CHAPTER

4

Money and Inflation

Learning Objectives

After studying this chapter, you should be able to:

- **4.1** Define money and explain its functions (pages 104–114)
- **4.2** Explain how central banks change the money supply (pages 114–118)
- **4.3** Describe the quantity theory of money, and use it to explain the connection between changes in the money supply and the inflation rate (pages 118–124)
- **4.4** Discuss the relationships among the growth rate of money, inflation, and nominal interest rates (pages 124–127)
- **4.5** Explain the costs of a monetary policy that allows inflation to be greater than zero (pages 128–132)
- **4.6** Explain the causes of hyperinflation (pages 133–135)
- **4.A** Online appendix: Explain how to derive the formula for the money multiplier

Working for Peanuts?

In Germany in 1923, people burned paper currency rather than wood or coal. In Zimbabwe in 2008, people were paying for health care with peanuts, not money. Burning paper money and using goods instead of money to pay for goods and services are signs that a country's money has become worthless.

People in most countries are used to some inflation. Even a moderate inflation rate of 2% or 3% per year gradually reduces the purchasing power of money. For example, if over the next 30 years the average rate of inflation in Canada is 2% (the mid-point of the current target inflation rate (see Chapter 12), a bundle of goods and services that costs $100 now will cost over $180 in 30 years. Germany and Zimbabwe experienced the much higher inflation rates known as *hyperinflation*, which is usually defined as a rate exceeding 50% per month (or 13 000% a year).

The inflation rates suffered by Germany and Zimbabwe were extreme, even by the standards of hyperinflations. In Germany a basket of goods and services that cost 100 marks in 1914 rose to 1 440 marks in January 1922, and then to 126 160 000 000 000 (i.e., 126 trillion) marks by December 1923. The German mark became nearly worthless. In Zimbabwe, the inflation rate reached 15 *trillion* percent by 2008. A tourist visiting the Victoria Falls Hotel in Zimbabwe during the summer of 2008 ordered dinner, two beers, and a mineral water. He received a bill for 1 243 255 000 Zimbabwean dollars. Subsequently, prices rose so much in Zimbabwe that you could have been a trillionaire in terms of the local currency and still be starving. By late 2008, Zimbabwe was printing banknotes with the value of $100 trillion Zimbabwe dollars. A facsimile of such banknote is on page 37.

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Countries suffer from hyperinflation when their governments allow the money supply to grow too rapidly. Between 1999 and 2008, the money supply in Zimbabwe rose over 7500% per year. In Germany, the money supply rose from 115 million marks in January 1922 to 1.3 billion in January 1923 and to 497 billion billion—or 497 000 000 000 000 000 000 (497×10^{18})—in December 1923.

Eventually hyperinflations are brought to an end, typically through a currency reform that introduces a new currency, places limits on money printing, and implements fiscal reforms. To make the reforms credible, budget deficit is usually eliminated so that the population can see there is no further reason for the government to print money. Credibility can also be established by making the central bank independent from the government. An independent central bank cannot be forced to print money to cover government deficit. In Germany, a new currency was issued and the government was committed to protecting the value of the currency. In contrast, the government of Zimbabwe was unable to make a credible commitment, and so it simply abandoned its own currency and began using the U.S. dollar instead.

But why would a government create so much money in the first place, especially when it knows that doing so will destroy the money's purchasing power? In this chapter, we will explore this question and other issues involving the relationship between money and prices.

Sources: Patrick McGroarty and Farai Mutsaka, "Hanging on to Dollars in Zimbabwe," *Wall Street Journal*, March 26, 2012; Steven D. Levitt and Stephen J. Dubner, "Freak Shots: $1 Billion Dinners and Other African Pricing Problems," *New York Times*, June 2, 2008; Federal Reserve Bank of Dallas, "Hyperinflation in Zimbabwe," *Globalization and Monetary Policy Institute, 2011 Annual Report*; Thomas Sargent, "The Ends of Four Big Inflations," in Robert E. Hall, ed., *Inflation: Causes and Effects* (Chicago: University of Chicago Press, 1982); "What Can You Do with a Zimbabwean Dollar?" *Economist*, July 26, 2010; "Zimbabwe Health Care, Paid with Peanuts," *New York Times*, December 18, 2010.

Introduction

In this chapter we analyze money, inflation and its costs, the role of the Bank of Canada in managing the money supply and inflation, and the relationship between the rate of inflation and nominal interest rates. We begin by looking at why modern societies use money and at the roles money plays in the economy. Money is used because it reduces the cost of exchange and allows for specialization, increasing the economy's efficiency. We look briefly at the history of money and describe its functions as a medium of exchange, a store of value, and a unit of account. In Section 4.3 we discuss how central banks change the monetary base

Useful Math 4.1: Constant Growth Rate

How do we calculate the increase in price over 30 years if inflation is constant at 2% per year, as discussed in the chapter opener? Let P_{2015} denote the price level in year 2015, P_{2016} denote the price level in 2016, and so on.

1. When the rate of inflation is 2% per year, the price level each year is equal to the price level in the previous year multiplied by 1.02. So, $P_{2016} = P_{2015} \cdot 1.02$; $P_{2017} = P_{2016} \cdot 1.02$; and so on.
2. Combining two consecutive years, we get $P_{2017} = P_{2016} \cdot 1.02 = (P_{2015} \cdot 1.02) \cdot 1.02 = P_{2015} \cdot 1.02^2$. The price level each year is equal to the price level two years prior multiplied by 1.02^2
3. Proceeding like this we get $P_{2045} = P_{2015} \cdot 1.02^{30} = P_{2015} \cdot 1.81$

Now let us calculate the increase in price over one year if the inflation rate is 50% per month.

1. After one month, prices increase by a factor of 1.5: $P_{Feb} = P_{Jan} \cdot 1.5$
2. After two months, prices increase by a factor of 1.5^2: $P_{Mar} = P_{Feb} \cdot 1.5 = P_{Jan} \cdot 1.5^2$ and so on.
3. After one year, the price level increases by the factor $1.5^{12} = 129.7$.
4. This means that the percentage increase in the price level over a year if the inflation rate is 50% per month is 12870%.

Avoiding a Common Mistake: Calculating Percentage Changes

Note that, when the price level increases by the factor 129.7, the percentage increase in price is 12 870%, *not* 12 970%. Why is that? The reason is that the percentage change is the percentage increase *above the previous level*. In other words, the percentage increase in price is the new price minus the old price divided by the old price. In the example above, denote the price at the beginning of the year as P. The price at the end of the year is $129.7P$. The percentage change in price is

$$\frac{129.7P - P}{P} = 128.7 = 12870\%.$$

An easy way to remember this is to recall that when the price doubles, it increases by 100%, not by 200%.

Practice question:

1. Calculate the number of years it takes for the price level to double when inflation is
   a. 1% per year (Hint: Use a spreadsheet program to multiply previous value by 1.01. Continue multiplying until the result is 2.)
   b. 2% per year
   c. 3% per year
2. Use the results to calculate X in the following approximate formula:

   Let inflation be k% per year and n denote the number of years it takes price level to double. Then $X = kn$

   Note that this useful formula holds well for small rates of inflation. The larger the rate of inflation, the less accurate the formula.

and influence the money supply through open market operations. In Section 4.4 we use the quantity theory of money to show that inflation is the result of fast growth of the money supply and analyze the Fisher effect, which shows how an increase in the inflation rate raises the nominal interest rate. In Section 4.5 we discuss the costs of expected and unexpected inflation, and of inflation uncertainty, as well as benefits of inflation. The chapter ends with a description of hyperinflation.

4.1 What Is Money, and Why Do We Need It?

Learning Objective

Define money and explain its functions.

Real variables Variables measured in terms of goods and services.

Nominal variables Variables measured in terms of money.

Classical dichotomy The assertion that in the long run, *nominal* variables, such as the money supply or the price level, do not affect *real* variables, such as real GDP or the level of employment.

Money supply The quantity of assets available to households and firms to conduct transactions.

In Chapter 2 we focused on real GDP and real GDP per worker. These are **real variables** because they are in terms of goods and services (i.e., they are adjusted for the effects of price changes). In this chapter, we focus on **nominal variables** such as the price level, the inflation rate, and the nominal interest rate.

In the long run, there is a separation between nominal and real variables. Economists call this separation the **classical dichotomy.** (In macroeconomics, "classical" refers to theories that were widely accepted before the Great Depression of the 1930s. Economists first discussed this dichotomy during that period.) According to the classical dichotomy, changes in nominal variables such as the price level or the **money supply** (that is, the quantity of assets available to households and firms to conduct transactions), affect only nominal variables such as nominal GDP, the nominal interest rate, or the nominal wage. Changes in nominal variables cannot cause changes in real variables such as real GDP or the level of employment. One implication of the classical dichotomy is *money neutrality*, or the assertion that in the long run, changes in the money supply have no effect on real variables. Today, most economists believe that the classical dichotomy is true in the long run, but not in the short run. In the short run, changes in the money supply can cause changes in real GDP.

In economics, the word *money* means any asset that is used to facilitate transactions. Various assets can play the role of money including, apart from cash, chequing accounts, saving accounts, and term deposits. As you will see later in the chapter, these assets are classified

depending on how easily they can be used to pay for goods or services. The ease with which an asset can be used as payment is called the **liquidity of an asset.** This definition of liquidity is slightly different from the definition in the previous chapter, where we defined liquidity of financial assets as the ease of converting the asset into cash. In general, liquidity of an asset means the ease of converting the asset into its common use. So, for financial assets it is the ease of converting it into money, and for money it is an ease of using it in a transaction. Nowadays, when economists refer to *money*, they usually mean the most liquid assets: the total amount of notes and coins plus chequing account balances.

Liquidity of an asset The ease of using the asset as payment in a transaction.

The meaning of *money* in economics is different from the common-language use of the word. When economists use the word *money*, they are not referring to wealth or income. In everyday conversation, we often describe people such as the American businessman and philanthropist Bill Gates (the richest person in the world in 2013) or the Canadian media magnate David Thompson (the richest person in Canada in 2013)[1] as "having a lot of money." In this case what we really mean is not the amount of currency they hold but the amount of resources they own—in other words, their wealth. Most of Mr. Gates's or Mr. Thompson's wealth is in the form of various financial and physical assets (shares and property); only a very small portion of their wealth is in cash. Similarly, we often describe people such as Gerard Schwartz, the CEO of Onex corporation, who was the best-paid executive in Canada in 2013, as someone who "makes a lot of money."[2] But income and money are not comparable. Income is a *flow,* measured in dollars *per unit of time,* for example a year or an hour. Money is a *stock,* measured in dollars *at a moment of time*.

So, when economists refer to money, they usually mean the total amount of paper currency, coins, and other assets available to households and firms to conduct transactions.

Barter, Money, and Transaction Costs

Simple economies can function without money. In the early stages of economic development, individuals often exchanged goods and services by trading output directly with each other. This type of exchange is called **barter**. For example, a trapper would exchange beaver pelts for food. In principle, people in a barter economy can obtain the goods and services they want. But it is complicated. The trapper needed to find someone who had food to sell and wanted to make himself a beaver coat. This requires a *double coincidence of wants*: The two parties to a transaction must need each other's goods or services. They also must need the right quantities. If the trapper had more beaver pelts than his food supplier needed, he would have to find people who were willing to exchange food for beaver pelts.

Barter Direct exchange of one good or service for another.

Exchange under barter required a lot of time and effort to find trading partners. The costs in time or other resources of making a trade or an exchange, called **transaction costs**, were very high. In other words a barter economy is inefficient, with a significant amount of resources devoted to conducting exchanges rather than to producing goods and services.

Transaction costs The costs in time or other resources of making a trade or an exchange.

Barter became more and more difficult as economies developed. Transaction costs increased with the number of goods and services as it became more difficult to find a trading partner. There was thus an incentive to identify a specific good that most people would accept in exchange for goods and services. This good would be accepted in exchange not

[1]The richest Canadian citizen is actually the Hong-Kong business magnate, Li-Ka Shing, who holds dual Canadian and Hong-Kong citizenship.

[2]Adam Brown, "Forbes Billionaires: Full List Of The World's 500 Richest People," *Forbes,* March 3, 2014; Janet Mcfarland, "Executive compensation: Canada's 100 top-paid CEOs," *The Globe and Mail*, June 1, 2014.

because the seller needed it, but because of the expectation that it could be used in another exchange in the future. Economists consider any such good *money*.

Goods that played the role of money in the past include shells, beads, bottles of whisky, stone wheels, cigarettes, and precious metals. In Canada beaver pelts (as well as wheat and moose skins) were used by settlers as money in the first colonial settlement on the St. Laurence River at the beginning of the seventeenth century. Aboriginal people in Canada had long used "wampum": strings and belts made with beads of white and purple shells.[3]

Commodity Money

A common characteristic of the goods listed above is that, apart from facilitating transactions, they had another use. For example, shells, beads, and precious metals could be used to make jewellery; cigarettes could be smoked. We call such goods *intrinsically useful:* They have a use on their own. An intrinsically useful good (i.e., one that has value independent of its use as money) that plays the role of money is called **commodity money**.

Commodity money A good used as money that has value independent of its use as money.

Once money was invented—as it was many times and in many places around the world—transactions costs were greatly reduced. Money enabled producers to specialize. Under barter, a farmer had to grow a range of crops to make it easier to find a trading partner. With money, he could specialize in growing the crop in which he was the most productive. The high income levels in modern economies are based on the specialization that money makes possible. So, the answer to the question "Do we need money?" is "Yes, because money allows for specialization, reduces transaction costs, and raises productivity and incomes."

Not every physical good can be used as commodity money. To be useful in exchange, the good must be

- a*cceptable* to most people;
- *valuable* relative to its weight;
- *standardized in terms of quality*, so that any two units are identical;
- *divisible*; and
- *durable*, so its value is not quickly lost due to wear and tear.

What distinguishes commodity money from other goods is that it is widely *acceptable* as a means of payment. Acceptability eliminates the need for double coincidence of wants. Money is a social convention: It is accepted in exchange for goods and services because of the expectation that other members of the society will accept it in turn. Thus commodity money differed from place to place. For example beaver pelts, which served as money in Northern Canada, were not very useful as payment in cities, where they were uncommon. Commodity money needs to be *valuable* relative to its weight so that the amount needed for a transaction can be transported relatively easily. This rules out, for example, rice. *Standardization* is important as it reduces the effort needed to assess the value of commodity money. Old paintings could, in principle, be used as money, but every transaction would require figuring out the value of the painting offered. Money should be *divisible* so that it can be used for large and small transactions—another reason to rule out old paintings or beaver pelts. Finally, commodity money needs to be *durable* so that the seller knows she will be able to use it in the future; this rules out, for example, fresh fish.

[3]The description in this paragraph of early money in Canada follows an excellent ebook by James Powell, *A History of the Canadian Dollar,* available at the Bank of Canada website: www.bankofcanada.ca/publications-research/books-and-monographs/history-canadian-dollar/ (Accessed May 5, 2013). See especially pp. 2 and 3.

There are many types of assets with these five characteristics. The most important are precious metals, in particular gold and silver. Because these metals are valuable, only relatively small amounts are needed in most transactions. People learned how to evaluate the purity of these metals and so could assess their value at a moderate cost. Once the purity was assessed, the value of a quantity of a precious metal could be easily established by weighing it. It is not difficult to divide gold and silver since both are relatively soft metals. Not surprisingly, in many societies, gold and silver have been a common form of commodity money.

Making the Connection

How Expensive Gold Really Is

Gold has been used as money for a long time. The main reason is that it is very valuable. Indeed, it is so valuable that to describe something that is very expensive (or metaphorically invaluable), we can say it is "worth its weight in gold."

Just how valuable is gold? Disregarding antiques and jewellery, at the mid-2014 average price of US$1300 per troy ounce (31.1 grams), few things are literally worth their weight in gold. The most expensive iPhone 6 (129 grams, US$849) costs about 1/6th, and Google Glass (50 grams, $1500) costs 3/4 of its weight in gold.

The value of gold is, however, often exaggerated. In the 1995 movie *Die Hard with Vengeance*, the bad guys steal $140 billion dollars worth of gold from the vault of the Federal Reserve Bank of New York. There is, indeed, a lot of gold in the vault of the Federal Reserve Bank of New York. The bank belongs to the Federal Reserve System, the U.S. central bank. On behalf of the Fed it provides custodial services for gold owned by other central banks. In 2012 it held 6700 tonnes of gold. So far so good: If you are wondering where a huge amount of gold can be stolen from, the Federal Reserve Bank of New York is a prime candidate. (Note, however, that breaking into their vault may be difficult. Their security is described here: www.newyorkfed.org/aboutthefed/goldvault.html.)

In the movie the bad guys steal US$140 billion worth of gold and transport the gold in 14 dump trucks. Would that be possible, or is it a Hollywood exaggeration? Let us check. In 1995 the average price of gold was about US$385[4] per troy ounce or US$12 380 per kilogram. (An ounce equals 31.1 grams or 0.0311 kg; a kilogram of gold cost US$385/0.0311 = US$12 380.) The amount of gold stolen would have weighed approximately 11 309 tonnes (i.e., US$140 billion/(US$12 380/kg) = 11 309 091 kg = 11 309 tonnes). If it was divided equally among 14 trucks, each would have to transport over 800 tonnes. This is three times more than the capacity of the biggest truck in the world and about 50 times as much as a standard dump truck can carry. Gold is valuable but not *that* valuable.

See related problem 1.6 at the end of the chapter.

The use of gold and silver as money has some disadvantages. Both are relatively soft metals. Consequently, during use, some of the metal rubs off and coins become lighter. In other words, an old coin would contain less precious metal than a new coin and thus be less valuable. In addition, the supply of gold and silver fluctuates with unpredictable discoveries and changes in mining technology. Gold also has the disadvantage that large quantities can be heavy and, therefore, difficult to transport.

[4]Lawrence H. Officer and Samuel H. Williamson, "The Price of Gold, 1257–Present," Measuring Worth, 2013, www.measuringworth.com/gold, accessed May 15, 2013.

A solution to some of these difficulties was the introduction of gold and silver certificates. A certificate was a claim on a specific quantity of gold or silver held in a vault. It allowed the holder to exchange the certificate for the precious metal on request. This type of money is called *representative money*: A claim on actual money that can be used in transactions. Gold and silver certificates became paper currency. The currency was *fully backed*: The value of certificates was equal to the value of precious metals held by the issuing institution, usually a bank.

A fully-backed currency is safe: A certificate holder can always exchange (redeem) it for precious metals, and there are enough precious metals for everyone to do it at the same time. Banks quickly found out, however, that few people bothered to redeem their certificates for gold and silver. The certificates were more convenient to use and the possibility of converting them into gold and silver was sufficient for them to be widely accepted. Banks therefore realized that the amount of certificates could exceed the amount of gold and silver they held. There was no problem as long as they were able meet current redemptions. They therefore issued more certificates and the currency became *partially backed*: The value of certificates exceeded the value of precious metals held by banks.

Seigniorage Issuing more certificates than the amount of precious metals is a profitable activity. The extra certificates can be lent to the public and earn interest. The issuer takes a piece of paper and converts it into an asset with a positive value. It is no wonder governments took over. While there exist privately issued currencies (for example, bitcoins or Salt Spring Island dollars), they depend on the willingness of the parties in the transaction to accept them. By their very nature, they are not widely accepted.

The Bank of Canada is the sole institution allowed to issue Canadian dollar banknotes. The Bank of Canada prints new notes and uses the proceeds to buy government bonds or interest-earning assets. The profit from issuing money is called **seigniorage**. The profit is the difference between interest earned and the cost of printing the notes. For example, the average $20 polymer banknote costs 19 cents to produce, 15 cents to distribute and is predicted to last, on average, around 7.5 years. The cost of maintaining the note is therefore around 4.5 cents per year. If the Bank of Canada uses it to buy government bonds yielding 2.5% per year, it earns 50 cents in interest, for a net yearly profit of 45.5 cents for each $20 dollar note.

Seigniorage The profit from issuing money.

Fiat Money What happens with the seigniorage? The Bank of Canada is wholly owned by the federal government. The profit becomes federal government revenue. In 2012, there was around $64 billion of notes in circulation. The Bank's interest earnings were $1.4 to 2.0 billion in recent years. The cost of issuing currency was $220 million.[5] The total amount of seigniorage was around 0.1% of Canadian GDP and 0.3% of federal government revenue. In some countries seigniorage is a much greater: For example in Italy and Greece, before they joined the Eurozone, it exceeded 5% of government revenue is some years.

The next step in the development of money was ending the convertibility of money into precious metals. The Canadian dollar was convertible into gold until 1914 and again between 1926 and 1931. Since 1931 the Canadian dollar is a **fiat money**: Canadian dollar banknotes have no value apart from their use as money.

Fiat money Money, such as paper currency, that has no value apart from its use as money.

Fiat money is *intrinsically useless*: It has no value apart from its use as money. (Fiat means "by order or by decree"; the value of money is assured by government order.) Why are people willing to exchange goods and services for pieces of intrinsically useless paper currency? The

[5]www.bankofcanada.ca/about/educational-resources/backgrounders (accessed May 11, 2013).

short answer is that money is a social convention. Households and firms have confidence that if they accept paper dollars in exchange for goods and services, they will be able to use the paper money to buy goods and services they want. Without this confidence, paper money could not serve as a medium of exchange.

Legal Tender If you look at a Canadian banknote, you will see the words "This note is legal tender." More precisely, legal tender in Canada includes notes issued by the Bank of Canada as well as coins issued by the Royal Canadian Mint. Most people think that "legal tender" means that Canadian dollars must be accepted in payment for transactions in Canada. But this is not the case. The payment method must be agreed upon by both the seller and the buyer; there is no legal requirement that the seller must accept Canadian dollars. According to the Bank of Canada website, "If bank notes are being offered as payment, they must have been issued by the Bank of Canada because no other bank notes are 'legal tender' in Canada." So a sign "we do not accept $100 bills" is perfectly legal, as is a sign "no cash payment accepted." The meaning of "legal tender" differs across countries. In the United States, cash must be accepted in private payments of debts; as in Canada, there is no legal obligation to accept dollars in exchange for goods and services. In the United Kingdom, legal tender "means that a debtor cannot successfully be sued for non-payment if he pays into court in legal tender."[6]

The Functions of Money

Money has three functions in the economy:

1. It acts as a medium of exchange
2. It is a store of value
3. It is a unit of account

Medium of Exchange If you are a teacher or an accountant, you are paid money for your services. You then use that money to buy goods and services. You essentially exchange your teaching or accounting services for food, clothing, rent, and other goods and services. But unlike with barter, where goods and services are exchanged directly for other goods and services, the exchanges you participate in involve money. Money acts as a **medium of exchange**. In other words, money is the medium through which exchange takes place. Because money is generally accepted as payment for goods and services or as payment for debts, you know that the money your employer pays you will be accepted at the stores where you purchase food, clothing, and other goods and services. Consequently, you can specialize in producing teaching or accounting services without having to worry about directly producing the other goods and services you require to meet your needs, as you would in a barter economy.

Medium of exchange Something that is generally accepted as payment for goods and services; a function of money.

Store of Value Money is a **store of value** as it allows the accumulation of wealth that can be used to buy goods and services in the future. For example, suppose you want to purchase an iPad next year that has a price of $500. If you have $500 in currency, you can put it aside and purchase the iPad in one year. Note, though, that if prices in an economy rise rapidly over time, as happened recently in Zimbabwe, the quantity of goods and services a given amount of money can purchase falls, and money's usefulness as a store of value is reduced. Of course, money is only one of many assets that can be used to store value. In fact, any asset—shares

Store of value The accumulation of wealth by holding dollars or other assets that can be used to buy goods and services in the future; a function of money.

[6]See www.bankofcanada.ca/banknotes/bank-note-series/past-series; www.treasury.gov/resource-center/faqs/Currency/Pages/legal-tender.aspx; www.royalmint.com/aboutus/policies-and-guidelines/legal-tender-guidelines (all accessed May 11, 2013).

of Apple stock, bitcoins, Government of Canada bonds, real estate, or Renoir paintings, for example—can be a store of value. There are two reasons money is used as a store of value. First, many of these assets are risky, while money is not. Second, money has the advantage of being perfectly liquid: It can be used in transaction without incurring additional costs.

In modern economies, the store of value role of money is not very important. For example, various bank accounts pay interest and are riskless, since they are insured by the Canada Deposit Insurance Corporation. Nowadays, few households hold significant portion of their wealth in cash.

Making the Connection

Money as a Store of Value in Cyprus

In March 2013 Cyprus became the fourth Eurozone country, after Greece, Ireland, and Portugal, to require a bailout of the banking system and prevent a default by Cypriot banks and the Cypriot government. In the previous 20 years Cyprus had become an off-shore banking centre, especially for wealthy Russians who wanted to hold their money out of the reach of the Russian tax office and other Russian institutions. The banking system became very large, with assets exceeding 800% of GDP. Cypriot banks held a lot of Greek government bonds and loans to private Greek borrowers. They incurred large losses when Greece de facto defaulted on loans from non-government lenders in 2011. Cyprus arranged an emergency loan from Russia, but by the spring of 2013 it was clear that the banking system was collapsing.

As in all Eurozone countries, the government guaranteed deposits up to €100 000. In case of a bank bankruptcy, the Cypriot government would have to cover all losses for deposits under €100 000. The government did not have adequate funds to meet the guarantees and asked the European Union for help. Cyprus needed €14.8 billion to fix the banking system and put national finances on a sustainable level. The so called "troika," the European Union, the International Monetary Fund, and the European Central Bank, agreed to provide Cyprus with a loan of only €10 billion, conditional on Cyprus contributing the remaining €4.8 billion. The reason for requiring Cypriot participation was concern about moral hazard. The troika was concerned that if it provided all the needed funds, Cyprus would return to previous, unsustainable policies and would run into trouble again.

The troika proposed that, to raise the €4.8 billion, uninsured deposits should be subject to a one-time tax of 15%. The Cypriot president, Nicos Anastasiades, did not agree. He insisted that no depositor should lose more than 9.9%. He did not want Cyprus to lose its role as an off-shore centre. Reducing tax on large depositors required a one-time tax on insured deposits of 6.75%. The troika agreed and the deal was announced on March 18, 2013. Banks were closed and Cypriots could withdraw only a limited amount of cash from bank machines.

The plan turned out to be very unpopular as it imposed costs on small depositors to reduce the tax on wealthy depositors, who were mostly foreigners. The deal was rejected by the parliament. In the final agreement, the guaranteed deposits were not taxed, but the damage was done. Depositors around the world realized that even government guarantees may be broken (with the result that even the governor of the Bank of Canada felt obliged to assure Canadians that their guaranteed deposits were safe). Further, unlike previous experience, it turned out that the return on bank deposits could be negative. This realization restored, at least for a time, the role of cash as a store of value.

Sources: James Mackintosh, "Bank Assets as Percentage of GDP," *Financial Times*, March 25, 2013; "What Went Wrong in Cyprus, *BBC News*, March 28, 2013; "Bank 'bail-in' plan shouldn't worry Canadians, Carney says," *The Canadian Press*, April 18, 2013.

Unit of Account Money serves as a **unit of account**, which means it is a way of measuring the value of goods and services in an economy. For example, when you purchase an iPad, the Apple store posts a price in terms of dollars rather than in terms of Apple shares or ounces of gold. Having an agreed-upon unit of account makes an economy more efficient because goods and services have a single price rather than many prices. A unit of account does not need to be the actual currency. The guinea was a gold coin that stopped circulating in Great Britain in 1816, when it was worth 21 shillings or 21/20 of a pound. It has remained a unit of account and some prices are still quoted in guineas. Note, however, that the value of the guinea was fixed in terms of the circulating currency.

Unit of account A way of measuring value in an economy in terms of money; a function of money.

Making the Connection

When Money Is No Longer Money: Hyperinflation in Zimbabwe

At the time of its independence from Great Britain in 1980, Zimbabwe was relatively well off by the standards of sub-Saharan Africa. Zimbabwe's GDP per capita was 35% higher than that of Kenya and 20% higher than that of Nigeria. The following three decades were not good for Zimbabwe. Real GDP per capita declined by 45% while it tripled in Kenya and increased by 230% in Nigeria. As a result, in 2011 Zimbabwe was one of the poorest countries in the world, with income per capita 70% lower than in Kenya and 80% lower than in Nigeria.

What happened to Zimbabwe's economy? Zimbabwe has suffered from a long period of economic mismanagement and, in recent years, political strife as long-time president Robert Mugabe has attempted to maintain power in the face of widespread opposition. Beginning in 2005, high inflation made the country's problems much more acute. As noted in the chapter opener, between 1999 and 2008 the Zimbabwean central bank, the Reserve Bank of Zimbabwe (RBZ), caused the money supply to increase at an annual rate of 7500%. The inflation rate exceeded 100% per year in 2001 and exploded following a temporary stabilization in 2004. The inflation data below are for year-on-year inflation, i.e., the percentage change in the price level between a given month and the same month in the previous year. For example, the monthly inflation rate in October 2007 is the monthly average inflation between October 2006 and October 2007. Hyperinflation started in October 2007, when the inflation rate was almost 15 000% per year. It exceeded 2 000 000% per year in May 2008 and 230 000 000% in July 2008. After July 2008, price statistics were no longer collected. Steve Hanke and Alex Kwok estimated the inflation to be 3190% *per month* (over 9 billion % per year) in August, 690 000 000% per month (almost 4 billion billion percent, or 4×10^{18} % per year) in October and 79 600 000 000% per month (9×10^{22} % per year) in November 14, 2008.[7]

As the Zimbabwean dollar lost nearly all of its value, the economy reverted to barter or switched to using U.S. dollars and other foreign currencies. Because exchanging Zimbabwean dollars for foreign currency was difficult, imports plunged, and shortages of food and other basic goods became widespread. Reliable statistics on Zimbabwe's economy are difficult to find; but in 2008, one journalist described a situation bordering on economic collapse:

[7]As no official price statistics were collected after July 2008, Hanke and Kwok estimated the inflation rate on the basis of the stock of the insurance and investment company Old Mutual, which was listed on both the London Stock Exchange and the Zimbabwe Stock Exchange. A comparison of the prices of the stock at both exchanges provided an estimate of the exchange rate.

"Zimbabwe is in the midst of a dire economic crisis with unemployment at almost 80%, most manufacturing at a halt, and basic foods in short supply." Some estimates put the unemployment rate as high as 95%. Nearly the entire labour force had to scratch out a subsistence living as best they could. Many unemployed Zimbabweans were reported as surviving only by growing vegetables in vacant lots or along roads.

Why would the RBZ allow such high rates of growth in the money supply if the result was a ruinous hyperinflation? The answer is that the RBZ was not independent of the rest of the Zimbabwean government. When the Zimbabwean government decided in the early 2000s to greatly increase its spending, primarily to support the efforts of Robert Mugabe to retain power, it did so not by raising taxes or borrowing by selling government bonds to investors but by having the RBZ increase the money supply.

In November 2008 the economy abandoned the use of Zimbabwean dollars and switched to U.S. dollars. The use of U.S. dollars became legal in January 2009, legalizing the de facto abolition of domestic currency. By 2011 the economy was showing signs of recovery as the inflation rate declined to less than 3% per year. Real GDP rose by 4% in 2010 and 6% in 2011. Still, the country faced severe structural problems, the political situation remained uncertain, and many Zimbabweans did not trust the government to control the money supply responsibly.

Sources: "Zimbabwe's Independence: Thirty Years On," *Economist*, April 20, 2010; Angus Maddison, *Contours of the World Economy* (New York: Oxford University Press, 2007); "Zimbabwe Inflation Rockets Higher," August 19, 2008, news.bbc.co.uk; "What a Full-Fledged Economic Collapse Looks Like," *Economist*, May 6, 2009; Michael Hartnack, "Zimbabwe Inflation Tops 1000 Percent," Associated Press, May 13, 2006; International Monetary Fund, "Statement of the IMF's Mission to Zimbabwe," Press Release No. 10/420, November 8, 2010; "Move Over, Mugabe," *Economist*, April 14, 2012; Robertson Economic Information Services, "August 2007 Forecast Paper," 2007; Steve H. Hanke and Alex K. F. Kwok, "On the Measurement of Zimbabwe' Hyperinflation," *Cato Journal* 29, no. 2 (2009).

See related problem 1.7 at the end of the chapter.

How Is Money Supply Measured?

Recall that the money supply is the quantity of assets available to households and firms to conduct transactions. Changes in the money supply are associated with changes in nominal interest rates and prices. Information on the money supply is compiled by the Bank of Canada. The task of measuring money is complicated as many different assets are used in exchange. The crucial characteristic the Bank of Canada takes into account is the asset's liquidity: the ease with which it can be used in transactions. The most liquid assets are cash: notes and coins, as well as chequing account balances, which can be used to pay for transactions with cheques or debit cards. Less liquid assets include term deposits, demand and notice deposits, foreign exchange deposits, money market mutual funds, Canada Saving Bonds, and the like. These assets are less liquid since, in order to use them in transactions, their owner must convert them into cash at their bank (or transfer the funds over the internet), or first give a notice and wait a period of time to avoid a penalty.

Monetary aggregates Broad measures combining, on the basis of liquidity, assets that can be used in exchange.

M1+ A narrow measure of the money supply. Currency outside banks plus chequable deposits at chartered banks and other financial institutions.

M2+ A broad measure of the money supply. M1+ plus non-chequable and personal term deposits at chartered banks and other financial institutions.

Assets that can be used in transactions are classified into **monetary aggregates**. Monetary aggregates are broad measures combining, on the basis of liquidity, assets that can be used in exchange. The main monetary aggregates followed by the Bank of Canada are called **M1+** and **M2+.** They are shown in Figure 4.1. The M1+ aggregate is a narrow measure of the money supply. It consists of currency outside banks plus chequable deposits at chartered banks, trust and mortgage loan companies, credit unions, and caisses populaires. The M2+ aggregate is a broader measure of the money supply. It consists of currency outside banks plus bank personal deposits (including personal chequable deposits), bank

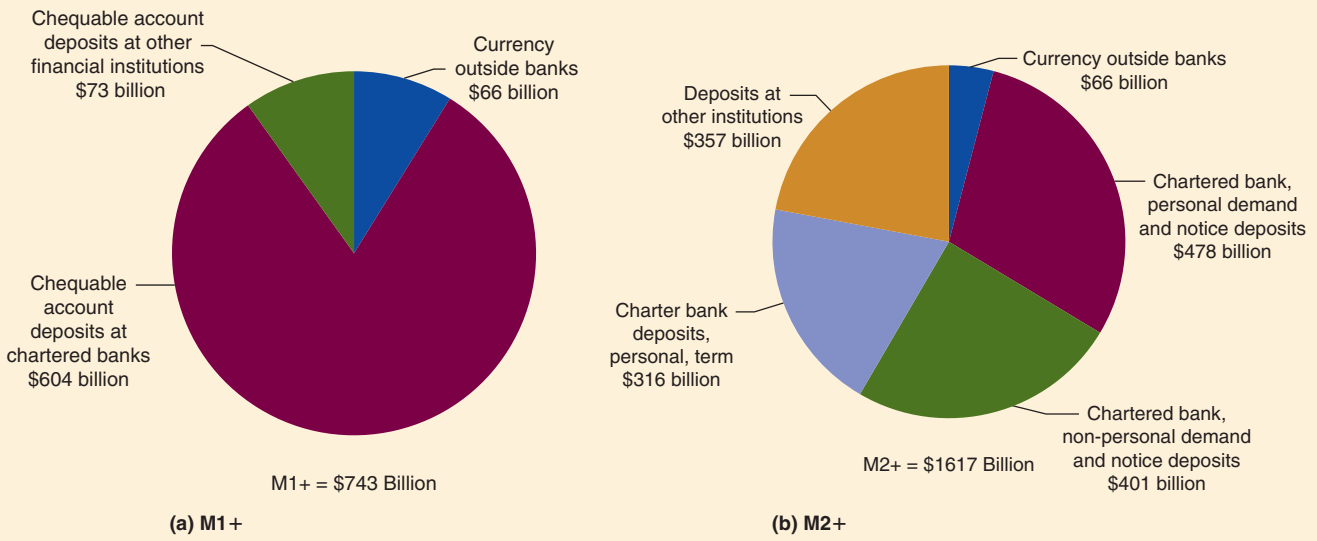


Figure 4.1 M1+ and M2+ and Their Components, March 2014

The Bank of Canada follows several monetary aggregates, of which M1+ and M2+ are the most important. M1+ is a narrow measure of the money supply. It includes currency outside banks and chequable deposits at chartered banks and other financial institutions. M2+ is a broad measure of the money supply. In addition to M1+ it includes non-chequable and personal term deposits at chartered banks and other financial institutions.

Source: Bank of Canada, Weekly Financial Statistics.

non-personal demand and notice deposits, and deposits at other financial institutions.[8] Households can easily convert these accounts into currency, although not as easily as the components of M1+.

Figure 4.2 shows the rates of growth of M1+ and M2+ in Canada between the years 1990 and 2014. M1+ and M2+ have similar growth rates over long periods of time but there are significant differences over short periods. The narrow aggregate (M1+) is more volatile. Note that, during the Great Recession, the rate of growth of M1+ increased in October 2008 and remained high until 2011. The rate of growth of the broad measure of the money supply (M2+) did not change much until November 2009 and then declined and remained below the pre-recession levels until 2014.

At one time fluctuations in the money supply were a major source of discussion among macroeconomists, investment analysts, and policymakers. This interest arose because, for most of the post–World War II period, there had been a stable short-run relationship between M1 and M2 (similar, respectively, to M1+ and M2+) and economic variables such as inflation, interest rates, and nominal GDP. Whether this relationship was stronger for M1 or for M2 was the subject of considerable debate. In Canada, monetary policy involved control of M1 between 1975 and 1981. The goal was to reduce the rate of inflation from the double-digit

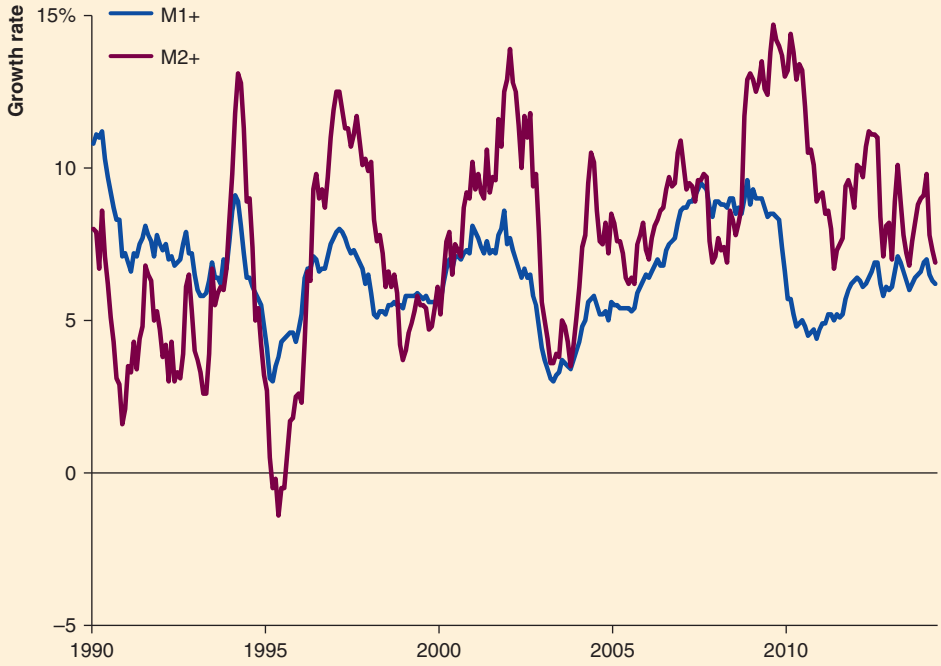
[8]More precisely, M1+ (gross) consists of "currency outside banks plus all chequable deposits held at chartered banks, trust and mortgage loan companies, credit unions and caisses populaires (excluding deposits of these institutions); plus continuity adjustments (to 'smooth' a time series when there are structural breaks)." M2+ (gross) consists of "currency outside banks plus bank personal deposits, bank non-personal demand and notice deposits; less interbank deposits; plus continuity adjustments; plus deposits at trust and mortgage loan companies and at government savings institutions; deposits and shares at credit unions and caisses populaires; life insurance company individual annuities; money market mutual funds; plus continuity adjustments and other adjustments." Source: Bank of Canada backgrounder "Canada's Money Supply."

Figure 4.2

Growth Rates of M1+ and M2+, 1990–2014

M1+ and M2+ have similar growth rates over long periods of time but there are significant differences over short periods.

Source: Bank of Canada.



level that prevailed during that time. M1 was chosen because the link between inflation and the rate of growth of M1 was particularly strong. The Bank of Canada was successful in slowing down the growth of M1 between 1976 and 1981. Inflation, however, did not fall during that period. The reason was that banks increased liquidity by creating accounts that were not part of M1, and consequently the previously strong relationship between M1 and inflation broke down. This experience suggests that as banks and other financial firms respond to the demands of households and firms by developing new assets, the relationship between whatever we define as *money* and economic variables may change. Since late 1981 the Bank of Canada has therefore de-emphasized the significance of M1+ and M2+ in monetary policymaking.

The Bank of Canada and the Money Supply

4.2

Learning Objective

Explain how central banks change the money supply

We now describe how a central bank affects the money supply through open market operations. Open market operations discussed in this chapter are used by many central banks but are no longer the main tool of the Bank of Canada; we describe the way the Bank of Canada operates in Chapter 12. Here we focus on open market operations to stress that central banks do not have complete control of the money supply. The size of M1+ and M2+ depends not only on the central bank's actions, but also on the behaviour of the banking system and the nonbank public: household and firms.

We now develop a simple model of how the money supply is determined. It includes the behaviour of three actors:

1. The central bank, which is responsible for controlling the money supply and regulating the banking system.
2. The banking system, which creates the chequing accounts that are an important component of the M1+ measure of the money supply.

3. The nonbank public, (households and firms) that decides the form in which they wish to hold money (for instance, as currency or as chequing accounts).

The process of determining the money supply begins with the **monetary base** (also called **high-powered money**), which is equal to the amount of currency in circulation plus the reserves of the banking system:

Monetary base (or **high-powered money**) The sum of currency in circulation and bank reserves.

$$\text{Monetary base} = \text{Currency in circulation} + \text{Reserves}.$$

Reserves are an asset to banks and consist of vault cash plus banks' deposits with the central bank. In the past the Bank of Canada required banks to hold a fraction of their chequing and other deposits as reserves. These reserves were called *required reserves*. Bank reserves often exceeded the required level; such reserves were called *excess reserves*. Since 1994 the Bank of Canada no longer requires banks to hold reserves. Nonetheless banks hold reserves to manage the regular cash flows: cash withdrawals (including ATMs) and cheque clearing. They also hold precautionary reserves for unexpected cash requirements. The reserves Canadian banks hold are called **desired reserves**. Desired reserves are simply the reserves a bank would like to hold. Note that, in countries with a reserve requirement, if a bank's reserves exceed required reserves, they are equal to the desired level. If a bank's reserves are equal to required reserves, desired reserves are likely lower than the required level.

Desired reserves The reserves a bank would like to hold.

How a Central Bank Changes the Monetary Base

The main method many central banks use to control the monetary base is **open market operations.** Open market operations involve purchases and sales of securities, usually short-term government bonds, in financial markets (in the open market—hence the name). When a central bank buys bonds, it increases the monetary base; when the central bank sells bonds, it reduces the monetary base.

Open market operations Central bank's purchases and sales of securities, usually short-term government bonds, in financial markets.

To explain how open market operations affect the monetary base we consider two cases: a purchase from a bank and a purchase from nonbank public. If the central bank buys a government bond worth $1 million from a bank, it pays for the purchase by crediting the bank's account at the central bank with $1 million. Since the balance of the bank's account at the central bank is a part of the bank's reserves, the bank's reserves and the monetary base both increase by $1 million.

If the central bank buys the bond from nonbank public, it pays with a cheque. The seller will, typically, deposit the cheque into her account. Her bank will then send the cheque to the central bank, which would clear the cheque by adding funds to the bank's account at the central bank. If the entire cheque is deposited, the bank's reserves and the monetary base increase by $1 million. What happens if the seller of the bond takes part of the cheque in cash, for example $10 000? The bank deposits the entire cheque at the central bank and gives the depositor $10 000 in cash. The bank's deposits at the central bank increase by $1 million, and vault cash falls by $10 000. Reserves (the sum of deposits at the central bank and cash held by the banking system) increase by $990 000: the $1 million deposit at the central bank minus the $10 000 reduction in cash. The monetary base (reserves plus cash outside of the banking system) increases by $1 million: the $990 000 increase in reserves and the $10 000 increase in cash outside of the banking system.

Similarly, a sale of a government bond reduces bank reserves and the monetary base. When the central bank sells a bank a $1 million bond, it simply debits the bank's account at the central bank, reducing the bank's reserves and the monetary base by $1 million. If it sells the bond to nonbank public , the central bank receives a cheque that it clears by deducting the amount from the buyer's bank deposit and reducing the bank's reserves and the monetary base by $1 million.

Using open market operations the central bank has, essentially, full control of the monetary base. If it wants to buy bonds, it can always pay a high enough price to find the seller; if it wants to sell bonds, it can always accept a low enough price to find a buyer. This is because the central bank can create cash, on which it does not pay interest, and receives interests when it holds government bonds.

From the Monetary Base to the Money Supply: The Process of Money Creation

The monetary base is just a small portion of money supply. The central bank's control of the money supply depends on the behaviour of the other actors in the process of money creation: the banking system and the nonbanking public. The banking system affects the money supply by its choice of the level of desired reserves; the nonbank public affects the money supply by its choice of how much cash to hold.

Money multiplier A number that indicates how much the money supply increases when the monetary base increases by $1.

The link between the monetary base and money supply is called the **money multiplier**. The money multiplier tells us how much the money supply increases when the monetary base increases by $1. The multiplier can be calculated for different definitions of the money supply. Below we consider the multiplier for M1+. Similarly we could consider the multiplier for M2+ and for other monetary aggregates. We let M stand for the money supply, MB stand for the monetary base, m stand for the money multiplier and Δ stand for "change in". The multiplier is:

$$m = \frac{\Delta M}{\Delta MB}. \tag{4.1}$$

To know the effect of the open market purchase on the money supply, the central bank needs to know the value of the money multiplier. What follows is a brief description of how banks and the nonbank public also affect the money supply through the money multiplier. We provide a more detailed explanation of the money multiplier in the online appendix to this chapter. In the simple model below we use a linear equation, and so the multiplier is equal both to the ratio of the *change* in money supply to the *change* in reserves as well as to the ratio of the *level* of the money supply to the *level* of the monetary base:

$$m = \frac{\Delta M}{\Delta MB} = \frac{M}{MB}. \tag{4.2}$$

If we use the M1+ definition of the money supply, then M is the sum of currency in circulation, C, and chequing account deposits, D, while the monetary base is the sum of currency in circulation, and desired bank reserves, R.[9] So, we can expand the expression for the money multiplier to:

$$m = \frac{C + D}{C + R}. \tag{4.3}$$

It is convenient to express the equation for the multiplier in terms of the ratios of cash to deposits and reserves to deposits. The nonbank public—households and firms—determine how much currency they wish to hold relative to chequing account deposits; this ratio is equal C/D. Banks determine how much reserves they want to hold relative to chequing account deposits, which is equal R/D. The two ratios are *behavioural* parameters, which depend on how households and banks arrange their financial operations. To include these

[9]We ignore the possibility that desired reserves are lower than required reserves. It would make the analysis more complicated and would not affect results. It is not an issue in Canada since required reserves are zero.

ratios in the expression for the money multiplier, we multiply numerator and denominator by 1/D and simplify:

$$m = \left(\frac{C + D}{C + R}\right)\frac{(1/D)}{(1/D)} = \frac{(C/D) + 1}{(C/D) + (R/D)}. \tag{4.4}$$

In March 2014 the money base was $71 billion, of which currency outside banks was $65 billion and bank reserves were 6 billion. The value of M1+ was 743 billion, so the multiplier was 743/71=10.5. This means the money supply M1+ is ten and a halftimes larger than the money base.

Since money supply = money multiplier times the monetary base, $M = m\,MB$, from equation (4.4), we obtain:

$$M = \left(\frac{C/D + 1}{(C/D) + (R/D)}\right) \cdot MB. \tag{4.5}$$

As we have a linear equation, the multiplier also shows how much the money supply changes for a given change in the monetary base:

$$\Delta M = \left(\frac{C/D + 1}{(C/D) + (R/D)}\right) \cdot \Delta MB. \tag{4.6}$$

Using the data from March 2014, since the multiplier equals 10.5, a $1 increase in the money base increases M1+ by $10.5. In other words, if the Bank of Canada buys $1 million of government bonds, M1+ increases by $10.5 million.

There are several important points to note about the expression linking the money supply to the monetary base:

1. The money supply will increase if either the monetary base or the money multiplier increases in value, and it will decrease if either the monetary base or the money multiplier decreases in value.
2. An increase in the currency-to-deposit ratio (C/D) causes the value of the money multiplier to decline and, if the monetary base is unchanged, it also causes the money supply to decline. This result makes economic sense: If households and firms increase their holdings of currency relative to their holdings of chequing account deposits, banks will have a relatively smaller amount of funds they can lend out, which reduces the money multiplier.
3. An increase in the reserves-to-deposit ratio (*R/D*) causes the value of the money multiplier to decline and, if the monetary base is unchanged, it also causes the value of the money supply to decline. This result also makes economic sense: An increase in *R/D* means that banks are holding relatively more reserves. They are not using these funds to make loans, which reduces the multiplier.

Figure 4.3 shows the money multiplier for M1+ in Canada since 1976. There has been a long-term upward trend in the multiplier. This is simply a reflection of the diminished use of cash in transactions. For any given amount of monetary base, more transactions are conducted using methods of payment other than cash. This is the result of financial innovations that make it easier to make non-cash payments. One such innovation is the use of debit cards, which provide direct access to chequing accounts. Canadians are among the heaviest users of debit cards in the world. Another is the use of credit cards, with the balances being paid for using chequing account balances.

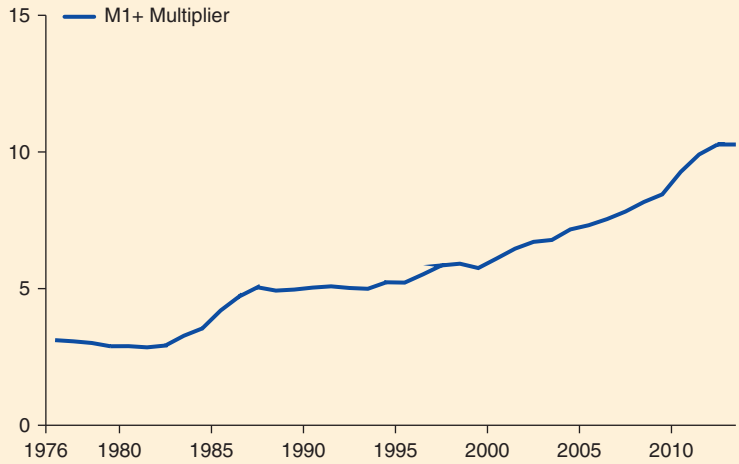
As you can see from Figure 4.3, efforts by the Bank of Canada to slow down the rate of growth of M1+ led to a slight decline in the multiplier over the period 1976–81. Once the Bank of Canada abandoned the control of M1+, the multiplier started increasing rapidly.

Figure 4.3

M1+ Multiplier in Canada

There has been a long-term upward trend in the size of the M1+ multiplier. This is because households and firms have been moving away from using cash for transactions. An important innovation was the introduction of debit cards, which provide direct access to chequing account balances.

Source: Statistics Canada, CANSIM Table 176-0025



4.3

Learning Objective

Describe the quantity theory of money, and use it to explain the connection between changes in the money supply and the inflation rate.

The Quantity Theory of Money and Inflation

Writers dating back at least as far as the Greek philosopher Aristotle in the fourth century BC have discussed the connection between increases in the money supply and increases in the price level. During the sixteenth century, the Spanish conquest of Mexico and Peru resulted in huge quantities of gold and silver being exported to Europe, where they were minted into coins. The inflow of gold and silver into Europe was followed by the first prolonged period of inflation. Many writers noted that the sharp increase in the money supply led to an increase in inflation. In the early twentieth century, Yale economist Irving Fisher formalized the relationship between money and prices by proposing the **quantity equation** (also called the **equation of exchange**). The quantity equation is an identity that states that the money supply, M, multiplied by the *velocity of money*, V, equals the price level, P, multiplied by real GDP, Y:

Quantity equation (or equation of exchange) An identity that states that the money supply multiplied by the velocity of money equals the price level multiplied by real GDP.

$$MV = PY. \tag{4.7}$$

Velocity of money The average number of times that each dollar in the money supply is used to purchase goods or services in a given period.

Why is it an identity? Because Fisher defined the **velocity of money**—or, simply, *velocity*—as the average number of times that each dollar in the money supply is used to purchase goods or services in a given period. So velocity is, by definition,

$$V = \frac{PY}{M}. \tag{4.8}$$

Since, by definition, V is always equal to $\frac{PY}{M}$ then, by multiplying both sides by M, we get $MV=PY$. Both sides of the quantity theory equation are always equal. The quantity equation is an identity. To see this, consider a simple example. Assume that the only good in the economy is pizza, and all transactions are paid in cash. A pizza costs \$10 and during the year 100 pizzas are produced. The total amount of cash in the economy is \$40. We can now calculate the velocity of cash:

$$V = \frac{\text{price of a pizza} \times \text{number of pizzas produced}}{\text{the amount of cash in the economy}} = \frac{\$10 \cdot 100}{\$40} = 25.$$

The quantity equation: $MV = PY$ becomes: $\$40 \cdot 25 = \$10 \cdot 100$. Both sides are equal because of the way velocity was calculated.

Unlike at the time of Fisher, there are now many different concepts of the money supply: the monetary base, M1+, M2+ etc. There are, therefore, many different velocities: the velocity of the monetary base, the velocity of M1+, the velocity of M2+, etc. The best way of thinking about the velocity of, for example, M1+, is as follows. Assume that the entire money supply consists solely of M1+ so that all transactions are conducted using components of M1+ (currency and chequing accounts). Velocity of M1+ is then *the average number of times each unit of M1+ is used during a year:*

$$V(M1+) = \frac{PY}{M1+}.$$

Since PY equals nominal GDP, the velocity of M1+ is simply nominal GDP divided by the value of M1+.

Similarly, the velocity of cash is calculated assuming all transactions are conducted using cash. The velocity of cash (the amount of notes and coins in circulation is then:

$$V(cash) = \frac{PY}{\text{cash}}.$$

In March 2014, Canadian nominal GDP was $1717 billion on annual basis, M1+ was $743 billion; and cash outside the banking system was $66 billion.[10] Using these data we can calculate the velocity of M1+ and of cash:

$$V(M1+) = \frac{\$1717\ billion}{\$743\ billion} = 2.3; \quad V(cash) = \frac{\$1717\ billion}{\$66\ billion} = 26.$$

The velocity of M1+ was 2.3. This means that, if all transactions in Canada in the first quarter 2014 had been paid for only with components of M1+, each unit of M1+ would have had to be used, on the average, 2.3 times. Similarly, the velocity of cash was 26; i.e., if all transactions had been paid in cash, each dollar would have had to be used on the average 26 times.

In fact, some transactions are done with cash, other with chequing accounts, other with credit cards, etc. This means that the numbers we obtained for velocity are not correct. For example, cash is used in only a small portion of transactions, and the actual number of times each dollar of cash circulates is much smaller. If we knew what amounts were paid using cash, using chequing accounts M2+, and in other ways we could, in principle, calculate the exact values of velocities for various monetary aggregates. We do not do so since, as we will see below, the variety and exact values of velocities are of secondary importance. What matters is *whether velocity is stable over time*. So from now on we will denote the amount of money as M, which may mean the monetary base or M1+ or some other monetary aggregate.

The quantity equation (4.7) tells us that the total amount of spending in the economy ($M\ V$) equals nominal GDP ($P\ Y$). Therefore, the money supply and the velocity of money together determine the level of nominal GDP. As we will see, the central bank determines the money supply in the long run, which means that as long as velocity is stable or changes in predictable ways, the central bank can also determine the level of nominal GDP in the long run.

The Quantity Theory of Money

A theory is a statement about the world that could be either true or false. The quantity equation (4.7) is always true, so it does not qualify as a theory. Irving Fisher turned the quantity

[10]Statistics Canada, CANSIM Tables 380-0064 and 176-0025.

Useful Math 4.2: Calculating the percentage change of a product or a ratio

There are simple and easy-to-remember formulas that relate variables to their percentage changes. We denote percentage change in variable X as $\%\Delta X$.

1. The percentage change of the product of two variables is equal to the sum of their percentage changes:

$$\%\Delta(XY) = \%\Delta X + \%\Delta Y.$$

2. The percentage change of a ratio is equal to the difference of percentage changes:

$$\%\Delta\left(\frac{X}{Y}\right) = \%\Delta X - \%\Delta Y.$$

These simple equations are often useful in assessing economic or business performance. For example, in 2012 nominal GDP in Canada grew by 3.1% [$\%\Delta(P \cdot Y) = 3.1\%$] while prices (GDP deflator) increased by 1.3% ($\%\Delta P = 1.3\%$). Nominal GDP $= P \cdot Y$ so, using the first formula, $\%\Delta$(Nominal GDP) $= \%\Delta P + \%\Delta Y$. Substituting the values, we obtain $3.1\% = 1.3\% + \%\Delta Y$ and so $\%\Delta Y = 1.8\%$: real GDP increased 1.8%.

For another example consider Tim Hortons. It is a multi-franchise company that can grow by increasing the sales per franchise or by increasing the number of franchises. Increasing sales per franchise (called intensive growth) is preferred to increasing the number of franchises (extensive growth). Last year total sales increased by 2%. Is it a good result? It depends on what happened with the number of franchises. The number of franchises increased by 3%. Denote the average sales per franchise by S, total sales by T, and the number of franchises by N. Since $S = T/N$, so, using the second equation, $\%\Delta S = \%\Delta T - \%\Delta N = 2\% - 3\% = -1\%$. While total sales grew by 2%, this was the result of extensive growth. Sales per franchise fell by 1%, not a good thing.

Practice Question

As we will see in Chapter 5, the real exchange rate is equal to the nominal exchange rate multiplied by the domestic price level and divided by the foreign price level. We denote the nominal exchange rate as E. Using symbols:

$$\text{real exchange rate} = E \cdot P^{\text{domestic}} / P^{\text{foreign}}.$$

(a) Calculate the rate of change of the real exchange rate.

(b) If the real exchange rate is constant, the nominal exchange rate appreciates 2% per year and domestic inflation is 2% per year, what is foreign inflation?

Quantity theory of money A theory about the connection between money and prices that assumes that the velocity of money is constant.

equation into the **quantity theory of money** by assuming that *velocity is constant*. Fisher argued that the average number of times a dollar is spent depends on factors that do not change very often, such as how often people get paid, how often they go grocery shopping, and how often businesses mail bills. Because this assertion that velocity is constant may be either true or false, the equation became a theory. As we will see, even if velocity is not constant, the quantity theory may still prove to be useful in predicting future inflation rates.

The Quantity Theory Explanation of Inflation

Applying the formula for the percentage change in the product to the quantity equation (4.7): $MV = PY$ we get:

$$\%\Delta M + \%\Delta V = \pi + \%\Delta Y. \tag{4.9}$$

The percentage change in the price level is the inflation rate, which we represent by $\pi = \%\Delta P$. According to the quantity equation, the percentage change in the money supply plus the percentage change in velocity equals the inflation rate plus the growth rate of real GDP.

The quantity theory assumes that velocity is constant, so the percentage change in V is 0. Inserting $\%\Delta V = 0$ into equation (4.9) we obtain:

$$\%\Delta M = \pi + \%\Delta Y.$$

So, this equation tells us that the growth rate of the money supply equals the inflation rate plus the growth rate of real GDP. Rewriting it, we have:

$$\pi = \%\Delta M - \%\Delta Y. \tag{4.10}$$

We now have an important conclusion from the quantity theory: *Inflation results from the money supply growing faster than real GDP.* For example, if the money supply grows by 5%, while real GDP grows by 3%, the inflation rate will be 2%. If the Bank of Canada were to increase the growth rate of the money supply from 5% to 6%, the quantity theory predicts that the inflation rate would increase from 2% to 3%. In other words, the quantity theory predicts that, holding the growth rate of real GDP constant, a 1 percentage point increase in the growth rate of the money supply will cause a 1 percentage point increase in the inflation rate.

Note that this conclusion about the source of inflation depends on the assumption that velocity is constant. Fluctuations in velocity, particularly in the short run, can break the link between changes in the rate of growth of the money supply and the inflation rate. In the long run, though, most economists believe that the quantity theory accurately predicts changes in the inflation rate. As a result, most economists agree that the central bank, by controlling the growth rate of the money supply, determines the inflation rate in the long run.

Solved Problem 4.1

The Effect of a Decrease in the Growth Rate of the Money Supply

The average annual growth rate of real GDP for Canada since World War II has been about 3%. Suppose that the growth rate of velocity is 0%. What happens to the inflation rate if the money supply growth rate decreases from 5% to 2%? Assume that the growth rate of velocity remains 0% and that changes in the growth rate of the money supply do not affect the growth rate of real GDP.

Solving the Problem

Step 1 **Review the chapter material.** The problem asks you to determine the effect of a decrease in the growth rate of the money supply on the inflation rate, so you may want to review the section "The Quantity Theory Explanation of Inflation," which begins on page 120.

Step 2 **Calculate the initial inflation rate.** The quantity equation tells us that:

$$\%\text{ Change in } M + \%\text{ Change in } V = \%\text{ Change in } P + \%\text{ Change in } Y,$$

so if the growth rate of velocity is 0%, we have:

$$\%\text{ Change in } M = \pi_1 + \%\text{ Change in } Y,$$

where π_1 = the initial inflation rate. We already know that the growth rate of real GDP is 3%, so the $\%\Delta Y = 3\%$. We also know that the growth rate of the money supply is initially 5%, so the $\%\Delta M = 5\%$. We can plug these two values into the above equation to get:

$$5\% = \pi_1 + 3\%$$

or

$$\pi_1 = 5\% - 3\% = 2\%.$$

Step 3 **Calculate the new inflation rate.** If the growth rate of the money supply decreases from 5% to 2%, then, given that velocity is unchanged, the inflation rate will also decrease. We assume that changing the growth rate of the money supply does not

change the growth rate of real GDP, which, therefore, remains 3%. The quantity equation tells us:

$$\%\Delta M = \pi_2 + \%\Delta Y,$$

where the $\%\Delta M$ is now 2%, and π_2 is the new inflation rate.
We can solve for the new inflation rate:

$$2\% = \pi_2 + 3\%$$

$$\pi_2 = 2\% - 3\% = -1\%.$$

The 3 percentage point decrease in the growth rate of the money supply led to a 3 percentage point decrease in the inflation rate. In this case, the inflation rate is negative, so the price level is decreasing. In other words, deflation occurs. Note that there can be substantial changes in velocity in the short run, so the connection between changes in the rate of growth of the money supply and changes in the inflation rate are usually not as close as in this problem.

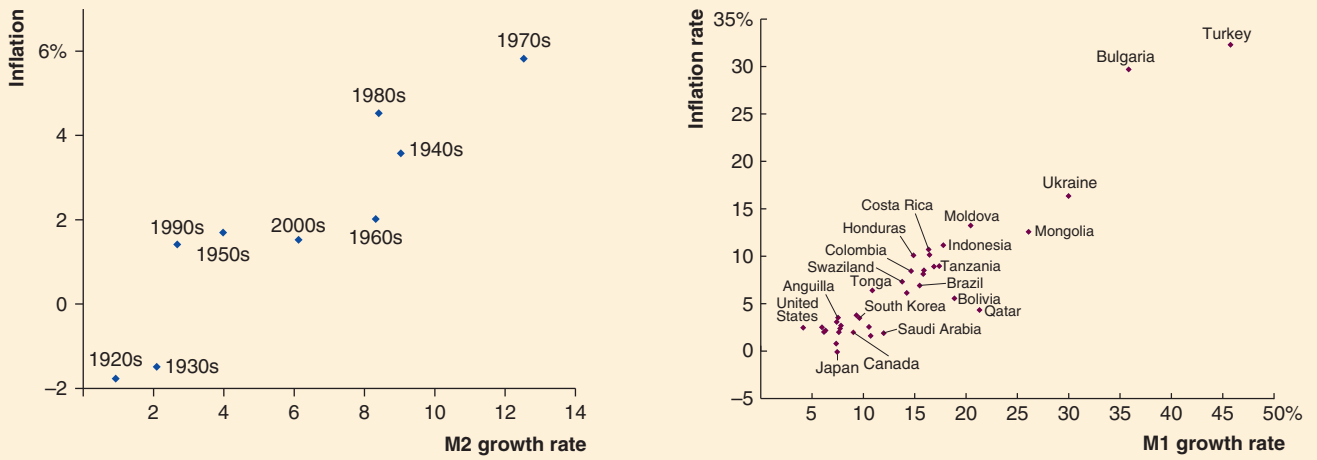
See related problem 3.7 at the end of the chapter.

Can the Quantity Theory Accurately Predict the Inflation Rate?

Velocity does not have to be constant in order for an increase in the growth rate of the money supply to cause an increase in the inflation rate. As long as velocity grows at a constant rate, there will be a close relationship between increases in the money supply and increases in the inflation rate. However, when the growth rate of velocity fluctuates, it is difficult for the central bank to predict how changes in the growth rate of the money supply will affect the inflation rate. For instance, an increase in the growth rate of the money supply might be offset by a decline in velocity, leaving the inflation rate unaffected. As described in the Making a Connection box on page 123, this indeed happened in the Eurozone and in the United States during the Great Recession: Despite huge increases in the monetary base, inflation did not rise because velocity fell.

What can we conclude, then, about the link between the growth rate of the money supply and the inflation rate? Because velocity sometimes moves erratically over short periods, we would not expect the quantity equation to provide good forecasts of inflation in the short run. Over the long run and across countries, however, there is evidence of a strong link between the growth rate of the money supply and the inflation rate. Figure 4.4 panel (a) shows the relationship between the growth rate of the M2 measure of the money supply and the inflation rate by decade in Canada. (We use M2 here because data for M2 are available for a longer period of time than for M1.) Because of variations in the rate of growth of real GDP and in velocity, there is not an exact relationship between the growth rate of M2 and the inflation rate. But there is a clear pattern: Decades with higher growth rates in the money supply were also decades with higher inflation rates. Both the inflation rate and the rate of growth of M2 were the highest in 1970s and the lowest in 1920s and 1930s. Except for the past 20 years, which were the period of rapid financial innovation, the relationship between the rate of inflation and the rate of growth of the money supply is very close. In other words, most of the variation in inflation rates across decades can be explained by variation in the rates of growth of the money supply.

Panel (b) provides further evidence consistent with the quantity theory by looking at rates of growth of the money supply and rates of inflation for 36 countries between 1995 and 2011. Although there is not an exact relationship between rates of growth of the money



(a) Inflation and money supply growth in Canada, 1920s–2000s

(b) Inflation and money supply growth in 36 countries, 1995–2011

Figure 4.4 The Relationship between Money Growth and Inflation over Time and around the World

Panel (a) shows the relationship between the growth rate of M2 and the inflation rate for Canada from 1920s to the 2000s. Panel (b) shows the relationship between the growth rate of M1 and inflation for 36 countries during the 1995–2011 period. In both panels, high money growth rates are associated with higher inflation rates.

Sources: Panel (a): Inflation: Statistics Canada, CANSIM Table 326-0020. Money supply: for 1960s–2000s, Statistics Canada, CANSIM Table 176-0025; for 1920s–1950s, Cherie Metcalf, Angela Redish, and Ronald Shearer (1998) New Estimates of the Canadian Money Stock: 1871–1967, *Canadian Journal of Economics*. Panel (b): International Monetary Fund, *International Financial Statistics*.

supply and rates of inflation across countries, the figure shows that countries where the money supply grew rapidly tended to have high inflation rates, while countries where the money supply grew more slowly tended to have much lower inflation rates.

We can conclude that the basic prediction of the quantity theory is one of the most reliable relationships in macroeconomics:

If the central bank increases the growth rate of the money supply, then, in the long run, this increase will lead to a higher inflation rate.

Making the Connection

Is the Inflation Rate around the World Going to Increase in the Near Future?

Through 2012, central banks increased bank reserves to help their economies recover from the Great Recession that started in 2008. In addition, the European Central Bank (ECB) bought bonds to support financial markets after governments in some European countries had difficulty selling bonds to private investors. The resulting increase in bank reserves increased the monetary base, which *can* lead to an increase in the money supply and higher prices, but not necessarily. The ECB's actions surprised some observers who had become accustomed to the central bank's anti-inflation stance. "The sovereign [debt] crisis has pushed the ECB into flooding the system with even more liquidity," wrote Morgan Stanley economist Joachim Fels. "Global excess liquidity should grow by even more, lifting the prices of commodities and other risky assets and adding to global inflation pressures." By mid-2012, the Eurozone inflation rate rose to 2.4%. Though this was above the ECB's target rate of 2%, some analysts predicted that weakness in Eurozone economies would reduce future inflation rates. Indeed, by late 2013, the problem of the Eurozone countries became the threat of deflation, with inflation declining below 0.5% in 2014 and prices falling in several countries.

In the United States, to combat the Great Recession the Federal Reserve reduced the short-term nominal interest rate to near 0% and started a new policy of purchasing long-term bonds, a process known as *quantitative easing*, in an attempt to improve the performance of the economy. Quantitative easing resulted in a large increase in the monetary base and could have been inflationary. Because the U.S. economy was slow to recover from the 2007–09 recession, the Fed embarked on two new rounds of quantitative easing. The United Kingdom also increased its monetary base significantly. Yet inflation did not increase. Why, despite the massive increases in the rate of growth of the money supply in the Eurozone, the United States and the United Kingdom, did inflation not explode?

The concept of money in the quantity equation is much wider than the monetary base. What matters is the amount of liquid assets held by nonbanking public. The increase in the monetary base did not lead to proportionally larger increases in the money supply in either Europe or the United States because many banks held on to most of their new reserves. Therefore, although the monetary base increased, the money multipliers decreased and the large increase in the monetary base had only a small effect on the amount of liquid assets held by the public. When the economies of Europe, the United States and the United Kingdom recover, however, banks will be more willing to lend out their new reserves, which will increase the possibility of a sudden rapid rise in the money supply. The quantity equation tells us that in the long run, a sustained increase in the money supply will cause an increase in the inflation rate. Many economists and policymakers, however, were more worried about slow growth than about inflation. John Williams, president of the Federal Reserve Bank of San Francisco, explained, "Some commentators have sounded an alarm that this massive expansion of the monetary base will inexorably lead to high inflation. . . . Despite these dire predictions, inflation in the United States has been the dog that didn't bark." The problem of how to avoid inflation when the economies recover remained one of the most pressing questions of macroeconomic policy.

Sources: Kevin Hall, "Bernanke Unveils Plan to Unwind Fed's Massive Asset Purchases," *McClatchy—Tribune Business News*, February 10, 2010; Neil Shah and Katie Martin, "Europe's Newest Risk: Inflation," *The Wall Street Journal*, May 14, 2010; Dave Kansas, "Whiffs of Inflation from Europe," *The Wall Street Journal*, January 4, 2011; John Hilsenrath, "Weak Report Lifts Chance of Fed Action," *The Wall Street Journal,* July 6, 2012; and Rahul Karunakar, "Euro Zone Price Pressures at 26-Month Low in May: ECRI," *Reuters*, July 6, 2012.

See related problem 3.6 at the end of chapter.

4.4 The Relationships among the Growth Rate of Money, Inflation, and the Nominal Interest Rate

Learning Objective

Discuss the relationships among the growth rate of money, inflation, and nominal interest rates.

As we have seen in Chapters 2 and 3, interest rates are critical for allocating resources in the economy. In this section, we discuss how the central bank can affect interest rates.

Real Interest Rates and Actual Real Interest Rates

In Chapter 2 we distinguished between the *expected real interest* rate and the *actual real interest rate.* The *expected real interest rate* is the real interest rate borrowers and lenders expect at the time that a financial decision is made. The actual real interest rate is determined by the actual rate of inflation over the life of the contract and is the real interest rate that borrowers end up paying and lenders actually receive. While the difference may be overlooked, it is crucial. Decisions of households and firms depend on the return (in case of lending or investing) or the cost (in case of borrowing) in terms of goods and services. The return and cost are not known at the time of the decision since they depend on the inflation

rate over the life of the contract. So households and firms need to form expectations about the inflation rate. The actual real interest rate, while it is what borrowers end up paying and lenders actually receive, is not relevant for making economic decisions since it is not known when decisions are made.

From now on we will call the expected real interest rate simply *the real interest rate*, or sometimes, to stress that it depends on expectations, as the *(expected) real interest rate*.

You should remember this distinction when, for example, we are comparing the real interest rate with the actual interest rate. Such comparison usually involves an evaluation of whether the actual outcome was beneficial to the borrower or to the lender. If the actual inflation rate and the expected inflation rate are equal, the actual real interest rate and the (expected) real interest rate are also equal. When inflation turns out to be lower than expected, the actual real interest rate is higher than the (expected) real interest rate. So borrowers lose, since they pay more in real terms for the loan than they had originally expected. By the same token, lenders gain because they receive more than they originally expected.

For example, assume you are a pizza shop owner. You take out a one-year loan with a nominal interest rate of 6%. You and your bank both expect inflation rate to be 2%. This means that the real interest rate is 4%. You plan to increase the price of pizza in line with inflation (i.e., by 2% over the year), so you expect you will need to give up 4% of your output to pay the interest on the loan. If the inflation rate turns out to be 0%, and you are not able to change the price of pizza, then the actual real interest rate equals 6%. To pay the interest on the loan you will have to give up 6% of your output. You lose, because you have to give up more, and the bank benefits. However, if the inflation rate turns out to be 5%, then the actual real interest rate is $6\% - 5\% = 1\%$. You raise the price of pizza by 5% and, to pay the interest on the loan, you need to give up only 1% of your output. You gain and the bank loses because the actual real interest rate turned out to be lower than expected.

We can generalize by noting that if the inflation rate is greater than the expected inflation rate, the real interest rate will be less than the expected real interest rate; in this case, borrowers will gain, and lenders will lose. If the inflation rate is less than the expected inflation rate, the real interest rate will be greater than the expected real interest rate; in this case, borrowers will lose, and lenders will gain. Table 4.1 summarizes the important relationships between the nominal interest rate, the expected real interest rate, and the actual real interest rate.

The Fisher Effect

In the pizza shop example, the nominal interest rate was fixed, so we could see what happens to the real interest rate when the inflation rate rises above or falls below the expected inflation rate. However, the nominal interest rate, as with other interest rates, is fixed only when the borrower signs a loan contract. Before the borrower and lender agree on an interest rate, they are free to negotiate an interest rate based on their assessments of market conditions, including the expected inflation rate over the duration of the loan. To determine what nominal

Table 4.1 The Relationship between the Expected Real Interest Rate and the Actual Real Interest Rate

If the inflation rate …	then the actual real interest rate …	so …
is greater than the expected inflation rate	will be less than the (expected) real interest rate	borrowers will gain and lenders will lose.
is less than the expected inflation rate	will be greater than the (expected) real interest rate	borrowers will lose and lenders will gain.

interest rate will be acceptable to borrowers and lenders, we can rearrange the expression for the real interest rate, equation (2.8) on page 58, as follows:

$$i = r + \pi^e. \tag{4.11}$$

Fisher equation The equation stating that the nominal interest rate is the sum of the expected real interest rate and the expected inflation rate.

This equation states that the nominal interest rate is the sum of the expected real interest rate and the expected inflation rate. It is called the **Fisher equation**, after the same Irving Fisher who developed the quantity theory of money. The equation implies that the nominal interest rate changes when the expected real interest rate changes or when the expected inflation rate changes.

To understand the Fisher equation, let us return to the pizza shop example. Ask yourself what nominal interest rate you and the bank will agree on. The real interest rate is determined by real factors such as the willingness of households and firms to save and invest and the government's spending and taxing decisions. By the *classical dichotomy* discussed earlier in the chapter, the rate of inflation will not affect the real interest rate.

With the expected real interest rate determined by real factors, the Fisher equation tells us that the nominal interest rate changes when the expected inflation rate changes. For example, assume that the real interest rate is 4%, and the expected inflation rate is 2%. In that case, the nominal interest rate on a loan is 4% + 2% = 6%. If the expected inflation rate rises from 2% to 3%, the nominal interest rate will also rise by 1%, to 7%. This adjustment of the nominal interest rate to changes in the expected inflation rate is called the *Fisher effect*. The **Fisher effect** holds that the nominal interest rate rises or falls point-for-point with changes in the expected inflation rate.

Fisher effect The assertion by Irving Fisher that the nominal interest rate rises or falls point-for-point with changes in the expected inflation rate.

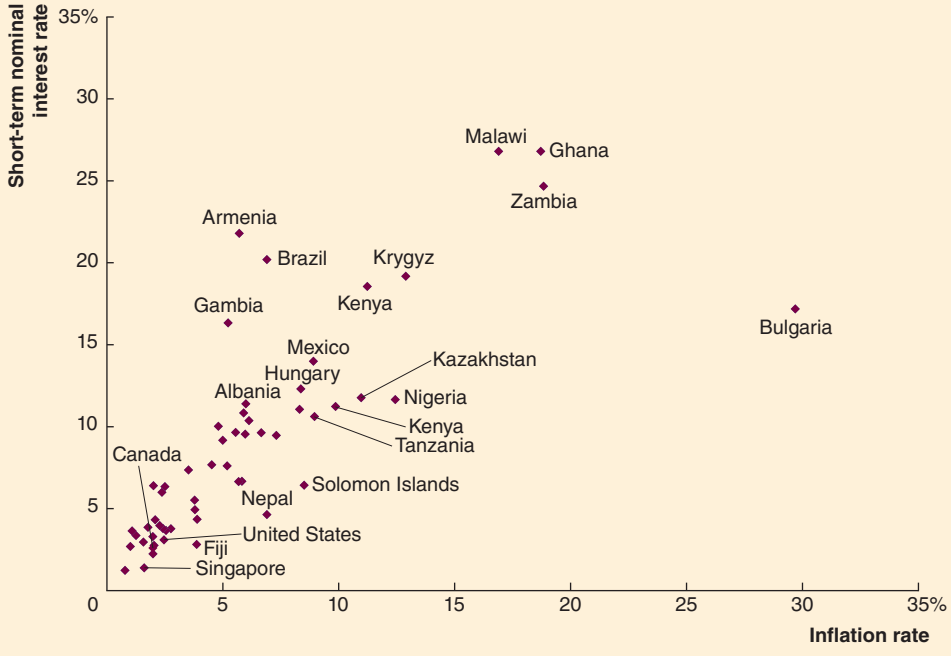
Do the data support the Fisher effect? Figure 4.5 shows the relationship between the inflation rate and the nominal interest rate for 56 countries over the period 1995–2011. There is a clear positive relationship between inflation and nominal interest rates, with nominal interest rates being higher in countries with higher inflation rates. Although the figure does not show nominal interest rates rising point-for-point with increases in inflation rates, the Fisher equation still provides a reasonable approximation of how inflation rates affect nominal interest rates around the world.

Figure 4.5

The Relationship between the Inflation Rate and the Nominal Interest Rate, 1995–2011

The figure shows a positive relationship between the inflation rate and the nominal interest rate for 56 countries. This relationship is consistent with the Fisher effect.

Source: International Monetary Fund, *International Financial Statistics*.



Avoiding a Common Mistake: Changes in the Actual Inflation Rate and the Fisher Effect

We have just considered two situations which are often confused: (1) What happens when the inflation rate is different than expected, and (2) What happens when the expected inflation rate changes (i.e. the Fisher effect). In the first case, households and firms form expectations about the inflation rate and, on their basis, enter financial contracts. We then consider what happens when the actual inflation rate is different than expected *after* the contract has been signed. If, for example, the borrower and lender both expect the inflation rate to be 2% and want a 3% real return, they agree to an interest rate of 5%. If inflation turns out different than expected, for example 4%, the actual real interest rate ends up being only 1% and the lender loses while the borrower gains.

In the second case, we consider what happens when the expected rate of inflation changes *before* the contract is signed. If, for example, the expected rate of inflation increases from 2% to 4% before the contract is signed, the Fisher effect tells us that the nominal interest rate on the contract will also increase, from 5% to 7%. The real interest rate will remain equal to 3% and both the borrower and lender will be, in real terms, unaffected.

Money Growth and the Nominal Interest Rate

If we combine the quantity theory of money with the Fisher effect we have an important relationship: In the long run, an increase in the growth rate of the money supply causes the inflation rate to increase, which then causes the nominal interest rate to increase. We can conclude that because the inflation rate varies across time and countries as a result of changes in the growth rate of the money supply, nominal interest rates will also vary across time and countries.

Solved Problem 4.2

Calculating the Nominal Interest Rate Using the Quantity Theory and Fisher Equations.

The money growth rate in Canada is 3% per year; the expected rate of change of velocity is 1% per year; real output growth is 2% per year; and the real interest rate is 3%. What is the nominal interest rate?

Solving the Problem

Step 1 **Review the chapter material.** You need to review the "Quantity Theory Explanation of Inflation" which begins on page 120 and the section: "The Relationships among the Growth rate of Money, Inflation, and and the Nominal Interest Rate" which begins on page 124.

Step 2 **Calculate the inflation rate.** In the presentation of the quantity theory equation we assumed the rates of growth of velocity, output, and the money supply were known with certainty. In general there is uncertainty about the value of these variables. Here we assume that the expected rates of change of velocity is uncertain. We denote it as $\%\Delta V^e$. Because of the uncertainty, the quantity equation (4.9) allows calculating the expected inflation rate, not the actual inflation rate: $\pi^e = \%\Delta M + \%\Delta V^e - \%\Delta Y$. So the expected inflation rate is $3\% + 1\% - 2\% = 2\%$.

Step 3 Calculate the nominal interest rate.

From the Fisher equation (4.11): $i = r + \pi^e$, so $i = 3\% + 2\% = 5\%$.

See related problem 4.4 at end of chapter.

4.5

Learning Objective

Explain the costs of a monetary policy that allows inflation to be greater than zero.

The Costs of Inflation

In the previous sections we discussed the quantity theory of money, the inflation rate, and nominal interest rates. We now consider how inflation affects households and firms, and explore the benefits to society of reducing inflation. We discuss the costs of inflation, distinguishing between expected and unexpected inflation, the costs of deflation (decreasing price level), and the potential benefits of inflation.

Costs of Expected Inflation

There are four costs of expected inflation:

- Shoe-leather costs
- Menu costs
- Inflation tax
- Tax distortions

Shoe-Leather Costs Households and firms change their behaviour to avoid inflation by choosing to hold less of their wealth as cash. Other assets, such as savings accounts and bonds, have nominal interest rates greater than zero. Some of these assets: government bonds and insured bank deposits (up to $100 000) are riskless. But these other assets are less liquid than cash. When people want to use their wealth to purchase goods and services, they must first transfer funds from the less liquid interest-bearing assets into cash. This transfer takes time and effort, so it is costly. When deciding how much cash to hold, people face a tradeoff between losing potential interest earnings (which they would have earned if they kept bonds or other assets instead of cash) and gaining liquidity. By the Fisher equation a higher rate of inflation raises the nominal interest rate, and holding cash results in losing more interest and is less attractive. So, with higher inflation, people hold less cash and must transfer funds more often. Economists use the term **shoe-leather costs** to refer to the costs of inflation to households and firms from reducing cash holdings and making more frequent trips to the bank. The origin of the term is not difficult to guess: It was introduced at a time when the transfers required actual trips to the bank and shoes had leather soles. Nowadays, many transfers can be made on the internet, but the general principle is unaffected: The more interest is lost by holding cash instead of bonds, the less cash people hold and the more often they need to do the transfers.

Shoe-leather costs The costs of inflation to households and firms from holding less money and making more frequent trips to the bank; costs related to expected inflation.

Menu Costs When you go to a restaurant, you see the menu with prices printed on it. When you go to a retail store, you see prices on shelves or on individual items. **Menu costs** are the costs to firms of changing prices due to reprinting price lists, informing customers, or angering customers by frequent price changes. The higher the inflation rate, the more frequently firms change prices and the greater is the effort needed to change prices. In addition, inflation leads to larger changes in relative prices. Not all firms have the same menu costs, so when expected inflation occurs, some firms will change prices and others will not. Firms with low menu costs are likely to adjust their prices to the desired level quickly, but firms with high menu costs will not. For example, restaurants often have to pay to have new menus printed up, so the menu costs for restaurants are high, and restaurants therefore do not change prices frequently. But, the price of a litre of gas can change every day because it is relatively cheap and easy for gasoline stations to change posted prices. Therefore, gasoline prices often respond quickly to inflation, while prices at restaurants do not respond quickly. As a result, the relative prices of goods and services can change, making markets less efficient because the relative price changes do not reflect underlying changes in demand or in production costs.

Menu costs The costs to firms of changing prices due to reprinting price lists, informing customers, and angering customers; costs related to expected inflation.

Inflation Tax Inflation causes the purchasing power of money to decrease. Suppose you want to purchase an iPad next year. The current price of the iPad is $500, and you decide to keep $500 in your chequing account for one year and then purchase the device. If as a result of the central bank increasing the money supply, the inflation rate is 10% for the year, then the price of the iPad will rise to $550. Your $500 can no longer purchase the iPad because inflation reduced the purchasing power of your money. You are poorer: You are unable to buy as much as you could last year. This means that you lost a part of your wealth. Where did the wealth go? To the government. Recall that money is printed by the Bank of Canada, which is wholly owned by the federal government. When the Bank of Canada increases the money supply, it earns seigniorage, which it then passes on to the federal government. So as a result of the increase in the money supply the government received seigniorage, raising its wealth. In other words, inflation transferred wealth from individuals to the government, just as taxes do. The loss of purchasing power of cash due to inflation is called **inflation tax**.

Inflation tax The loss of purchasing power of money due to inflation.

Inflation tax is, however, fundamentally different from other taxes. All other taxes are imposed by fiscal authorities (federal, provincial, and local). The inflation tax is imposed by the Bank of Canada. It is largely independent of the government and so fiscal needs do not determine the size of inflation tax. In other words, the federal government, while it receives the proceeds, does not determine the size of the tax. This is the consequence of central bank independence. As we discussed earlier, the situation in Zimbabwe was different. The central bank was not independent and was directed by the government. In Zimbabwe, inflation tax was similar to other taxes.

Tax Distortions Expected inflation also creates inefficiencies in the tax system by distorting the behaviour of households and firms. There are numerous distortions in the tax code that increase as the rate of inflation rises. The general problem is simple. The goal of economic activity is *real* consumption: the amount of goods and services you can buy. However, the basis of many taxes is the nominal value: property prices; the value of inventory, machinery, and other assets; nominal interest earned; etc. As these values rise with inflation, the tax that is paid on the increase in nominal, rather than real, values rises, distorting choices of households and firms. The most important distortions are related to capital gains and interest earnings.

A *capital gain* is the increase in the price of an asset. Assume that you buy shares of CIBC stock for $100 and sell them 10 years later for $200, and that the price level has doubled over the 10 years. The real price of the stock remained the same: the amount of goods and services you can buy when you sell it now for $200 is the same as the amount you could buy for $100 when you bought the share. Since there is no real gain, you should pay no tax. But you are taxed on the $100 gain. If inflation were zero over the 10 years and the price of the stock had not changed, you would have paid no tax. The failure to adjust the value of capital gains for inflation increases the tax burden on investors and may reduce the level of saving in the economy.

The tax code also fails to adjust for inflation the values of inventories and the tax allowances that businesses are allowed to take for the depreciation of buildings, machinery, and other assets. For example, assume that you buy a machine for your business for $100 000. The machine lasts 10 years, during which the price level doubles. The price of the machine also doubles and it now costs $200 000, which means that the real price has not changed. Clearly, the machine was a cost of production and you should be able to deduct from taxable profits the amount needed to replace the machine (i.e., $200 000). But you can deduct only the original cost of the machine, $100 000. This means your taxable profits are overstated and the profit tax you pay is too high. Taxing nominal capital gains makes the economy less efficient by increasing the real value of the tax payments corporations make, thereby reducing their real profits. This may lead firms to reduce investments in new factories and equipment. This tax burden is particularly large during periods of high inflation.

The second major reason expected inflation distorts financial decisions is due to the fact that lenders pay taxes on nominal rather than real returns. Suppose that expected inflation is 2% and that your marginal tax rate is 50%. You are making an investment with the real interest rate of 4%. Let us calculate nominal and real returns. Of course, what matters to you is your real after-tax return. Let us calculate it:

- The nominal interest rate, and the *nominal before-tax* return, are $2\% + 4\% = 6\%$.
- The *nominal after-tax* return is $6\% \cdot (1 - 50\%) = 3\%$.
- The *real after-tax return*, obtained by subtracting the inflation rate from the before-tax return, is $(1 - 0.50) \cdot (6\%) - 2\% = 1\%$.

Suppose now that the expected inflation rate rises to 4% and that the real interest rate remains at 4%. The nominal interest rate, and the nominal before-tax return, are $4\% + 4\% = 8\%$. The nominal after-tax return is $(1 - 0.50) \cdot (8\%) = 4\%$ and the real after-tax return is $(1 - 0.50) \cdot (8\%) - 4\% = 0\%$. Even though the real interest rate remained unchanged, your real after-tax return fell because of inflation. Inflation reduces your after-tax return, discouraging saving.

There are, however, winners as well as losers during a period of high inflation. Borrowers such as corporations benefit from higher inflation because borrowers deduct nominal interest payments in calculating their income tax liabilities. Changes in expected inflation can change the real after-tax cost of borrowing. For example, with high expected inflation, corporations find selling bonds or taking out loans more attractive because nominal interest payments are deductible. Buying housing becomes more attractive relative to renting and investing in stocks because capital gains on the first property are not taxed. All these actions are undertaken only in order to reduce the tax bill and so create distortions in the economy.

Costs of Unexpected Inflation

When the inflation rate turns out to be higher or lower than expected, wealth is redistributed. For example, suppose you borrowed $500 to purchase an iPad instead of paying cash for it. You and the bank agreed on the real interest rate of 4%. You both expected the inflation rate to be 6% so that the nominal interest rate on the loan was set at 10%. After one year you repay the bank $550. What happens if the inflation rate turns out to be 8%? In that case, the actual real interest rate is $10\% - 8\% = 2\%$, less than you agreed on. You gain, and the bank loses. As we saw in Table 4.1 on page 125, when actual inflation is higher than expected, borrowers gain, and lenders lose.

In general, if inflation is higher than households and firms expected, there is a redistribution of wealth from lenders, such as banks, to borrowers. The total wealth in the economy does not change, but unexpected inflation can nevertheless generate true costs for the economy. To see this, we introduce the simple concept of *revealed preference*. It says that if, out of two equally costly alternatives you choose one, this means you prefer it to the one you have not chosen. In other words, you reveal preference for the alternative you chose. How can we apply it to the example above? You and the bank had the choice of many real interest rates. You could enter a contract with 2% real interest rate but instead you chose the real interest rate of 4%. By revealed preference, it means that a 4% real interest rate was preferred, or superior, to the inferior contract with the real interest rate of 2%. Because of unexpected inflation, however, you ended up with the inferior contract. While you gained and the bank lost, the concept of revealed preference implies that your gain was smaller than the bank's loss.

Inflation Uncertainty

Relative prices play an important role in allocating resources. The more the inflation rate changes from year to year, the more likely it is to distort relative prices. We can measure the volatility of inflation with the standard deviation of the inflation rate. Figure 4.6 shows

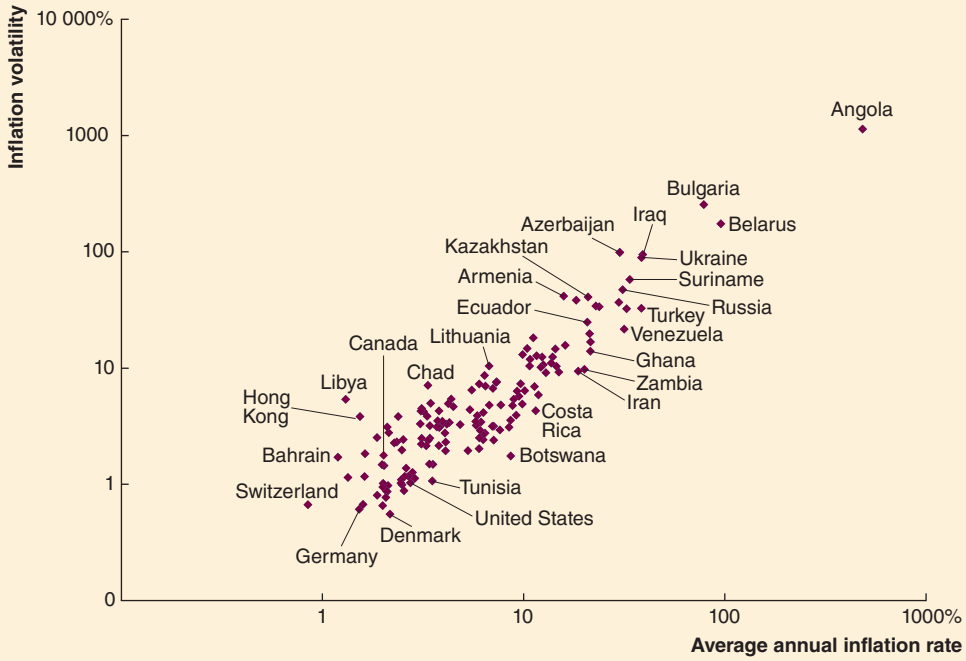


Figure 4.6

Inflation and Inflation Volatility around the World, 1996–2011

The volatility of inflation tends to increase as the average annual inflation rate increases. As the inflation rate increases, it becomes less predictable. The figure measures the volatility of inflation as the standard deviation of annual inflation rates. Note that the axes are in log base 10 scale.

Source: International Monetary Fund, *International Financial Statistics*.

the relationship between the average inflation rate and the volatility of the inflation rate for countries around the world. There is a clear tendency for the volatility of inflation to increase as the average inflation rate increases. Therefore, as the inflation rate increases, it becomes less predictable. In this situation, the ability of market prices to help households and firms allocate resources is reduced.

Inflation uncertainty is especially detrimental for long-term plans, in particular for investment decisions. Imagine you are considering building a bread factory with the help of a loan. We will make all the calculations in real terms. It takes five years for the factory to become operational. The cost of production will be 85% of the factory's output and, at current relative prices, you need, on the average, 10% of the factory output to pay off the loan. So, if nothing changes, you will earn an average profit equal to 5% of the factory's output. But over the five years the relative price of bread can change: If it goes up, you will benefit since less bread, and a smaller portion of output, will be needed to pay off the loan. If the relative price of bread goes down, you will lose since a larger portion of output is needed to pay off the loan.

When inflation is low, relative prices are fairly stable. Let us assume that you predict that there is a 50% chance you will need 8% of output to pay off the loan and a 50% chance that you would need 12% of output. So, after the production costs equal to 85% of output, you expect your profit will be between 3% and 7% of output. If the inflation rate is high, relative prices can change a lot. You now predict that you will need between 5% and 15% of output to pay off the loan, and so you expect your profit will be between 0% and 10% of output. Higher inflation, by allowing relative prices to change more, made the project riskier. You may not like the higher risk of the project and decide not to build the factory. We conclude that higher inflation uncertainty increases the riskiness of long-term projects and deters investment.

Benefits of Inflation

So far, we have emphasized the costs of inflation. However, many economists believe that there are some benefits to low inflation because it can allow for adjustments in relative prices in situations where nominal prices adjust slowly. Economists call such prices *sticky prices*.

Inflation Greasing the Wheels of the Labour Market The number of workers a firm employs depends on the real wage: the nominal wage divided by the price level. In a situation where the real wage needs to decrease to restore equilibrium in the labour market, this decrease can happen either by cutting the nominal wage or by keeping the nominal wage constant and letting inflation reduce the real wage.

Workers are often more reluctant to see their nominal wages cut than they are to see their real wages fall as a result of inflation, even when, in the end, the result is the same in real terms. For example, in 2012 the Government of Ontario, facing a large budget deficit, decided to reduce the real spending on teachers' wages. Rather than cutting the nominal wages, it froze nominal wages for two years. Clearly, it was concerned that cutting nominal wages would cause labour strife. With 2% inflation, after two years real wages have fallen by 4%. If, instead, inflation was zero, the same reduction would require cutting nominal wages. Economists sometimes refer to the situation where nominal wages are rigid but inflation allows the reduction of real wages as *inflation greasing the wheels of the labour market*.

There is no agreement among economists on how important "greasing the wheels" is. Compare two situations. In the first, nominal wages are frozen and the inflation rate is 4% per year. In the second, nominal wages decrease by 2% per year and the inflation rate is 2% per year. According to the "greasing the wheels" hypothesis, workers prefer the first situation. But in both cases the real wage falls by 4% per year. Workers who focus on nominal wages rather than on real wages exhibit *money illusion*: they attach importance to nominal values. That goes against the belief of most economists that people are rational and distinguish between nominal and real variables.

Zero Lower Bound During the Great Recession many central banks reduced the short-term nominal interest rates in order to reduce real interest rates and stimulate investment. But there is a limit to reducing the nominal interest rate: it cannot be negative. A negative nominal interest rate means that, if you buy a short-term government bond for $100, you will receive less than $100 when the bond matures. You would not buy such bond since you can put your cash in a safety deposit box or in a government-guaranteed bank account and not lose any of your money. [11] Recall that, by the Fisher equation, the real interest rate is equal to the nominal interest rate minus the inflation rate. With inflation of around 2% central banks were not able to lower the real interest rates below minus 2%. During the Great Recession this was insufficient and they had to resort to unconventional monetary policies that we will discuss in Chapter 12. This problem has become known as *zero lower bound on nominal interest rates*. Some economists argued that, to ameliorate the zero lower bound problem, central banks should target a higher inflation rate, for example 4%. With inflation of 4%, the real interest rate could have been lowered to minus 4%, providing a stronger stimulus for the economy. This suggestion has not been popular. There seems to be an agreement among central banks that the proper goal of monetary policy is an inflation rate of 2% or lower.

In May 2014 the European Central Bank found a novel way of overcoming the problem of zero lower bound and reducing the nominal interest rates below zero. It required banks to deposit a certain portion of their reserves at the ECB, and charged them a percentage fee on their deposits. This was, essentially, a tax on reserves, aimed at inducing banks to increase lending activity.

[11] During the Great Recession, nominal interest rates were actually, at times, very slightly negative in Germany, Switzerland, and the United States. Some financial institutions had large amounts of liquid funds (hundreds of millions of dollars) they wanted to put in riskless assets. Converting them for cash and stashing it in a safety deposit box was not practical. Bank accounts were risky since banks could fail and government insurance does not cover large deposits. The only way to safely store the funds was to buy government bonds, even if the nominal interest rate on these bonds was negative.

Hyperinflation and Its Causes

4.6

Learning Objective

Explain the causes of hyperinflation.

Hyperinflation occurs when the inflation rate is extremely high. At extremely high rates of inflation, the volatility of inflation is also typically high, making it difficult for households and firms to determine relative prices of goods and services, which can result in a severe misallocation of resources. When a country experiences hyperinflation, its currency will eventually cease to function as money, which is what happened in Germany in 1923 and more recently in Zimbabwe.

Prices rise rapidly during a hyperinflation, so households and firms try to minimize how much currency they hold, and firms must pay employees frequently. Employees must spend money quickly or convert it to more stable foreign currencies before prices increase further. Merchants raise prices as fast as possible. The ability of government to collect taxes diminishes significantly during a hyperinflation. Because tax bills typically are fixed in nominal terms, households and firms have an incentive to delay their payments to reduce their real tax burden.

Causes of Hyperinflation

Hyperinflations begin when governments rapidly increase the growth rate of the money supply, and hyperinflations end when governments reverse course and reduce the growth rate of the money supply in a credible manner. Hyperinflations are typically due to persistently large budget deficits. To understand why large budget deficits cause hyperinflations, we first look at the *government's budget constraint*. Governments purchase goods and services, G, and make transfer payments, TR. A government must raise the funds for these expenditures by collecting taxes, T, borrowing by selling more bonds, B, or printing money, M (for simplicity we do not consider interest on debt). So, in any given year

$$G + TR = T + \Delta B + \Delta M.$$

The government's budget deficit is the difference between its expenditure and its tax revenue, T. We can therefore rewrite the above equation with the government's budget deficit on the left side as

$$G + TR - T = \Delta B + \Delta M.$$

A government can finance a budget deficit either by issuing bonds (borrowing) or by printing money. Some governments, however, may have trouble selling bonds because investors believe that the government may not pay them back. If investors will not buy the government's bonds and the government is unable or unwilling to raise taxes or cut spending, the government can finance the budget deficit only by printing money. In these circumstances, to finance a large budget deficit, the growth rate of the money supply will have to increase dramatically, leading to higher inflation.

German Hyperinflation after World War I

At the end of World War I, the German government was unable to find the political support necessary to balance its budget by raising taxes or cutting expenditures. Once inflation began to accelerate, the structure of the tax system made the government's budget deficit worse. Taxes were levied in nominal terms, and there were lags between when the government levied a tax and when it collected the tax revenue. For example consider tax collection in October 1923. Inflation was at its peak and reached almost 29 500% *per month*.[12] Consider someone who earned 1000 papiermarks (the currency of the day) in September 1923 and paid a 30% tax on his earnings in October 1923. The government got 300 papiermarks in October 1923. With inflation of 29 500% the price level was 300.5 times higher in October

[12]All numbers in this section are from Steve H. Hanke and Nicholas Krus (2012), "World Hyperinflations," Cato Institute Working Paper, August.

than in September and the 300 papiermarks in tax revenue the government received in October had the same purchasing power as 1 papiermark in September. This revenue was the tax on 1000 papiermarks and so the effective tax rate was 0.1% (1 out of 1000). Clearly, tax revenues could not finance government expenditure. As a result, the government was forced to print money to finance the budget deficit, until eventually it was financing nearly 100% of its expenditures by printing money.

By the time the hyperinflation ended in Germany, the price level was *50 billion* times higher than before the hyperinflation. The inflation rate reached 21% *per day* during October 1923, so prices doubled every four days. A similar hyperinflation today in Canada would cause the price of a pack of gum to increase from $1.50 to nearly $45 000 after one month and $1.5 *billion* in two months. Such rapid increases in the price level made the papiermark essentially worthless.

How do hyperinflations end? Lowering the rate of growth of the money supply is not sufficient. As long as the underlying problem of insufficient government revenues is not solved, households and firms will be concerned that the government may return to printing money. The reforms need to be credible. The government must eliminate the budget deficit and make institutional changes that will prevent it from using the printing press again. In Germany, the hyperinflation ended in November 1923, after the German government made major policy changes. It:

- Established a new central bank in October 1923 called the Rentenbank. It issued a new currency, the Rentenmark, which was worth 1 trillion of the old German marks.
- Limited the ability of the Rentenbank to issue new currency.
- Limited the ability of the Rentenbank to extend loans to the German government.
- Cut the number of its employees by 25% in October 1923 and by another 10% in January 1924.
- Negotiated relief from the reparation payments it was making to France and the United Kingdom as part of the treaty to end World War I.

Just a few months after the establishment of the Rentenbank, the German government stopped borrowing from the central bank, balanced its budget, and the hyperinflation ended.

These steps were enough to bring the hyperinflation to an end—but not before the savings of anyone holding the old German currency had been wiped out. Most middle-income Germans were extremely resentful of this outcome. Many historians believe that the hyperinflation greatly reduced the allegiance of many Germans to the Weimar Republic, the government at that time, and may have helped pave the way for Adolf Hitler and the Nazis to seize power 10 years later.

Hyperinflations around the World

Why do hyperinflations happen? Hanke and Krus[13] provide a comprehensive list of over 50 hyperinflations since the First World War (plus the French hyperinflation in the eighteenth century). The list indicates several reasons: wars, revolutions, and regime changes, the collapse of communism in the 1990s, and fiscal mismanagement in South America.

During wars, revolutions, and regime changes government expenditures are very high because of armed conflict and reconstruction, and revenues fall. (Germany, in addition, had to pay WW1 reparations.) Examples include:

- wars (Greece in 1941, China in 1943, Philippines in 1944) and their aftermath (for example Austria, Germany, and Poland in 1920s)
- revolutions (France in 1795, China and Taiwan in 1947)
- civil wars, coups, and regime changes (the Soviet Union in 1922, Chile 1973, Yugoslavia 1992, Congo 1991, 1993, 1998)

[13]Hanke and Krus, 2012, p. 16.

Under the communist form of government, prices were controlled and revenue collection was organized differently than in market economies. In some countries households did not pay income taxes directly. As private property was very limited, most people were employed by state-owned enterprises. Governments received the difference between revenue from sales and costs of production. This difference included what in a market economy would be profits and income tax. When communism ended, government revenues collapsed and price controls ended. Governments resorted to printing money and shopkeepers raised prices, leading to short periods of hyperinflation in many countries.

Many South American governments in 1980s and 1990s ran extensive government programs, resulting in high government expenditures. At the same time tax collection was not well developed and governments had problems raising sufficient revenue. Governments resorted to printing money, resulting in persistent high inflation which, sometimes, would reach hyperinflation levels.

As you can see from this summary, hyperinflations are unusual events. In the past two decades the number of wars and coups declined, former communist countries succeeded in transforming their economies, and many South American countries reduced government spending and improved tax collection so they no longer need to rely on money printing. As a result, the only hyperinflation after 2000 was in Zimbabwe. It was the second highest hyperinflation in history; the record belongs to Hungary where, in July 1946, inflation reached 40 million billion percent per month (four followed by16 zeros) and 207% per day.

Key Terms and Problems

Key Terms

Barter, p. 105
Classical dichotomy, p. 104
Commodity money, p. 106
Desired reserves, p. 115
Fiat money, p. 108
Fisher effect, p. 126
Fisher equation, p. 126
Inflation tax, p. 129
Liquidity of an asset, p. 105
M1+, p. 112
M2+, p. 112
Medium of exchange, p. 109
Menu costs, p. 128
Monetary aggregates, p. 112
Monetary base (or high-powered money), p. 115
Money multiplier, p. 116
Money supply, p. 104
Nominal variables, p. 104
Open market operations, p. 115
Quantity equation (or equation of exchange), p. 118
Quantity theory of money, p. 120
Real variables, p. 104
Seigniorage, p. 108
Shoe-leather costs, p. 128
Store of value, p. 109
Transaction costs, p. 105
Unit of account, p. 111
Velocity of money, p. 118

4.1 What Is Money, and Why Do We Need It?

Define money and explain its functions.

Review Questions

1.1 Briefly describe the four functions of money.

1.2 Describe the five characteristics needed for an asset to be used as a medium of exchange. Identify two types of assets that have these five characteristics.

1.3 Explain why the Bank of Canada publishes data on the M2+ monetary aggregate even though currency and chequing account deposits, which are the most liquid of assets, are already measured in M1+.

Problems and Applications

1.4 Each of the following has been used as money at some time in the past. Briefly discuss how well each fulfills the four functions of money.

a. Gold or silver

b. Cigarettes

c. Salt

d. First Nations beads

1.5 People living in Yap, an island group in the Pacific, at one time used as money large stone disks known as Rai. These disks can be up to 12 feet in diameter and were made of a stone that is not native to the islands, so they had to be transported by canoe with great difficulty and risk. The stones were valued both due to their scarcity and because of the history of their acquisition.

a. How well do large stones fulfill the functions of money?

b. In 1874, a Western immigrant to the islands used ships to transport more stones to Yap. While these stones were larger, they did not have the history of risk and hardship associated with them.

i. What effect would the introduction of these new stones have on Yap's money supply and on the overall value of stones?

ii. How does what happened to Yap's money illustrate a central problem of commodity monies?

iii. How would you expect old stones to be valued relative to new stones? Briefly explain.

1.6 **[Related to the** Making the Connection **on page 107.]** In 2012 the New York Fed held 6700 tonnes of gold. Find the value of the gold at the beginning of 2012 and at the beginning of 2013. (Hint: use www.gold.org/investment/statistics/gold_price_chart/.)

1.7 **[Related to the** Making the Connection **on page 112.]** After the French Revolution in 1789, France experienced a hyperinflation similar to Zimbabwe's. At one point, the French currency was worth so little that people used it for fuel rather than to purchase goods and services.

a. What function(s) of money did the French currency fail to fulfill during the hyperinflation?

b. Eventually, France issued a new currency, backed by gold. Why might the French government have believed that it needed to back the new currency with gold?

1.8 On January 1, 2002, Germany officially adopted the euro as its currency, and the deutsche mark stopped being legal tender. According to an article in the *Wall Street Journal*, many Germans continued using the deutsche mark, and many stores in Germany continued to accept it. Briefly explain how it is possible for a currency to continue to be used when the government that issued it has replaced it with another currency.

Source: Vanessa Fuhrmans, "Who Needs the Euro When You Can Pay with Deutsche Marks?" *Wall Street Journal*, July 18, 2012.

4.2 The Bank of Canada and the Money Supply

Explain how central banks change the money supply.

Review Questions

2.1 Why does the central bank have greater control over the monetary base than over the money supply?

2.2 What three actions by households and firms, banks, or the central bank will cause the value of the money multiplier to decline?

Problems and Applications

2.3 In July 2012, the money supply, as measured by M2+, was approximately $1524 billion. The monetary base was approximately $62 billion.

a. What was the value of the money multiplier?

b. Why is the value of the money multiplier typically greater than 1?

Source: Bank of Canada

2.4 As of mid-2014, U.S. and European banks continued to hold large amounts of reserves, leading to concern that potential increases in lending activity could increase the money supply and the inflation rate. Use the money multiplier to explain how a reduction in reserves could lead to an increase in the money supply.

2.5 Consider the following statement: "Only the central bank can print money. Therefore, the central bank has complete control over the money supply." Do you agree with this statement? Briefly explain.

2.6 Briefly explain why the monetary base is often called "high-powered money."

2.7 Suppose that the desired reserve ratio is 13%, and the currency-to-deposit ratio is 2.

a. What is the value of the money multiplier?

b. If the central bank conducts open market operations and buys $100 million in government bonds from banks, what will happen to the money supply?

c. How would your answer to part (b) change if banks become concerned about the risk involved in making loans and now choose to hold 20% of chequing account deposits as reserves?

4.3 The Quantity Theory of Money and Inflation

Describe the quantity theory of money, and use it to explain the connection between changes in the money supply and the inflation rate.

Review Questions

3.1 What is the difference between the quantity equation and the quantity theory of money?

3.2 Explain why most economists agree that the Bank of Canada determines the inflation rate in the long run.

3.3 How accurate are the quantity theory's predictions of inflation? Briefly explain.

Problems and Applications

3.4 **[Related to the** Making the Connection **on page 123.]** Would you expect that the quantity theory would do a better job of predicting inflation in high-income countries such as Canada and Germany or in less developed countries such as Kenya or Zimbabwe? Briefly explain.

3.5 In 2012, the money supply, M1+, was $668 billion and nominal GDP was $1658 billion.

a. What was the velocity of money measured using M1+?

b. In 2012, the monetary base was $60.4 billion. What was the velocity of money measured using the monetary base?

c. Briefly explain why these measures of velocity are different.

3.6 **[Related to** Making the Connection **on page 123.]** Following the stock market crash in 1989, Japan experienced periods *deflation*, or a falling price level. Explain using the quantity theory of money how deflation is possible. Is it necessary for the quantity of money to decline for deflation to occur?

3.7 **[Related to** Solved Problem 4.1 **on page 121.]** Assume that the growth rate of real GDP is 3%, the growth rate of velocity is 0%, the rate of growth of the money supply is 4%, and that changes in the rate of growth of the money supply do not affect real GDP.

a. What is the current rate of inflation?

b. What will happen to the inflation rate if the rate of growth of the money supply increases to 7%?

c. What will happen to the inflation rate if the rate of growth of the money supply increases to 7%, and, at the same time, the growth rate of velocity increases to 2%?

4.4 The Relationships among the Growth Rate of Money, Inflation, and the Nominal Interest Rate

Discuss the relationships among the growth rate of money, inflation, and nominal interest rates.

Review Questions

4.1 If the inflation rate turns out to be greater than the expected inflation rate, will the expected real interest rate be higher or lower than the actual real interest rate?

4.2 Explain under what circumstances lenders gain and borrowers lose if the inflation rate differs from the expected inflation rate.

4.3 According to the Fisher effect, what must occur for the nominal interest rate to increase by 5%? To decrease by 5%?

Problems and Applications

4.4 **[Related to** Solved Problem 4.2 **on page 127.]** The long-run growth rate of real GDP for Canada is about 3%, and the expected real interest rate on 10 year government bonds has averaged about 2.5%.

a. If the growth rate of velocity is 0% and the rate of growth of the money supply is 6%, in the long run what is the nominal interest rate?

b. What will happen to the nominal interest rate in the long run if the rate of growth of the money supply falls to 3%?

c. What will happen to the nominal interest rate in the long run if the rate of growth of the money supply falls to 3% and the growth rate of real GDP falls to 2.5%?

4.5 Suppose that the inflation rate turns out to be higher than expected. Is this good news or bad news for investors who bought bonds issued when the inflation rate was expected to be lower? Briefly explain.

4.6 Suppose that inflation has been equal to 3% per year for several years and that the real interest rate that banks require on typical mortgage loans is 2%.

a. What nominal interest rate would banks currently be charging on 30-year home mortgages?

b. Suppose that the Bank of Canada unexpectedly decreases the rate of growth of the money supply by 1%, and this change is expected to be permanent. How are banks likely to change the nominal interest rate they charge on mortgages?

c. What effect is the Bank of Canada's action likely to have on the actual real interest rate that banks receive on mortgages made prior to the increase in the growth rate of the money supply?

4.7 In the summer of 2012, as worries about the possibility of the Spanish government defaulting on its sovereign debt rose, the nominal interest rate on the government's bonds increased sharply.

a. Why did the nominal interest rate increase?

b. Would you expect there to be a difference between the actual real interest rate and the expected real interest rate in this situation?

4.8 During the Great Depression, the price level fell during some years.

a. With a falling price level, what happens to the actual real interest rate? Does your answer depend on what happens to the nominal interest rate? Briefly explain.

b. In contrast, during the 2007–09 financial crisis, nominal interest rates on short-term government bonds were close to zero, and inflation remained positive for most of this period. What was the actual real interest rate on the bonds during this period?

c. Assume that savers expected inflation to be positive. Why would they be willing to hold government bonds with the real interest implied by positive inflation and the nominal interest rate of zero?

4.5 The Costs of Inflation

Explain the costs of a monetary policy that allows inflation to be greater than zero.

Review Questions

5.1 What is seigniorage? In what sense is it an inflation tax?

5.2 Explain how inflation can be costly to an economy, even if it is expected.

5.3 It is often said that inflation "greases the wheels of the labour market." Explain what this statement means.

Problems and Applications

5.4 Some central banks set an explicit inflation target, essentially committing themselves to keeping inflation within a certain range. How might an explicit inflation target affect the expected inflation rate?

5.5 Forty years ago, it was typical for grocery stores to post prices by labelling each individual can or box. When prices changed, an employee would have to relabel every item in the store so that the cashier could enter them correctly into the cash register. (Bar code scanners had not yet been invented.) Today, most prices are posted on shelf labels and scanned into cash registers using bar codes.

a. How has this change to pricing items in stores affected menu costs?

b. Are menu costs the same for all grocery store items? Briefly explain.

5.6 Suppose that consumer preferences are changing, so that more consumers want to buy chicken and fish and fewer want to buy beef and pork.

a. If inflation is low and fully anticipated, how would you expect the relative price of these goods to change, and how would that affect production of these goods?

b. Suppose now that inflation is volatile, so that it is difficult to tell the difference between an increase in the price of an individual good and an increase in the overall price level. How might volatile inflation lead to a misallocation of resources?

5.7 From 1939 until the early 1960s, the price of nearly all comic books was $0.10. In the late 1960s and early 1970s, as the inflation rate increased significantly, comic book publishers frequently increased their prices. Often, though, they would first sell comics at the higher price in only a few cities, selling at the old price elsewhere. Briefly explain why publishers would have expected that this strategy would increase their profits.

5.8 The idea of shoe-leather costs is that people wear out their shoes going back and forth to the bank. While people are unlikely to actually wear out their shoes in this way, what are some examples of actual costs that you might incur by trying to reduce the costs to you of inflation?

4.6 Hyperinflation and Its Causes

Explain the causes of hyperinflation.

Review Questions

6.1 What is hyperinflation, and why does it occur?

6.2 Why would a government risk experiencing hyperinflation by printing money rather than issuing bonds to finance a large budget deficit?

Problems and Applications

6.3 While hyperinflations are always caused by rapid growth in the money supply, they can be intensified by the actions of households and firms trying to protect themselves from inflation by spending money as soon as they receive it.

a. What is likely to happen to the velocity of money during a hyperinflation?

b. Use the quantity equation to show how the change in velocity affects the inflation rate.

6.4 Hyperinflation reduces economic growth, both through resource misallocation and by reducing saving and investment.

a. Why does hyperinflation cause misallocation of resources?

b. Why does hyperinflation reduce saving and investment?

c. What effects do the misallocation of resources and reduced saving and investment have on economic growth?

6.5 Hyperinflation occurred in U.S. South during the Civil War (1861–65). Unable to tax effectively in a largely agricultural economy, the Confederate government was forced to print money.

a. Explain how the rapid increase in the money supply combined with wartime scarcity of goods would cause prices to escalate.

b. In 1864, the Confederate government attempted to reduce inflation by reducing the money supply by approximately one-third. The Confederacy forced paper currency to be converted into bonds by a specific date (or converted at a penalty after that date). What do you expect the immediate effect of this policy would have been?

6.6 **[Related to the Chapter Opener on page 102.]**

The following table shows the approximate *daily* rates of inflation from some of the notable hyperinflation episodes in history:

Country	Month with Highest Inflation Rate	Daily Inflation Rate
Hungary	July 1946	207%
Zimbabwe	November 2008	98%
Germany	October 1923	20.9%
France	August 1796	4.77%
Russia	January 1992	4.22%
Argentina	July 1989	3.69%

For each of the hyperinflations shown in the table, calculate the amount of time it would take for prices to double. (Hint: Because these are daily rates, in some cases, prices will double in a matter of hours.)

A simple way of calculating the approximate amount of time it will take prices to double is to divide 70 by the growth rate; this is called the Rule of 70. It is an approximate formula; the higher is the inflation, the worse is the approximation. You can use it for the last three countries without a problem; for Germany it is only a rough approximation. For Zimbabwe and for Hungary you need to do the direct calculation.

Source: Steve H. Hanke and Nicholas Krus, "World Hyperinflations," *Cato Working Paper*, August 2012.

6.7 **[Related to the Chapter Opener on page 102.]** By the end of 2008, Zimbabwe was experiencing inflation that was estimated to be 80 billion percent per month. The peak daily inflation rate was 98% per day. Because of the rapidly falling value of paper money, the government was forced to issue currency in larger and larger denominations, including a $50 billion dollar note. (The highest denomination note was $100 trillion. You can buy it now on eBay for around $15). An economist in Zimbabwe was quoted as saying, "It is a waste of resources to print Zimbabwe dollar notes now. Who accepts a currency that loses value by almost 100 percent daily?"

a. The government of Zimbabwe authorized many stores to make transactions in foreign currencies. What difficulties would this cause stores and consumers?

b. If inflation is 98% per day, how much value does the currency lose in a day?

Source: "Zimbabwe Introduces $50 Billion Note," CNN.com, January 10, 2009.

Data Exercises

D4.1: Using data from Statistics Canada (www5.statcan.gc.ca/CANSIM/), Table 176-0025, analyze the money supply.

a. Download and graph monthly data for M1+ gross and M2+ gross for the period from 1990 to the present (use the add/remove data button). Calculate the growth rate as the percentage change from the same month in the previous year. Describe the relationship between the two measures of the money supply. Which is more volatile?

b. In general, what happens to M1+ and M2+ as the monetary base increases?

c. Is the relationship that you found in part (a) different after 2009?

D4.2: **[Related to the Chapter Opener on page 102].** Steve Hanke at the Cato Institute (www.cato.org/zimbabwe) has calculated a hyperinflation index for Zimbabwe and other countries suffering from hyperinflations.

a. Where does Zimbabwe rank in Hanke's index? How long did it take for prices to double at the peak of the hyperinflation?

b. Search media sources to find out what the current state of Zimbabwe's economy is. How did the government get to this point?

D4.3: The World Bank (www.worldbank.org) has data on money growth rates and inflation for different countries. These data are listed under "Money and Quasi-Money" growth, which is roughly the same as M2+ in Canada. Choose 10 countries to analyze.

a. Which countries have the most rapid rates of money growth? The slowest?

b. Compare the data on rate of money growth with the growth rate of consumer prices. Are the data consistent or inconsistent with the quantity theory?

D4.4: [Spreadsheet exercise] Use data from the World Bank (www.worldbank.org) to do the following:

a. Find the correlation coefficient for M2 growth and consumer price growth for each country in the group of 10 high-income countries.

b. Find the correlation coefficient for each country in the group of 10 low-income countries.

c. Now find the correlation coefficient for the entire group of twenty countries.

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d. If you have had a statistics class covering regression analysis, run a regression using money growth as the independent variable and the average price growth as the dependent variable. Explain your results.

D4.5: Using data from Statistics Canada (www5.statcan.gc.ca/CANSIM/), Table 176-0025, analyze the money supply.

a. Find data for the M1+ (gross) and the M2+ (gross) from 1990 to the present.

b. Using the data found above, calculate M1+ as a proportion of M2+ for each of the years.

c. Explain whether this proportion has increased, decreased, or remained the same over time.

D4.6: Using data from Statistics Canada (www5.statcan.gc.ca/CANSIM/), Table 176-0025, analyze the relationship between the monetary base and the wider aggregates, M1+ and M2+.

a. Find data for the monetary base (*MB*), M1+ (gross) and the M2+ (gross) from 1990 to the present.

b. Calculate the ratios *MB*/M1+ and *MB*/M2+ and show them on a graph.

c. Was there any trend in the ratio of monetary base to wider aggregates?

d. What does the trend imply about the multiplier?

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