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Describing Fed Behavior

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Describing the reasons for the policy actions of the Federal Reserve has long been a popular topic for economists, economic journalists, investors, and others. In particular, there is keen interest in what economists call the Fed's implied "reaction function," which models how the Fed sets monetary policy in response to conditions in the economy. This interest is not surprising given that the reaction function can provide insight into possible future changes in the stance of Fed policy. Also, within the context of a model of the economy, a reaction function provides a basis for evaluating monetary policy (as in Rudebusch and Svensson 1998), as well as for understanding the effects of other policies (for example, fiscal policy) or economic shocks (for example, the 1970s oil embargo) that may induce a monetary policy response. In this *Letter*, we summarize the results of our research paper–Judd and Rudebusch 1998–which provides estimates of a Fed reaction function.

Large numbers of Fed reaction functions have been estimated by economists. But despite this work, researchers have not been particularly successful in providing a definitive representation of Fed behavior (see Rudebusch 1998). In part, this lack of success stems from the fact that the Fed's specific response to certain economic situations seems to change over time.

One factor that may be associated with changes in the Fed's reaction function over time is changes in the composition of the policymaking body–the Federal Open Market Committee (FOMC). Such compositional changes may bring to the fore policymakers with different preferences and different conceptions of the appropriate operation and the likely transmission of monetary policy. While many people and events influence policy, arguably one of the more important and *identifiable* compositional changes is in the Fed Chairmanship.

In this *Letter*, we use the Taylor rule as a tool for characterizing Fed policy. In essence, the rule

describes a policy regime in which the Fed sets the real (inflation-adjusted) funds rate with an eye toward controlling inflation and stabilizing the business cycle. Thus the rule focuses on the variables of primary interest to the Fed. We examine whether the rule is capable of capturing the broad differences in how policy was conducted during the tenures of Fed Chairmen Greenspan, Volcker, and Burns.

Taylor Rule

Taylor (1993) suggested a very specific and simple rule for monetary policy. It sets the level of the real funds rate equal to an "equilibrium" real funds rate (a benchmark for neutral policy that is consistent with full employment) plus a weighted average of two gaps: (1) recent inflation less a target rate, and (2) the (percent) deviation of real GDP from an estimate of its potential, or full-employment, level.

Taylor assumed that the equilibrium real interest rate and the inflation target were both equal to 2%, and that the weights the Fed gave to deviations of inflation and output were both equal to ½. Thus, for example, if inflation were 1 percentage point above its target and output were at its potential level, the rule would recommend a funds rate of 5½% (3% for inflation plus 2% for the equilibrium real funds rate plus ½% for the excess of inflation over its target).

This rule is consistent with a policy regime in which the Fed attempts to control inflation in the long run and to smooth the amplitude of the business cycle in the short run. The arguments in the rule–inflation and the GDP gap–roughly correspond with goals legislated for U.S. monetary policy, namely, stable prices and full employment. In this spirit, Governor Meyer (1998) stresses that stabilizing real GDP around its trend in the short run and controlling inflation in the longer term are important concerns of the Fed. Although U.S. policymakers look at many economic and financial indicators, the two gaps specified in the rule may be stylized measures of their ultimate goals.

Moreover, the GDP gap can be interpreted not only as a measure of business cycle conditions but also as an indicator of future inflation in the context of a Phillips curve model. The productive capacity of the U.S. economy, whether measured by potential GDP, industrial capacity, or the "natural" rate of unemployment, appears to figure prominently in Fed forecasts of future inflation.

In contrast to the Taylor rule, most empirical reaction functions suggest that the Fed responds both to the broad measures of economic performance that are of ultimate interest for policy, such as output and inflation, as well as to so-called intermediate variables, which are not of direct interest to the Fed but may affect or predict the ultimate goal variables. Examples of such intermediate variables include the monetary aggregates, exchange rates, the budget deficit, and commodity prices. However, Fed responses to these intermediate variables are especially likely to change over time because their relationship to the ultimate goal variables may shift.

For example, the monetary aggregates played a more direct role in policy formulation in the 1970s and especially the early 1980s than they do now. Even when the Fed was explicitly targeting the aggregates, it was not ultimately interested in them per se, but instead cared about how the aggregates affected economic performance.

By focusing on the ultimate goals of policy, the Taylor rule may be capable of capturing Fed reactions in a consistent way during periods when the Fed actively targeted money and when it did not. More generally, by eliminating intermediate variables and focusing only on a few basic goal variables, the Taylor rule may be able to avoid some of the instability plaguing previous Fed reaction functions.

Findings

Taylor (1993) showed that his rule does a reasonable job of describing the actual funds rate under Chairman Greenspan. The rule also provides some perspective on policies under Chairmen Burns and Volcker (Judd and Trehan 1995). With regard to the Burns period, the actual funds rate consistently was

lower than the rule's recommended rate, which accords with the overall increase in inflation during this period. During the Volcker period, when the Fed significantly reduced inflation, the actual funds rate was consistently higher than what the rule recommended.

But while the original Taylor rule provides a reasonable starting point, it is useful to examine alternatives to Taylor's simple specification by estimating the reaction function weights using the historical record, rather than simply assuming weights as Taylor did. Estimating Taylor-type equations may provide a different or better description of Fed policy. In this *Letter*, we can only summarize our results. The details of the empirical analysis can be seen in Judd and Rudebusch (1998).

One complication in estimating the Taylor rule is that central banks often appear to adjust interest rates in a gradual fashion–taking small steps toward a desired setting. We allow for such interest rate smoothing by estimating the Taylor rule in the context of a so-called error-correction model. This approach allows for the possibility that the funds rate adjusts *gradually* to achieve the rate recommended by the rule. In fact, such interest rate smoothing is apparent in the regression results for the entire period examined from 1970 to the present.

The estimated Taylor rule for Chairman Greenspan's tenure (1987 to the present) fits the data quite well. The estimated equation explains two-thirds of the quarterly variation in the funds rate during this period. The estimated weight on inflation of 0.54 is very close to what Taylor (1993) assumed (0.5), while the estimated coefficient on the GDP gap of 0.99 is higher than Taylor assumed (0.5). Finally, the data suggest that the equilibrium funds rate and the inflation target both fall in a range of 1¾ to 2¾%–not far from Taylor's assumption of 2%.

The estimation for the period during which Paul Volcker was Chairman (1979 to 1987) similarly finds evidence that policy was concerned with both the rate of inflation relative to a target and the growth rate of real GDP relative to the growth rate of potential GDP. The coefficient on the inflation gap is again very close to the 0.5 assumed by Taylor, while the response to output growth is 1.5.

However, the equation is estimated for this period with much less precision than for the Greenspan period. For example, the equation explains only slightly less than one-half of the quarterly variation in the funds rate compared with two-thirds for Greenspan. In part, this could be because the problem facing policy in 1979 was so clear. The double-digit inflation prevailing at the time was so far above any reasonable inflation target that policy did not need to be as concerned with the rather refined judgments about funds rate settings provided by a Taylor-style reaction function. Instead, policy could simply keep the real funds rate at a "high" level until inflation began to come down.

A key feature of the reaction function for Chairman Burns's tenure (1970 to 1978) is the clear insignificance of the coefficient on the inflation gap. Instead, the funds rate responded only to the GDP gap. The lack of an implicit or explicit inflation target is consistent with the large increase in inflation during this period.

Of course, other factors may have played a role as well. In particular, there were two large oil shocks that added substantially to the price leve

In addition, the output gap may have been underestimated during this period. The existence of such a mistake has been given an important role during the period by many analysts. Such a consistent string of mistakes would not be too surprising. During this period, productivity and potential output both exhibited a surprising slowdown in growth, a development which is still largely unexplained by economists. At the same time, demographic factors, especially the entrance of the baby boom generation into the labor force, created an increase in the natural rate of unemployment that also was unexpected. Indeed, there was a widespread view that an unemployment rate of 4% was a suitable benchmark rate for policy. In contrast, recent (time-varying) estimates of the natural rate that prevailed during this period are in the 6 to 6½% range (e.g., Gordon 1997). Both of these factors–an

underestimate of the GDP gap and the natural rate of unemployment–could have contributed to unduly easy policy, since it may have appeared at the time that inflationary pressures were less severe than they really were.

Conclusion

Overall, our analysis finds that the Taylor rule–which describes policy in terms of the Fed's basic goal variables–is a useful framework for summarizing key elements of monetary policy. Estimates of this equation confirm that while inflation was not a key variable guiding policy in the 1970s, policy has focused on controlling inflation and smoothing the business cycle in the 1980s and 1990s.

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