Notes on the Taylor Rule

1 Introduction

The Taylor Rule (named for John Taylor, a macroeconomist at Stanford) is a particular example of a "central bank reaction function"—that is, a function or rule according to which the central bank sets its policy instrument as a reasonably predictable response to the state of the economy.

The US Federal Reserve operates under a dual mandate: they are required to pay attention to inflation (keep it low and stable) and also to employment (keep it as high as reasonably possible). So when we talk about the Fed reacting to the "state of the economy" we mean, primarily, to the rate of inflation and the rate of unemployment. Further, when we talk of the Fed's "policy instrument," these days we mean the Federal Funds rate of interest.

There are various ways of expressing the Taylor Rule, but here's one version:

$$\text{RF} = c + a(\pi - \pi^*) + b(u - u^*) \tag{1}$$

In this equation RF means the Federal Funds rate, π means inflation, and u means unemployment. The starred values π^* and u^* indicate the Fed's targets for inflation and unemployment respectively. The symbols c, a and b are the *parameters* or coefficients of the rule; as a first pass we could describe these values as numerical constants, but later we'll return to the possibility that changed macroeconomic circumstances may call for changes in one or more of the parameters.

To get a sense of how the rule works, first consider a state of the economy in which both inflation and unemployment are (happily) at their target values. In that case, regardless of the values of a and b, the last two terms in equation (1) will equal zero and the Federal Funds rate will be set at c. So c represents the interest rate that the Fed judges appropriate when the economy is doing "just fine."

Now suppose inflation is running above target. What should the Fed do? To slow down the inflation rate they need to reduce the level of Aggregate Demand, and they can achieve that by raising the rate of interest. So the coefficient a should be positive: if $\pi > \pi^*$, RF should increase to $c + a(\pi - \pi^*)$.

What if unemployment is above target? In that case the Fed will wish to stimulate the economy, which requires a reduction in the interest rate. So b ought to be a negative number: high unemployment calls for a cut in RF below its baseline value of c. (Note, though, that a cut in the Federal Funds rate is not always a practical possibility—not if it's already just about zero.)

2 Measuring the Fed's behavior

The Fed has not formally committed itself to following a Taylor rule, and has certainly not specified a set of coefficients c, a and b that it claims to be using. Nonetheless, if we examine the Fed's behavior since the late 1980s it seems that in fact they have been behaving much as the Taylor Rule prescribes.

The rule as expressed in equation (1) is not something we can "take to the data" as it stands. But we can simplify it a bit. Suppose that the Fed's targets for inflation and unemployment have not changed (much) over time. In that case we can lump them into the constant term:

$$\text{RF} = (c - a\pi^* - bu^*) + a\pi + bu = k + a\pi + bu \tag{2}$$

where k is shorthand for $(c - a\pi^* - bu^*)$.

We show below the results of an Ordinary Least Squares regression, using monthly observations from January 1988 to October 2008 ($T = 250$). The dependent variable is the Federal Funds rate and the independent variables are the rates of inflation and unemployment.

$$\widehat{\mathrm{RF}} = \underset{(0.341)}{7.55} + \underset{(0.060)}{1.99}\ \pi - \underset{(0.067)}{1.60}\ u$$

Table 1: Taylor rule estimates, 1988:01–2008:10 (standard errors in parentheses, $R^2 = 0.833$)

The a estimate (coefficient on π) of 1.99 tells us that if inflation exceeds the Fed's target by one percentage point, they tend to raise the Federal Funds rate by about 2 points. And it appears that if unemployment exceeds its target by one percentage point they tend to lower RF by about 1.6 points (the coefficient on u). The R^2 value of 0.833 tells us that this equation accounts for about 83 percent of the variation of RF over the period.

From the general concept of the Taylor Rule we don't get a specific value for the a coefficient; however, the idea as expounded by Taylor does require that $a > 1$ (which is satisfied by this estimate for the Fed). Why should that be? The idea is that if the Fed wants to lower Aggregate Demand in order to slow down inflation, they ought to raise the *real* rate of interest, $\mathrm{RF} - \pi$. And that means that have to raise RF by more than the increase in inflation.

The estimate of k in Table 1 (namely 7.55) is not so easy to interpret. Recall from equation (2) that $k \equiv c - a\pi^* - bu^*$. Turn that around, and we can back out c:

$$c = k + a\pi^* + bu^*$$

The Fed has told us that their inflation target, π^*, is about 2 percent. They haven't been so definite about their unemployment target but if for the sake argument we suppose $u^* = 5$ percent, then we get

$$c = 7.55 + 1.99 \times 2 - 1.60 \times 5 = 3.53$$

which suggests that over this period the "baseline" RF value that the Fed would favor when both of their targets were met was around 3.5 percent. However, this estimate is quite sensitive to our assumption regarding u^*: if we make that 4.5 percent we get a c value of 4.33 percent.

3   Recent experience

It is interesting to plot the "fitted values" (that is, what the estimated equation predicts) along with the actual value of the Federal Funds rate—this is done in Figure 1. In this Figure we continue to apply the estimated formula "out of sample," up to the present.

Note that the actual and fitted values track quite well together until late 2008. After that point—as the Great Recession took hold and unemployment rose to 10 percent while inflation remained low—the Taylor Rule hitherto followed by the Fed would have called for values of RF as low as -7 percent. Since that couldn't be done, the Fed just continued with a near-zero value of RF.

However, the apparent departure from the prior Taylor rule continued even after the fitted value climbed above zero in March of 2014. As of November 2016, for example, inflation was at $\pi = 2.1$ percent and unemployment at $u = 4.6$ percent. If we simply plug these values into the equation shown in Table 1 we get $\widehat{\mathrm{RF}} = 4.39$ percent, versus an actual Fed Funds rate of 0.54 percent in December 2016.

Does this mean that the Fed has given up on following a Taylor rule? Not necessarily. It could be that their target values, π^* and/or u^*, have changed somewhat. Or—perhaps more likely—their idea of what's a suitable c value has been updated. We take up this point in the final section below.

4   The "neutral" rate of interest

In equation (1), c represents the level of the policy interest rate that the central bank reckons is appropriate when their targets for inflation and unemployment are met. What might this value depend on? Well, presumably c should be such that, absent any "shock" to the macroeconomy, it will tend to preserve (or at least,
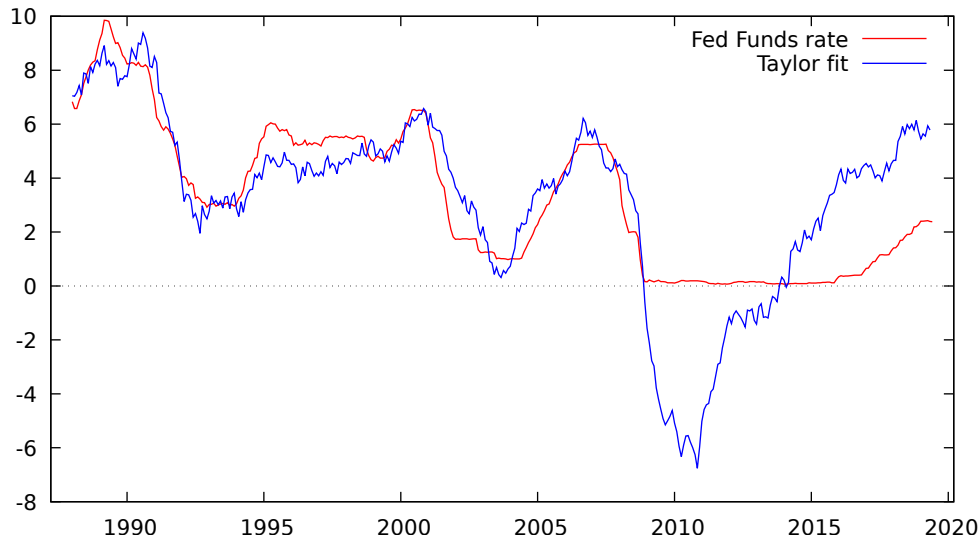
Figure 1: The Federal Funds rate, 1988:01–2019:06, along with fitted values from estimation of a Taylor rule over the period 1988:01–2008:10

be consistent with) the existing rates of inflation and unemployment. That is, its effect should neither be expansionary (which would tend to drive inflation above target) nor contractionary (which would tend to push unemployment above target). In the language of the FOMC such an interest rate is described as "neutral."

A question arises: what sort of macroeconomic developments might change the "neutral" value of the rate of interest? It's perhaps easiest to answer this by first tackling the inverse question: taking the rate of interest as given, what sort of macroeconomic developments will tend to raise (or lower) Aggregate Demand on a relatively long-term basis? The point is that if something happens (not just a "blip") to raise Aggregate Demand, this will tend to speed up inflation and lower unemployment, which means that it also raises the neutral rate of interest; and a development that lowers Aggregate Demand (hence slowing inflation and raising unemployment, other things equal) will lower the neutral rate of interest. In each case, the argument is simply that the neutral rate is that rate which holds Aggregate Demand steady, so it must change to offset changes in other determinants of Aggregate Demand.

Here are a few examples:

- If households decide that they should save more (perhaps because with increased life expectancy they anticipate a longer period of retirement), this will lower Aggregate Demand at any given interest rate. So the neutral rate falls.

- If firms find that the stream of technological innovations that can be profitably exploited has slowed down, this will lower investment spending and hence Aggregate Demand, again at any given interest rate. The neutral rate falls.

- If fiscal policy becomes significantly more expansionary (big long-term tax cuts and/or public infrastructure spending) this will raise Aggregate Demand. The neutral rate rises.

No doubt you can think of more cases. Anyway, the recent behavior of the Fed is consistent with a judgment on the part of the FOMC that the neutral rate of interest has fallen since the period over which the Taylor-type equation above was estimated (1988–2008).

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