interest rate from point A to point B, as illustrated in Figure 15.1. In words: By introducing more money, the central bank drives down interest rates.

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.

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. Since 1990, many advanced economies have 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.

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. Professor Kenneth Rogoff (former IMF chief economist) has shown that societies can reduce inflation without loss of output if they appoint a conservative central banker to control monetary policy. When an independent monetary authority can commit credibly to keep inflation low, it lowers inflation expectations today.

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 speech at NYU:

> 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 remember, we have a lot to be humble about).

The focus on price stability is often expressed as a desire for predictability with firms, investors, and workers all needing 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 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.

The Taylor rule: the bond trader's guide to monetary policy

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 the commitment to low inflation in order to stimulate the economy unsustainably.

The rules vs. discretion debate has a long history, so economists have proposed a variety of monetary policy rules over the years. One famous rule—proposed in 1960—was Friedman's k-percent rule, which called for the central bank to increase the supply of money at a constant rate of k-percent, where k was selected to steady the price level. Subsequent research has indicated that a feedback rule—which responds to economic conditions—will be more effective than Friedman's k-percent rule 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, a Stanford economist and former treasury official, 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:

$$i_t \;=\; r^* + \pi_t + a_1(\pi_t - \pi^*) + a_2(y_t - y_t^*), \tag{15.3}$$

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 $r^* = 2\%$. 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 keep the inflation rate from exploding.

- **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, an official estimate of how much output the economy would generate if firms operated at capacity. If we think of the world as the AS/AD model, then the potential level might be 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: that it's not obvious that our measure (the mean growth rate) is the same as "potential growth."

- **Parameters a_1, a_2.** Taylor suggested that $a_1 = a_2 = 0.5$, 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 $a_2 = 0.25$.

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 should be 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).

Quantitative easing, credit easing, and signaling the future

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.