In response to the subprime financial crisis in the United States, the Bank of Canada lowered the target overnight interest rate from 4.5% in August 2007 to 0.25% in April 2009. Moreover, for over a year (from April 1, 2009 to June 1, 2010), the Bank of Canada also lowered the operating band for the overnight interest rate from 50 basis points to 25 basis points and instead of targeting the overnight interest rate at the midpoint of the operating band (as it does during normal times), it targeted the overnight rate at the bottom of the operating band, at 0.25%, thus setting an effective lower bound for the overnight interest rate.

To see how a monetary policy action like the one above affects the economy, we need to analyze how monetary policy affects aggregate demand. We start this chapter by explaining why monetary policymakers set interest rates to rise when inflation increases, leading to a positive relationship between real interest rates and inflation, which is called the monetary policy (MP) curve. Then, using the MP curve with the IS curve we developed in the previous chapter, we derive the aggregate demand curve featured in the aggregate demand and supply framework in the next chapter.

The Bank of Canada and Monetary Policy

Central banks throughout the world use a very short-term interest rate as their primary policy tool. In Canada, the Bank of Canada conducts monetary policy via its setting of the overnight interest rate.

As we have seen in Chapter 17, the Bank of Canada controls the overnight rate by varying the settlement balances (reserves) it provides to the banking system. When it provides more reserves, banks have more money to lend to each other, and
The Monetary Policy Curve

We have now seen how the Bank of Canada can control real interest rates in the short run. The next step in our analysis is to examine how monetary policy reacts to inflation. The monetary policy (MP) curve indicates the relationship between the real interest rate the central bank sets and the inflation rate. We can write this curve as follows:

$$r = \bar{r} + \lambda \pi$$

where \( \bar{r} \) is the autonomous component of the real interest rate set by the monetary policy authorities, which is unrelated to the current level of the inflation rate, while \( \lambda \) is the responsiveness of the real interest rate to the inflation rate.

To make our discussion of the monetary policy curve more concrete, Figure 23-1 shows an example of a monetary policy curve MP in which \( \bar{r} = 1.0 \) and \( \lambda = 0.5 \):

$$r = 1.0 + 0.5 \pi$$

At point A, where inflation is 1%, the Bank of Canada sets the real interest rate at 1.5%, while at point B, where inflation is 2%, the Bank sets the real interest rate at 2%, and at point C, where inflation is 3%, the Bank of Canada sets the real interest rate at 2.5%. The line going through points A, B, and C is the monetary policy curve MP, and it is upward-sloping, indicating that monetary policymakers raise real interest rates when the inflation rate rises.

To see why the MP curve has an upward slope, we need to recognize that central banks seek to keep inflation stable. To stabilize inflation, monetary policymakers follow the Taylor principle, named after John Taylor of Stanford University, in which they raise nominal rates by more than any rise in expected inflation so that real interest rates rise when there is a rise in inflation, as the MP curve suggests.\(^1\) John Taylor and many other researchers have found that monetary policymakers tend to follow the Taylor principle in practice.

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\(^1\)Note that the Taylor principle differs from the Taylor rule, described in Chapter 18, because it does not provide a rule for how monetary policy should react to conditions in the economy, while the Taylor rule does.
To see why monetary policymakers follow the Taylor principle, in which higher inflation results in higher real interest rates, consider what would happen if monetary policymakers instead allowed the real interest rate to fall when inflation rose. In this case, an increase in inflation would lead to a decline in the real interest rate, which would increase aggregate output, in turn causing inflation to rise further, which would then cause the real interest rate to fall even more, increasing aggregate output. Schematically, we can write this as follows:

\[ \pi \uparrow \Rightarrow r \downarrow \Rightarrow Y \uparrow \Rightarrow \pi \uparrow \Rightarrow r \downarrow \Rightarrow Y \uparrow \Rightarrow \pi \uparrow \]

As a result, inflation would continually keep rising and spin out of control. Indeed, this is exactly what happened in the 1970s, when the Bank of Canada did not raise nominal interest rates by as much as inflation rose, so that real interest rates fell. Inflation accelerated to over 10%.  

In common parlance, the Bank of Canada is said to tighten monetary policy when it raises real interest rates, and to ease it when it lowers real interest rates. It is important, however, to distinguish between changes in monetary policy that shift the monetary policy curve, which we call autonomous changes, and the Taylor principle–driven changes which are reflected as movements along the monetary policy curve, which are called automatic adjustments to interest rates.

Central banks may make autonomous changes to monetary policy for various reasons. They may wish to change the inflation rate from its current value. For

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2 In a web appendix to Chapter 24 we formally demonstrate the instability of inflation when central banks do not follow the Taylor principle.
example, to lower inflation they could increase $r$ by one percentage point, and so raise the real interest rate at any given inflation rate, what we will refer to as an autonomous tightening of monetary policy. This autonomous monetary tightening would shift the monetary policy curve upward by one percentage point from $MP_1$ to $MP_2$ in Figure 23-2, thereby causing the economy to contract and inflation to fall. Or, the banks may have information above and beyond what is happening to inflation that suggests interest rates must be adjusted to achieve good economic outcomes. For example, if the economy is going into a recession, monetary policymakers would want to lower real interest rates at any given inflation rate, an autonomous easing of monetary policy, in order to stimulate the economy and also to prevent inflation from falling. This autonomous easing of monetary policy would result in a downward shift in the monetary policy curve, say, by one percentage point from $MP_1$ to $MP_3$ in Figure 23-2.

We contrast these autonomous changes with automatic, Taylor principle–driven changes, a central bank’s normal response (also known as an endogenous response) of raising real interest rates when inflation rises. These changes to interest rates do not shift the monetary policy curve, and so cannot be considered autonomous tightening or easing of monetary policy. Instead, they are reflected in movements along the monetary policy curve.

The distinction between autonomous monetary policy changes and movements along the monetary policy curve is illustrated by the monetary policy actions the Bank of Canada took at the onset of the 2007–2009 financial crisis in the fall of 2007.

FIGURE 23-2 Shifts in the Monetary Policy Curve

Autonomous changes in monetary policy, such as when a central bank changes the real interest rate at any given inflation rate, shift the $MP$ curve. An autonomous tightening of monetary policy that increases the real interest rate shifts the $MP$ curve up to $MP_2$, whereas an autonomous easing of monetary policy that lowers the real interest rate shifts the $MP$ curve down to $MP_3$. 

![Figure 23-2 Shifts in the Monetary Policy Curve](image-url)
The Aggregate Demand Curve

We are now ready to derive the relationship between the inflation rate and aggregate output when the goods market is in equilibrium, the aggregate demand curve. The $MP$ curve we developed demonstrates how central banks respond to changes in inflation with changes in interest rates, in line with the Taylor principle. The $IS$ curve we developed in Chapter 22 showed that changes in real interest rates, in turn, affect equilibrium output. With these two curves, we can now link the quantity of aggregate...
output demanded with the inflation rate, given the public’s expectations of inflation and the stance of monetary policy. The aggregate demand curve is central to the aggregate demand and supply analysis we develop further in the next chapter, which allows us to explain short-run fluctuations in both aggregate output and inflation.

Using the hypothetical \( MP \) curve from Equation 2, we know that when the inflation rate rises from 1% to 2% to 3%, real interest rates rise from 1.5% to 2% to 2.5%. We plot these points in panel (a) of Figure 23-4 to create the \( MP \) curve. In panel (b), we graph the \( IS \) curve described in Equation 13 of Chapter 22 \( (Y = 12 - r) \). As the real interest rate rises from 1.5% to 2% to 2.5%, the equilibrium moves from point 1 to point 2 to point 3 and aggregate output falls from $10.5 trillion to $10 trillion to $9.5 trillion. In other words, as real interest rates rise, investment and net exports decline, leading to a reduction in aggregate demand. Panels (a) and (b) demonstrate that as inflation rises from 1% to 2% to 3%, the equilibrium moves from point 1 to point 2 to point 3 in panel (c), and aggregate output falls from $10.5 trillion to $10 trillion to $9.5 trillion.

The line that connects the three points in panel (c) is the aggregate demand curve, \( AD \), and it indicates the level of aggregate output corresponding to each of the three real interest rates consistent with equilibrium in the goods market for any given inflation rate. The aggregate demand curve has a downward slope, because a higher inflation rate leads the central bank to raise real interest rates, thereby lowering planned spending, and hence lowering the level of equilibrium aggregate output.

By using some algebra (see the FYI box, “Deriving the Aggregate Demand Curve Algebraically”), the \( AD \) curve in Figure 23-4 can be written numerically as follows:

\[
Y = 11 - 0.5\pi
\]  

(3)

Movements along the aggregate demand curve describe how the equilibrium level of aggregate output changes when the inflation rate changes. When factors besides the inflation rate change, however, the aggregate demand curve can shift. We first review the factors that shift the \( IS \) curve, and then consider other factors that shift the \( AD \) curve.

**FIGURE 23-4** Deriving the \( AD \) Curve

The \( MP \) curve in panel (a) shows that as inflation rises from 1.5% to 2% to 3.0%, the real interest rate rises from 1.5% to 2.0% to 2.5%. The \( IS \) curve in panel (b) then shows that higher real interest rates lead to lower planned investment spending, and hence aggregate output falls from $10.5 trillion to $10 trillion to $9.5 trillion. Finally, panel (c) plots the level of equilibrium output corresponding to each of the three inflation rates: the line that connects these points is the \( AD \) curve, and it is downward sloping.
(b) IS Curve

Step 2. The IS curve links the real interest rate level from the MP curve to equilibrium output.

(c) Aggregate Demand Curve

Step 3. The AD curve links the inflation rate from the MP curve to equilibrium output.

SHIFTS IN THE IS CURVE

We saw in the previous chapter that six factors cause the IS curve to shift. It turns out that the same factors cause the aggregate demand curve to shift as well:

1. Autonomous consumption expenditure
2. Autonomous investment spending
3. Government purchases
4. Taxes
5. Autonomous net exports
6. Financial frictions

We examine how changes in these factors lead to a shift in the aggregate demand curve in Figure 23-5.

Figure 23-5 shows that any factor that shifts the IS curve shifts the aggregate demand curve in the same direction. Therefore, “animal spirits” that encourage a rise in autonomous consumption expenditure or planned investment spending, a rise in government purchases, an autonomous rise in net exports, a fall in taxes, or a decline in financial frictions—all of which shift the IS curve to the right—will also shift the aggregate demand curve to the right. Conversely, a fall in autonomous consumption expenditure, a fall in planned investment spending, a fall in government
FIGURE 23-5 Shift in the $AD$ Curve from Shifts in the $IS$ Curve

At a 2% inflation rate in panel (a), the monetary policy curve indicates that the real interest rate is 2%. An increase in government purchases shifts the $IS$ curve to the right in panel (b). At a given inflation rate and real interest rate of 2.0%, equilibrium output rises from $10 trillion to $12.5 trillion, which is shown as a movement from point $A_1$ to point $A_2$ in panel (c), shifting the aggregate demand curve to the right from $AD_1$ to $AD_2$. Any factor that shifts the $IS$ curve shifts the $AD$ curve in the same direction.

(a) MP Curve

(b) IS Curve

(c) Aggregate Demand Curve

Step 1. The MP curve links the inflation rate to the real interest rate level set by the central bank.

Step 2. A rise in government purchases increases equilibrium output, shifting the IS curve rightward . . .

Step 3. and shifting the AD curve rightward.
CHAPTER 23
The Monetary Policy and Aggregate Demand Curves

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purchases, a fall in net exports, a rise in taxes, or a rise in financial frictions will cause the aggregate demand curve to shift to the left.

SHIFTS IN THE MP CURVE We now examine what happens to the aggregate demand curve when the MP curve shifts. Suppose that the Bank of Canada decides to autonomously tighten monetary policy by raising the real interest rate by one percentage point at any given level of the inflation rate because it is worried about the economy overheating. At an inflation rate of 2.0%, the real interest rate rises from 2.0% to 3.0% in Figure 23-6. The MP curve shifts up from MP1 to MP2 in panel (a).

FIGURE 23-6 Shifts in the AD Curve from Autonomous Monetary Policy Tightening
Autonomous monetary tightening that raises real interest rates by one percentage point at any given inflation rate shifts the MP curve up from MP1 to MP2 in panel (a). With the inflation rate at 2.0%, the higher 3% interest rate results in a movement from point A1 to A2 on the IS curve, with output falling from $10 trillion to $9 trillion. This change in equilibrium output leads to movement from point A1 to point A2 in panel (c), shifting the aggregate demand curve to the left from AD1 to AD2.

(a) MP

Step 1. Autonomous monetary policy tightening increases the real interest rate . . .

Inflation Rate, $\pi$ (%)  

2.0%  

Real Interest Rate, $r$ (%)  

2.0%  

3.0%  

Continued
As policy rates around the world have reached the zero lower bound in recent years, central banks are in a liquidity trap, unable to lower them further. Moreover, central banks have lost their usual ability to signal policy changes via changes in the policy rate and to lower long-term interest rates by lowering short-term interest rates.

With the policy rate at the zero lower bound, a decoupling of long- and short-term interest rates, and the possibility of a deflationary trap (that is, extremely low nominal interest rates and sustained deflation), central banks have departed from the traditional interest-rate targeting approach to monetary policy and are now considering new tools to steer their economies. As we discussed in Chapter 17, the Bank of Canada has identified three alternative instruments that it would consider using in an environment with low short-term (nominal) interest rates: forward guidance, quantitative easing, and credit easing. That is, central banks are switching from the “one tool, one target” mode of operation and are searching for new tools to steer their economies in an environment with interest rates at or near zero.
Panel (b) shows that when the inflation rate is at 2.0%, the higher interest rate results in the equilibrium moving from point $A_1$ to $A_2$ on the $IS$ curve, with output falling from $10$ trillion to $9$ trillion. The lower output of $9$ trillion occurs because the higher real interest leads to a decline in investment and net exports, which lowers aggregate demand. The lower output of $9$ trillion then decreases the equilibrium output level from point $A_1$ to point $A_2$ in panel (c), and so the $AD$ curve shifts to the left from $AD_1$ to $AD_2$.

Our conclusion from Figure 23-6 is that an autonomous tightening of monetary policy—that is, a rise in the real interest rate at any given inflation rate—shifts the aggregate demand curve to the left. Similarly, an autonomous easing of monetary policy shifts the aggregate demand curve to the right.

We have now derived and analyzed the aggregate demand curve—an essential element in the aggregate demand and supply framework that we examine in the next chapter. We will use the aggregate demand curve in this framework to determine both aggregate output and inflation, as well as to examine events that cause these variables to change.

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### SUMMARY

1. When the Bank of Canada lowers the overnight interest rate by providing more liquidity to the banking system, real interest rates fall in the short run; and when the Bank of Canada raises the overnight rate by reducing the liquidity in the banking system, real interest rates rise in the short run.

2. The monetary policy ($MP$) curve shows the relationship between inflation and the real interest rate arising from monetary authorities’ actions. Monetary policy follows the Taylor principle, in which higher inflation results in higher real interest rates, as represented by a movement up along the monetary policy curve. An autonomous tightening of monetary policy occurs when monetary policymakers raise the real interest rate at any given inflation rate, resulting in an upward shift in the monetary policy curve. An autonomous easing of monetary policy and a downward shift in the monetary policy curve occurs when monetary policymakers lower the real interest rate at any given inflation rate.

3. The aggregate demand curve tells us the level of equilibrium aggregate output (which equals the total quantity of output demanded) for any given inflation rate. It slopes downward because a higher inflation rate leads the central bank to raise real interest rates, which leads to a lower level of equilibrium output. The aggregate demand curve shifts in the same direction as a shift in the $IS$ curve; hence it shifts to the right when government purchases increase, taxes decrease, “animal spirits” encourage consumer and business spending, autonomous net exports increase, or financial frictions decrease. An autonomous tightening of monetary policy—that is, an increase in real interest rates at any given inflation rate—leads to a decline in aggregate demand and the aggregate demand curve shifts to the left.

### KEY TERMS

- aggregate demand curve, p. xx
- autonomous tightening of monetary policy, p. xx
- autonomous easing of monetary policy, p. xx
- liquidity trap, p. xx
- monetary policy ($MP$) curve, p. xx
- Taylor principle, p. xx
QUESTIONS

1. When the inflation rate increases, what happens to the overnight interest rate? Operationally, how does the Bank of Canada adjust the overnight interest rate?

2. What is the key assumption underlying the Bank of Canada's ability to control the real interest rate?

3. Why is it necessary for the MP curve to have an upward slope?

4. If \( \lambda = 0 \), what does that imply about the relationship between the nominal interest rate and the inflation rate?

5. How does an autonomous tightening or easing of monetary policy by the Bank of Canada affect the MP curve?

6. How is an autonomous tightening or easing of monetary policy different from a change in the real interest rate due to a change in the current inflation rate?

7. Suppose that a new Bank of Canada governor is appointed, and his or her approach to monetary policy can be summarized by the following statement: “I care only about increasing employment; inflation has been at very low levels for quite some time; my priority is to ease monetary policy to promote employment.” How would you expect the monetary policy curve to be affected, if at all?

8. “The Bank of Canada decreased the overnight interest rate in late 2007, even though inflation was increasing. This demonstrates a violation of the Taylor principle.” Is this statement true, false, or uncertain? Explain your answer.

9. What factors affect the slope of the aggregate demand curve?

10. “Autonomous monetary policy is more effective at changing output when \( \lambda \) is higher” Is this statement true, false, or uncertain? Explain your answer.

11. If net exports were not sensitive to changes in the real interest rate, would monetary policy be more—or less—effective in changing output?

12. How does an autonomous tightening or easing of monetary policy by the Bank of Canada affect the aggregate demand curve?

13. For each of the following, describe how (if at all), the IS curve, MP curve, and AD curves are affected.
   a. A decrease in financial frictions.
   b. An increase in taxes, and an autonomous easing of monetary policy.
   c. An increase in the current inflation rate.
   d. A decrease in autonomous consumption.
   e. Firms become more optimistic about the future of the economy.
   f. The new Bank of Canada governor begins to care more about fighting inflation.

14. What would be the effect of an increase in Canadian net exports on the aggregate demand curve? Would an increase in net exports affect the monetary policy curve? Explain why or why not.

15. Why does the aggregate demand curve shift when “animal spirits” change?

16. If government spending increases while taxes are raised to keep the budget balanced, what happens to the aggregate demand curve?

17. Suppose that government spending is increased at the same time that an autonomous monetary policy tightening occurs. What will happen to the position of the aggregate demand curve?

18. “If \( f \) increases, then the Bank of Canada can keep output constant by reducing the real interest rate by the same amount as the increase in financial frictions.” Is this statement true, false, or uncertain? Explain your answer.

APPLIED PROBLEMS

19. Assume the monetary policy curve is given by \( r = 1.5 + 0.75 \pi \).
   a. Calculate the real interest rate when the inflation rate is 2%, 3%, and 4%.
   b. Draw the graph of the MP curve, labeling the points from part (a).
   c. Assume now that the monetary policy curve is \( r = 2.5 + 0.75 \pi \). Does the new monetary policy curve represent an autonomous tightening or loosening of monetary policy?
   d. Calculate the real interest rate when the inflation rate is 2%, 3%, and 4%, and draw the new MP curve showing the shift from part (b).

20. Use an IS curve and an MP curve to derive graphically the AD curve.

21. Suppose the monetary policy curve is given by \( r = 1.5 + 0.75 \pi \), and the IS curve is \( Y = 13 - r \).
   a. Calculate an expression for the aggregate demand curve.
   b. Calculate the real interest rate and aggregate output when the inflation rate is 2%, 3%, and 4%.
   c. Draw graphs of the IS, MP, and AD curves, labeling the points in the appropriate graphs from part (b) above.
22. Consider an economy described by the following:
\[C = 4 \text{ trillion}\]
\[I = 1.5 \text{ trillion}\]
\[G = 3.0 \text{ trillion}\]
\[T = 3.0 \text{ trillion}\]
\[\bar{X} = 1.0 \text{ trillion}\]
\[f = 0\]
\[mpc = 0.8\]
\[d = 0.35\]
\[\lambda = 0.15\]
\[\lambda = 0.5\]
\[\tau = 2\]

a. Derive expressions for the \(MP\) curve and \(AD\) curve.
b. Calculate the real interest rate and aggregate output when \(\pi = 2\) and \(\pi = 4\).
c. Draw a graph of the \(MP\) curve and \(AD\) curve, indicating the points in part (b) above.

23. Consider an economy described by the following:
\[C = 3.25 \text{ trillion}\]
\[I = 1.3 \text{ trillion}\]
\[G = 3.5 \text{ trillion}\]
\[T = 3.0 \text{ trillion}\]
\[\bar{X} = -1.0 \text{ trillion}\]
\[f = 1\]
\[mpc = 0.75\]
\[d = 0.3\]
\[\lambda = 0.1\]
\[\lambda = 1\]
\[\tau = 2\]

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