15
Money and Interest Rates

Tools: Open market operations; central bank balance sheet; Taylor rule.

Key Words: Real interest rate; nominal interest rate; expected inflation; real money balances; inflation targeting; interest-rate rules; rules vs. discretion; zero lower bound; quantitative easing; credit easing; policy duration commitment.

Big Ideas:

- In conventional practice, central banks use open market operations to manage interest rates. These policy actions are equivalent to managing the money supply directly.
- The Taylor rule provides a guide to how central banks manage their target interest rates in response to data on inflation and (real) GDP growth.
- When interest rates are at or near zero, a central bank can resort to unconventional monetary policy, including quantitative easing, credit easing, and policy-duration commitments. These policies have been in widespread use since 2008.

Where do interest rates come from? We doubt this was your first question when you were growing up, but you probably have an opinion about it now. Most people say they're set by the Fed — or the appropriate central bank if you're in another country. There's some truth to that, but it can't be that simple. We had interest rates before the Fed was established, and, if anything, they varied more then than now. It's probably better to say that the Fed "manages" interest rates — that is they vary the supply of money to set the market interest rate they think is appropriate, consistent with market conditions. Market interest rates reflect, after all, the behavior of private borrowers and lenders, as well as the Fed.

We outline how this works, starting with a review of interest rates (there are lots of them) and moving on to monetary policy as practiced in most developed countries these days. Along the way, we show how you would expect new information about inflation or economic growth to affect interest rates.

15.1 Interest rates

Here's a quick review of interest rates: real and nominal, short and long, risk-free and risky.

Real and nominal. It may not strike you at first, but interest rates have units. The interest rates we're used to are reported in currency units: A one-period bond pays currency later in return for currency now. That's one of the reasons why interest rates differ around the world: If countries have different currencies, their interest rates are measured in different units. Since they're measured in currency units, we refer to them as nominal interest rates, just as GDP measured in currency units is referred to as nominal GDP.

It's traditional, as we saw in Chapter 12, to decompose a nominal interest rate i into a real interest rate r and expected inflation π^e:

$$i \quad = \quad r + \pi^e. \tag{15.1}$$

The real interest rate "corrects" the nominal rate for the loss of purchasing power reflected in the inflation rate. In words: A nominal interest rate of five percent delivers greater purchasing power in a year if the inflation rate is two percent than if it is five percent.

Short and long. bonds differ, of course, by maturity: that's the idea behind the "term structure of interest rates," a popular finance topic. If we consider a zero-coupon bond of maturity m years, the price and (nominal) interest rate or yield are related by

$$q_m \quad = \quad 100/(1+i_m)^m.$$

The interest rate has been annualized — that's what the exponent does — but it applies to a bond whose maturity can be something besides one year.

Interest rates on long bonds often differ from those on short bonds. Long rates are higher than short rates, on average, but not always. We commonly attribute the difference to two factors. The first is expected differences in interest rates over the life of the bond: If we expect short-term interest rates to rise over the life of the bond, then its interest rate should be higher as a result. The second is risk. Long bonds have greater exposure to the risk of changing interest rates. Their price and yield , therefore, incorporate adjustments for this risk. We can express this in an equation as

$$i_m \;=\; \text{Expected Future Short Rates} + \text{Risk Premium}.$$

Long-term interest rates have a similar distinction between real and nominal. The equation is the same with the appropriate maturities noted:

$$i_m \;=\; r_m + \pi^e_m.$$

For example, the expected inflation rate in this case is the one that applies to the period from now until m years from now.

Credit risk. There's another source of risk that comes up later in the course: the possibility that the borrower defaults. We tend to ignore that in the US Treasury market, although credit default swaps now price in some such risk. With bonds issued by banks, corporations, and foreign "sovereigns" (governments), the risk can be substantial. We might see, for example, that interest rates on Argentine or Greek government bonds are several hundred basis points above US Treasuries of similar maturity. (A basis point is one hundredth of a percent.)

15.2 Changing the money supply (review)

We'll come back to interest rates shortly. But before we do, we consider monetary policy, which plays a central role in their short-term movements. central banks control the quantity of currency in circulation (money, for our purposes). We show here how that works, then move on in later sections to describe how they use their control over money to influence interest rates. Our analysis of the central bank's control of the money supply involves the balance sheets of the treasury, the central bank, and individuals and firms. You've seen this before, but it's important enough to run through again. We'll see it again when we look at fixed exchange rates.

Day-to-day monetary policy in most countries consists of what we term *open-market operations*: purchases or sales by the central bank of government securities (bonds). At any point in time, the treasury's balance sheet looks something like this:

Treasury

Assets		Liabilities	
		bonds	200

The central bank's looks like this:

Central bank

Assets		Liabilities	
bonds	100	Money	100

And the private sector's looks like this:

Private sector

Assets		Liabilities
Money	100	
bonds	100	
Other	500	

If it seems strange to treat money as a liability of the central bank , think of it as a bond with the unusual feature that its nominal interest rate is zero. That's what it is, which makes it a good deal for the borrower.

An open-market purchase of bonds results in an increase in bonds held by the central bank and an equal increase in its monetary liability. The private sector does the opposite; it sells bonds to the central bank, reducing its holdings of bonds and increasing its holdings of money (currency). For example, a central bank purchase of 20 dollars worth of bonds would change the balance sheets to

Central bank

Assets		Liabilities	
bonds	120	Money	120

Private sector

Assets		Liabilities
Money	120	
bonds	80	
Other	500	

Note that this doesn't change anyone's net worth; it's a portfolio shift, which changes only the composition of assets and liabilities. The result is an increase in the amount of money in private hands since the private sector (the other side of this transaction) has reduced its holdings of government bonds and increased its holdings of money. Similarly, an open-market sale of bonds would reduce the amount of money in private hands.

15.3 Managing the interest rate

Typically, we describe monetary policy in terms of managing the short-term interest rate, which is different from what we've described before (namely, controlling the money supply). How does managing the money supply relate to managing the short-term interest rate? Let's work through the impact of a change in the supply of money in a simple model.

This is essentially a supply and demand exercise, and the first step is to describe the demand for money. Consider a modified version of the quantity theory:

$$M_t/P_t \quad = \quad Y_t/V(i_t). \tag{15.2}$$

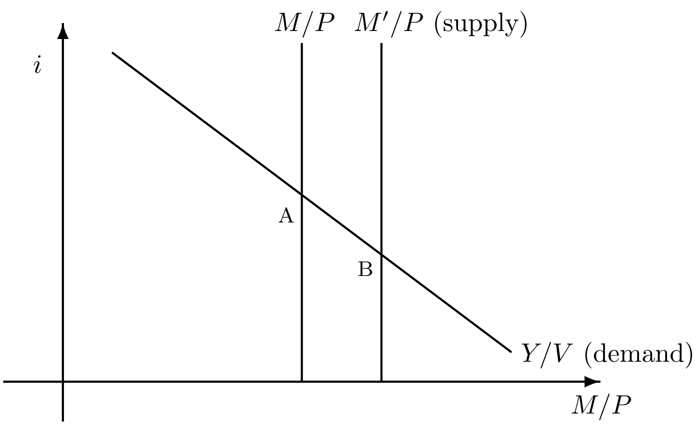
Here (as before), M is the supply of money (think currency), P is the price level (think price index), Y is real output (real GDP), and $V(i_t)$ is velocity. We refer to the M/P as *real balances*: the real value of money issued by the central bank and held by the public.

Our key innovation here is allow velocity to increase with the nominal interest rate. When the nominal interest rate is high, we will assume that velocity is high, and vice versa. As a result, real money balances (M/P) decline when the nominal interest rate rises. We noted the same thing in Chapter 12, where we noted that at high inflation rates people did anything they could to avoid money, thereby raising its velocity. They same rationale applies in less extreme settings: when the nominal interest rate is high, people shift their portfolios from non-interest-bearing money to interest-bearing assets.

In Figure 15.1 we plot supply and demand curves for money with the nominal interest rate i on the y-axis and real money balances M/P on the x-axis. The downward-sloping line is the demand for real balances. Its slope illustrates the relationship between real balances and the nominal interest rate: As the nominal interest rate rises, the quantity of money demanded falls. The vertical line is the supply of real balances. At a given value of P, this line is vertical because supply is determined by the central bank.

We now have a model of the supply and demand for real balances and can explore the relation between the supply of money and the nominal interest rate.

Figure 15.1: Supply and demand for money.



The very short-run impact of an increase in the money supply is a shift right in the vertical supply curve (M/P) and a movement down the demand curve (Y/V) from A to B.

What happens if the central bank increases the supply of money M? There are two outcomes, one in the long run and one in the short run. In the long run, the price level increases proportionally with the money supply, and the supply curve stays in the same place and nothing changes. That's the logic of the quantity theory taken literally: Any increase in money (in the long run) results in an increase in prices.

In the short run, the results differ. In the short run, we might guess that production plans won't change (Y is fixed), and we generally think that prices won't change either (P is fixed). Then the money-supply curve shifts out and the interest rate falls. In the figure, we move from point A to point B. In words: By increasing the supply of money, the central bank drives down the interest rate.

The key point here is that we can think of changes in the interest rate as reflecting changes in the money supply. Put this way, there's little difference between changing the money supply and changing the interest rate.

One last thought: Context matters here. If the context is relatively stable prices, changes in the money supply affect the interest rate as described. But if an increase in the money supply is interpreted as a sign that the central bank is abandoning price stability, then we could see an increase in the supply of money raise the interest rate rather than lower it. That's why you hear central bankers talk about "anchoring expectations" and "maintaining credibility" for stable prices. More on that shortly.

15.4 Goals of monetary policy

If the tools of monetary policy are the money supply and the short-term interest rate, what is the goal? Should central banks focus on inflation, growth, or some combination? This, in turn, raises the question of what they're capable of doing. There is clear evidence that monetary policy affects inflation, at least over periods of several years. Persistent high inflation is invariably associated with high rates of money growth. There is also clear evidence that countries with high and variable inflation rates have poor macroeconomic performance, although the cause and effect are less clear. Is high inflation the cause of poor economic performance, or the result?

With these facts in mind, most countries charge their central banks with producing stable and predictable prices. In practice, this is typically understood to mean a stable inflation rate of about 2 percent a year. Many advanced economies have also made their central banks independent — in the sense that they can set their policy instrument (usually an interest rate) without being overridden by a legislature or a government for short-run political reasons. (Argentina did this, too, but it didn't last very long.)

Why have so many countries granted their central banks such "instrument independence?" One reason is that it helps overcome a classic time-consistency problem. If people expect a government with a short time horizon to set monetary policy, they would expect it to stimulate the economy now even if that spells high inflation later. But if countries appoint conservative central bankers, they can — in theory, at least — reduce inflation without loss of output. When an independent monetary authority can commit credibly to keep inflation low, it lowers inflation expectations today and improves both inflation and output performance.

In the US, the Federal Reserve Act asks the Fed "to promote the goals of maximum employment, stable prices, and moderate long-term interest rates." This is, to be sure, the usual political mush — the Fed should accomplish "all of the above." The term "maximum employment" is interpreted to mean that the Fed should act to reduce the magnitude and duration of fluctuations in output and employment. What role does monetary policy play in these fluctuations? In the long run, expert opinion is that the impact is close to zero; the long-term growth rate of the economy depends on its productivity and institutions, not on its monetary policy. But in the short run, expansionary monetary policy (high money growth, low interest rate) probably has a modest positive effect on employment and output. The connection is fragile, in the sense that too much monetary expansion seems to lead not to higher output but to high inflation, higher interest rates, and, perhaps, lower output. Most experts suggest, therefore, that central banks (including the Fed) should emphasize price stability and give secondary importance to output and employment.

One of the arguments in favor of price stability is that our attempts to do more have been notably unsuccessful. Ben Bernanke put it this way in a 2003 speech at NYU ("Constrained discretion"):

> The early 1960s [were] a period of what now appears to have been substantial over-optimism about the ability of [monetary] policymakers to 'fine-tune' the economy. Contrary to the expectation of that era's economists and policymakers, the subsequent two decades were characterized not by an efficiently managed, smoothly running economic machine but by high and variable inflation and an unstable real economy, culminating in the deep 1981-82 recession. Although a number of factors contributed to the poor economic performance of this period, I think most economists would agree that the deficiencies of ... monetary policy — including over-optimism about the ability of policy to fine-tune the economy ... played a central role.

Another way to put this: Economists should be humble about what we can accomplish. (And to paraphrase Winston Churchill, we have a lot to be humble about!)

The focus on price stability is often expressed as a desire for predictability. Firms, investors, and workers all need to have a clear picture of future inflation — hence, future monetary policy — since the consequences of current decisions depend on it. Built into this statement is a belief that many such decisions — prices of bonds, wages and salaries, long-term supply contracts — are expressed in units of currency, whose future value depends on policy. Therefore, it's helpful for policy to be predictable, so that these decisions can be made according to their economic merits rather than on guesses of future policy. As Bernanke suggests, the unpredictability of policy in the 1970s was a factor in the poor macroeconomic performance of that decade. Big inflations are an extreme example, in which even day-to-day price changes are not only large, they're wildly uncertain. In such conditions, capital markets typically either disappear or shift to another currency.

With these ideas in mind, many central banks now follow procedures that focus on price stability (so that people can make long-term decisions) and transparency (so that their actions are well understood). In the industrial world, targeting inflation over the medium term (say, over several years) has become common. The Federal Reserve announced a quantitative inflation goal (of 2 percent) for the first time in 2012. In developing countries, fixed exchange rates are a common device in which a currency is tied to one that is thought to be more predictable. Most commonly, there has been a move toward interest-rate rules that connect (at least approximately) interest rates set by central banks with inflation and (possibly) output.

15.5 The Taylor rule: the bond trader's guide

One way to make monetary policy predictable and transparent is to follow a rule. The rule tells us how policy will be set, at least approximately, both now and in the future, which makes policy more predictable to market participants, including bond traders.

As we saw in previous chapters, concerns about time consistency tend to favor rules over discretion in setting economic policy. In the case of monetary policy, a well-designed rule can help anchor inflation expectations and stabilize economic activity. It does so by limiting the scope for future policymakers to renege on their commitment to low inflation in return for politically popular short-term output gains.

The rules vs. discretion debate has a long history, and a number of monetary policy have been proposed over the years. One of the most famous is Milton Friedman's k-percent rule, which called for the central bank to increase the supply of money at a constant rate of k-percent. Subsequent research suggests that a "feedback rule" which responds to economic conditions will be more effective in stabilizing inflation and economic growth over business cycles. In addition, most research — and virtually all central bank practice — focuses on rules for setting the policy interest rate, rather than the supply of money.

Of these interest-rate feedback rules, the most famous and widely used is the *Taylor rule*. John Taylor suggested in 1993 that an interest-rate rule would provide a relatively simple summary of monetary policy in many countries. It's a guideline really, not a rule, but it nevertheless goes by the name "Taylor rule." It consists of the following equation:

$$i_t = r^* + \pi_t + a_1(\pi_t - \pi^*) + a_2(y_t - y_t^*), \qquad (15.3)$$

where i_t is the short-term nominal interest rate; r^* is a "normal" or long-term average real interest rate; π_t is the inflation rate; π^* is the target inflation rate; y_t is (the logarithm of) real output; and y_t^* is the "normal" (sometimes called "potential") level of output (also in logarithms). The parameters a_1, a_2 indicate the sensitivity of the interest rate to inflation and output.

Let's walk through equation (15.3) piece by piece, as applied in the US:

- **Nominal interest rate i.** Standard practice in the US is to use the "fed funds rate." In the US, commercial banks and other "depository institutions" have accounts (deposits) at the Federal Reserve that are referred to as fed funds. They trade these deposits among themselves in an overnight fed funds market. The Fed currently indicates its policy stance by setting an explicit target for the interest rate on these trades and performs open-market operations to bring the market rate close to the target. This rate anchors the very short end of the yield curve.

- **Normal real interest rate r^*.** Experience suggests that the real fed funds rate (nominal rate minus inflation) has averaged about two percent over the last two decades, but it moves around over time, both over long periods of time (real interest rates were unusually high in the 1980s and low in the 2000s) and over the business cycle. Most people simply set $r^* = 2\%$, but members of the FOMC that determine the policy rate target have lowered their estimates of r^* into the 1.5–2 percent range. The first component of the target fed funds rate is, thus, the target real rate (two percent) plus the current inflation rate, thus giving us a nominal interest rate target.

- **Inflation deviation $(\pi - \pi^*)$.** The next term is a reaction to the difference between current inflation (π) and the target (π^*). If the target is two percent and actual inflation is three percent, then we increase the nominal fed funds rate by a_1 percent. Typically $a_1 > 0$, meaning that we increase the interest rate in response to above-target inflation. Why? Because higher interest rates are associated with slower money growth and, therefore, (eventually) lower inflation. Larger values of a_1 indicate more aggressive reactions to inflation. Since inflation enters equation (15.3) both directly *and* as part of this term, any increase in inflation leads to a greater increase in the nominal interest rate. This "overreaction" is intended to stabilize the inflation rate.

- **Output deviation $(y - y^*)$.** The final term is a reaction of the interest rate to deviations of output from its normal or potential level. Some people use a smooth trend for y^* or a measure of potential output. (You may recall the discussion of Chapter 14.) If we think of the world as the AS/AD model, then potential output is what the economy would generate if wages and prices weren't sticky — whatever that is! The Fed's goal, in this case, is to offset the impact of those frictions on output. The practical difficulty is distinguishing increases in y from increases in y^*. One approach is to use the difference in the year-on-year growth rate from its mean. This is easier to measure, but has the same issue: it's not obvious that our measure (the mean growth rate) is the same as the long-run equilibrium.

- **Parameters** $(a_1,\ a_2)$**.** Taylor suggested $a_1 = a_2 = 1/2$, giving equal weight to inflation and output deviations. Some recent studies of actual central bank behavior find larger values of a_1 and smaller values of a_2 — say $a_1 = 0.75$ and $a_2 = 0.25$. By some interpretations, the European central bank (ECB) places greater weight than the Fed on inflation and less weight on output.

That's the rule. The bond traders' perspective is that it's a reasonable guide to how short-term interest rates respond to data releases, as bond traders respond to how they see monetary policy reacting to new information about economic conditions. If a high inflation number comes out, the interest rate goes up. Why? Because they know that this will lead the central bank to raise the short-term interest rate. Even if the Fed doesn't respond immediately, long yields may rise in anticipation of future interest-rate changes. Ditto a high output number: Short- and long-term interest rates rise. The timing may differ somewhat from the rule, but its overall impact is generally similar.

There are several issues you run across in practice. One is that the Fed (or other central banks) may deviate from the rule, perhaps on principle, perhaps because of special circumstances. Despite its widespread use, no central bank is on record saying that it follows such a rule. Another is the difficulty in determining y^*. If output goes up, do we decide that the economy is overheating and raise the interest rate? Or do we decide that productivity has gone up, increasing the growth of the economy and y^*? That's exactly the issue that the Fed faced in the late 1990s. Some felt that the rule dictated higher interest rates, but Greenspan argued that y^* had gone up because productivity growth had accelerated. This goes back to our distinction between supply shocks and demand shocks. In the AS/AD framework, demand shocks should generally be resisted, but supply shocks should be accommodated/acquiesced to. Yet another issue is that the normal real interest rate r^* may change over time (for example, it might be high when productivity growth is high, reflecting the marginal productivity of capital).

Despite these open issues, the Taylor rule has been a useful guide to policy and a helpful indicator of how bond markets respond to announcements of macroeconomic activity.

15.6 Deflation

Some people are concerned with the possibility of deflation: a decline in prices or negative inflation. There are two good reasons for this. One is a couple of well-documented episodes in which deflation was associated with poor economic performance: the US in the Great Depression and Japan in the 1990s. The other reason is that deflation raises the real value of debt, which makes it more difficult for borrowers to repay them. Modest temporary deflation is unlikely to have much effect, but large sustained unexpected deflation, such as the US experienced in the early 1930s, likely has an adverse effect on the economy.

Whether that's the case or not, the issue comes up regularly in policy discussions. Examples include Japan during the 1990s, the US during the financial crisis, and Europe today.

15.7 Quantitative easing, credit easing, and signaling

If the short-term interest rate falls to zero, or close to it, is the central bank powerless? This issue came up in Japan in the 1990s and much of the developed world after 2008. The answer is no, but let's review the logic — and the collection of acronyms that go along it.

The so-called *zero lower bound* (ZLB) is a practical limit on how low nominal interest rates can go. Why can't they go lower? Because currency guarantees a nominal interest rate of zero, so there's no reason to accept anything lower. Transaction costs and regulations that give preference to short-term government securities have let interest rates go a little below zero, but, as a practical matter, that's the limit.

If you follow (say) a Taylor rule and it indicates a negative interest rate, what do you do? Your first guess might be that you're stuck: zero is it. But remember: You can always increase the money supply, even if it doesn't lead to a fall in the nominal interest rate. This change in the quantity of money is generally referred to as *quantitative easing* (QE). For those of us who grew up thinking about monetary policy in terms of the supply of money, this has a back-to-the-future ring to it: Isn't that how we used to talk? The key is the new terminology, which makes an old idea sound modern. That marketing lesson apparently works as well in economics as with consumer products.

In contrast to QE, which increases the size of the central bank's balance sheet, *credit easing* (CE) shifts the composition of the balance sheet from default-free assets toward assets with credit (or other kinds of) risk. A classic example of CE is for the central bank to sell Treasury debt and buy mortgage-backed securities of the same maturity. Another example is to exchange short-term assets for long-term assets (as in the Fed's so-called Operation Twist). Only the mix of assets has changed. CE is thought to lower the cost and increase the supply of credit, particularly when private markets are illiquid.

A different approach to policy at the ZLB is to commit future monetary policy to keeping interest rates low. If policymakers believe that inflation will stay below their target, they can promise to keep their interest-rate target low for an extended period. The Fed has used *forward guidence* extensively since 2008, and occasionally before that.

Executive summary

1. Most central banks use interest rates as their primary policy tool.
2. Theory and experience suggest that monetary policy should emphasize price stability and predictability.
3. The Taylor rule is an approximate description of how central banks set interest rates: They raise them in response to increases in inflation and output.
4. When interest rates hit zero, central banks can still implement policy through quantitative easing, credit easing, or commitments to future policy actions.

Review questions

1. Real and nominal interest rates. Consider the following information about inflation and US interest rates. If we ignore the difference between actual and expected inflation, what was the real interest rate in each year presented in the table? When was it highest?

	Inflation Rate	One-Year yield
1980	8.75	12.05
1990	3.80	7.88
2000	2.15	6.11
2010	1.33	0.32

Answer. The real interest rates for the four dates were 3.30, 4.08, 3.96, and –1.01. The highest was 1990, but 2000 is close. By far the lowest is 2010.

2. Money supply mechanics. How does a central bank increase the money supply? What is the likely effect on the short-term interest rate?

   Answer. It purchases government bonds from private agents, giving them money in return. An increase in the money supply reduces the short-term interest rate. The argument is that this increases liquidity in markets, reducing the rate. It depends on an overall environment of price stability.

3. Taylor rule in action. If the inflation rate rises, how would a central bank following a Taylor rule respond? Why?

   Answer. It would raise the interest rate. Note that the interest rate rises by more than one-for-one with inflation.

4. The Cleveland Fed has a beautiful chart that describes the asset side of the Fed's balance sheet since January 2007. Search: "Cleveland fed credit easing." Which features of the chart represent quantitative easing (QE)? Which represent credit easing (CE)?

   Answer. The large increase in the size of the Fed's asset positions in 2008 represents QE. CE is less striking in its timing, but the increase in mortgage-backed agency debt (brown) in 2009 is a good example.

If you're looking for more

For more on the art and science of monetary policy:

- Ben Bernanke's speeches are typically clear and thoughtful. See especially:
  - "Constrained discretion," February 2003.
  - "The Logic of monetary policy," December 2004.
  - "Implementing Monetary Policy," March 2005.
- The Cleveland Fed's *Taylor rule guide*.

Table 15.2: Data table.

Variable	Source
Federal funds rate	FEDFUNDS
2yr Treasury yield	GS2
10yr Treasury yield	GS10
Moody's Baa corporate yield	BAA
BofA Merrill public sector emerging market yield	BAMLEMPBPUBSICRPIEY
CBO real potential GDP	GDPPOT
Real GDP	GDPC1
consumer price index	CPIAUCSL

To retrieve the data online, add the identifier from the source column to http://research.stlouisfed.org/fred2/series/. For example, to retrieve the Federal funds rate, point your browser to http://research.stlouisfed.org/fred2/series/FEDFUNDS

Symbols and data used in this chapter

Table 15.1: Symbol table.

Symbol	Definition
π^e	Expected Inflation
i	Nominal interest rate
r	Real interest rate $(= i - \pi^e)$
q_m	Price of m-year bond
i_m	Nominal interest rate or yield on m-year bond
π^e_m	Expected Inflation over m years
M	Money stock
$V(i)$	Velocity of money as a function of interest rate i
P	Price level
Y	Real output or GDP
Y^*	Equilibrium or potential real output
r^*	Equilibrium real interest rate
π^*	Target inflation rate
y	Natural logarithm of Y $(= ln[Y])$
y^*	Natural logarithm of Y^*
a_1, a_2	Coefficients or weights in Taylor rule

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