a failure to act would incur a substantial risk of increasing pressure on already tight labor markets and higher inflation."

3. This was first discussed by Thomas J. Sargent and Neil Wallace in "Rational Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule," *Journal of Political Economy*, vol. 83, no. 2 (April 1975), pp. 241–54. A general-equilibrium version is contained in Charles T. Carlstrom and Timothy S. Fuerst, "Interest Rate Rules vs. Money Growth Rules: A Welfare Comparison in a Cash-in-Advance Economy," *Journal of Monetary Economics*, vol. 36, no. 2 (November 1995), pp. 247–67. Carlstrom and Fuerst show that this nominal indeterminacy becomes real in the presence of a nominal rigidity.

4. In contrast to a model in which firms set prices in advance, one could imagine that after any arbitrarily large but finite period, not all firms will have adjusted their prices, as

postulated by Richard H. Clarida, Jordi Galí, and Mark Gertler in "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," Centre for Economic Policy Research, discussion paper no. 1908 (June 1998). In this case, a forward-looking rule may be determinate; however, with capital and forward-looking rules, their model is almost always indeterminate. See Charles T. Carlstrom and Timothy S. Fuerst, "Forward-Looking Versus Backward-Looking Taylor Rules," Federal Reserve Bank of Cleveland, unpublished manuscript, 1999.

5. This is not meant to indicate whether or not capacity utilization causes changes in expected inflation independent of its influence on money growth.

6. A constant money-growth rule will generally also eliminate these sunspot possibilities.

7. It doesn't completely end the coordination problem because the public's movement is based on expectations of the future and thus on the monetary authority's future action. This is why a backward-looking rule must also be sufficiently aggressive to eliminate sunspots.

8. We have assumed flexible prices here. With sticky prices, the argument is basically the same but becomes more difficult to tell.

9. Price divergence is not a rational outcome if everyone believes that the monetary authority will stop the process before money becomes worthless.

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