CHAPTER 4

Budget Analysis and Deficit Financing

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Questions to keep in mind

- What has happened to the U.S. budget deficit over time?
- What is the right way to measure the long-run budget deficit?
- What is the effect of higher budget deficits on the economy?

"We will continue along the path toward a balanced budget in a balanced economy."

President Lyndon Johnson, State of the Union Address (January 4, 1965)

Deficit in first year in office (1964): 0.9% of GDP

Deficit in last year in office (1968): 2.9% of GDP

"We must balance our federal budget so that American families will have a better chance to balance their family budgets."

President Richard Nixon, State of the Union Address (January 22, 1970)

Deficit in first year in office (1969): -0.3% of GDP (surplus)

Deficit in last year in office (1974): 0.4% of GDP

"We can achieve a balanced budget by 1979 if we have the courage and the wisdom to continue to reduce the growth of federal spending."

President Gerald Ford, State of the Union Address (January 15, 1975)

Deficit in first year in office (1975): 3.4% of GDP

Deficit in last year in office (1976): 4.2% of GDP

"With careful planning, efficient management, and proper restraint on spending, we can move rapidly toward a balanced budget, and we will."

President Jimmy Carter, State of the Union Address (January 29, 1978)

Deficit in first year in office (1977): 2.7% of GDP

Deficit in last year in office (1980): 2.7% of GDP

"[This budget plan] will ensure a steady decline in deficits, aiming toward a balanced budget by the end of the decade."

President Ronald Reagan, State of the Union Address (January 25, 1983)

Deficit in first year in office (1981): 2.6% of GDP

Deficit in last year in office (1988): 3.1% of GDP

"[This budget plan] brings the deficit down further and balances the budget by 1993."

President George H. W. Bush, State of the Union Address (January 31, 1990)

Deficit in first year in office (1989): 2.8% of GDP

Deficit in last year in office (1992): 4.7% of GDP

"[This budget plan] puts in place one of the biggest deficit reductions ..in the history of this country."

President William Clinton, State of the Union Address (February 17, 1993)

Deficit in first year in office (1993): 3.9% of GDP

Deficit in last year in office (2000): -2.4% of GDP (surplus)

"Unrestrained government spending is a dangerous road to deficits, so we must take a different path."

President George W. Bush, State of the Union Address (February 27, 2001)

Deficit in first year in office (2001): −1.3% of GDP (surplus)

Deficit in last year in office (2008): 3.2% of GDP

"This budget builds on these reforms ..it's a step we must take if we hope to bring down our deficit in the years to come."

President Barack Obama, Address to the Joint Session of Congress (February 24, 2009)

Deficit in first year in office (2009): 9.8% of GDP

Deficit in last year in office (2016): 3.2% of GDP

"We can do so much more with the money we spend. With $20 trillion in debt..the government must learn to tighten its belt, something families all over the country have had to learn to do."

President Donald Trump, Address to the National Governors Association (February 27, 2017)

Deficit in first year in office (2017): 3.5% of GDP

Deficit in last year in office (2020): 14.9% of GDP

"You can't run a [budget] deficit."

President Joseph R. Biden, Roundtable Discussion in Tampa, Florida (February 15, 2020)

Deficit in first year in office (2021, projected): 13.4% of GDP

Each of the presidents of the United States, from Lyndon Johnson on, has vowed to balance the federal budget, or at least to reduce the deficit or debt. Yet all but two have dramatically failed to achieve these goals. Under six presidents, the deficit increased; under two, surpluses became deficits, and only under Presidents Clinton and Obama did the deficit actually shrink (becoming a surplus under Clinton).

Why is it so difficult to balance the federal budget? Conservatives often blame the deficit on the growth in spending by the federal government, while liberals counter that an insufficiently progressive tax system fails to raise revenues needed for valuable government programs. The generally persistent budget deficits could thus be due to a clash between conservatives who oppose raising taxes and liberals who oppose cutting government programs. Or it could be something deeper, a structural problem within the very nature of the U.S. budgeting process.

Dealing with budgetary issues is a problem familiar to most U.S. households that periodically consider how to match their outflows of expenditures with their inflows

of income. In a similar process, budgetary considerations are foremost in many decisions that are made by government policy makers. It is, therefore, critical that we understand how governments budget and the implications of budget imbalances for the economy.

Budgeting for the government is far more complicated than it is for a household, however. A household has inflows from a small number of income sources and outflows to a relatively small number of expenditure items. The federal government has hundreds of revenue-raising tools and thousands of programs on which to spend its revenue.

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The budgetary process at the federal level is complicated further by the dynamic nature of budgeting. Many federal programs have implications not only for this year, but for many years to come. The difficulty of incorporating the long-run consequences of government policy into policy evaluation has bedeviled policy makers and budgetary analysts alike.

In this chapter, we delve into the complexity of budgetary issues that arise as governments consider their revenue and expenditure policies. We begin with a description of the federal budgeting process and of efforts to limit the federal deficit. We then discuss the set of issues involved in appropriately measuring the size of the budget and the budget deficit. After looking at how to model the long-run budgetary consequences of government interventions, we discuss why we should care about reducing the budget deficit as a goal of public policy.

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4.1 Government Budgeting

In this section, we discuss the issues involved in appropriately measuring the national deficit and the national debt. As discussed in Chapter 1, government **debt** is the amount that a government owes to others who have loaned it money. Government debt is a *stock:* the debt is an amount that is owed at any point in time. The government's **deficit**, in contrast, is the amount by which its spending has exceeded its revenues in any given year. The government's deficit is a *flow:* the deficit is the amount each year by which expenditures exceed revenues. Each year's deficit flow is added to the previous year's debt stock to produce a new stock of debt owed.

debt
The amount that a government owes to those who have loaned it money.
deficit
The amount by which a government's spending exceeds its revenues in a given year.

The Budget Deficit in Recent Years

Figure 4-1 graphs the level of federal government revenue, spending, and surplus/deficit from 1965 to the present. As Figure 1-4 from Chapter 1 shows, the mid-1970s marked the end of an era of post–World War II balanced budgets in the United States. The period from the late 1960s through 1992 was marked by a fairly steady upward march in government expenditures due to the introduction and expansion of the nation's largest social insurance programs. Tax revenues did not keep pace, however, due to a series of tax reductions during this period, the most significant of which were the sharp tax cuts in the early 1980s. While government spending was rising from 16.6% of gross domestic product (GDP) in 1965 to 22.5% by 1982, taxes were roughly constant as a share of GDP at 18%. The result was a large deficit that emerged in the early 1980s and persisted throughout that decade.

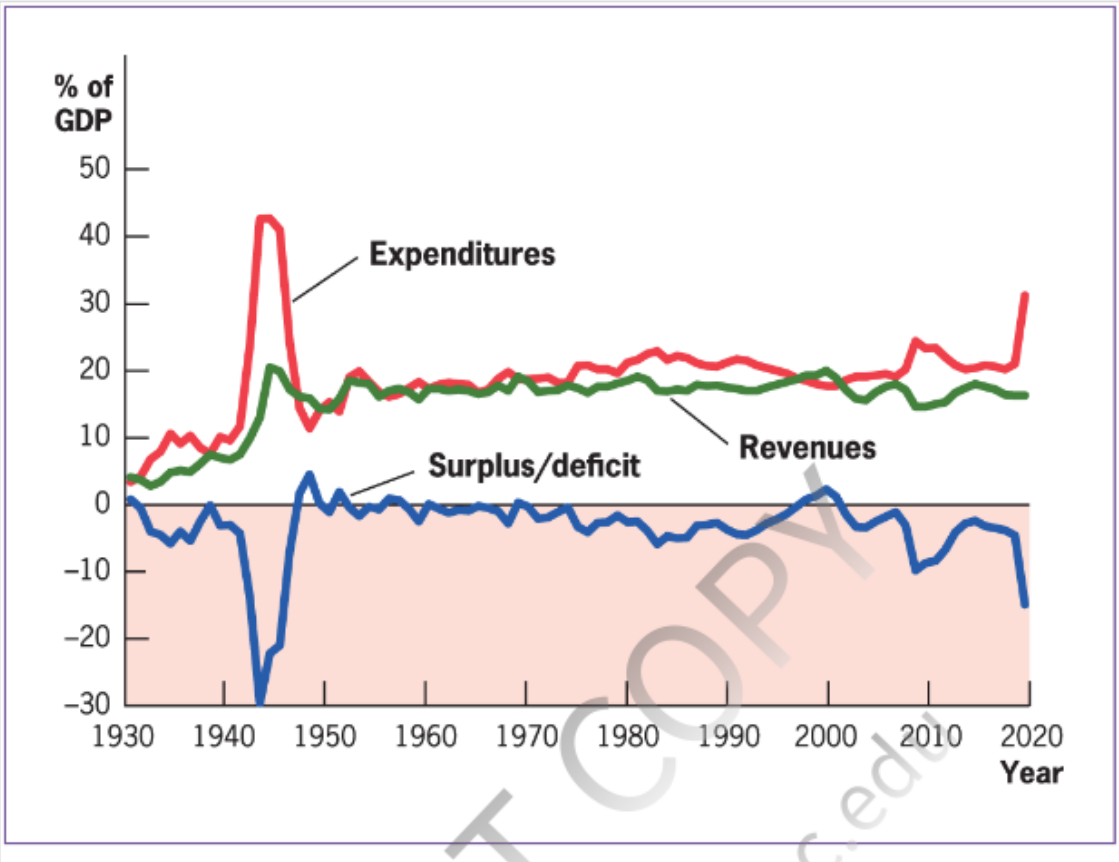

FIGURE 4-1 Federal Taxes, Spending, and the Deficit Through Time in the United States • Federal government spending rose fairly steadily from 1965 through the mid-1980s, but tax revenues did not keep pace, leading to a large deficit. This deficit was eroded and turned to a surplus in the 1990s, but by 2002, the United States was back in deficit again. This deficit grew to very large levels during the Great Recession. It then returned to levels similar to the 1980s before expanding to historic highs due to spending during the Covid-19 pandemic.

Data from: Office of Management and Budget (2021), Table 1.2.

The fiscal picture reversed dramatically in the 1990s. By the end of that decade, spending had fallen back to under 20% of GDP, due to reductions in military spending and a slowdown in the historically rapid growth in medical costs (a major driver of government expenditures through the nation's public health insurance programs). Tax collections rose significantly as well due to a tax increase on the highest income groups enacted in 1993 and a very rapid rise in asset values relative to GDP (which led to a large increase in *capital income taxes,* the taxes collected on asset returns).

The fiscal picture reversed itself again in the early twenty-first century, however, as a recession, growing medical costs, and a growing military budget caused government spending to rise to 20.2% of GDP in 2008. At the same time, falling asset values, tax cuts, and slow earnings growth led government tax receipts to fall back below 18% of GDP. The budget deficit rose in the first half of this decade, peaking at

3.4% of GDP in 2004, before shrinking again through 2007. The Great Recession that began at the end of 2007 raised the deficit again to 3.1% of GDP ($459 billion) in 2008. The deficit ballooned to 9.8% of GDP ($1.4 trillion) in 2009, before falling again in subsequent years; by 2014, the deficit as a share of GDP was at roughly its typical level over the past four decades. From there, the deficit rose slowly until 2020, when the Covid-19 pandemic suddenly hit the world, driving the deficit to a startling 14.9% of GDP, the largest share since World War II.

The Budget Process

The budget process begins with the President's submission to Congress of a budget on or before the first Monday in February. The President's budget, compiled from input by various federal agencies, is a detailed outline of the administration's policy and funding priorities and a presentation of the coming year's economic outlook. The House and Senate then work out that year's Congressional Budget Resolution, a blueprint for the budget activities in the coming fiscal year and at least five years into the future. The resolution, which must be ready by April 15, does not require a presidential signature but must be agreed to by the House and Senate before the legislative processing of the budget begins.

When Covid-19 arrived at the start of 2020, the steady climb of the budget deficit over the past decade suddenly turned into an all-out sprint. In late February, the Trump Administration announced their plan to spend $2.5 billion on Covid relief. Just a month later, the $2.2 trillion CARES Act was signed into law, quickly followed by the $349 billion Paycheck Protection Program, announced in April.[10] By November 30, $2.7 trillion had been allocated to federal Covid relief, driving the deficit to 14.9% of GDP, the largest deficit since 1945.[11] In December 2020, an additional $900 billion in stimulus spending was pushed through Congress, and in January 2021, President Biden announced a new $1.9 trillion Covid relief plan.[12] In 2019, the deficit had been predicted to shrink to 3.7% by 2021. The 2021 deficit is now projected to be 13.4% of GDP, more than triple the previous year's estimate.[13] ■

State and International Deficit Rules

The federal government's inability to control its deficit for any long period of time contrasts greatly with state governments'. As shown in Chapter 1, state government budgets are almost always in balance, with no net deficit at the state level in most years. Why is this?

Most likely because every state in the union, except Vermont, has a **balanced budget requirement (BBR)** that forces it to balance its budget each year. Many states adopted these requirements after the deficit-induced banking crises of the 1840s. Newer states generally adopted BBRs soon after admission into the Union. As a result, all existing BBRs have been in place since at least 1970.

balanced budget requirement (BBR)
A law forcing a given government to balance its budget each year (spending = revenue).

BBRs are not the same in all states, however. Roughly two-thirds of the states have **ex post BBRs**, meaning that the budget must be balanced at the end of a given fiscal year. One-third have **ex ante BBRs**, meaning that either the governor must submit (what is supposed to be) a balanced budget, the legislature must pass a balanced budget, or both. A number of studies have found that only ex post BBRs are fully effective in restraining states from running deficits; ex ante BBRs are easier to evade, for example, through rosy predictions about the budget situation at the start of the year. These studies find that when states are subject to negative shocks to their budgets (such as a recession that causes a state's tax revenues to fall), the

states with the stronger ex post BBRs are much more likely to meet those shocks by cutting spending than are states with the weaker ex ante BBRs.

ex post BBR
A law forcing a given government to balance its budget by the end of each fiscal year.
ex ante BBR
A law forcing either the governor to submit a balanced budget or the legislature to pass a balanced budget at the start of each fiscal year, or both.

Fiscal rules matter in other nations as well. This is demonstrated in a study by Grembi et al. (2016), which looks at the impact of a rule introduced in Italy in 1999 that restricts the rate at which municipal (city or town) deficits can grow over time (to between 0 and 3% per year). In 2001, the Italian government relaxed these rules for the smallest municipalities (those with fewer than 5,000 residents). The study finds that when these municipalities were not subject to these fiscal restraints, their taxes went down and deficits went up.

4.2 Measuring the Budgetary Position of the Government: Alternative Approaches

The figures for the size of the budget deficit presented earlier represent the most common measure of government deficits that are used in public debate. Yet there are a number of alternative ways of representing the budgetary position of the federal government that are important for policy makers to consider.

Real Versus Nominal

The first alternative way to represent the deficit is to take into account the beneficial effects of inflation for the government as a debt holder. An important distinction that we will draw throughout this text is the one between **real prices** and **nominal prices**. Nominal prices are those stated in today's dollars: the price of a cup of coffee today is $3. This means that consuming a cup of coffee today requires forgoing $3 consumption of other goods today. Real prices are those stated in some constant year's dollars: the cost of today's cup of coffee in 1982 dollars would be $0.97. That is, buying this same cup of coffee in 1982 required forgoing $0.97 of consumption of other goods in 1982. Using real prices allows analysts to assess how any value has changed over time, relative to the overall price level, and thus how much more consumption of other goods you must give up to purchase that good. The overall price level is measured by the **Consumer Price Index (CPI)**, an index that captures the change over time in the cost of purchasing a "typical" bundle of goods.

real prices
Prices stated in some constant year's dollars.
nominal prices
Prices stated in today's dollars.
Consumer Price Index (CPI)
An index that captures the change over time in the cost of purchasing a "typical" bundle of goods.

From 1982 through 2020, the CPI rose by 159%; that is, there was a 159% *inflation* in the price of the typical bundle of goods. So any good whose price rose by less than 159% would be said to have a *falling real price:* the cost of that good relative to other goods in the economy is falling. That is, the amount of other consumption that you would have to forgo to buy that good is lower today than it was in 1982. Similarly, a good whose price rose by more than 159% would have a *rising real price*. For example, the cost of a typical bundle of medical care in the United States rose by 419% from 1982 through 2018. So, in real terms, the cost of medical care rose by 419–

159% or 260%. Thus, in 2020, individuals had to sacrifice 260% more consumption to buy medical care than they did in 1982.[14]

Government debts and deficits are both typically stated in nominal values (in today's dollars). This practice can be misleading, however, because inflation typically lessens the burden of the national debt, as long as that debt is a nominal obligation to borrowers.

This point is easiest to illustrate with an example. Suppose that you owe the bank $100 in interest on your student loans. Suppose further that you like to buy as many bags of Skittles candy as possible with your income, and Skittles cost $1 per bag. If you pay the bank the $100 of interest, you are forgoing 100 bags of Skittles each year.

Now suppose that the price level doubles for all goods so that a bag of Skittles now costs $2. Now, when you pay the bank $100 for interest, you only need to forgo the purchase of 50 bags of Skittles. In real terms, the cost of your interest payments has fallen by half; the consumption you have to give up in order to pay the interest is half as large as it was at the lower price level. From the bank's perspective, however, the price level increase is not a good thing. They used to be able to buy 100 bags of Skittles with your interest payments; now they can only buy 50. They are worse off, and you are better off, because the price level rose.

A similar logic applies to the national debt. When price levels rise, the consumption that the nation has to forgo to pay the national debt falls. The interest payments the government makes are in nominal dollars, which are worth less at the higher price level, so when prices rise, the real deficit falls. This outcome is called an *inflation tax* on the holders of federal debt (although it isn't really a tax). Due to rising prices, federal debt holders are receiving interest payments that are worth much less in real terms (like the bank in the previous paragraph).

This inflation tax can be sizeable, even in the low-inflation environment of the early twenty-first century. In 2020, the national debt was $26.9 trillion and the inflation rate was 1.2%. The "inflation tax" in that year, therefore, was 0.012×26.9, or $323 billion. The conventionally measured deficit in 2020 (government expenditure minus government revenue) was $3.13 trillion, but if we add these inflation tax revenues to the deficit, the deficit falls to $2.81 trillion.[15] Thus, taking into account the effects of inflation on eroding the value of the national debt reduces the measured deficit.

Economic Conditions

A second alternative way to represent the deficit is to recognize the distinction between short-run factors that affect government spending and revenue and longer-run trends in the government's fiscal position. In particular, the government can account for the fiscal role of **automatic stabilizers**, automatic reductions in revenues, and increases in outlays when GDP is falling relative to potential GDP. Both of these factors tend to increase the deficit in the short run, but over the long run, they should be balanced by the rise in receipts and the decline in spending that occurs during periods of economic growth.

automatic stabilizers
Automatic reductions in revenues and increases in outlays when the economy shrinks relative to its potential.

To account for these factors, the CBO computes a **cyclically adjusted budget deficit**. The CBO starts with its baseline projection of revenues and outlays, which captures business cycle effects and other factors. It then estimates how much revenue loss and spending increase are due to the economy's deviation from its full potential GDP, the economy's output if all resources were employed as fully as possible. The result of this adjustment for automatic stabilizers is shown in Figure 4-2. As expected, this figure shows that in periods of economic expansion (e.g., the late 1990s), the cyclically adjusted deficit is actually higher than the reported deficit. On the other hand, when the economy is underperforming—such as in the early 1990s, the early 2000s, and the early to mid-2010s—the cyclically adjusted deficit is significantly lower than the reported deficit.

cyclically adjusted budget deficit
A measure of the government's fiscal position if the economy were operating at full potential GDP.

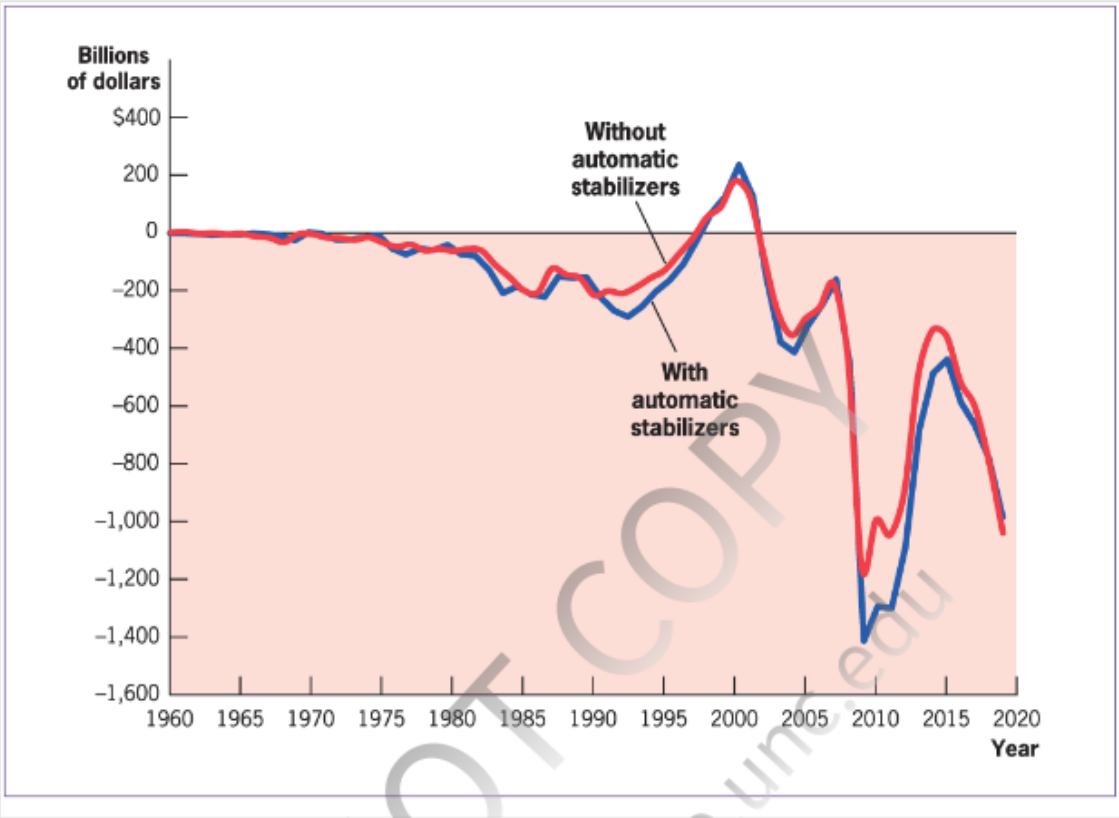

FIGURE 4-2 Economic Adjustment to Measuring the Budget Deficit • The cyclically adjusted budget deficit controls for the impacts of economic activity on the budget. In periods of economic expansion (e.g., the late 1990s), the cyclically adjusted deficit is actually higher than the reported deficit. On the other hand, when the economy is underperforming—such as in the early 1990s, the early 2000s, and the early to mid-2010s—the cyclically adjusted deficit is significantly lower than the reported deficit.

Data from: Congressional Budget Office (2021a).

Cash Versus Capital Accounting

Suppose that the government borrows $2 million and spends it on two activities. One is a big party to celebrate the President's birthday, which costs $1 million. The second is a new office building for government executives, which also costs $1 million. When the government produces its budget at the end of the year, both of these expenditures will be reported identically, and the deficit will be $2 million bigger if there is no corresponding rise in taxes. Yet these expenditures are clearly not the same. In one case, the expenditure financed a fleeting pleasure. In the other, it financed a lasting *capital asset,* an investment with value not just for today but for the future.

This example points out a general concern with the government's use of **cash accounting**, a method of assessing the government's budgetary position that measures the deficit solely as the difference between current spending and current

measures the deficit solely as the difference between current spending and current revenues. Some argue that, instead, the appropriate means of assessing the government's budgetary position is to use **capital accounting**, which takes into account the change in the value of the government's net asset holdings. Under capital accounting, the government would set up a capital account that tracks investment expenditures (funds spent on long-term assets such as buildings and highways) separately from current consumption expenditures (funds spent on short-term items such as transfers to the unemployed). Within the capital account, the government would subtract investment expenditures and add the value of the asset purchased with this investment. For example, if the building built with the second $1 million had a market value of $1 million, then this expenditure would not change the government's capital account because the government would have simply shifted its assets from $1 million in cash to $1 million in buildings.

cash accounting
A method of measuring the government's fiscal position as the difference between current spending and current revenues.

capital accounting
A method of measuring the government's fiscal position that accounts for changes in the value of the government's net asset holdings.

The absence of capital accounting gives a misleading picture of the government's financial position. In 1997, for example, the Clinton administration trumpeted its victory in proposing a balanced budget for the first time in 28 years. Little recognized in this fanfare was that $36 billion of the revenues that would be raised to balance this budget came from one-time sales of a government asset, broadcast spectrum licenses (which allow the provision of wireless services such as cell phones). The government was gaining the revenues from this sale, but at the same time, it was selling off a valuable asset—the spectrum licenses. So the fiscal budget was balanced, but at the expense of lowering the value of the government's asset holdings.

Problems with Capital Budgeting

While adding a capital budget seems like a very good idea, there are enormous practical difficulties with implementing such a budget because it is very hard to distinguish government consumption from investment spending. For example, is the purchase of a missile a capital investment or current period consumption? Does its classification depend on how soon the missile is used? Are investments in education capital expenditures because they build up the abilities of a future generation of workers? And if these are capital expenditures, how can we value them? For example, without selling the spectrum licenses in 1997, how could the

them? For example, without selling the spectrum licenses in 1997, how could the government appropriately assess the value of this intangible asset? In Chapter 8, we discuss the difficulties of appropriately valuing these types of investments. These difficulties might make it easier for politicians to misstate the government's budgetary position with a capital budget than without one.

As a result of these difficulties, while some states use capital budgets, they have not been implemented at the federal level. The international experience with capital budgeting at the national level is mixed.

New Zealand was the first country to fully implement capital budgeting in 1989, and it still continues to use this method.[16] Other countries (such as Denmark, Finland, and the Netherlands) have used this method in the past as well but have stopped doing so because of the problematic issues discussed earlier. Britain implemented capital budgeting in 2001. In its 2013 proposal, Investing in Britain's Future, Britain not only set a capital budget for each department of the government but also outlined investment plans to grow each department's capital budget year by year. For example, Britain plans to increase research and development investments by £22 billion annually through at least 2024, with the hopes of R&D reaching 2.4% of GDP by 2027.[17]

Static Versus Dynamic Scoring

Another important source of the current debate over budget measurement is the debate between *static* and *dynamic scoring*. When budget estimators assess the impact of policies on the government budget, they account for many behavioral effects of these policies. For example, people spend more on child care when the government subsidizes child care expenditures. Similarly, people are more likely to sell assets to realize a capital gain if the capital gains tax rate on such asset sales is reduced. While budget estimators take into account these types of effects of policies on individual and firm behavior in computing the overall effect of legislation, they do *not* take into account that a tax policy might affect the size of the economy as well. That is, budget modelers use **static scoring**, which assumes that the size of the economic pie is fixed and that government policy serves only to change the relative size of the slices of the pie.

static scoring
A method used by budget modelers that assumes that government policy changes only the distribution of total resources, not the amount of total resources.

The static assumption has been strongly criticized by those who believe that government policy affects not only the distribution of resources within the economy but also the size of the economy itself. These analysts advocate **dynamic scoring**, an approach to budget modeling that includes not only a policy's effects on resource distribution but also its effects on the size of the economy. For example, lowering taxes on economic activity (such as labor income taxes) may increase the amount of that activity (hours worked), increasing the production of society. This larger economic pie in turn produces more tax revenues for a given tax rate, offsetting to some extent the revenue losses from the tax reduction. Ignoring this reaction can lead the government to overstate the revenue loss from cutting taxes.

dynamic scoring
A method used by budget modelers that attempts to model the effect of government policy on both the distribution of total resources and the amount of total resources.

Budget estimators have resisted the dynamic approach largely because the impact of government policy on the economy is not well understood. Nevertheless, as proponents of dynamic scoring point out, it is not clear why policy makers and budget estimators should assume there are zero effects. The CBO took its first step toward dynamic scoring in its 2003 evaluation of the budget proposed by President Bush, which included sizeable tax cuts and increased defense spending. The CBO used five different models to evaluate the long-run impacts of the administration's budget on the economy, including feedback effects on tax revenues and government spending. The message that the CBO delivered was fairly consistent: unless the 2003 budget proposals were accompanied by tax increases within a decade, dynamic effects would increase its budgetary costs.[18] This is because the budgetary changes, on net, increased the deficit. As we discuss in Section 4.4, the government borrowing to finance the increased deficit that would occur as a result would crowd out private savings, decrease investment, and ultimately decrease economic growth. Slower economic growth in the long run would cause a fall in future tax revenues, raising the deficit further.

In 2011, the CBO used dynamic scoring to consider the short- and long-run impacts of "stimulus spending" to offset the Great Recession, such as increases in unemployment insurance benefits or providing refundable tax credits. It found that such policies would increase GDP over the 2012–2013 period by 0.1 to 1.9% of GDP, depending on the policy and its generosity. At the same time, its dynamic model suggests that such policies would cause a very slight long-run reduction in GDP due to increased government borrowing and, therefore, reduced investment; it predicted that GDP in 2021 would be $0 to $0.10 lower for each dollar of stimulus spending today.[19] While imprecise, these estimates highlight the trade-off between short-run stimulus to a recessionary economy and long-run deficit increases that may slow growth.

In 2015, the CBO was required to start using dynamic scoring to analyze major legislation, and it began incorporating macroeconomic effects and changes in behavior into its projections. An early report doing so from the CBO found that the Affordable Care Act would reduce the deficit by less than originally estimated because one of the impacts of the law would be to lower labor supply and, therefore, reduce GDP. This report was immediately controversial because the analysis incorporated reduced economic output but not the benefits to those who no longer had to work to get their health insurance (as discussed in Chapter 15).[20]

Dynamic scoring was again put to the test in 2020, when the Covid-19 pandemic prompted unprecedented government spending, pushing the deficit to record highs. Primarily as a result of the deficit increase, when the CBO published their Budget and Economic Outlook report in September 2020, the economic outlook had changed dramatically from just March 2020. For instance, the revised estimate of debt as a percentage of GDP in 2049 was 45 percentage points higher than the previous estimate. Despite this, the projected cumulative deficit over 2021–2030 remained practically unchanged, largely due to the predicted economic downturn in the wake of the pandemic, which resulted in lower interest rates and less inflation than originally predicted. So while spending from Covid-19 relief legislation, lower GDP, and lower taxable wages all caused the predicted primary deficit to increase by $2.1 trillion, this was entirely offset by an $2.2 trillion increase in projected interest payments.[21]

4.3 Do Current Debts and Deficits Mean Anything? A Long-Run Perspective

Suppose that the government initiates two new policies this year. One provides a transfer of $1 million to low-income individuals in the current year. The other promises a transfer of $1 million to low-income individuals *next year*. From the perspective of this year's budget deficit, the former policy costs $1 million, while the latter policy is free. This view is clearly incorrect: the latter policy is almost as expensive; it is only slightly cheaper because the promise is in the future, rather than today.

Governments in the United States and around the world are always making such **implicit obligations** to the future. Whenever Congress passes a law that entitles individuals to receipts in the future, it creates an implicit obligation that is not recognized in the annual budgetary process. In this section, we discuss the implications of implicit obligations for measuring the long-run budgetary position of the government.

implicit obligation
Financial obligations that the government has in the future that are not recognized in the annual budgetary process.

Background: Present Discounted Value

To understand implicit obligations, it is important to review the concept of *present discounted value*. Suppose that I ask to borrow $1,000 from you this year and promise to pay you back $1,000 next year. You should refuse this deal because the $1,000 that you will get back next year is worth less than the $1,000 that you are giving up this year. If instead you take that $1,000 and put it in the bank, you will earn interest on it and have more than $1,000 next year. To compare the value of money in different periods, one must compare the **present discounted value (PDV)**: the value of each period's payment in today's terms. Receiving a dollar in the future is worth less than receiving a dollar today because you have forgone the opportunity to earn interest on the money. Because dollars received in different periods are worth different amounts, we cannot simply add them up; we must first put them on the same basis. This is what PDV does: it takes all future payments and values them in today's terms.

present discounted value (PDV)
The value of each period's dollar amount in today's terms.

To compute the present value of any stream of payments, we *discount* payments in a future period by the interest rate that could be earned between the present and that future period. So if you can invest your money at 10%, then a dollar received seven years from now is only worth 51.3¢ today because you can invest that 51.3¢ at 10% today and have a dollar in seven years. A dollar received one year from now is only worth 91¢ today because you can invest 91¢ at 10% today and have a dollar one year from now.

Mathematically, if the interest rate is r, and the payments in each future period are

$F_1, F_2, \ldots$, and so on, then the PDV is computed as:

$$PDV = \frac{F_1}{(1+r)} + \frac{F_2}{(1+r)^2} + \frac{F_3}{(1+r)^3} \ldots$$

A convenient mathematical shorthand to remember is that if payments are a constant amount for a very long time into the future (e.g., 50 years or more), then the $PDV = F/r$, where F is the constant payment and r is the interest rate.

APPLICATION

Present Discounted Value and Interpreting Sports Contracts

On January 19, 2015, it was reported that the Washington Nationals would sign pitcher Max Scherzer to a seven-year, $210 million contract. This contract for Scherzer, one of the best pitchers in baseball, would represent one of the largest financial commitments in history for a professional sports franchise in the United States. At the time of its signing, Scherzer's contract total ranked eleventh overall in baseball history and was the second highest ever for a pitcher.[22]

But all was not what it initially seemed. It was soon revealed that Scherzer's contract had an unusual provision: the $210 million total was paid not in $30 million installments for each of the seven years Scherzer would play for the Nationals but rather in $15 million installments over 14 years, including seven years after Scherzer's on-the-field commitment was over. Based on the principle of present discounted value, we can compute that this means the contract was worth a lot less than it seemed: money paid out in years 8–14 would be worth a lot less than money received in years 1–7 because Scherzer could have invested the latter and earned interest.

Using as a discount rate the 4.7% long-run projection from the Congressional Budget Office,[23] the PDV of Scherzer's contract was "only" $166 million, putting him 20th overall in baseball history and fourth among pitchers at the time. The money Scherzer receives in the final year of his deal, 2029, will be worth only 73% as much as if he had gotten it in the seventh year of his contract.[24] While Max Scherzer

will clearly be well compensated, his relative ranking in baseball history is much lower than it seems without accounting for present discounted value. ■

Why Current Labels May Be Meaningless

Policy debates have traditionally focused on the extent to which this year's governmental spending exceeds this year's governmental revenues. The existence of implicit obligations in the future, however, suggests that these debates may be misplaced. This concept is nicely illustrated by an example in Gokhale and Smetters (2003). Suppose that the government offers you the following deal when you are 20 years old. When you retire, the government will pay you $1 less in Social Security benefits. In return, the government will reduce the payroll tax that you pay today to finance the Social Security program by 8.7¢, the present value of that $1.[25] In terms of the government's net obligations throughout the future, this policy has no impact; it is lowering current tax revenues and lowering future expenditures by the same present discounted value amount. From today's perspective, however, this policy increases the deficit because it lowers current tax revenues but does not lower current expenditures. As a result, the current deficit will rise, leading to higher national debt for the next 50 years until this payroll tax reduction is repaid through lower benefits.

This example is even more striking if we consider the following alternative: the government offers to pay you $1 less in Social Security benefits, in return for which the government will reduce your payroll tax today by only *half of* the present value of that $1. For example, if the *PDV* of $1 of Social Security benefits to a 20-year-old is 8.7¢, the government will reduce the payroll tax by 4.35¢ in return for cutting benefits by $1 when the 20-year-old retires. Such a deal would clearly be a net winner for the government: in *PDV* terms, the government is reducing current taxes by less than it is reducing future expenditures. Yet, from today's perspective, it is still cutting current taxes and not reducing current expenditures, so the deficit and the debt are rising. Just as in the case of capital budgeting, such a problem can lead to biased government policy making that favors policies that look good in terms of current budgets, even if they have bad long-term consequences for the fiscal position of the government.

Measuring Long-Run Government Budgets

Over the past two decades, researchers have begun to consider alternative measures of government budgets that include implicit obligations. The basic idea of these alternative measures is to correctly measure the **government's intertemporal budget constraint**, comparing the total present discounted value of the government's obligations (explicit and implicit) with the total present discounted value of its revenues.

government's intertemporal budget constraint
An equation relating the present discounted value of the government's obligations to the present discounted value of its revenues.

Measures of the intertemporal budget constraint began with work by Jagdish Gokhale and Kent Smetters in 2003.[26] They computed what the government will spend, and what it will collect in taxes, in each year into the future. They then took the present discounted value of these expenditures and taxes and subtracted expenditures from taxes to get a *PDV* of the government's *fiscal imbalance,* how much more the government has promised in spending than it will collect in taxes.

Gokhale and Smetters highlighted in their work that the entire long-run fiscal imbalance of the federal government arises solely from the major entitlement programs for older adults, Social Security and Medicare: there is little fiscal imbalance in the remainder of government. More recently, this approach was adopted by the Trustees of the Medicare and Social Security Funds, who, in 2012, released data on the long-run fiscal imbalance of the Social Security and Medicare programs. The results are stunning: from the perspective of 2012, the fiscal imbalance of these two programs is $64.8 trillion. That is, if government policy does not change, the government has promised to pay out $64.8 trillion more in benefits than it will collect in taxes. Most of the fiscal imbalance ($54.4 trillion) comes from the Medicare program. The large imbalance caused by this program reflects the fact that the government has not funded in advance the large benefits that it will have to pay out as society ages. In the case of Medicare, this aging trend is compounded by the rapid rise in medical care costs.

Moreover, while the figures have not been updated, they are likely much larger today. As Gokhale points out, his estimate is based on a perhaps unrealistic assumption that the entire government other than Medicare and Social Security will actually shrink over time. Under a more realistic assumption that these programs grow in the future, the fiscal imbalance rises to $91 billion. And this does not incorporate the large reduction in individual and corporate taxes passed at the end of 2017.

of 2017.

It is worth putting this number in perspective. This figure suggests that the implicit debt of the U.S. government (i.e., the extent to which future benefit obligations exceed future tax collections) is three to four times as large as its existing outstanding debt. To achieve intertemporal budget balance would require a tax increase of about 12% of payroll. This would mean almost doubling the existing payroll tax that finances the government's social insurance programs.[27]

The U.S. government today is like a family that has many small children and a $15,000 balance on their credit card. The balance on the credit card is a major problem, and it is causing large interest payments. But it is a trivial problem relative to the enormous fiscal burden that this family will face when its children need to go to college!

Problems with Long-Run Measures

The facts presented in this section are sobering, yet they are typically taken with a grain of salt by policy makers. This casual attitude reflects, in part, the short-run focus of policy makers most interested in winning the next election (as discussed in more detail in Chapter 9). This casualness also reflects the fairly tenuous nature of all these computations, which depend critically on a wide variety of assumptions about future growth rates in costs and incomes, as well as assumptions about the interest rate used to discount future taxes and spending.

"These projected figures are a figment of our imagination. We hope you like them."

For example, these fiscal imbalance calculations assume an interest rate of 3.2%. At that interest rate, the payroll tax increase required to address the long-run fiscal deficit is 11.7%. If the interest rate is raised to 4%, which is well within the forecast error for this variable, then the imbalance falls by almost 10%, to 10.7% of payroll.

There is no reason, however, to think that these estimates are biased one way or another, either always too low or always too high. If the interest rate were to fall to

2.4%, then the imbalance rises by more than 10 to 13.4% of payroll. Thus, while the assumption of an interest rate of 3.2% is a sensible central guess, there is a wide range of uncertainty around it.[28]

Moreover, not only do these calculations require potentially heroic assumptions about interest rates, costs, and incomes in the very distant future, they also assume that government policy remains unchanged. Even relatively small changes in government policy, such as a small cut in Social Security benefits, could have large implications for these estimates. This is not necessarily a problem with these measures, so long as the observer is clear that the measures are based on today's set of policies.

Another problem with these long-run imbalance measures is that they only consider the pattern over time of transfer programs and not of other investments and government policies. Suppose that the government borrowed $1 billion today and invested it in cleaning up the environment. This would look like an increase in the fiscal imbalance of the federal government, eventually requiring higher taxes on future generations to meet the government's intertemporal budget constraint. But this conclusion would not take into account that future generations not only pay the tax bill but also benefit from the improved environment. So a true generational or long-run fiscal accounting should include not only future taxes and transfers but also the benefits to future generations of investments made today.

What Does the U.S. Government Do?

While not adopting these types of very-long-run measures, the U.S. government has moved to consider somewhat longer-run measures of policy impacts. Until the mid-1990s, the budgetary impacts of most policies were considered over a one- or five-year window. This approach was viewed as having the important limitation of promoting policies that had their greatest costs outside of that window. For example, a policy that cut taxes starting in six years was viewed as having no budgetary cost, but the implicit obligation implied by this policy change could be quite large.

In 1996, the government moved to evaluating most policy options over a ten-year window to try to avoid these types of problems. In principle, this should help promote policies that are more fiscally balanced over the long run. In practice, however, moving to a ten-year window added a new problem: it worsened the forecast error inherent in projecting the implications of government programs. The

further the time frame moves from the present, the more difficult it is for the CBO to forecast the government's budget position. This approach leaves policy makers dealing with very uncertain numbers when assessing the ten-year impact of a tax or spending policy.

The bill itself contained numerous tax cuts operating on erratic schedules. Many of the cuts would phase in over periods longer than in any prior American legislation, backloading most of the fiscal impact toward 2010. After gradual phase-ins, many of the cuts would be fully enacted for only a short time before expiring because of the sunset provision. For example, the estate tax, which was levied on bequests over (roughly) $2 million, would be phased out entirely by 2010 and then reintroduced in 2011. This schedule led economist and Nobel laureate Paul Krugman to point out that children may want to make sure their parents die in 2010 rather than 2011, labeling this the "Throw Momma from the Train" Act! Similar tricks were played with expansions of tax credits and other tax reductions; for example, full reductions in upper-income tax rates would start only in 2006 and then expire in 2010.
Such convoluted scheduling allowed legislators to claim that action had been taken on a wide range of issues, while delaying the fiscal consequences associated with these actions. Though the Joint Committee on Taxation estimated the bill's final cost at $1.349 trillion (just under the limit!), other estimates were significantly higher. The Center on Budget and Policy Priorities (CBPP), for example, noted that the cost rose to $1.8 trillion once measures certain to pass in the near future were accounted for. The CBPP then calculated the cost of increased interest payments due to rising debt caused by the tax cuts, and it found the true cost of the bill through 2011 to be $2.3 trillion. Assuming the sunset provision was ultimately eliminated, the tax cut's cost would grow in the decade from 2012 to 2021 to $4.1 trillion, without even including the additional costs of interest payments. Indeed, over the next 75 years, these tax cuts were estimated to cost 1.7% of the GDP, which is more than twice the size of the much debated Social Security deficit over this same time period.

The concerns about this financial trickery were realized in 2010, when President Obama and Congress extended the tax cuts for another two years, raising the cost of the tax cuts by $858 billion.[33] The reduced tax rates for those making under $400,000 were permanently extended in the American Taxpayer Relief Act of 2012, while the rate for higher earners rose.[34]

Despite this outcome, financial trickery was once again used to help meet deficit targets under the most recent round of tax cuts in 2018. This law imposed large reductions in individual taxes, but these individual tax cuts are set to sunset in 2025.[35] And a one-time multinational tax on existing foreign profits will be used to make the overall set of cuts fit within the deficit target.[36] ■

4.4 Why Do We Care About the Government's Fiscal Position?

Now that we understand the complexities involved in defining the federal deficit and debt, we turn to another question: Why do we care? Continuing a theme from Chapter 1, there are two reasons we might care: efficiency and (intergenerational) equity.

Short-Run Versus Long-Run Effects of the Government on the Macroeconomy

One reason to care about budget deficits has to do with **short-run stabilization issues**—that is, the role of government policies in combating the peaks and troughs of the business cycle. Short-run stabilization is accomplished on two fronts. **Automatic stabilization** occurs through policies that automatically cut taxes or increase spending when the economy is in a downturn in order to offset recession-induced declines in household consumption levels. Such automatic stabilization is provided by, for example, the unemployment insurance program, which pays benefits to unemployed workers to offset their income losses. **Discretionary stabilization** occurs through policy actions undertaken by the government to offset a particular instance of an underperforming or overperforming economy, for example, a tax cut legislated during a recession.

short-run stabilization issues
The role of the government in combating the peaks and troughs of the business cycle.
automatic stabilization
Policies that automatically alter taxes or spending in response to economic fluctuations in order to offset changes in household consumption levels.
discretionary stabilization
Policy actions taken by the government in response to particular instances of an underperforming or overperforming economy.

There are a number of interesting questions about the stabilization role of the government. These questions have not, however, been the focus of the field of public finance for more than two decades. This lack of attention perhaps reflects the 1970s conclusion that the tax and spending tools of the government are not well equipped to fight recessions, given the long and variable lags between when changes are proposed and when laws become effective.

The Great Recession inspired a resurgence of interest in this area, although most of the debate is largely carried out in the field of macroeconomics, and courses in that field are the place where one can learn about recessions and the role of government in combating them. A number of studies over the past decade have shown convincingly that fiscal policies such as spending and tax cuts can play an important role in stabilizing the macroeconomy.[37] But public finance courses are typically more concerned with the longer-run impacts of government budget deficits on economic growth.

Background: Savings and Economic Growth

The field of economic growth is a vast and rapidly growing area of academic study. There are a host of exciting issues being investigated about what drives countries to grow faster or slower, but perhaps the most long-standing issue raised by this literature is the impact of savings on economic growth. The earliest economic growth models emphasized a central role for savings as an engine of growth, and this insight remains important for growth economics today.

More Capital, More Growth

The intuition behind the important role of savings in growth can be seen by returning to the production function (Chapter 2), which translates labor and capital inputs into output. Recall that for a short-run production function, the marginal productivity of labor falls as more labor is applied to a fixed level of capital. In the long run, however, capital need not be fixed. Over time, the level of capital can be increased: new plants can be built and machines can be purchased and employed for production. Employing more capital then raises the marginal productivity of labor; that is, workers are more productive if they have more and better buildings and machines with which to work.

This same type of production function analysis can be applied to the production level of an economy. As there is more capital in an economy, each worker is more productive, and total social product rises. A larger capital stock means more total output for any level of labor supply. Thus, the size of the capital stock is a primary driver of growth.

More Savings, More Capital

The determination of the size of the capital stock is shown in Figure 4-4. On the horizontal axis is the size of the capital stock, *K*. On the vertical axis is the price of

capital, which is the interest rate r. The **interest rate** is the rate of return in the second period on investments made in the first period. So, if the interest rate is 10%, that means that for each dollar invested in the first period, individuals receive that dollar plus ten extra cents in the second period. Firms pay the interest rate to investors to obtain the financing they need to build machines, so it is the price for their capital.

interest rate
The rate of return in the second period of investments made in the first period.

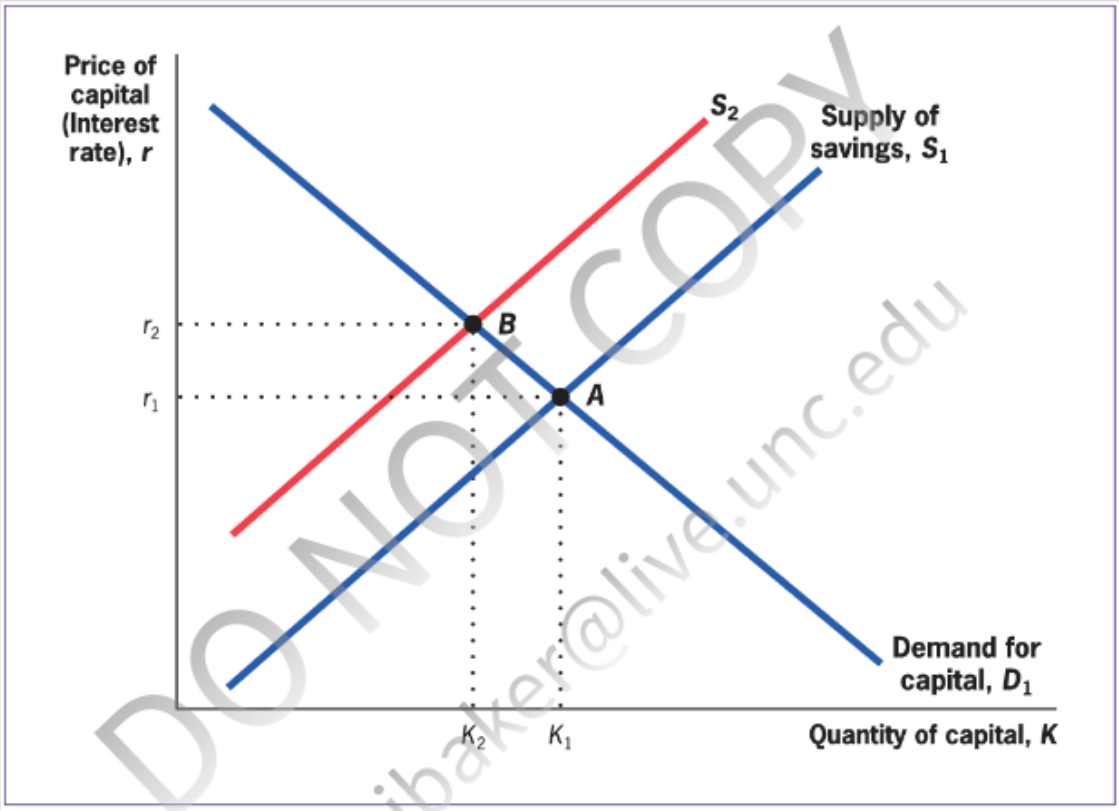

FIGURE 4-4 Capital Market Equilibrium • The equilibrium in the capital market is determined by the interaction of the demand for capital by firms (D_1) and the supply of savings by individual savers (S_1). When the government demands more savings to finance its deficits, this lowers the supply of savings available to private capital markets to S_2, raising interest rates to r_2 and reducing capital accumulation to K_2. This reduction ultimately reduces economic growth.

The demand for capital is driven by firms' investment demands. This demand curve is downward sloping because firms are less willing to pay high interest rates to finance their machines; the higher the interest rate, the more that firms must pay investors to obtain money to invest, so the less attractive investment becomes. The supply curve represents the savings decisions of individuals. Individuals face a decision about whether to consume their income today or save some of it for

tomorrow. As the interest rate rises, each dollar of delayed consumption yields more consumption tomorrow. Because individuals are more willing to save their money and lend it out to firms at higher interest rates (rather than consuming it today), the supply curve slopes upward. That is, just as a higher wage causes individuals to take less leisure (more work) and have more consumption, a higher interest rate causes individuals to consume less and save more today in order to have more consumption in the future.[38]

In a competitive capital market, the equilibrium amount of capital is determined by the intersection of these demand and supply curves. This level of capital then enters the production function, along with the level of labor derived from the type of labor market analysis discussed in Chapter 2. The result is the equilibrium level of output for society.

The Federal Budget, Interest Rates, and Economic Growth

Now, let's introduce a federal government into this scenario. Suppose that, as in most years in recent history, there is a federal deficit, and the government must borrow to finance the difference between its revenues and its expenditures. The key concern about federal deficits is that the federal government's borrowing might compete with the borrowing of private firms. That is, if a fixed supply of savings is used to finance both the capital of private firms and the borrowing of the government, then the government's borrowing may *crowd out* the borrowing of the private sector and lead to a lower level of capital accumulation.

Figure 4-4 illustrates this crowd-out mechanism. Adding government borrowing into the capital market reduces the supply of saved funds available to the private capital market because the government is using some of that supply of savings to finance its deficit. Thus, government borrowing to finance a deficit causes the supply of savings to the private capital market to decrease, so the supply shifts inward from S_1 to S_2 in Figure 4-4. This inward shift in supply leads to a higher interest rate (r_2), which in turn leads to a lower quantity of capital demanded by firms (K_2). Subsequently, this lower level of capital may lower economic growth, by making each unit of labor less productive. Thus, when the government competes with the private sector for limited private savings, the private sector ends up with fewer resources to finance the capital investments that drive growth.

This is a very simple model of how government financing affects interest rates and growth. In reality, there are a number of complications.

International Capital Markets

In Figure 4-4, the reason that government deficits reduce capital expenditures by firms is that they drive up the interest rate. But suppose that the pool of savings is not limited by interest rates, as implied by Figure 4-4, but is essentially unlimited and unaffected by interest rates. That is, suppose that the pool of savings available to finance both private investment and public borrowing was close to perfectly elastic so that even small rises in interest rates would call forth additional savings. In that case, federal deficits would cause only small interest rate rises, and there would be little crowding out of private capital accumulation by government borrowing.

Such would be the case if there were perfectly integrated international capital markets. While the U.S. government's deficit may be large relative to the pool of available savings in the United States, it is very small relative to the entire global pool of available savings. If the federal government can borrow not only domestically but also from abroad to finance its deficit, then there may not be negative implications for capital accumulation and growth. And, in fact, more than one-third of the U.S. federal government debt is held by foreigners owning U.S. government bonds.

There is a large body of economics literature that has investigated the integration of international capital markets. It has generally concluded that while integration is present (and perhaps growing), it is far from perfect. As a result, the supply of capital to the United States may not be perfectly elastic, and government deficits could crowd out private savings.

That U.S. debt is held to some extent internationally, however, raises another issue about growing federal debt. At this time, it seems inconceivable that the United States could possibly default on (not repay) its federal debt, but if the debt gets large enough, then default could become a risk. At that point, international investors might be wary of buying U.S. government bonds. This reduction in demand from abroad would mean that more debt must be held domestically, further raising interest rates and crowding out domestic savings. No one knows how large "large enough" is, but the confidence of foreign investors that we will repay our debts is an important benchmark to consider as the federal debt grows.

Expectations

A particularly important simplification that we make in Figure 4-4 is that we consider only a two-period world, in which savings done today is rewarded with interest payments that are spent tomorrow. In reality, we live in a world in which businesses need to think many years ahead. As a result, there are both short-term (e.g., 30-day) and long-term (e.g., ten-year) interest rates. Short-term rates reflect the current economic environment, while long-term rates also reflect expectations about the future. If the government has a surplus today, this surplus will reduce the total supply of savings and lower short-term interest rates. If the government is expected to run a deficit starting next year, this will put upward pressure on long-term interest rates. Because businesses tend to make long-standing capital investments, they focus more on these longer-term rates. As a result, the entire future path of government surpluses and deficits matters for capital accumulation, not just the surplus or deficit today.

Evidence

Theory, therefore, tells us that higher deficits lead to higher interest rates and less capital investment, but it does not tell us how much higher and how much less. The existing empirical literature on this question is somewhat inconclusive, although past evidence suggests that projected long-term deficits do appear to be reflected to some extent in long-term interest rates. In recent years, however, large increases in public indebtedness have not resulted in higher interest rates, which remain very low. As reviewed in the Application, this has lent support to a "new view" of macroeconomic policy that suggests that the United States can absorb quite large increases in debt without interest rates rising.

APPLICATION

Secular Stagnation and the New View of Deficits

One of the most striking regularities of the world economy over the past three decades has been a sustained decline in real interest rates. Figure 4-5 shows the real interest rate since 1985 across the major industrialized nations. Real interest rates fell from an average of more than 5% in the mid- to late 1980s to a level below zero by 2020 and are projected to be negative for at least the next ten years. And this was not a U.S. specific phenomenon, as illustrated by the figure.

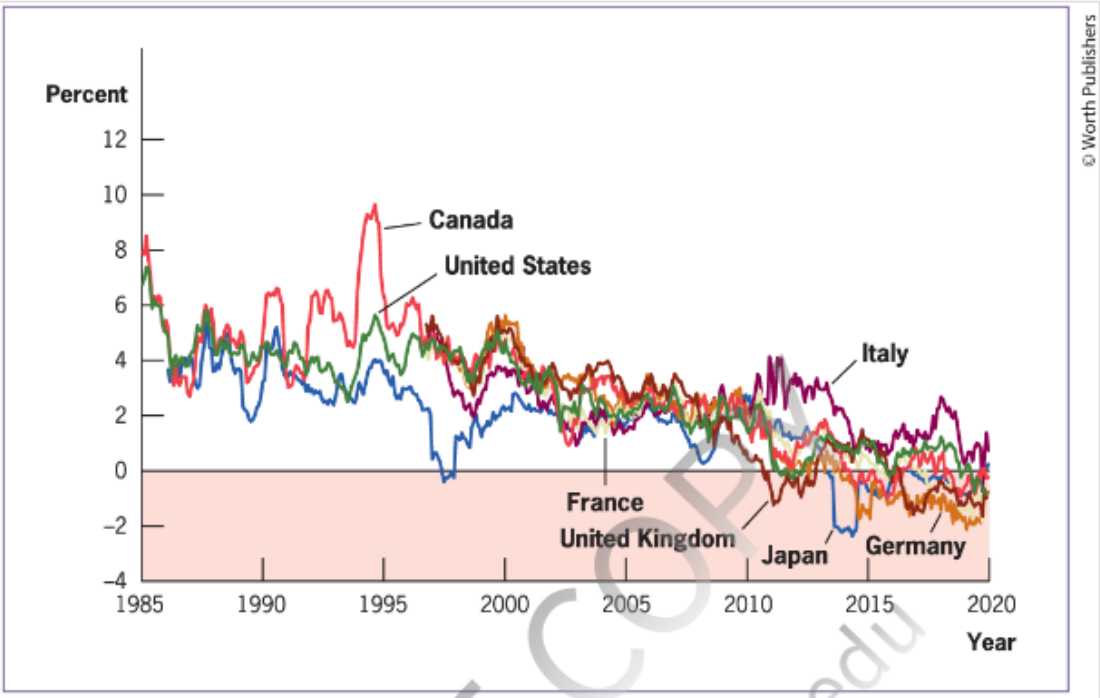

FIGURE 4-5 The Worldwide Decline in Real Interest rates • Over the past 35 years, there has been a strong and systematic decline in real interest rates around the world.

Data from: Furman and Summers (2020)

What is perhaps most striking is that this rapid fall in real interest rates comes despite a host of factors that should have been putting *upward* pressure on real interest rates. As Furman and Summers (2020) point out, in January 2000, when the U.S. debt was projected to be paid off in the next decade, real interest rates were 4.3%. Before the Covid-19 crisis in February 2020, when the United States was in a similar short-term macroeconomic position but the debt was projected to rise to more than 100% of GDP, the real interest rate had fallen to −0.1%! Rachel and Summers (2019) conclude that, accounting for outside factors that should have raised real interest rates, the real interest rate in the industrialized world is about 7 full percentage points below what we would have expected based on standard models.

So what happened? The answer appears to be some form of what Summers (2014) called *secular stagnation,* leading us to an era of permanently low interest rates. The causes of this stagnation remain uncertain. One possibility is that there is a global glut of savings: longer retirement periods, increased inequality (given the higher savings rates of the rich), and rising uncertainty (given the precautionary motives for savings discussed in Chapter 22) have led to more savings, while at the same time, slower labor force growth and increased market power of technology firms that require less capital than legacy firms have led to reduced demand for capital. Meanwhile, the developed nations remain the safest place for individuals in developing countries to put their extra income.

Regardless of the causes, the implications of the secular stagnation hypothesis are fairly radical. As Furman and Summers (2020) say "… fiscal sustainability cannot be assessed by traditional debt-to-GDP ratios but should instead be understood with measures like nominal or real interest as a share of GDP." Traditional thinking—which suggests that larger government deficits crowd out private investment—no longer holds when interest rates do not move upward as deficits grow. Thus, Furman and Summers suggest alternative measures of fiscal burden, such as the ratio of real interest

and Summers suggest alternative measures of fiscal burden, such as the ratio of real interest payments to GDP.

This new view does *not* imply that government spending is simply "free" in the long run. Debts must ultimately be paid. But it does imply a very different view of fiscal policy. In particular, it suggests that we pay less attention to the notion that we have to worry about the level of the debt per se, since we are placing an "unaffordable burden" on future generations. More generally, this suggests that *any* productive government investments that have a rate of return in excess of the economy's long-run growth rate should be made—even if they only repay themselves many years later. Many of the investments described in this book, from early education to research and development, more than pay themselves back over decades. Given the low cost of borrowing for such investments, they should be made today. ■

4.5 Conclusion

Most of this text will focus on fiscal policy actions taken by the government through spending or taxation. Every such action has implications for the federal budget deficit. The deficit has been a constant source of policy interest and political debate over the past decades, as the government has moved from severe deficit to large surplus and back to severe deficit again. The existing deficit is quite large, but what is more worrisome than this cash flow deficit is the long-run implicit debt that is owed to the nation's seniors through the Social Security and Medicare programs. This long-term debt is many multiples of current cash debt and could have major negative effects on both economic efficiency (by crowding out private savings and, ultimately, national growth) and intergenerational equity (by placing the enormous burden of balancing the government's obligations on future generations).

4.5 Conclusion

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Highlights

- The U.S. government's budget has generally been in deficit since the 1960s, despite many attempts to legislate balanced budgets.
- Defining the government's budget position appropriately raises a number of difficult issues, such as using real versus nominal budgets and cash versus capital accounting. A more important issue is the short-run versus long-run debt of the U.S. government. Adding up the total net present value of the government's promised taxes and spending shows that the U.S. government faces a major fiscal imbalance.
- The U.S. government tries to focus on longer-term issues by using a ten-year budget window, but this approach raises problems with forecasting and does not seem to end politicians' willingness to play games with the timing of taxes and expenditures to avoid budget restrictions.
- The major problem with budget deficits is that they are likely to crowd out private capital accumulation, leading to lower long-term growth, although recent years have not been supportive of that view.

Questions and Problems

1. Every year, the Office of Management and Budget publishes historical tables describing the composition of federal receipts and outlays. Navigate to https://www.whitehouse.gov/omb/historical-tables/ to view them. You can see that these detailed tables cover the federal budget's history from 1940 to present (and in some cases, all the way back to 1789!). These tables also display projections for the federal budget up to four years into the future. Using Table 6.1, "Composition of Outlays," discuss how federal outlays have changed from 1940 to the present. Where are the biggest projected changes looking four years into the future?
2. We say that a variable is *cyclical* if it increases with economic booms and declines with economic recessions. We say that a variable is *countercyclical* if the opposite is true. Which elements of the U.S. federal budget are cyclical, and which are countercyclical? (To get a sense of the main elements of the budget, visit the Office of Management and Budget's website, https://www.whitehouse.gov/omb/historical-tables/, to view historical tables describing the federal budget.)
3. How have the major federal laws to promote balanced budgets lost their effectiveness over time?

4. Consider government revenues, expenditures, and surplus/deficit since 1930. Are deficits in recent years typical or atypical from a historical perspective?
5. From 1962 to 1964, federal spending on nondefense-related education and training rose from $1.31 billion to $1.61 billion, while from 2012 to 2014, it rose from $96.9 billion to $99.5 billion.[39] Given that the CPI (in January) was 30.0 in 1962, 30.9 in 1964, 226.7 in 2012, and 233.9 in 2014, which was the larger increase in education and training spending?
6. Why does the CBO construct a cyclically adjusted budget deficit for the purposes of monitoring federal income and outlays?
7. The federal government is considering selling tracts of federally owned land to private developers and using the revenues to provide aid to victims of an earthquake in a foreign country. How would this policy affect the levels of federal revenues, expenditures, and deficits under a cash accounting system? What would be different under a capital accounting system?
8. A government is considering paving a highway with a newly developed "wear-proof" material. Paving the highway would cost $4 billion today, but it would save $400 million in maintenance costs for each of the next ten years. Use the concept of present value to determine whether the project is worth undertaking if the government can borrow at an interest rate of 4%. Is it worth it if the interest rate is 0%? 8%? A politician says to you, "I don't care what the interest rate is. The project is clearly a good investment: it more than pays for itself in only eight years, and all the rest is money in the bank." What's wrong with this argument, and why does the interest rate matter?
9. Why has it been so puzzling to economists that real interest rates have fallen since 1985? Explain some of the factors that might be contributing to these low and falling real interest rates.
10. Consider a one-year project that costs $126,000, provides an income of $70,000 a year for five years, and costs $225,000 to dispose of at the very end of the fifth year. Assume that the first payment comes at the start of the year after the project is undertaken. Should the project be undertaken at a 0% discount rate? How about 2%? 5%? 10%?
11. The 2018 tax overhaul cut taxes for both individuals and corporations. But it includes a provision to sunset the individual tax cuts in the year 2025. Why does the bill include this provision? What do you think supporters of the law expect will happen in 2025? How might political considerations

surrounding sunset provisions increase the final cost of the law, compared with the original estimates by the CBO?

ADVANCED QUESTIONS

12. What is meant by dynamic scoring of the budget? Why does dynamic scoring potentially lead to more realistic estimates of the "true" effective size of a budget deficit? What are some methodological issues involved in dynamic scoring? (Note that you can read more about the move to dynamic budget scoring on the CBO's website. Informative presentations by CBO economists can be found at https://www.cbo.gov/publication/50919 and https://www.cbo.gov/publication/50803.)
13. In 2015, the Congressional Budget Office (CBO) estimated the impact of repealing the Affordable Care Act (ACA) using both traditional and dynamic scoring practices. Under traditional scoring, they found full repeal of the ACA would increase the federal deficit by $353 billion, while under dynamic scoring it would increase the federal deficit by less—$137 billion. Why would dynamic scoring reduce the budgetary impact of repealing the law?
14. Several public interest watchdog groups point out "earmarks" in the federal budget—spending that they claim would have little or no national benefit but would benefit a small number of people in a geographically concentrated area. Why are these types of spending more likely to occur in the federal budgeting process than they would if they were each voted on individually?
15. Explain how the Summers/Furman hypothesis might support increased government spending on budget areas like education in an era of rising inequality.
16. How might large federal deficits affect future economic growth? How would your answer change if foreign confidence in the ability of the United States to repay its debts erodes?
17. Consider the same highway paving project from question 8. A second politician says to you, "At an interest rate of 4%, the project is a bad idea. Over ten years, the project reduces maintenance costs by a total of $4 billion. But borrowing $4 billion for ten years at a 4% interest rate means paying $1.44 billion in interest. The total cost of the project over ten years

is therefore $5.44 billion!" What's wrong with the second politician's argument?

18. The BEA of 1990 created a PAYGO system prohibiting any policy changes that increased the estimated deficit in any year in the subsequent six-year period. Another type of possible PAYGO system would prohibit any policy changes that increase the present value of the deficit over the entire six-year period. Discuss the relative advantages and disadvantages of these "annual" and "cumulative" PAYGO systems.

CHAPTER 5

Externalities: Problems and Solutions

James Andrews/iStock/Getty Images

Questions to keep in mind

- What is an externality, and why does it cause a market failure?
- When can the private market solve the problem of externalities?
- What are possible public-sector solutions to the problem of externalities, and what are the advantages and disadvantages of each?

In December 2015, representatives from 195 nations met in Paris, France, to attempt one of the most ambitious international negotiations ever: an international pact to limit temperature rise around the world, and prepare to deal with its consequences. The motivation for this international gathering was increasing concern over the problem of climate change. As Figure 5-1 shows, there has been a steady rise in global temperatures in the twentieth and twenty-first centuries. Significant scientific consensus suggests that the cause of this warming trend is human activity

—in particular, the use of fossil fuels. The burning of fossil fuels such as coal, oil, natural gas, and gasoline produces carbon dioxide, which in turn traps the heat from the sun in the Earth's atmosphere. In fact, scientists expect the global temperature to rise by as much as 10 degrees Fahrenheit by the end of the century.[1] The global sea level is projected to rise by over a foot in the next three decades, increasing risks of general flooding and completely submerging low-level coastal areas. Climate experts predict, for example, that Bangladesh will lose 17% of the nation's land in that time frame, displacing 20 million people and destroying their local economy.[2]

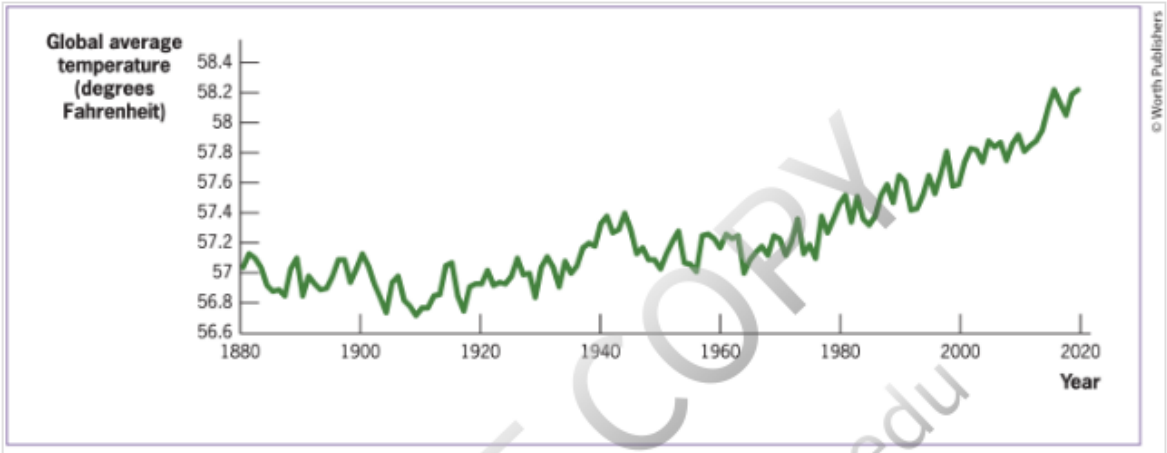

FIGURE 5-1 Average Global Temperature, 1880–2020 • There was a steady upward trend in global temperature throughout the twentieth century, which has continued into the twenty-first century.

Data from: Figure adapted from NASA's Goddard Institute for Space Studies (2021).

Despite this dire forecast, the nations gathered in Paris faced a daunting task. The cost of reducing the use of fossil fuels, particularly in the major industrialized nations, is enormous. Fossil fuels are central to heating our homes, transporting us to our jobs, and lighting our places of work. Replacing these fossil fuels with alternatives would significantly raise the costs of living in developed countries. To end the problem of climate change, some predict that we will have to reduce our use of fossil fuels to the nineteenth-century (preindustrial) levels.

That is not a demand that any country was willing to meet, but most countries, including the United States, committed to sizable reductions. The United States pledged to reduce greenhouse gas emissions by 26 to 28% below 2005 levels.[3] In order to fulfill these commitments, the Obama administration created a Climate Action Plan (see Chapter 6 for details). Supporters of the deal hailed it as a turning point for the planet. Joe Romm, the founder of the blog *Climate Progress,* called the

agreement "a literally world changing deal."[4] Advocates argued that jobs lost to fossil fuels would be replaced in the green energy sector, such as wind and solar energy.

Critics focused on other predictions. They cited slower economic growth and an unfair burden on the United States as reasons to disregard the deal. In 2017, President Trump announced plans to leave the Paris deal. Senate Majority Leader Mitch McConnell lauded the Paris withdrawal as "protecting middle class families across the country and workers throughout coal country from higher energy prices and potential job loss." On his first day as President on January 21, 2021, President Biden immediately joined the Paris agreement, recommitting the United States to ambitious climate goals.[5]

Climate change due to emissions of fossil fuels is a classic example of what economists call an **externality**. An externality occurs whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so. Thus, when we drive cars in the United States, we increase emissions of carbon dioxide, raise world temperatures, and thereby increase the likelihood that Bangladesh will be flooded out of existence in 100 years. Did you think about this when you drove to class today? Not unless you are a very interested student of environmental policy. Your enjoyment of your driving experience is in no way diminished by the damage that your emissions are causing. Externalities occur in many everyday interactions. Sometimes they are localized and small, such as the impact on your roommate if you play your music too loudly or the impact on your neighbors if your dog uses their garden as a bathroom. Externalities also exist on a much larger scale, such as in the case of climate change or particulate emissions. When utilities in the Midwest produce electricity using coal, a by-product of that production is the emission of sulfur dioxide and nitrogen oxides into the atmosphere, where they form sulfuric and nitric acids. These acids may fall back to Earth hundreds of miles away, in the process destroying trees, causing billions of dollars of property damage, and increasing respiratory problems in the population. Without government intervention, the utilities in the Midwest bear none of the cost for the polluting effects of their production activities. But due to government regulations that we discuss in Chapter 6, there has been an enormous reduction in this type of pollution.

externality
Externalities arise whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so.

Externalities are a classic example of the type of **market failures** discussed in Chapter 1. Recall that the most important of our four questions of public finance is, when is it appropriate for the government to intervene? As we show in this chapter, externalities present a classic justification for government intervention. Indeed, in 2012, it was estimated that 176,950 federal employees, or about 6.4% of the federal workforce, are ostensibly charged with dealing with environmental externalities in agencies such as the Environmental Protection Agency (EPA) and the Department of the Interior.[6] This chapter begins with a discussion of the nature of externalities. Throughout the chapter, we focus primarily on environmental externalities, although we briefly discuss other applications as well. We then ask whether government intervention is necessary to combat externalities and under what conditions the private market may be able to solve the problem. We discuss the set of government tools available to address externalities, comparing their costs and benefits under various assumptions about the markets in which the government is intervening. In the next chapter, we apply these theories to the study of some of the most important externality issues facing the United States and other nations today: the cases of particulates, climate change, and health externalities such as cigarette smoking, drinking, and obesity.

market failure
A problem that causes the market economy to deliver an outcome that does not maximize efficiency.

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market failure
A problem that causes the market economy to deliver an outcome that does not maximize efficiency.

5.1 Externality Theory

In this section, we develop the basic theory of externalities. As we emphasize next, externalities can arise either from the production of goods or from their consumption and can be negative (as in the examples discussed earlier) or positive. We begin with the classic case of a negative production externality.

Economics of Negative Production Externalities

Somewhere in the United States, there is a steel plant located next to a river. This plant produces steel products, but it also produces "sludge," a by-product useless to the plant owners. To get rid of this unwanted by-product, the owners build a pipe out the back of the plant and dump the sludge into the river. The sludge produced is directly proportional to the production of steel; each additional unit of steel creates one more unit of sludge as well.

The steel plant is not the only producer using the river, however. Farther downstream is a traditional fishing area where fishers catch fish for sale to local restaurants. Since the steel plant has begun dumping sludge into the river, the fishing has become much less profitable because there are many fewer fish left alive to catch.

This scenario is a classic example of what we mean by an externality. The steel plant is exerting a **negative production externality** on the fishers because its production adversely affects the well-being of the fishers, but the plant does not compensate the fishers for their loss.

negative production externality
When a firm's production reduces the well-being of others who are not compensated by the firm.

One way to see this externality is to graph the market for the steel produced by this plant (Figure 5-2) and compare the private benefits and costs of production to the social benefits and costs. Private benefits and costs are the benefits and costs borne directly by the actors in the steel market (the producers and consumers of the steel products). Social benefits and costs are the private benefits and costs plus the benefits and costs to any actors outside this steel market who are affected by the steel plant's production process (the fishers).

private marginal cost (*PMC*)
The direct cost to producers of producing an additional unit of a good.

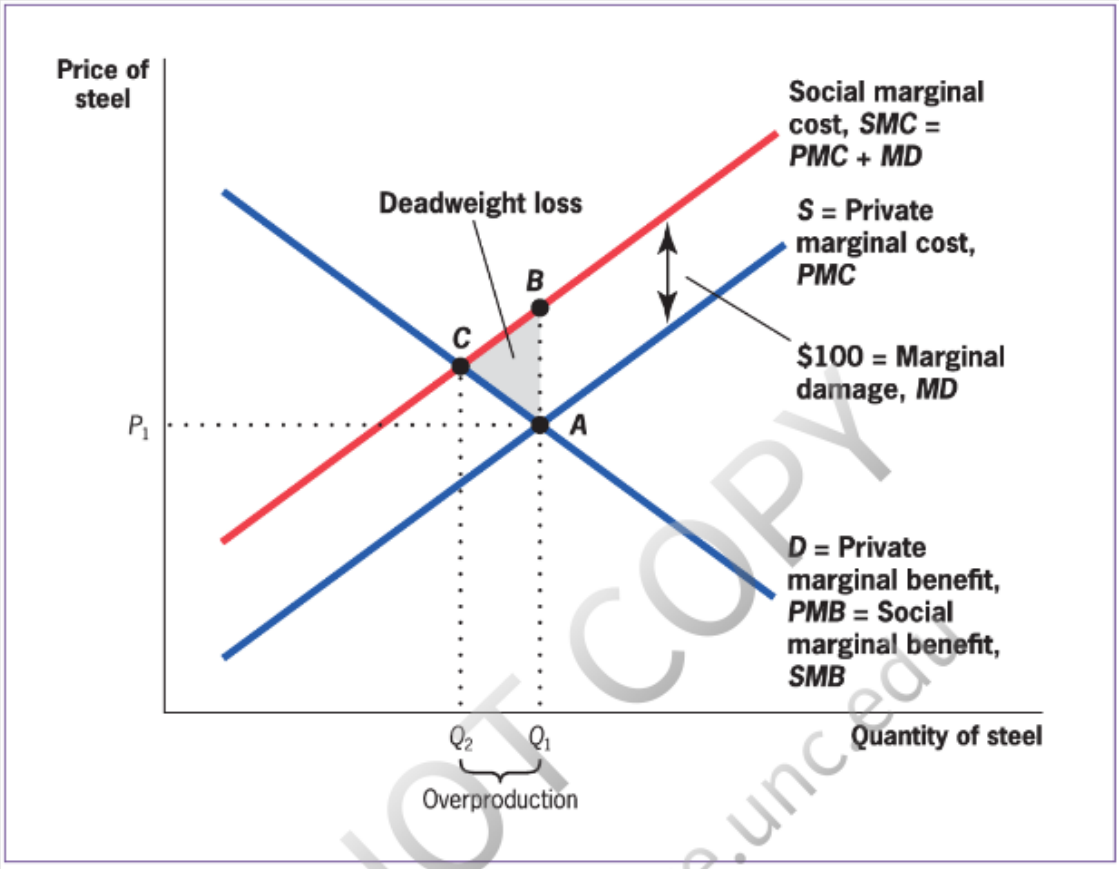

FIGURE 5-2 Market Failure due to Negative Production Externalities in the Steel Market • A negative production externality of $100 per unit of steel produced (marginal damage, *MD*) leads to a social marginal cost that is above the private marginal cost and a social optimum quantity (Q_2) that is lower than the competitive market equilibrium quantity (Q_1). There is overproduction of $Q_1 - Q_2$ with an associated deadweight loss of area *BCA*.

Recall from Chapter 2 that each point on the market supply curve for a good (steel, in our example) represents the market's marginal cost of producing that unit of the good—that is, the **private marginal cost (*PMC*)** of that unit of steel. What determines the welfare consequences of production, however, is the **social marginal cost (*SMC*)**, which equals the private marginal cost to the producers of producing that next unit of a good plus any costs associated with the production of that good that are imposed on others. This distinction was not made in Chapter 2 because without market failures, the social costs of producing steel are equal to the costs to steel producers, $SMC = PMC$. Thus, when we computed social welfare in Chapter 2, we did so with reference to the supply curve.

social marginal cost (*SMC*)
The private marginal cost to producers plus any costs associated with the production of the good that are imposed on others.

But the social returns, after accounting for all the spillovers to firms in technology space and product space, are 58%—almost three times as large! That is, each one hundred dollars that is invested in R&D by a firm raises total social output by almost $60 per year. This is an enormous rate of return. More importantly, it suggests very important positive knowledge spillovers—and therefore positive externalities.

Quick Hint

One confusing aspect of the graphical analysis of externalities is knowing which curve to shift and in which direction. To review, there are four possibilities:

- Negative production externality: *SMC* curve lies above *PMC* curve.
- Positive production externality: *SMC* curve lies below *PMC* curve.
- Negative consumption externality: *SMB* curve lies below *PMB* curve.
- Positive consumption externality: *SMB* curve lies above *PMB* curve.

Armed with these facts, the key is to assess which category a particular example fits into. This assessment is done in two steps. First, you must assess whether the externality is associated with producing a good or with consuming a good. Then, you must assess whether the externality is positive or negative.

The steel plant example is a negative production externality because the externality is associated with the production of steel, not its consumption; the sludge doesn't come from using steel but rather from making it. Likewise, our cigarette example is a negative consumption externality because the externality is associated with the consumption of cigarettes; secondhand smoke doesn't come from making cigarettes, it comes from smoking them.

5.2 Private-Sector Solutions to Negative Externalities

In microeconomics, the market is innocent until proven guilty. An excellent application of this principle can be found in a classic work by Ronald Coase, a professor at the Law School at the University of Chicago, who asked in 1960: Why won't the market simply compensate the affected parties for externalities?[11]

The Solution

To see how a market might compensate those affected by the externality, let's look at what would happen if the fishers owned the river in the steel plant example. They would march up to the steel plant and demand an end to the sludge dumping that was hurting their livelihood. They would have the right to do so because they have property rights over the river; their ownership confers to them the ability to control the use of the river.

Suppose for the moment that when this conversation takes place, there is no pollution-control technology to reduce the sludge damage; the only way to reduce sludge is to reduce production. So ending sludge dumping would mean shutting down the steel plant. In this case, the steel plant owner might propose a compromise: she would pay the fishers $100 for each unit of steel produced, so that they were fully compensated for the damage to their fishing grounds. As long as the steel plant can make a profit with this extra $100 payment per unit, then this is a better deal for the plant than shutting down, and the fishers are fully compensated for the damage done to them.

This type of resolution is called **internalizing the externality**. Because the fishers now have property rights to the river, they have used the market to obtain compensation from the steel plant for its pollution. The fishers have implicitly created a market for pollution by pricing the bad behavior of the steel plant. From the steel plant's perspective, the damage to the fish becomes just another input cost that the plant has to pay it in order to produce.

internalizing the externality
When either private negotiations or government actions lead the price to the party to reflect fully the external costs or benefits of that party's actions.

This point is illustrated in Figure 5-5. Initially, the steel market is in equilibrium at point *A*, with quantity Q_1 and price P_1, where $PMB = PMC_1$. The socially optimal level of steel production is at point *B*, with quantity Q_2 and price P_2, where $SMB = SMC = PMC_1 + MD$. Because the marginal cost of producing each unit of steel has increased by $100 (the payment to the fishers), the private marginal cost curve shifts upward from PMC_1 to PMC_2, which equals *SMC*. That is, social marginal costs are private marginal costs plus $100, so by adding $100 to the private marginal costs, we raise the *PMC* to equal the *SMC*. There is no longer overproduction because the social marginal costs and benefits of each unit of production are equalized. This example illustrates **Part I of the Coase theorem**: when there are well-defined property rights and costless bargaining, then negotiations between the party creating the externality and the party affected by the externality can bring about the socially optimal market quantity. This theorem states that externalities do not necessarily create market failures because negotiations between the parties can lead the offending producers (or consumers) to internalize the externality, or account for the external effects in their production (or consumption).

Coase theorem (Part I)
When there are well-defined property rights and costless bargaining, then negotiations between the party creating the externality and the party affected by the externality can bring about the socially optimal market quantity.

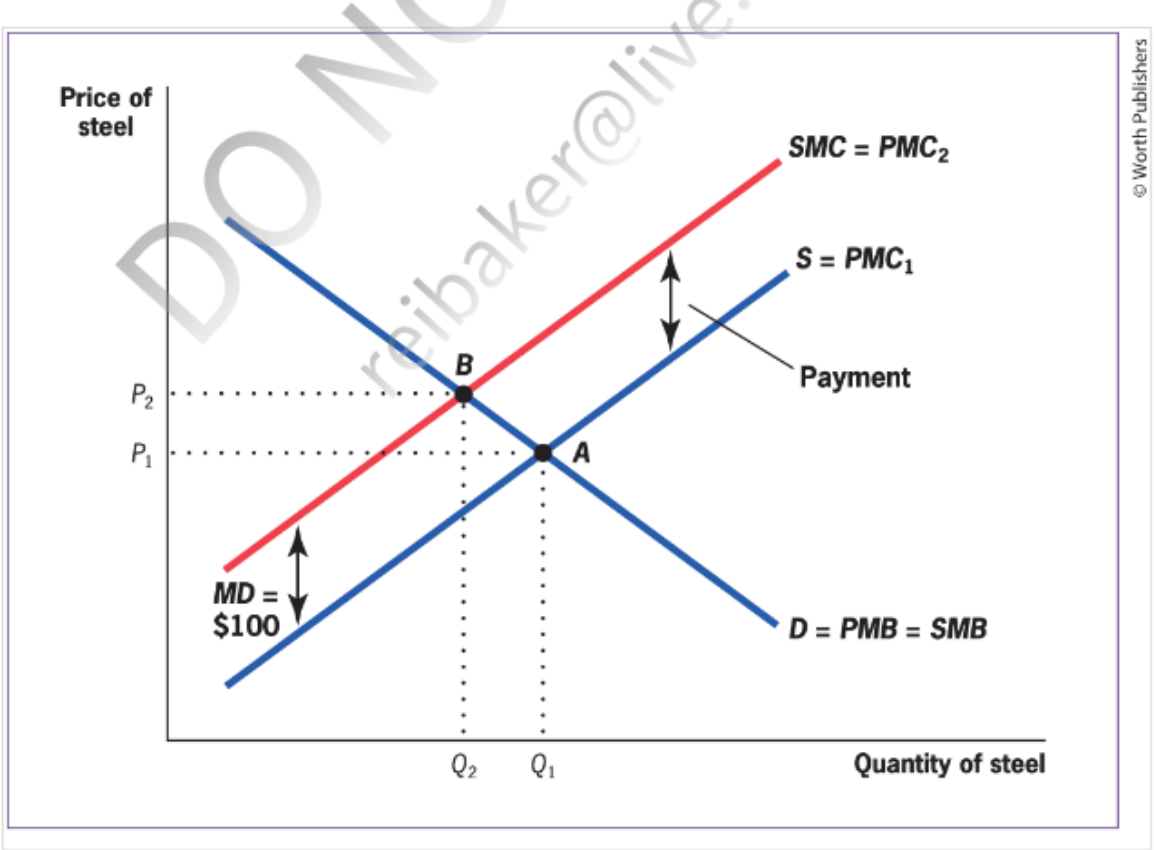

FIGURE 5-5 A Coasian Solution to Negative Production Externalities in the Steel Market • If the fishers charge the steel plant $100 per unit of steel produced, this increases the plant's private marginal cost curve from PMC_1 to PMC_2 which coincides with the *SMC* curve. The quantity produced falls from Q_1 to Q_2 the socially optimal level of production. The charge internalizes the externality and removes the inefficiency of the negative externality.

The Coase theorem suggests a very particular and limited role for the government in dealing with externalities: establishing property rights. In Coase's view, the fundamental limitation to implementing private-sector solutions to externalities is poorly established property rights. If the government can establish and enforce those property rights, then the private market will do the rest.

The Coase theorem also has an important **Part II**: the efficient solution to an externality does not depend on which party is assigned the property rights, as long as someone is assigned those rights. We can illustrate the intuition behind Part II using the steel plant example. Suppose that the steel plant, rather than the fishers, owned the river. In this case, the fishers would have no right to make the plant owner pay a $100 compensation fee for each unit of steel produced. The fishers, however, would find it in their interest to pay the steel plant to produce less. If the fishers promised the steel plant owner a payment of $100 for each unit that the plant did not produce, then the steel plant owner would rationally consider there to be an extra $100 cost to each unit that the plant did produce. Remember that in economics, opportunity costs are included in a firm's calculation of costs; thus, forgoing a payment from the fishers of $100 for each unit of steel not produced has the same effect on production decisions as being forced to pay $100 extra for each unit of steel produced. Once again, the private marginal cost curve would incorporate this extra (opportunity) cost and shift out to the social marginal cost curve, and there would no longer be overproduction of steel.

Coase theorem (Part II)
The efficient solution to an externality does not depend on which party is assigned the property rights, as long as someone is assigned those rights.

Quick Hint

You may wonder why the fishers would ever engage in either of these transactions: They receive $100 for each $100 of damage to fish or pay $100 for each $100 reduction in damage to fish. So what is in it for them? The answer is that this is a convenient shorthand that economics modelers use for saying, "The fishers would charge at least $100 for sludge dumping" or "The fishers would pay up to $100 to remove sludge dumping." By assuming that the payments are exactly $100, we can conveniently model private and social marginal costs as equal. It may be useful for you to think of the payment to

model private and social marginal costs as equal. It may be useful for you to think of the payment to the fishers as $101 and the payment from the fishers as $99, so that the fishers make some money and private and social costs are approximately equal. In reality, the payments to or from the fishers will depend on the negotiating power and skill of both parties in this transaction, highlighting the importance of the issues raised next.

The Problems with Coasian Solutions

This elegant theory would appear to rescue the standard competitive model from important causes of market failures and make government intervention unnecessary (other than to ensure property rights). In practice, however, the Coase theorem is unlikely to solve many of the types of externalities that cause market failures. We can see this by considering realistically the problems involved in achieving a "Coasian solution" to the problem of river pollution.

The Assignment Problem

The first problem involves assigning blame. Rivers can be very long, and there may be other pollution sources along the way that are doing some of the damage to the fish. The fish may also be dwindling for natural reasons, such as disease or a rise in natural predators. In many cases, it is impossible to assign blame for externalities to one specific entity.

Assigning damage is another side of the assignment problem. We have assumed that the damage was a fixed dollar amount, $100. Where does this figure come from in practice? Can we trust the fishers to tell us the right amount of damage that they suffer? It would be in their interest in any Coasian negotiation to overstate the damage in order to ensure the largest possible payment. And how will the payment be distributed among the fishers? When a number of individuals are fishing in the same area, it is difficult to say whose catch is most affected by the reduction in the stock of available fish.

The significance of the assignment problem as a barrier to internalizing the externality depends on the nature of the externality. If my loud music disturbs your studying, then assignment of blame and damages is clear. In the case of climate change, however, how can we assign blame clearly when carbon emissions from countless sources around the world contribute to this problem? And how can we assign damages clearly when some individuals are affected by rising temperatures more than others? Because of assignment problems, Coasian solutions are likely to be more effective for small, localized externalities than for larger, more global externalities.

The Holdout Problem

Imagine that we have surmounted the assignment problem and that by careful scientific analysis, we have determined that each unit of sludge from the steel plant kills $1 worth of fish for each of 100 fishers, for a total damage of $100 per unit of steel produced.

Now, suppose that the fishers have property rights to the river, and the steel plant can't produce unless all 100 fishers say it can. The Coasian solution is that each of the 100 fishers gets paid $1 per unit of steel production, and the plant continues to produce steel. Each fisher walks up to the plant and collects his check for $1 per unit. As the last fisher is walking up, he realizes that he suddenly has been imbued with incredible power: the steel plant cannot produce without his permission because he is a part owner of the river. So, why should he settle for only $1 per unit? Having already paid out $99 per unit, the steel plant would probably be willing to pay more than $1 per unit to remove this last obstacle to their production. Why not ask for $2 per unit? Or even more?

This is an illustration of the **holdout problem**, which can arise when the property rights in question are held by more than one party: the shared property rights give each owner power over all others. If the other fishers are thinking ahead, they will realize this might be a problem, and they will all try to be the last one to go to the plant. The result could very well be a breakdown of the negotiations and an inability to negotiate a Coasian solution. As with the assignment problem, the holdout problem would be amplified with a huge externality such as climate change, where billions of persons are potentially damaged.

holdout problem
Shared ownership of property rights gives each owner power over all the others.

The Free Rider Problem

Can we solve the holdout problem by simply assigning the property rights to the side with only one negotiator, in this case the steel plant? Unfortunately, doing so creates a new problem.

Suppose that the steel plant has property rights to the river, and it agrees to reduce production by 1 unit for each $100 received from fishers. Then the Coasian solution would be for the fishers to pay $100, and for the plant to then move to the optimal level of production. Suppose that the optimal reduction in steel production (where

social marginal benefits and costs are equal) is 100 units, so that each fisher pays $100 for a total of $10,000, and the plant reduces production by 100 units.

Suppose, once again, that you are the last fisher to pay. The plant has already received $9,900 to reduce its production, and will reduce its production as a result by 99 units. The 99 units will benefit all fishers equally because they all share the river. Thus, as a result, if you don't pay your $100, you will still be almost as well off in terms of fishing as if you do. That is, the damage avoided by that last unit of reduction will be shared equally among all 100 fishers who use the river, yet you will pay the full $100 to buy that last unit of reduction. Thought of that way, why would you pay? This is an example of the **free rider problem**: when an investment has a personal cost but a common benefit, individuals will underinvest. Understanding this incentive, your fellow fishers will also not pay their $100, and the externality will remain unsolved; if the other fishers realize that someone is going to grab a free ride, they have little incentive to pay in the first place.

free rider problem
When an investment has a personal cost but a common benefit, individuals will underinvest.

Transaction Costs and Negotiating Problems

Finally, the Coasian approach ignores the fundamental problem that it is hard to negotiate when there are large numbers of individuals on one or both sides of the negotiation. How can the 100 fishers effectively get together and figure out how much to charge or pay the steel plant? This problem is amplified for an externality such as climate change, where the potentially divergent interests of billions of parties on one side must be somehow aggregated for a negotiation.

Moreover, these problems can be significant even for the small-scale, localized externalities for which Coase's theory seems best designed. In theory, my neighbor and I can work out an appropriate compensation for my loud music disturbing their studying. In practice, this may be a socially awkward conversation that is more likely to result in tension than in a financial payment. Similarly, if the person next to me in the restaurant is smoking, it would be far outside the norm, and probably considered insulting, to lean over and offer him $5 to stop smoking. Alas, the world does not always operate in the rational way economists wish it would!

Bottom Line

Ronald Coase's insight that externalities can sometimes be internalized was a brilliant one. It provides the competitive market model with a defense against the onslaught of market failures that we will bring to bear on it throughout this course. It is also an excellent reason to suspect that the market may be able to internalize some small-scale, localized externalities. Where it won't help, as we've seen, is with large-scale, global externalities that are the focus of, for example, environmental policy in the United States. The government may, therefore, have a role to play in addressing larger externalities.

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5.3 Public-Sector Remedies for Externalities

In the United States, public policy makers do not think that Coasian solutions are sufficient to deal with large-scale externalities. The Environmental Protection Agency (EPA), was formed in 1970 to provide public-sector solutions to the problems of externalities in the environment. The agency regulates a wide variety of environmental issues, in areas ranging from clean air to clean water to land management.[12]

Public policy makers employ three types of remedies to resolve the problems associated with negative externalities.

Corrective Taxation

We have seen that the Coasian goal of "internalizing the externality" may be difficult to achieve in practice in the private market. The government can achieve this same outcome in a straightforward way, however, by taxing the steel producer an amount *MD* (for the marginal damage of the pollution) for each unit of steel produced.

Figure 5-6 illustrates the impact of such a tax. The steel market is initially in equilibrium at point *A*, where supply $(= PMC_1)$ equals demand $(= PMB = SMB)$, and Q_1 units of steel are produced at price P_1. Given the externality with a cost of *MD*, the socially optimal production is at point *B*, where social marginal costs and benefits are equal. Suppose that the government levies a tax per unit of steel produced at an amount $t = MD$. This tax would act as another input cost for the steel producer, and would shift its private marginal cost up by *MD* for each unit produced. This will result in a new *PMC* curve, PMC_2, which is identical to the *SMC* curve. As a result, the tax effectively internalizes the externality and leads to the socially optimal outcome (point *B*, quantity Q_2). The government per-unit tax on steel production acts in the same way as if the fishers owned the river. This type of corrective taxation is often called "Pigouvian taxation," after the economist A. C. Pigou, who first suggested this approach to solving externalities.[13]

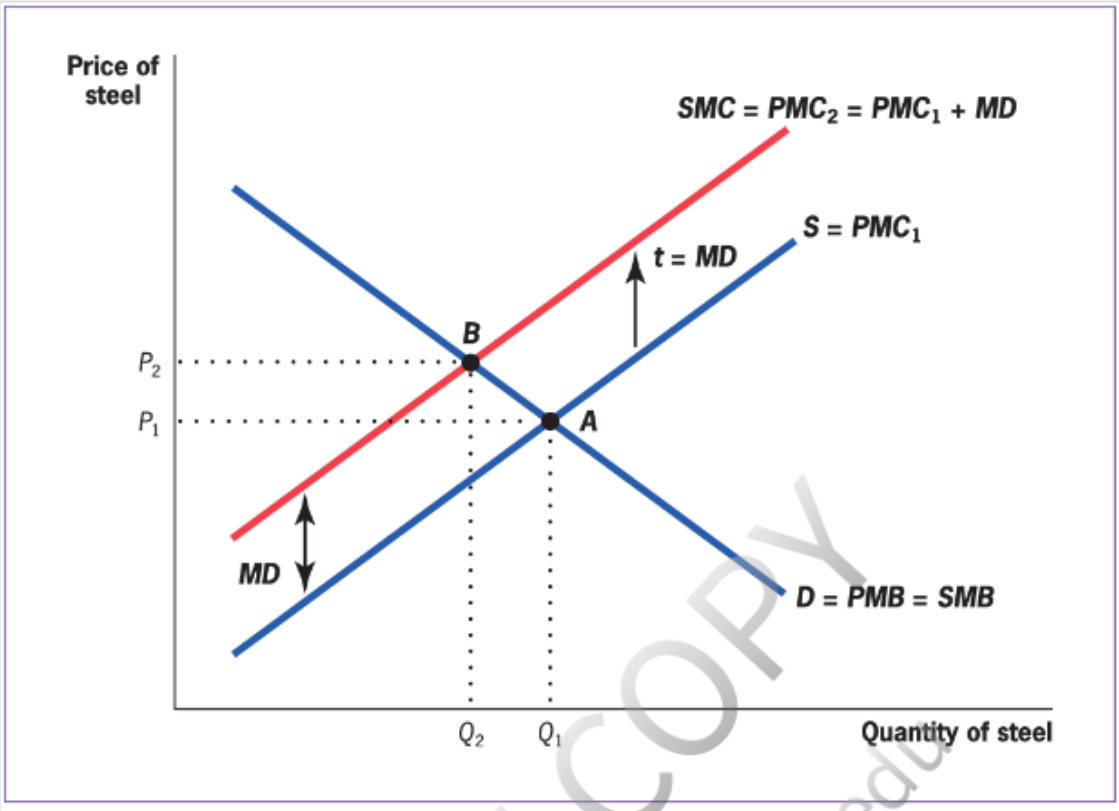

FIGURE 5-6 Taxation as a Solution to Negative Production Externalities in the Steel Market • A tax of $100 per unit (equal to the marginal damage of pollution) increases the firm's private marginal cost curve from PMC_1 to PMC_2, which coincides with the *SMC* curve. The quantity produced falls from Q_1 to Q_2 the socially optimal level of production. Just as with the Coasian payment, this tax internalizes the externality and removes the inefficiency of the negative externality.

APPLICATION

Congestion Pricing

Traffic jams are expensive. A study conducted in 2019 found that over 99 hours were wasted through traffic congestion for each and every American driver. This time cost alone is equivalent to almost $1,400 per driver per year, although this fails to account for the environmental detriment through wasted fuel, carbon emissions, and psychological struggles. Including these factors, congestion costs the United States over $150 billion annually.[14] This litany of negative side effects associated with traffic is a classic example of negative externalities: each driver does not account for the fact that adding her car to the road increases wait times and degrades the environment and health of others in the area.

Economists' preferred solution to these externalities is corrective taxation, and in the particular case of traffic externalities, this is often called "congestion pricing," which is catching on around the world. London, England, was one of the first to create a congestion tax in 2003. There is a flat fee of about $21 per day for entrance into a 8 square mile congestion zone between 7 am and 10 pm. Electric vehicles,

vehicles used for essential services, taxis, and people with disabilities are exempt. Since the introduction of this policy, the number of private cars that enter the city during enforced hours decreased by 39%.[15] A drastic increase in private for-hire vehicles, such as Uber and taxi cabs, has slightly undermined the success of London's congestion tax, but new policies are emerging to tackle these issues.

In Stockholm, Sweden, the congestion price has a maximum of $12.50, but it varies depending on when and where you enter the zone, as well as how long you stay, in order to try to impose the highest prices on the trips with the largest externalities.[16] Putting the tax into effect created an opportunity to examine the health effects of reduced car pollution. Researchers found that in the long run, visits by children to health care providers for acute asthma decreased by as much as 15% per unit of traffic pollution reduced.[17] Other benefits include a 5% increase in sales, 22% less traffic, and a 14% decrease in greenhouse gases within the taxed radius between 2006 and 2010.[18]

A critical factor for the success of congestion pricing is creating alternatives for those who need to travel in the congested zones. London added 300 extra buses the day that congestion pricing took effect,[19] and bicycle trips in the city increased by 210% between 2000 and 2016.

Nevertheless, congestion pricing can be a really hard sell politically, as policy makers in New York City have discovered. New York City is the third most congested city in the world. Congestion pricing was first proposed in 2008, but ran into immediate political opposition. Part of the problem is that advocates argue for the funds raised from congestion taxes to be used to improve public transit (as in London), but evidence suggests that New York City does not have a strong history of using public transportation funds efficiently.[20] Finally, in 2019, New York City became the first U.S. city to attempt to implement a congestion tax, with implementation planned for the end of 2020. However, due to the Covid-19 pandemic, these efforts have been pushed to the side as lockdowns and regulation have driven tens of thousands from Manhattan, the area the policy was intended for.[21]

Subsidies

As noted earlier, not all externalities are negative; in cases such as research and development or nice landscaping by your neighbors, externalities can be positive.

The Coasian solution to cases such as R&D investment would be for the other oil companies to take up a collection to pay the initial firm (thus giving that initial firm a chance to make more money from their R&D activities). But, as we discussed, this may not be feasible; after all, it would be impossible to define exactly which firms see spillovers of specific amounts and to organize them to pay that amount to other firms doing R&D. The government can achieve the same outcome, however, by making a payment, or a **subsidy**, to firms doing R&D. The amount of this subsidy would exactly equal the benefit to the other firms-em-the difference between the private and social returns estimated in the earlier empirical application. This would cause the initial firm to carry out much more R&D, moving us toward the optimal amount.

subsidy
Government payment to an individual or firm that lowers the cost of consumption or production, respectively.

The impact of such a subsidy is illustrated in Figure 5-7, which shows once again the market for R&D. The market is initially in equilibrium at point *A*, where PMC_1 equals *PMB*, and Q_1 units of R&D are produced at price P_1. Given the positive externality with a benefit of *MB*, the socially optimal production is at point *B*, where social marginal costs and benefits are equal. Suppose that the government pays a subsidy per unit of R&D produced of $S = MB$. The subsidy would lower the private marginal cost of research and development, shifting the private marginal cost curve down by *MB* for each unit produced. This will result in a new *PMC* curve, PMC_2, which is identical to the *SMC* curve. The subsidy has caused the initial firm to internalize the positive externality, and the market moves from a situation of underproduction to one of optimal production.

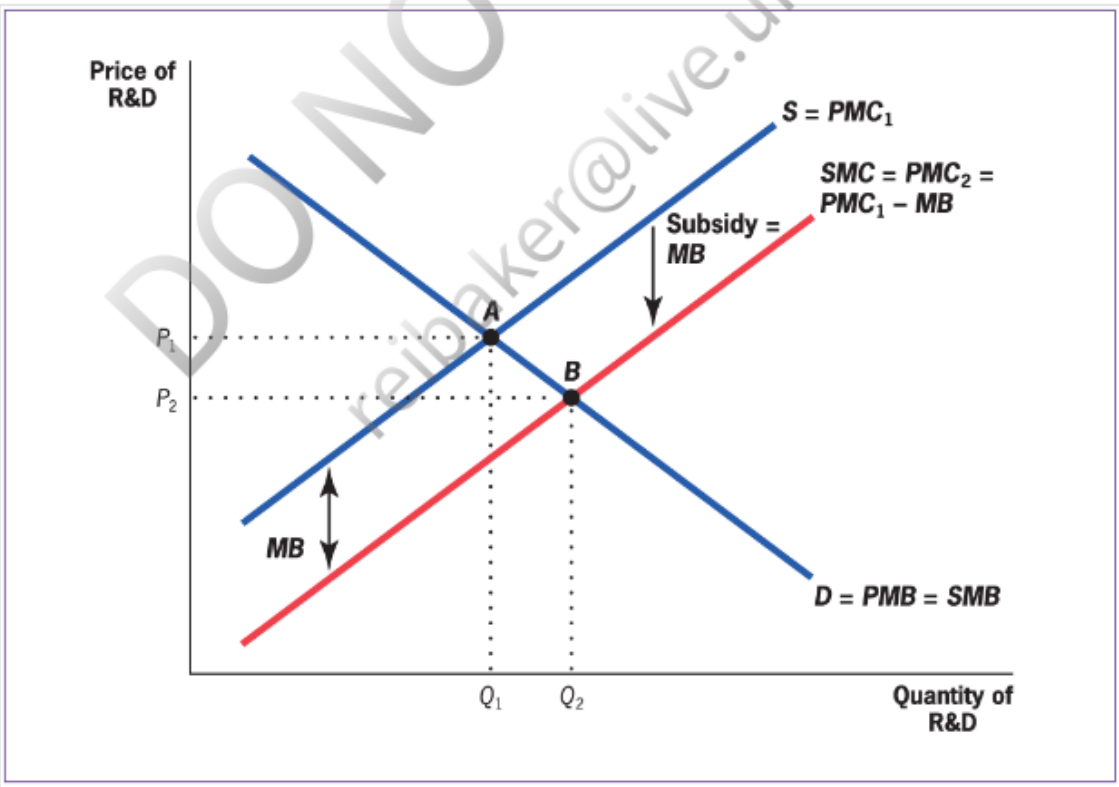

FIGURE 5-7 Subsidies as a Solution to Positive Production Externalities in the Market for R&D • A subsidy that equals the marginal benefit from R&D reduces the initial firm's marginal cost curve from PMC_1 to PMC_2, which coincides with the *SMC* curve. The quantity produced rises from Q_1 to Q_2, the socially optimal level of production.

Policy makers often use subsidization not just to promote positive externalities but to combat negative externalities as well, by subsidizing alternatives to the externality-producing activity. The most common forms of such policies are tax credits or other benefits for producers of renewable energies (such as solar or wind power) that produce fewer environmental externalities than traditional energy sources (such as fossil fuels). Such policies are generally inferior to taxing the negative externality–producing activity because they require government to raise revenues rather than provide revenues (as we show in Chapters 18–20, as you raise the government revenue–raising requirement, you likely reduce economic efficiency). Moreover, subsidization may be much riskier: we know that taxing carbon will reduce its use, whereas subsidizing unknown alternatives may or may not provide a plausible long-run substitute.[22]

5.4 Distinctions Between Price and Quantity Approaches to Addressing Externalities

In this section, we compare price (taxation) and quantity (regulation) approaches to addressing externalities, using more complicated models in which the social efficiency implications of intervention might differ between the two approaches. The goal in comparing these approaches is to find the most efficient path to environmental targets. That is, for any reduction in pollution, the goal is to find the lowest-cost means of achieving that reduction.[33]

Basic Model

To illustrate the important differences between the price and quantity approaches, we have to add one additional complication to the basic competitive market that we have worked with thus far. In that model, the only way to reduce pollution was to cut back on production. In reality, there are many other technologies available for reducing pollution besides simply scaling back production. For example, to reduce sulfur dioxide emissions from coal-fired power plants, utilities can install smokestack scrubbers that remove SO_2 from the emissions and sequester it, often in the form of liquid or solid sludge that can be disposed of safely. Passenger cars can also be made less polluting by installing "catalytic converters," which turn dangerous nitrogen oxide into compounds that are not harmful to public health.

To understand the differences between price and quantity approaches to pollution reduction, it is useful to shift our focus from the market for a good (e.g., steel) to the "market" for pollution reduction, as illustrated in Figure 5-8. In this diagram, the horizontal axis measures the extent of pollution reduction undertaken by a plant; a value of zero indicates that the plant is not engaging in any pollution reduction. Thus, the horizontal axis also measures the amount of pollution: as you move to the right, there is more pollution reduction and less pollution. We show this by denoting more reduction as you move to the right on the horizontal axis; R_{full} indicates that pollution has been reduced to zero. More pollution is indicated as you move to the left on the horizontal axis; at P_{full}, the maximum amount of pollution is being produced. The vertical axis represents the cost of pollution reduction to the plant,

or the benefit of pollution reduction to society (i.e., the benefit to other producers and consumers who are not compensated for the negative externality).

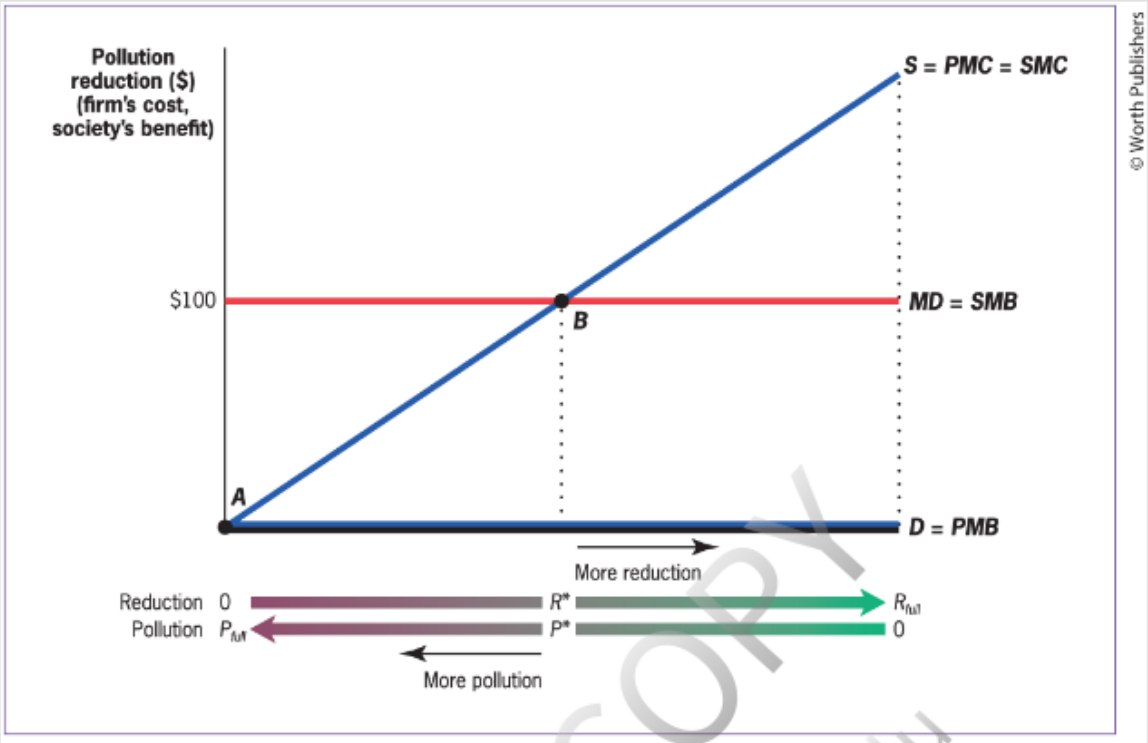

FIGURE 5-8 The Market for Pollution Reduction • The marginal cost of pollution reduction ($PMC = SMC$) is a rising function, while the marginal benefit of pollution reduction (SMB) is (by assumption) a flat marginal damage curve. Moving from left to right, the amount of pollution reduction increases, while the amount of pollution falls. The optimal level of pollution reduction is R^* the point at which these curves intersect. Because pollution is the complement of reduction, the optimal amount of pollution is P^*.

The *MD* curve represents the marginal damage that is averted by additional pollution reduction. This measures the social marginal benefit of pollution reduction. Marginal damage is drawn flat at $100 for simplicity, but it could be downward sloping due to diminishing returns. The private marginal benefit of pollution reduction is zero, so it is represented by the horizontal axis; there is no gain to the plant's private interests from reducing dumping.

The *PMC* curve represents the plant's private marginal cost of reducing pollution. The *PMC* curve slopes upward because of the diminishing marginal productivity of this input. The first units of pollution are cheap to reduce: just tighten a few screws or put a cheap filter on the sludge pipe. Additional units of reduction become more expensive until it is incredibly expensive to have a completely pollution-free production process. Because there are no externalities from the production of pollution reduction (the externalities come from the end product, reduced

pollution, as reflected in the *SMB* curve, not from the process involved in actually reducing the pollution), the *PMC* is also the *SMC* of pollution reduction.

The free market outcome in any market would be zero pollution reduction. Because the cost of pollution is not borne by the plant, it has no incentive to reduce pollution. The plant will choose zero reduction and a full amount of pollution P_{full} (point *A*, at which the *PMC* of zero equals the *PMB* of zero).

What is the optimal level of pollution reduction? The optimum is always found at the point at which social marginal benefits and costs are equal, here point *B*. The optimal quantity of pollution reduction is *R**: at that quantity, the marginal benefits of reduction (the damage done by pollution) and the marginal costs of reduction are equal. Note that setting the optimal amount of pollution reduction is the same as setting the optimal amount of pollution. If the free market outcome is pollution reduction of zero and pollution of P_{full}, then the optimum is pollution reduction of *R** and pollution of *P**.

Price Regulation (Taxes) Versus Quantity Regulation in This Model

Now, contrast the operation of taxation and regulation in this framework. The optimal tax, as before, is equal to the marginal damage done by pollution, $100. In this situation, the government would set a tax of $100 on each unit of pollution. Consider the plant's decision under this tax. For each unit of pollution the plant makes, it pays a tax of $100. If there is any pollution reduction that the plant can do that costs less than $100, it will be cost-effective to make that reduction: the plant will pay some amount less than $100 to get rid of the pollution and avoid paying a tax of $100. With this plan in place, plants will have an incentive to reduce pollution up to the point at which the cost of that reduction is equal to the tax of $100. That is, plants will "walk up" their marginal cost curves, reducing pollution up to a reduction of *R** at point *B*. Beyond that point, the cost of reducing pollution exceeds the $100 that they pay in tax, so they will just choose to pay taxes on any additional units of pollution rather than to reduce pollution further. Thus, a Pigouvian (corrective) tax equal to $100 achieves the socially optimal level of pollution reduction, just as in the earlier analysis.

Regulation is even more straightforward to analyze in this framework. The government simply mandates that the plant reduce pollution by an amount *R**, to

get to the optimal pollution level P^*. Regulation seems more difficult than taxation because, in this case, the government needs to know not only MD but also the shape of the MC curve. This difficulty is, however, just a feature of our assumption of constant MD; for the more general case of a falling MD, the government needs to know the shapes of both MC and MD curves in order to set either the optimal tax or the optimal regulation.

Multiple Plants with Different Reduction Costs

Now, let's add two wrinkles to the basic model. First, suppose that there are now two steel plants doing the dumping, with each plant dumping 200 units of sludge into the river each day. The marginal damage done by each unit of sludge is $100, as before. Second, suppose that technology is now available to reduce the sludge associated with production, but this technology has different costs at the two different plants. For Plant A, reducing sludge is cheaper at any level of reduction because it has a newer production process. For Plant B, reducing sludge is much more expensive for any level of reduction.[34]

Figure 5-9 summarizes the market for pollution reduction in this case. In this figure, there are separate marginal cost curves for Plant A (MC_A) and for Plant B (MC_B). At every level of reduction, the marginal cost to Plant A is lower than the marginal cost to Plant B because Plant A has a newer and more efficient production process available. The total marginal cost of reduction in the market, the horizontal sum of these two curves, is MC_T: for any total reduction in pollution, this curve indicates the cost of that reduction if it is distributed most efficiently across the two plants and is, therefore, the social marginal cost of reduction. For example, the total marginal cost of a reduction of 50 units is $0 because Plant A can reduce 50 units for free; so the efficient combination is to have Plant A do all the reducing. The socially efficient level of pollution reduction (and of pollution) is the intersection of this MC_T curve with the marginal damage curve, MD, at point Z, indicating a reduction of 200 units (and pollution of 200 units).

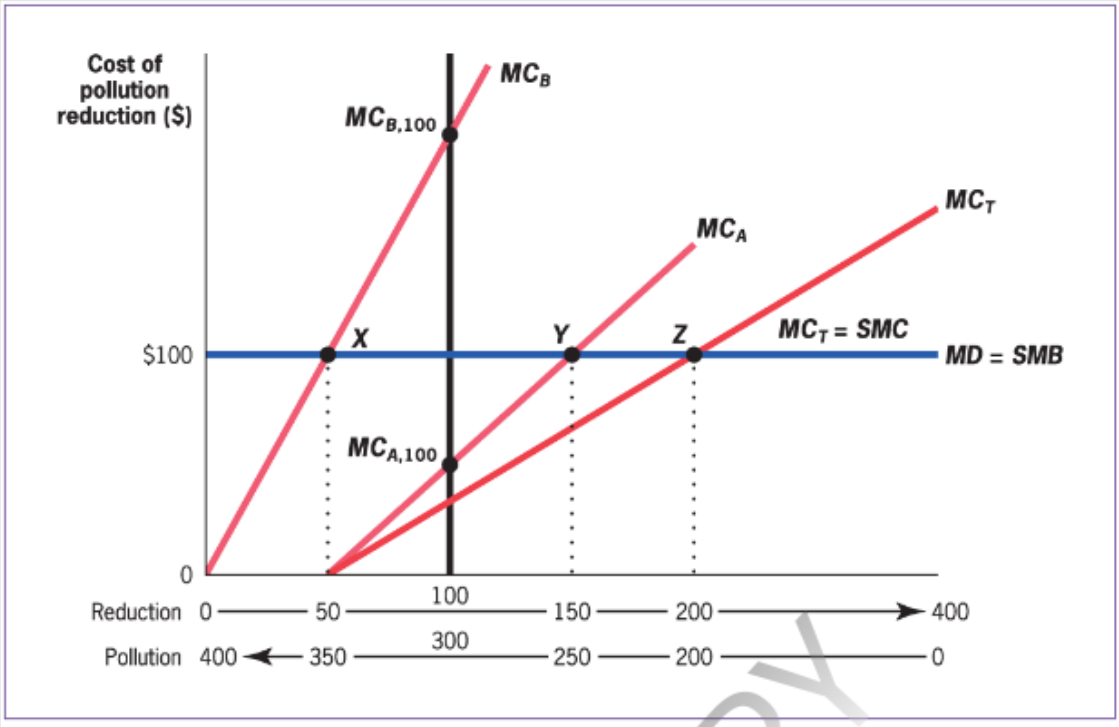

FIGURE 5-9 Pollution Reduction with Multiple Firms • Plant A has a lower marginal cost of pollution reduction at each level of reduction than does Plant B. The optimal level of reduction for the market is the point at which the sum of marginal costs equals marginal damage (at point *Z*, with a reduction of 200 units). An equal reduction of 100 units for each plant is inefficient because the marginal cost to Plant B (*MCB*) is so much higher than the marginal cost to Plant A (*MCA*). The optimal division of this reduction is where each plant's marginal cost is equal to the social marginal benefit (which is equal to marginal damage). This occurs when Plant A reduces by 150 units and Plant B reduces by 50 units, at a marginal cost to each of $100.

Policy Option 1: Quantity Regulation

Let's now examine the government's policy options within the context of this example. The first option is regulation: the government can demand a total reduction of 200 units of sludge from the market. The question then becomes: How does the government decide how much reduction to demand from each plant? The typical regulatory solution to this problem in the past was to ask the plants to split the burden: each plant reduces pollution by 100 units to get to the desired total reduction of 200 units.

This is not an efficient solution, however, because it ignores the fact that the plants have different marginal costs of pollution reduction. At an equal level of pollution reduction (and pollution), each unit of reduction costs less for Plant A (MC_A) than for Plant B (MC_B). If, instead, we got more reduction from Plant A than from Plant B, we could lower the total social costs of pollution reduction by taking advantage of reduction at the low-cost option (Plant A). So society as a whole is worse off if Plant

A and Plant B have to make equal reductions than if they share the reduction burden more efficiently.

This point is illustrated in Figure 5-9. The efficient solution is one where, for each plant, the marginal cost of reducing pollution is set equal to the social marginal benefit of that reduction—that is, where each plant's marginal cost curve intersects with the marginal benefit curve. This occurs at a reduction of 50 units for Plant B (point *X*) and 150 units for Plant A (point *Y*). Thus, mandating a reduction of 100 units from each plant is inefficient; the total costs of achieving a reduction of 200 units will be lower if Plant A reduces by a larger amount.

Policy Option 2: Price Regulation Through a Corrective Tax

The second approach is to use a Pigouvian corrective tax, set equal to the marginal damage, so each plant would face a tax of $100 on each unit of sludge dumped. Faced with this tax, what will each plant do? For Plant A, any unit of sludge reduction up to 150 units costs less than $100, so Plant A will reduce its pollution by 150 units. For Plant B, any unit of sludge reduction up to 50 units costs less than $100, so it will reduce pollution by 50 units. Note that these are exactly the efficient levels of reduction! Just as in our earlier analysis, Pigouvian taxes cause efficient production by raising the cost of the input by the size of its external damage, thereby raising private marginal costs to social marginal costs. Taxes are preferred to quantity regulation, with an equal distribution of reductions across the plants, because taxes give the plants more flexibility in choosing their optimal amount of reduction, allowing them to choose the efficient level.

Policy Option 3: Quantity Regulation with Tradable Permits

Does this mean that taxes *always* dominate quantity regulation with multiple plants? Not necessarily. If the government had mandated the appropriate reduction from each plant (150 units from A and 50 units from B), then quantity regulation would have achieved the same outcome as the tax. Such a solution would, however, require much more information. Instead of just knowing the marginal damage and the total marginal cost, the government would also have to know the marginal cost curves of each individual plant. Such detailed information would be hard to obtain.

Quantity regulation can be rescued, however, by adding a key flexibility: issue permits that allow a certain amount of pollution and let the plants trade. Suppose the government announces the following system: It will issue 200 permits that entitle the bearer to produce one unit of pollution. It will initially provide 100

entitle the bearer to produce one unit of pollution. It will initially provide 100 permits to each plant. Thus, in the absence of trading, each plant would be allowed to produce only 100 units of sludge, which would in turn require each plant to reduce its pollution by half (the inefficient solution previously described).

If the government allows the plants to trade these permits to each other, however, Plant B would have an interest in buying permits from Plant A. For Plant B, reducing sludge by 100 units costs MC_{B100}, a marginal cost much greater than Plant A's marginal cost of reducing pollution by 100 units, which is MC_{A100}. Thus, Plants A and B can be made better off if Plant B buys a permit from Plant A for some amount between MC_{A100} and MC_{B100}, so that Plant B would pollute 101 units (reducing only 99 units) and Plant A would pollute 99 units (reducing 101 units). This transaction is beneficial for Plant B because as long as the cost of a permit is below MC_{B100}, Plant B pays less than the amount that it would cost Plant B to reduce the pollution on its own. The trade is beneficial for Plant A as long as it receives for a permit at least MC_{A100} because it can reduce the sludge for a cost of only MC_{A100} and make money on the difference.

By the same logic, a trade would be beneficial for a second permit, so that Plant B could reduce sludge by only 98 and Plant A would reduce by 102. In fact, any trade will be beneficial until Plant B is reducing by 50 units and Plant A is reducing by 150 units. At that point, the marginal costs of reduction across the two producers are equal (to $100), so that there are no more gains from trading permits.

What is going on here? We have simply returned to the intuition of the Coasian solution: we have internalized the externality by providing property rights to pollution. So, like Pigouvian taxes, trading allows the market to incorporate differences in the cost of pollution reduction across firms. In Chapter 6, we discuss a successful application of trading to the problem of environmental externalities.

Uncertainty About Costs of Reduction

Differences in reduction costs across firms are not the only reason that taxes or regulation might be preferred. Another reason is that the costs or benefits of regulation could be uncertain. Consider two extreme examples of externalities: climate change and forest fires. Figure 5-10 extends the pollution reduction framework from Figure 5-8 to the situation in which the marginal damage (which is equal to the marginal social benefit of pollution reduction) is now no longer constant, but falling. That is, the benefit of the first unit of pollution reduction is quite high, but once the production process is relatively pollution-free, additional

quite high, but once the production process is relatively pollution-free, additional reductions are less important (i.e., there are diminishing marginal returns to reduction).

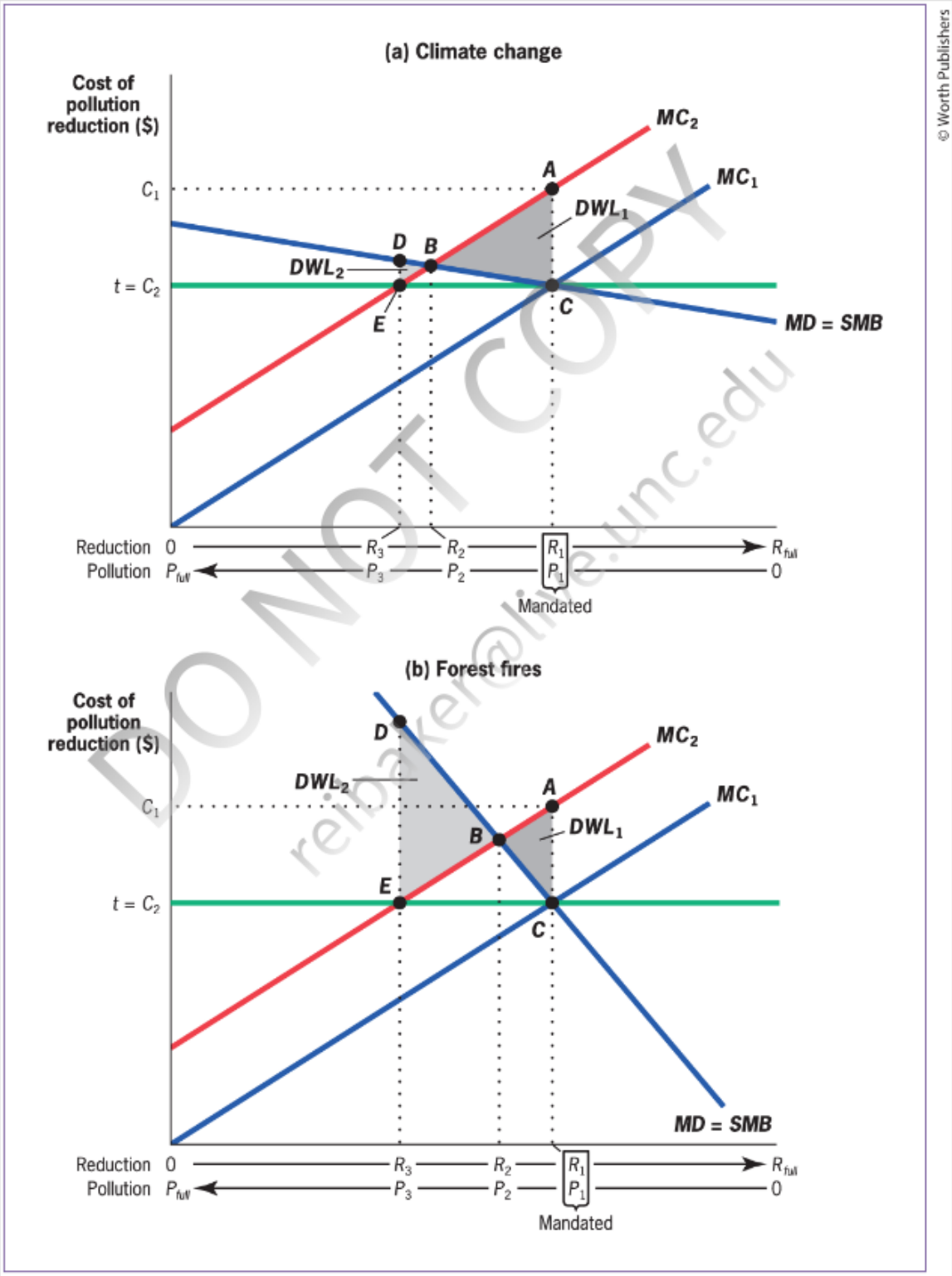

FIGURE 5-10 Market for Pollution Reduction with Uncertain Costs • In the case of climate change [panel (a)], the marginal damage is fairly constant over large ranges of emissions (and thus emission reductions). If costs are uncertain, then taxation at level $t = C_2$ leads to a much lower deadweight loss (DBE) than does regulation of R_1 (ABC). In the case of forest fires [panel (b)], the marginal damage is very steep. If costs are

uncertain, then taxation leads to a much larger deadweight loss (*DBE*) than does regulation (*ABC*).

Panel (a) of Figure 5-10 considers the case of climate change. In this case, the exact amount of pollution reduction is not so critical for the environment. Because what determines the extent of climate change is the total accumulated stock of carbon dioxide in the air, which accumulates over many years from sources all over the world, even fairly large shifts in carbon dioxide pollution in one country today will have little impact on climate change. In that case, we say that the social marginal benefit curve (which is equal to the marginal damage from climate change) is very flat: that is, there is little benefit to society from modest additional reductions in carbon dioxide emissions.

Panel (b) of Figure 5-10 considers the case of forest fires. In this case, a very small difference in the amount of fire that spreads can make a huge difference in terms of lives saved. Indeed, it is possible that the marginal damage curve (which is once again equal to the marginal social benefit of pollution reduction) for forest fires is almost vertical, with each reduction in the spread of fires being very important in terms of saving lives. Thus, the social marginal benefit curve in this case is very steep.

Now, in both cases, imagine that we don't know the true costs of pollution reduction on the part of firms or individuals. The government's best guess is that the true marginal cost of pollution reduction is represented by curve MC_1 in both panels. There is a chance, however, that the marginal cost of pollution reduction could be much higher, as represented by the curve MC_2. This uncertainty could arise because the government has an imperfect understanding of the costs of pollution reduction to the firm, or it could arise because both the government and the firms are uncertain about the ultimate costs of pollution reduction.

Implications for Effect of Price and Quantity Interventions

This uncertainty over costs has important implications for the type of intervention that reduces pollution most efficiently in each of these cases. Consider regulation first. Suppose that the government mandates a reduction, R_1, which is the optimum if costs turn out to be given by MC_1: this is where social marginal benefits equal social marginal costs of reduction if marginal cost equals MC_1. Now, suppose that the marginal costs actually turn out to be MC_2, so that the optimal reduction should instead be R_2, where $SMB = MC_2$. That is, regulation is mandating a reduction in

pollution that is too large, with the marginal benefits of the reduction being below the marginal costs. What are the efficiency implications of this mistake?

In the case of climate change [panel (a)], these efficiency costs are quite high. With a mandated reduction of R_1, firms will face a cost of reduction of C_1, the cost of reducing by amount R_1 if marginal costs are described by MC_2. The social marginal benefit of reduction of R_1 is equal to C_2, the point where R_1 intersects the *SMB* curve. Because the cost to firms (C_1) is so much higher than the benefit of reduction (C_2), there is a large deadweight loss (DWL_1) of area *ABC* (the triangle that incorporates all units where the cost of reduction exceeds benefits of reduction).

In the case of forest fires [panel (b)], the costs of regulation are very low. Once again, with a mandated reduction of R_1, firms will face a cost of reduction of C_1, the cost of reducing by amount R_1 if marginal costs are described by MC_2. The social marginal benefit of reduction at R_1 is once again equal to C_2. In this case, however, the associated deadweight loss triangle *ABC* (DWL_1) is much smaller than in panel (a), so the inefficiency from regulation is much lower.

Now, contrast the use of corrective taxation in these two markets. Suppose that the government levies a tax designed to achieve the optimal level of reduction if marginal costs are described in both cases by MC_1, which is R_1. As discussed earlier, the way to do this is to choose a tax level, *t*, such that the firm chooses a reduction of R_1. In both panels, the tax level that will cause firms to choose reduction R_1 is a tax equal to C_2, where MC_1 intersects *MD*. A tax of this amount would cause firms to do exactly R_1 worth of reduction, if marginal costs are truly determined by MC_1.

If the true marginal cost ends up being MC_2, however, the tax causes firms to choose a reduction of R_3, where their true marginal cost is equal to the tax (where $t = MC_2$ at point *E*), so that there is too little reduction. In the case of climate change in panel (a), the deadweight loss (DWL_2) from reducing by R_3 instead of R_2 is only the small area *DBE*, representing the units where social marginal benefits exceed social marginal costs. In the case of forest fires in panel (b), however, the deadweight loss (DWL_2) from reducing by R_3 instead of R_2 is a much larger area, *DBE*, once again representing the units where social marginal benefits exceed social marginal costs.

Implications for Instrument Choice

The central intuition here is that *the instrument choice depends on whether the government wants to get the amount of pollution reduction right or whether it wants to minimize costs.* Quantity regulation ensures there is as much reduction as desired, regardless of the cost. So, if it is critical to get the amount exactly right, quantity regulation is the best way to go. This is why the efficiency cost of quantity regulation under uncertainty is so much lower with the forest fire case in panel (b). In this case, it is critical to get the reduction close to optimal; if we end up costing firms extra money in the process, so be it. For climate change, getting the reduction exactly right isn't very important; thus, it is inefficient in this case to mandate a very costly option for firms.

Price regulation through taxes, on the other hand, ensures that the cost of reductions never exceeds the level of the tax but leaves the amount of reduction uncertain. That is, firms will never reduce pollution beyond the point at which reductions cost more than the tax they must pay (the point at which the tax intersects their true marginal cost curve, MC_2). If marginal costs turn out to be higher than anticipated, then firms will just do less pollution reduction. This is why the deadweight loss of price regulation in the case of climate change is so small in panel (a): the more efficient outcome is to get the exact reduction wrong but protect firms against very high costs of reduction. This is clearly not true in panel (b): for forest fires, it is most important to get the quantity close to right (almost) regardless of the cost to firms.

In summary, quantity regulations ensure environmental protection, but at a variable cost to firms, while price regulations ensure the cost to the firms, but at a variable level of environmental protection. So, if the value of getting the environmental protection close to right is high, then quantity regulations will be preferred; but if getting the protection close to right is not so important, then price regulations are a preferred option.

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Highlights

- Externalities arise whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so.
- Negative externalities cause overproduction of the good in a competitive market, while positive externalities cause underproduction of the good in a competitive market, in both cases leading to a deadweight loss.
- Private markets may be able to "internalize" the problems of externalities through negotiation, but this Coasian process faces many barriers that make it an unlikely solution to global externalities, such as most environmental externalities.
- The government can use either price (tax or subsidy) or quantity (regulation) approaches to addressing externalities.
- When firms have different marginal costs of pollution reduction, price mechanisms are a more efficient means of accomplishing environmental goals, unless quantity regulation is accompanied by the ability to meet regulatory targets by trading pollution permits across polluters.
- If there is uncertainty about the marginal costs of pollution reduction, then the relative merits of price and quantity regulations will depend on the steepness of the marginal benefit curve. Quantity regulation gets the amount of pollution reduction right, regardless of cost, and so is more appropriate when marginal benefits are steep; price regulation through taxation gets the costs of pollution reduction right, regardless of quantity, so it is more appropriate when marginal benefits are flat.

Questions and Problems

1. In 2012, the state of California implemented a system of quantity regulation of greenhouse gases, which included tradable permits. This "cap-and-trade" program for greenhouse gas emissions distributes a fixed amount of greenhouse gas "allowances" to large emitters of greenhouse gases, such as electric power stations and large industrial plants. Plants may then purchase additional greenhouse gas emission allowances at auction, or, alternatively, may purchase unused allowances from another polluter. Theory predicts that this trading system will lead to a socially

efficient allocation of pollution. Describe how such an outcome would occur.

2. Can an activity generate both positive and negative externalities at the same time? Explain your answer.
3. In the midwestern United States, where winds tend to blow from west to east, states tend to approve new polluting industries more easily near their eastern borders than in other parts of the state. Why do you think this is true?
4. The rise of apps such as Uber and Lyft has generated considerable debate among policy makers and politicians in major urban areas over whether these services are net harmful or beneficial. The debate has centered, in part, on the positive and negative externalities generated by these ride-sharing services. Discuss one negative and one positive externality generated by these services.
5. Can government assignment and enforcement of property rights internalize an externality? Will this approach work as well as, better than, or worse than direct government intervention? Explain your answers and describe one of the difficulties associated with this solution.
6. In close congressional votes, many members of Congress choose to remain "undecided" until the last moment. Why might they do this? What lesson does this example teach about a potential shortcoming of the Coasian solution to the externality problem?
7. Suppose that a firm's marginal production costs are given by $MC = 10 + 30Q$. The firm's production process generates a toxic waste, which imposes an increasingly large cost on the residents of the town where it operates: the marginal external cost associated with the Qth unit of production is given by $6Q$. What is the marginal private cost associated with the 10th unit produced? What is the total marginal cost to society associated with producing the 10th unit (the marginal social cost of the 10th unit)?
8. In two-car automobile accidents, passengers in the larger vehicle are significantly more likely to survive than are passengers in the smaller vehicle. In fact, death probabilities are decreasing in the size of the vehicle you are driving, and death probabilities are increasing in the size of the vehicle you collide with. Some politicians and lobbyists have argued that this provides a rationale for encouraging the sale of larger vehicles and discouraging legislation that would induce automobile manufacturers to make smaller cars. Critically examine this argument using the concept of externalities.

9. Why do governments sometimes impose quantity regulations that limit the level of negative-externality-inducing consumption? Why do governments sometimes impose price regulations by taxing this consumption?
10. Answer the following two questions for each of the following examples: (i) smoking by individuals; (ii) toxic waste production by firms; (iii) research and development by a high-tech firm; and (iv) individual vaccination against communicable illness.
    a. Is there an externality? If so, describe it, including references to whether it is positive or negative and whether it is a consumption or production externality.
    b. If there is an externality, does it seem likely that private markets will arise that allow this externality to be internalized? Why or why not?

ADVANCED QUESTIONS

11. Warrenia has two regions. In Oliviland, the marginal benefit associated with pollution cleanup is $MB = 300 - 10Q$, while in Linneland, the marginal benefit associated with pollution cleanup is $MB = 200 - 4Q$. Suppose that the marginal cost of cleanup is constant at \$120 per unit. What is the optimal level of pollution cleanup in each of the two regions?
12. The private marginal benefit associated with a product's consumption is $PMB = 350 - 4Q$ and the private marginal cost associated with its production is $PMC = 6Q$. Furthermore, the marginal external damage associated with this good's production is $MD = 4Q$. To correct the externality, the government decides to impose a tax of T per unit sold. What tax T should it set to achieve the social optimum?
13. Suppose that demand for a product is $Q = 1{,}200 - 4P$ and supply is $Q = -240 + 2P$. Furthermore, suppose that the marginal external damage of this product is \$12 per unit. How many more units of this product will the free market produce than is socially optimal? Calculate the deadweight loss associated with the externality.
14. The marginal damage averted from pollution cleanup is $MD = 200 - 5Q$. The marginal cost associated with pollution cleanup is $MC = 25 + 2Q$.
    a. What is the optimal level of pollution reduction?
    b. Show that this level of pollution reduction could be accomplished through taxation. What tax per unit would generate the optimal

amount of pollution reduction?

15. Two firms are ordered by the federal government to reduce their pollution levels. Firm A's marginal cost associated with pollution reduction is $MC = 150 + 3Q$. Firm B's marginal cost associated with pollution reduction is $MC = 10 + 9Q$. The marginal benefit of pollution reduction is $MB = 250 - 4Q$.
    a. What is the socially optimal level of each firm's pollution reduction?
    b. Compare the social efficiency of three possible outcomes: (i) require all firms to reduce pollution by the same amount; (ii) charge a common tax per unit of pollution; or (iii) require all firms to reduce pollution by the same amount, but allow pollution permits to be bought and sold.
16. One hundred commuters need to use a strip of highway to get to work. They all drive alone and prefer to drive in big cars—it gives them more prestige and makes them feel safer. Bigger cars cost more per mile to operate, however, since their gas mileage is lower. Worse yet, bigger cars cause greater permanent damage to roads.

    The weight of the car is w. Suppose that the benefits from driving are $12w$, while the costs are $3 \times w^2$. The damage to roads is $2 \times w^3$. Assume that individuals have utility functions of the form $U = x$, where x are the net benefits from driving a car of a given size.
    a. What car weight will be chosen by drivers?
    b. What is the optimal car weight? If this differs from (a), why does it?
    c. Can you design a toll system that causes drivers to choose the optimal car weight? If so, then how would such a system work (e.g., how might the toll depend on the car)?
17. Firms A and B each produce 80 units of pollution. The federal government wants to reduce pollution levels. The marginal costs associated with pollution reduction are $MC_A = 50 + 3Q_A$ for firm A and $MC_B = 20 + 6Q_B$ for firm B, where Q_A and Q_B are the quantities of pollution *reduced* by each firm. Society's marginal benefit from pollution reduction is given by $MB = 620 - 3Q_T$, where Q_T is the total reduction in pollution.
    a. What is the socially optimal level of each firm's pollution reduction?
    b. How much total pollution is there in the social optimum?
    c. Explain why it is inefficient to give each firm an *equal* number of pollution permits (if they are not allowed to trade them).
    d. Explain how the social optimum can be achieved if firms are given equal numbers of pollution permits but *are* allowed to trade them.
    e. Can the social optimum be achieved using a tax on pollution?

c. Can the social optimum be achieved using a tax on pollution?

18. Suppose that the (external) damage done by pollution is known to be $MD = 300 + 5Q$, and the (private) cost and benefit are given by $MC = 100 + 2Q$ and $MB = D_0 - 2Q$, where D_0 is not precisely known.
    a. If $D_0 = 1{,}000$, what would be the optimal quantity? What tax would be necessary in order for that to be the equilibrium quantity?
    b. Suppose that, based on the result from part (a), a cap-and-trade system is imposed to allow the optimal quantity of pollution to be produced. If $D_0 = 900$, what would be the deadweight loss associated with having the wrong quantity?
    c. Suppose that, based on the result from part (a), a tax is imposed to allow the optimal quantity of pollution to be produced. If $D_0 = 900$, what would be the deadweight loss associated with having the wrong tax level?
    d. If D_0 is not exactly known, which is likely to give better results, a cap-and-trade system or a tax? What would be the answer to this question if the marginal damage were $300 + 3Q$ instead of $300 + 5Q$?

CHAPTER 6

Externalities in Action: Environmental and Health Externalities

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Questions to keep in mind

- How has public policy toward particulates affected the environment and the economy?
- How can the world come together to combat climate change?
- What are the appropriate government responses to health externalities associated with cigarette smoking, alcohol use, and obesity?

As discussed in the introduction to Chapter 5, the major environmental threat facing the world over the coming century is the warming of our atmosphere and resulting changes in our climate known as climate change. Responding to this threat, in 2009, the U.S. Environmental Protection Agency (EPA) ruled that it had the power to regulate the major cause of climate change, carbon dioxide (CO_2).[1]

In the summer of 2014, the Obama administration announced the Clean Power Plan (CPP), stipulating that the United States would cut annual carbon dioxide emissions from existing power plants by 17% by 2020 and 30% by 2030. The rule provided for a number of options (called "building blocks") to cut carbon emissions and proposed specific emissions rate targets for each state by estimating the extent to which a state can utilize each block. The blocks include improving the efficiency of fossil fuel plants, utilizing more low-CO_2-emitting power sources, expanding the use of renewable energy sources (wind, solar) to generate power, and using electricity more efficiently. Different states had dramatically different targets, reflecting each state's unique mix of energy-generation resources, energy technology, costs, and emissions reduction potential with regard to each of the blocks. The state of Washington, for example, had to cut carbon emissions by 72% by 2030, which the EPA deemed reasonable because the state's enormous Centralia coal plant is slated to shut down in the 2020s. By contrast, Indiana was only be required to cut carbon emissions by 20% because it lacks easy access to natural gas.[2]

This rule was praised by environmental groups. Daniel J. Fiorino, who directs the Center for Environmental Policy at American University, said that the approach is a "really nice example of smarter regulation" because it gave the states great leeway in choosing how to meet the federal standard. Similarly, Andrew Steer of the World Resources Institute claimed that the Clean Power Plan is a "momentous development" that "raises the bar for controlling carbon emissions in the United States."[3] The EPA estimated that the rule would cut traditional air pollutants such as sulfur dioxide, nitrogen oxides, and soot by 25% by 2030, yielding a positive externality of between $55 and $93 billion per year until 2030, far outweighing the expected costs of between $7 and $9 billion per year for implementing the plan.[4]

Meanwhile, opponents of the rule argued that Obama's proposed emissions cuts were simply not feasible given current technology. House Speaker John Boehner went on record, claiming, "The president's plan is nuts, there's no really succinct way to describe it." He argued that Obama's efforts to address climate change would "ship jobs overseas" and condemn Americans to "higher bills and lower incomes."[5] The U.S. Chamber of Commerce released a report outlining that the Clean Power Plan would cost businesses more than $50 billion a year.

Due to pushback in the courts, the Clean Power Plan did not take effect under the Obama administration. When President Trump took office, he moved policy in a very different direction. The Trump White House and EPA began dismantling the wide array of climate reforms instituted under President Obama, including the CPP.

Standards for emissions from new power plants and startup and shutdown practices of existing plants were loosened. Limits for release of coal-ash waste and toxic byproducts were also scaled back.[6] And emissions standards that would have required new cars and light trucks to increase fuel efficiency by 5% annually through 2026 were rolled back to require increases of only 1.5%, although 23 states filed a lawsuit against the Trump administration for attempting to revoke the states' abilities to set their own emissions standards.[7]

The Trump Administration could not simply repeal the CPP with no replacement, because the law states that the EPA is required to regulate (CO_2). emissions so as to minimize the harm to humans.[8] To reconcile the contradiction between this requirement and the administration's goals, the Trump EPA turned to revisiting the calculation of the "social cost of carbon" first developed by Obama's EPA. The social cost of carbon is found by valuing all of the damages from additional carbon emissions, such as decreased agricultural productivity, destruction from climate-related disasters, reduced fresh water availability, and impacts on human health. Mortality-related damages (those arising from premature deaths and the associated costs such as lost productivity) alone are expected to amount to 0.6–3.2% of the global GDP by 2100, depending on the magnitude of emissions through the end of the century.[9]

In 2009, a team of experts assembled under the Obama administration had calculated the social cost of carbon to be $47 per metric ton of CO_2. This was the basis for their aggressive implementation of the CPP. The EPA revised this estimate in 2017, finding the cost to be between $1 and $6. The reduction can be explained, in part, because the 2017 calculation increases the discount rate and only considers domestic benefits of cutting carbon emissions, while the 2009 calculations included global benefits. This reduction in the social cost of carbon set a precedent for the repeal of many Obama-era regulations, such as the CPP.[10]

In 2019, the Trump administration's EPA finalized its replacement plan, the Affordable Clean Energy (ACE) Rule. While the CPP outlined state-specific targets for emissions as well as the nationwide plan to cut CO_2 emissions, the ACE Rule focused only on guidelines for performance for individual power plants. The difference in policy largely stemmed from the debate over the EPA's authority to issue measures that require fuel switching, such as setting standards for transitioning from fossil fuels to clean alternative sources. As a result, the ACE Rule's guidelines covered only the first of the three building blocks from the original CPP plan, offering guidance for heat-rate improvements at existing coal-fired

plants. The ACE Rule offered no quantitative guidelines for emissions and essentially left the judgment to individual states on how to best shift to clean energy based on the EPA's recommended course of action. Relative to a no action baseline, the ACE Rule would have reduced CO_2 emissions by 11 million tons by 2030, compared to 415 million tons under the CPP.[11] However, on the last day of Trump's presidency, the ACE rule was struck down in the U.S. Court of Appeals for the D.C. Circuit after they ruled that it failed to provide adequate environmental protections.

In this chapter, we apply the theoretical tools of Chapter 5 to real-world policy issues such as the regulation of CO_2 emissions. We begin by focusing on a different but historically important source of negative environmental externalities—particulate emissions.

The U.S. experience with particulate regulation highlights the enormous value of a tool introduced in the previous chapter: emissions trading. Allowing trade within the particulate regulatory scheme lowered the costs of these regulations by 50% or more. This lesson has proved influential in the debate over climate change. In this chapter, we discuss the initial efforts to address climate change and the important role that trading can play in future regulatory interventions.

We then turn to another major potential source of externalities: health externalities, especially those caused by cigarette smoking. Health behaviors provide an excellent forum for assessing when actions cause externalities on others (and when they do not), as well as for raising the question of whether actions of an individual that harm only that individual should be regulated by the government.

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6.1 The Role of Economics in Environmental Regulation: The Case of Particulates

Here is a miniature but important chemistry lesson: power plants that burn coal and natural gas create energy by breaking bonds between carbon atoms. Breaking these bonds releases energy, which the plants then capture. The issue is that in the process of breaking carbon bonds, other chemical reactions take place. These reactions release harmful particulates and chemicals into the air. Burning coal releases mercury, a heavy metal toxic to humans; SO_2 (sulfur dioxide) and NO_x (nitrogen oxide), which combine with hydrogen in the atmosphere to create "acid rain"; and particulate matter (soot), which is associated with everything from low visibility to heart attacks. The majority of these particulate pollutants come from coal-fired power plants, most of which are heavily concentrated in the Ohio River Valley.[12]

Particulates have a large number of negative impacts on the environment, ranging from raising the acidity of our water, to corroding metals and paint, to reduced visibility.[13] But the most significant impacts are on human health. Emissions from fine particulates can be inhaled deep into people's lungs, triggering lung, blood vessel, and heart inflammation. Fine particulates can also penetrate indoors. Many scientific studies have identified a relationship between elevated levels of fine particulates and increased illness and premature death from heart and lung disorders such as asthma and bronchitis. Other health effects from exposure include difficulty breathing, coughing, lung damage, irregular heartbeat, heart attacks, and cancers.[14] In fact, airborne particulates often contain complex organic materials, including benzene, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons (PAHs), many of which are known and suspected carcinogens.[15] Some individuals are particularly at risk, especially children, older adults, and those with existing heart and lung diseases.

Particulates are a classic negative production externality. As a by-product of their production, power plants in the Midwest damage the quality of life along the East Coast of the United States. Private-sector (Coasian) solutions are unavailable because of the problems noted in Chapter 5, such as negotiation difficulties with hundreds of polluters and millions of affected individuals. Thus, government intervention is required to address this externality. In fact, the government has intervened to reduce particulates for more than 30 years. The story of this

intervention and the effects it has had on the environment, on health, and on the economy provides an excellent example of the possibilities and limitations of government policy toward the environment.

History of Particulate Regulation

Regulation of the emissions that contain damaging particulates began with the **1970 Clean Air Act (CAA)**, which set maximum standards for atmospheric concentrations of various substances, including SO_2. The act set New Source Performance Standards (NSPS) for any new coal-fired power plant, forcing any new plant to limit emissions in one of two ways: either by switching to coal with a lower sulfur content or by installing scrubbers, which are devices that remove a large portion of pollutants from the plant's exhaust fumes. In terms of the theory of government policy discussed in Chapter 5, the government chose a regulatory (quantity) approach over a tax (price) approach for dealing with this environmental problem.

1970 Clean Air Act (CAA)
Landmark federal legislation that first regulated damaging emissions by setting maximum standards for atmospheric concentrations of various substances, including SO_2.

Total emissions of SO_2 declined by the early 1980s, but some new concerns arose that motivated additional attention to the emissions issue. Most importantly, the vast majority of emissions came from older plants that were not subject to the NSPS. By mandating NSPS only for new plants, the 1970 act gave utilities great incentive to run older, dirtier plants for longer than policy makers had predicted (i.e., longer than the plants' natural "lifetimes"). Moreover, an additional requirement put in place in 1977 that all new plants have scrubbers increased the expense of building new plants and thus further encouraged the upkeep of older plants. These problems are excellent examples of the hazards of partial policy reform. By mandating regulations only for new plants, the government opened a major loophole in the law that encouraged firms to extend the use of outdated, more highly polluting older plants, thus undercutting the effectiveness of the law.

6.2 Climate Change

The environmental externality that could potentially cause the most harm to humans is climate change. The Earth is heated by solar radiation that passes through our atmosphere and warms the Earth's surface. The Earth radiates some of the heat back into space, but a large portion is trapped by certain gases in the Earth's atmosphere, such as CO_2 and methane, which reflect the heat back toward the Earth again. This phenomenon is called the **greenhouse effect** because a greenhouse works by letting in sunlight and trapping the heat produced from that light. The greenhouse effect is essential to life: without it, the Earth would be about 60 degrees cooler, and life as we know it would end.[24]

greenhouse effect
The process by which gases in the Earth's atmosphere reflect heat from the sun back to the Earth.

The problem is that human activity has been increasing the atmospheric concentration of greenhouse gases, and thus, the magnitude of the greenhouse effect has risen. Since the Industrial Revolution (which took place in Europe and the United States from the eighteenth to nineteenth centuries), for example, the amount of CO_2 in the atmosphere has increased by about a third, to 800 billion metric tons of carbon—its highest level in 400,000 years (amounts of CO_2 are measured by what the carbon alone would weigh if in solid form, sort of like a chunk of coal). Most of this CO_2 has come from the use of fossil fuels such as coal, oil, and natural gas. By our use of fossil fuels, humans have contributed to the warming of the Earth's atmosphere as reflected in the increase of surface temperatures by more than 1 degree Fahrenheit since 1951, the most rapid increase in at least 1,000 years (see Figure 5-1, p. 114). Global snow cover has declined by 10% since the 1960s, and global sea levels have risen by two-thirds of a foot over the last century. The year 2020 was the hottest on record, and the last seven years have been the seven hottest ever recorded.[25]

More worrisome are projections for the next century. The average surface temperature of the Earth is likely to increase by 0.5 to 8.6 degrees Fahrenheit by the end of the twenty-first century, relative to 2005, with a best estimate of at least 3.2 degrees. The average rate of warming over each inhabited continent is very likely to be at least twice as great as that experienced during the twentieth century.[26] A

temperature rise of 6 degrees would lower global GDP in 2100 by more than 10%, with India, Africa, and western Europe seeing reductions of more than 15%.[27]

Temperature rise will also have dramatic implications for biodiversity: a temperature rise of 3% is projected to lead to the extinction of up to 30% of all the world's species.[28] Four out of five of the last mass extinctions happened when the amount of carbon dissolved in the ocean passed a "threshold of catastrophe"; we are set to reach that threshold around 2100, though species are already going extinct at a rate comparable to previous mass extinctions.[29]

When carbon dioxide (CO_2) dissolves in the ocean, it combines with water (H_2O), to create carbonic acid (H_2CO_3). In the last 200 years, the ocean has become 30% more acidic. This is incredibly dangerous to ocean life. The water literally dissolves animals' shells, putting the entire food chain at risk. Pteropods, pea-sized shelled animals, form much of the base of the food chain, and their shells are already dissolving in the Southern Ocean.[30]

"Gentlemen, it's time we gave some serious thought to the effects of global warming."

"Gentlemen, it's time we gave some serious thought to the effects of global warming."

And climate change is projected to increase the severity of extreme weather conditions dramatically: as surface temperatures have increased by 1% since the 1970s, there has been a 75% increase in category 4 or 5 hurricanes. Based on the damage from recent natural disasters, we may now face the choice between a carbon tax and a "climate disaster tax": In 2017, the United States spent $136 billion on climate-related disaster funding, approximately $1,000 per taxpayer. Moreover, these disasters are becoming both more frequent and costlier. In 2019, there were 14 weather and climate disasters that cost more than a billion dollars each, the fifth year in a row with ten or more such disasters. It is predicted that there will be a 275% increase in major hurricane damage risk by 2050 under a scenario with no climate change-mitigating action.[31]

A striking example of climate-related damage is the wildfires that swept California during 2020. In just one summer, which included the state's hottest August on

record, California was hit by the largest wildfire in its history, along with four of the next nine largest. Unfortunately, that year's devastating fires weren't an exception, but rather a continuation of a trend—2020 surpassed 2018 as the worst year on record in terms of area burned. California's wildfires have increased in area more than fivefold since 1972.[32]

While these disasters cause widespread tangible damage, the impact that rising temperatures have already had on human health are becoming more apparent. For years, chronic kidney disease has been on the rise, particularly in warmer regions such as Central America. Chronic kidney disease is often caused by frequent dehydration, which puts a greater strain on the kidneys. The odds of acute kidney injury, the ultimate cause of kidney failure, increase by 47% for every 5-degree temperature increase. In Costa Rica's Guanacaste province, the prevalence of chronic kidney disease has increased by as much as tenfold in men and fourfold in women since the 1970s. As temperatures rise, the "kidney stone risk belt" is moving north; 70% of Americans will live in high-risk areas by 2050, compared to 40% in 2000.[33]

Along with the impact on human health, climate change's effects on infrastructure and supply chains will be costly. According to current estimates climate change could shrink the U.S. economy by as much as 10% by the end of the century. By then, the cost of heat-related deaths and sea level rise is expected to total over $250 billion per year.[34]

Perhaps the most vivid short-run illustration of the damages of climate change was the destruction of the Ward Hunt ice shelf. This ice shelf was 80 feet thick and three times the size of Boston, making it the largest ice shelf in the Arctic, but in the summer of 2003, it split into two large pieces and many small islands, an event labeled "unprecedented" by scientists. Unprecedented, but perhaps not surprising: temperatures have been rising by 1 degree Fahrenheit per decade in the Arctic, and the thickness of this ice shelf had decreased by half since 1980.[35]

On July 12, 2017, one of the largest icebergs on record broke off of the Larsen C ice shelf in Antarctica. This chunk of ice covered more than 2,000 square miles and weighed about 1 trillion tons.[36] Over the past 25 years, Antarctica has lost 2.71 trillion tons of ice.[37] Recent studies have found that the eventual collapse of the West Antarctica Ice Sheet appears likely, leading to another 4 feet of sea level rise over the next several centuries, on top of the existing projected sea level rises.[38]

Figure 6-2 shows how much CO_2 the most polluting nations emit annually by burning fossil fuels, the main source of greenhouse gas emissions. (In the United States, in 2019, for example, fossil fuels accounted for about 63% of all the energy used).[39] China and the United States are by far the largest emitters of CO_2, together accounting for more than two-fifths of the world's total. But the high share of emissions for developing countries such as China or India is a relatively recent phenomenon: If we add up such emissions over the course of the twentieth century, we find that although developed nations have only 20% of the world's population, they are responsible for 60% of the total greenhouse gas emissions from fossil fuels.[40]

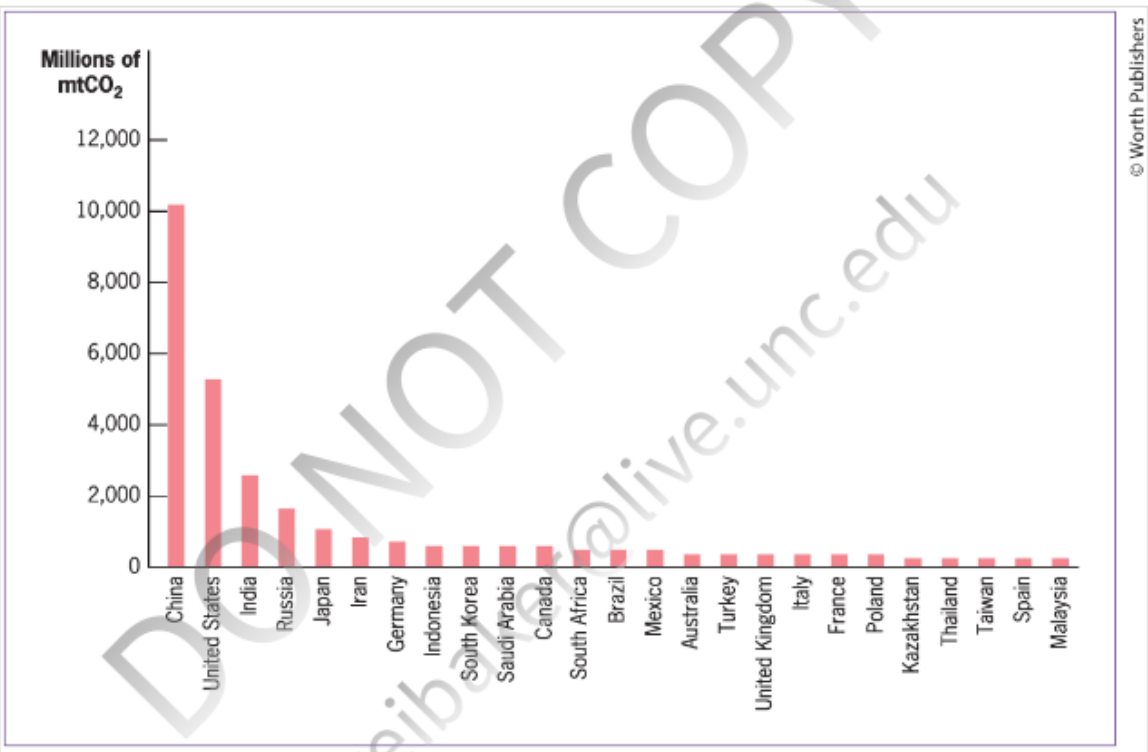

FIGURE 6-2 Top 25 Fossil Fuel CO_2, Emitters in 2019 • The United States and China together accounted for more than 40% of the world's total CO_2 emissions in 2019.

Data from: Friedlingstein et al. (2020).

Despite this unequal role in producing emissions, climate change is truly a global problem. Carbon emissions have the same effect on the global environment whether they come from Boston or Bangkok. Moreover, it is the stock of CO_2 in the air, not the level of yearly emissions, that causes warming. Climate change, therefore, is not a problem that can be solved immediately by cutting back on carbon use. Even if all nations ended their use of all fossil fuels today, it would take centuries to undo the damage done by the industrialization of the developed world.

APPLICATION

The Montreal Protocol

An excellent example of international cooperation is the Montreal Protocol of 1987, which banned the use of chlorofluorocarbons (CFCs). CFCs were a popular chemical used in many everyday products, including refrigerators, air conditioners, and aerosol sprays such as deodorant and hair spray. Their popularity partly derived from their very long life, but this longevity also led to a major environmental problem: CFCs were drifting into our stratosphere, and in the process of decaying were breaking down the ozone layer that protects the Earth from harmful UV-B radiation from the sun. As with climate change, this was a potentially enormous long-run problem: projections showed that, by 2050, ozone depletion would have reached 50 to 70% in the Northern Hemisphere, resulting in 19 million more cases of nonmelanoma skin cancer, 1.5 million cases of melanoma cancer, and 130 million more cases of eye cataracts.[41]

Unlike climate change, the CFC problem was showing itself immediately and urgently: by the 1980s, a hole measuring 25 million square kilometers had opened in the ozone layer over Antarctica. This hole spurred the international community to action, and in September 1987, the Montreal Protocol was adopted, aiming for a complete phaseout of specified chemicals (mostly CFCs and halons) according to specified schedules. This agreement was ratified by 184 countries, and worldwide consumption of CFCs dropped from 1.1 million tons in 1986 to 64,112 tons in 2004.[42] The result is that, after reaching its peak size in 2000 of 30 million square kilometers, the hole in the ozone layer has declined by 9%. It currently is about the same size as it was when it was first discovered, but will continue to recover and is expected to return to normal around 2070.[43]

One unintended consequence of banning chlorofluorocarbons is that the world found a substitute for hydrofluorocarbons (HFCs). HFCs are surprisingly large contributors to the greenhouse effect. Recognizing this, 197 countries met in Kigali, Rwanda, in 2016 to update the Montreal Protocol. Deliberations were difficult. Developing countries worried that using more expensive alternatives to HFCs would make air conditioners unaffordable for millions. Facing a projected explosion in HFC use, countries eventually agreed to an amendment to the Montreal Protocol. Wealthy countries would cap their HFC use by 2019, developing countries such as China and Brazil will have until 2024 to curb their use, and the poorest countries will have until 2028 and will be provided with foreign monetary assistance. Cutting these pollutants is projected to curb global temperature rise by 0.4 to 0.8 degrees Fahrenheit.[44] Although the United States signed the Kigali Amendment in 2016, it was not until January 2021, during President Biden's first week in office, that the United States began proceedings to ratify the amendment.

These positive examples of international coordination to curb CFCs and HFCs are very exciting. But these are cases with consequences that are immediate and observable and with required behavioral changes that are modest. The problem with the climate change case is that the changes are more subtle and the behaviors that we would have to curb are much more central to daily life (e.g., driving and heating). This makes international coordination of this type much more challenging. ■

The Kyoto Treaty

International conferences to address the problem of climate change began in 1988. The first peak of activity was a 1997 meeting in Kyoto, Japan, which was attended by more than 170 nations. At that meeting, after intense negotiation, the 38 industrialized nations agreed to begin to combat climate change by reducing their emissions of greenhouse gases to 5% below 1990 levels by the year 2010.[45]

These goals were written into a treaty that was ratified by 37 of the 38 signatory countries and went into effect in early 2005. Notably absent from the ratification list is the United States, which was not interested in committing to this level of emissions reduction. Given the growth in the U.S. economy since the Kyoto treaty was signed, a reduction to 7% below 1990 levels would have meant reducing 2010 emissions by 16%.[46] Nordhaus and Boyer (2000, Table 8.6) estimated that achieving the Kyoto targets would imply a present discounted value cost to the United States of more than $1 trillion. These authors estimated that the United States would bear a much higher share of the total world cost of meeting the Kyoto targets than the share that it contributes to annual greenhouse gas emissions. This is because U.S. emissions were forecast to grow so rapidly and would be very costly to reduce due to continued reliance on coal-fired power plants (as opposed to natural gas or nuclear-powered plants more frequently used in other nations at the time, such as Japan, which produced much lower levels of greenhouse gases).

Can Trading Make Environmental Agreements More Cost-Effective?

Given the enormous cost estimates just presented, the reluctance of the United States to ratify Kyoto is understandable. But these estimates ignored a key feature negotiated into the Kyoto treaty, largely at the behest of the United States: **international emissions trading**. Under the Kyoto treaty, the industrialized signatories are allowed to trade emissions rights among themselves, as long as the total emissions goals are met. That is, if the United States wanted to reduce its emissions to only 1990 levels, rather than to 7% below 1990 levels, it could have done so by buying emissions permits from another nation and using them to cover the reduction shortfall.

international emissions trading
Under the Kyoto treaty, the industrialized signatories are allowed to trade emissions rights among themselves, as long as the total emissions goals are met.

This is an important aspect of the treaty because there are tremendous differences across developed nations in the costs of meeting these goals, for two reasons. First,

across developed nations in the costs of meeting these goals, for two reasons. First, there are large differences in the rate of growth since 1990: the lack of economic (and thus emissions) growth in the 1990s in Russia, for example, implies that it will not be very costly for Russia to return to 1990 emissions levels. Second, growth has been more "environmentally conscious" in some nations than in others, so economic growth has not been as much accompanied by emissions growth in nations such as Japan that use more gas- and nuclear-powered production. Thus, much as with our two-firm example in Chapter 5, the total costs of emissions reductions can be reduced if we allow countries with low costs of reduction, such as Russia, to trade with countries with high costs of reduction, such as the United States. By some estimates, such trading could have lowered the global costs of reaching the Kyoto targets by 75%.[47]

This point is illustrated in Figure 6-3. This figure shows the market for carbon reduction, with millions of metric tons of carbon reduction on the x axis. There is a fixed target of carbon reduction in the Kyoto treaty for the United States at 7% below 1990 levels, a reduction of 440 million metric tons. The total worldwide mandated reduction under Kyoto was 630 million metric tons, so that the rest of the world would have had to achieve a net reduction of 190 million metric tons.

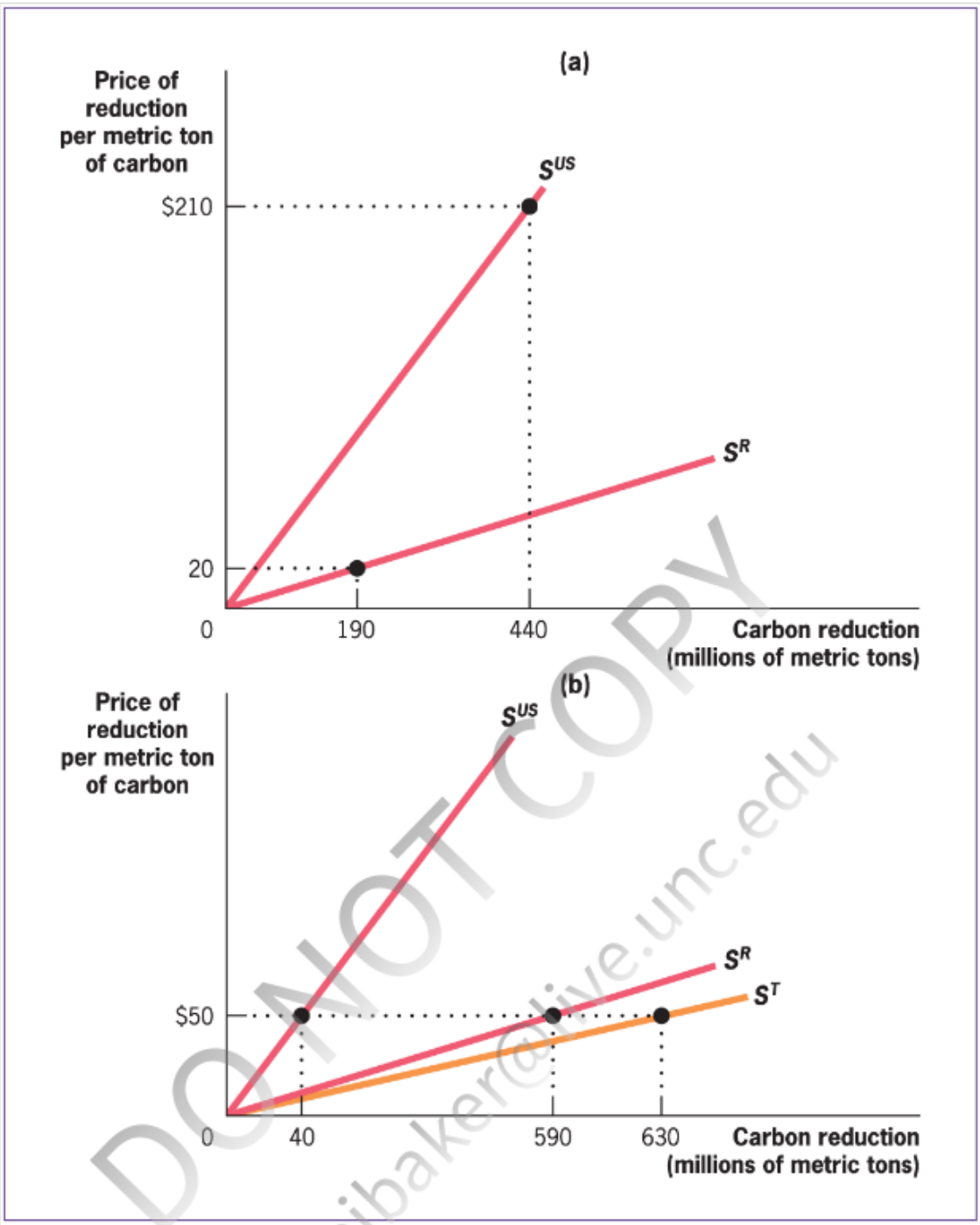

FIGURE 6-3 The Benefits of Trading • The supply curve of reductions for the United States (S^{US}) is much steeper than that for the rest of the world (S^R). If the United States has to do all of its reductions by itself (panel a), it costs $210 per ton of reduction. In that case, the United States reduces by 440 million metric tons (mmt) and the rest of the world reduces by 190 mmt. If the United States and other nations can trade (panel b), then the relevant supply curve is S^T. In that case, the price per ton falls to $50, with the rest of the world reducing by 590 mmt and the United States reducing by only 40 mmt.

With no trading, shown in panel (a), nations would have to meet this target from their own supply of reduction opportunities. The reduction opportunities in the

United States are represented by the supply curve S^{US}. This curve slopes upward because initial reduction opportunities are low cost: for example, plants that are close to energy-efficient can be fitted with relatively cheap changes to become energy-efficient. Costs rise as reduction increases, however: additional reductions may require replacing energy-inefficient but perfectly functional plants with newer ones at great cost.

In this no-trading world, the marginal cost of achieving the Kyoto target of a reduction of 440 million metric tons (as measured by the S^{US} curve) is $210 per metric ton of carbon. For ease, we combine the rest of the world into one group with reduction opportunities represented by S^{R} in panel (a) of Figure 6-3. The S^{R} curve lies far below S^{US}, indicating that these nations have much lower marginal cost reduction opportunities. For those nations to reduce by 190 million metric tons would cost them only $20 per metric ton of carbon.

Now suppose that the United States can buy permits from Russia and other nations. In panel (b) of Figure 6-3, we can measure the aggregate supply curve to the world market by horizontally summing the two supply curves S^{R} and S^{US} to obtain the aggregate supply curve S^{T}. The cost of the worldwide required level of reduction of 630 million metric tons is $50 per ton, given this supply curve. This means that, with international trading, any reductions that cost more than $50 per ton can be offset by purchasing permits instead. At that price, the United States would choose to reduce its own emissions by 40 million metric tons (because any additional reduction costs more than the $50 price per permit) and buy the remaining 400 from other nations. Other nations would reduce their emissions by 590 million metric tons, the 190 million required plus the 400 million sold to the United States. The total cost of meeting the Kyoto target worldwide would now have fallen substantially: instead of most of the reduction being done at high cost in the United States, it would now be done at low cost elsewhere.

That is, by distributing the reduction from the high-cost United States to other low-cost nations, we have significantly lowered the price of reductions worldwide. Note that, even though the marginal cost of reduction in other nations has risen, this is because they have moved up their supply curve: these other nations are happy to supply that higher level of reduction at $50 per metric ton (they are deriving substantial producer surplus from that transaction because most of their reduction costs much less than $50 per ton). The importance that U.S. environmental negotiators placed on negotiating this trading regime shows the extent to which

environmentalists in the United States internalized the lessons from the Acid Rain Program about the benefits of allowing flexibility in meeting environmental targets.[48]

Participation of Developing Countries

The trading story does not end with the developed nations of the world, however: emissions by developing countries have grown rapidly over the past several decades, and in 2019, advanced economies produced only about one-third of all global emissions, roughly the same share of emissions as China and India alone.[49] As a result, an agreement that does not ultimately include developing nations is doomed to failure as a mechanism for addressing climate change.

Moreover, including developing nations in such a plan adds flexibility and lowers the costs of meeting emission reduction targets. The cost of reducing emissions in developing countries is much lower than in the developed world. This is because it is much cheaper to use fuel efficiently as you develop an industrial base than it is to "retrofit" an existing industrial base to use fuel efficiently. By some estimates, if we had an international trading system that included developing nations, the cost to the developed world of complying with the Kyoto treaty would fall by another factor of four.[50] That is, with both international trading and developing country participation, the costs of meeting the Kyoto targets would be only one-sixteenth of their costs without these "flexibilities."

The developing nations wanted no part of this argument at Kyoto, however. They pointed out, correctly, that the problem facing the world resulted from environmentally insensitive growth on the part of developed nations. Why, they asked, should they be forced to be environmentally conscious and clean up the mess that the United States and other developed nations left behind? This conflict must be resolved for an effective solution to this global problem. Ultimately, obtaining the participation of developing nations will likely involve some significant international transfers of resources from the developed to the developing world as compensation.

APPLICATION

Congress Takes on Climate Change and Fails

In 2009, government initiatives to reduce climate change became a "hot" issue again, thanks to the election of a new Democratic president and to Democratic majorities in the House and Senate. In the House, Democrats Henry Waxman and Edward Markey cosponsored the American Clean Energy and Security Act (ACES), the most far-reaching effort to date to regulate carbon emissions.

A central feature of the proposal was to allow emissions permits to be traded, a process built on the lessons drawn from basic economics and on the success of trading under the CAA and its amendments. Under ACES, there would be lower limits on the amount of emissions allowed, and firms could comply with the tighter targets in a number of ways:

- They could reduce their emissions.
- They could continue emitting pollutants up to the amount of their purchased emissions permits.
- They could purchase pollution credits to offset their emissions. Such credits would be given to other entities that are not subject to the caps but that take actions to reduce climate change. For example, farmers who plant trees that sequester carbon from the air could receive credits for doing so, and they could sell these credits to a power plant, which could then use the credits to offset their emissions.

The Congressional Budget Office (CBO; 2009) estimated that emissions permits would cost $28 per ton of emissions by 2020.[51] In that year, roughly 80% of the permits would be given away to existing carbon-emitting firms, and 20% would be sold to polluters to raise government revenue. Over time, the share that is sold would rise, reaching 70% by 2035.

ACES immediately drew criticism from several sources. First up were those who criticized the bill for raising the cost of energy production because emitting firms would either need to buy permits, buy credits, or undertake other expensive actions to reduce their emissions. As one critic wrote, "[T]here's no getting around it—higher energy costs will inevitably lead to higher consumer prices and fewer jobs."[52] Indeed, the CBO estimated that the firms that must acquire permits would pass on the costs of doing so to their customers in the form of higher energy prices, with a gross cost to the economy of $110 billion in 2020, or almost $900 per household. To counter this objection, the CBO pointed out that these valuable permits would be initially allocated to emitting firms and that any money that the firms would receive if they sold their permits could offset their need to raise prices. The CBO estimated that the value of these permits would be $85 billion in 2020, so the net cost in 2020 would be only $25 billion ($110 billion − $85 billion) or $175 per household.[53]

Remember, however, that all such analysis was only a projection, and, as discussed in Chapter 5, because the costs of emissions reduction were uncertain, the cost to society of a fixed emissions target could have been much higher. The legislation recognized this issue and took several actions to address it, including allowing firms to "bank" any excess emissions permits they had purchased or been issued, allowing firms to meet their targets over a two-year period so they would not have to undertake radical reductions in one given period, and setting up a "strategic reserve" of extra allowances that would be provided to the market if the cost of allowances rose to more than 160% of their projected price.

The second source of criticism of ACES came from those who felt that the full value of the allowances should be rebated to consumers, not simply given back to the polluting industries. ACES attempts to address this concern by specifying that polluting utility companies should pass the value of the allocated permits back to consumers. This solution has two problems, however. First, there was no guarantee that the utilities would do so; they may have instead used the money raised from the sale

of these valuable permits to raise their profitability and thus the return to their investors. Second, if the permit values were passed back to consumers of energy, then ACES may have undone the very goal of the legislation, which was to raise the price of energy so that consumers use less of it!

It is for these reasons that economists strongly support not only having tradeable permits but also determining the initial allocation of permits through auction. That is, instead of directly giving the permits to various polluting firms, the government would hold an auction in which polluting firms would bid against each other for the permits that allow them to emit a specified amount of pollution. By charging polluters for their permits rather than giving them away, the government would simultaneously raise money and raise the prices of energy consumption (which would address the negative externality of climate change directly). But such an approach is less popular with politicians because they would then face opposition from polluting industries (which would have to pay for their permits) and from energy consumers (who would see higher energy prices). Whether the revenue raised from such an auction could be used to offset these criticisms is unclear. In the case of ACES, politicians apparently felt that the only way to pass the legislation was to give the pollution permits to the polluters rather than raise revenues by selling them.

The final concern came from others who felt that the legislation didn't go far enough to address climate change. But President Obama was confident that the bill would allow the United States to turn the corner toward more efficient energy use, saying, "This legislation will finally make clean energy … profitable energy."[54]

The debate over this legislation on the floor of the House of Representatives was contentious. The bill's opponents continued to portray the bill as a massive tax on U.S. energy consumption; Pennsylvania Republican Joe Pitts said, "No matter how you doctor it or tailor it, it is a tax."[55] Ultimately, on June 26, 2009, the bill passed by a narrow margin of seven votes. But, there was not enough support in the Senate to bring the bill to a vote, partly due to the political problems of raising energy costs during a recession, and the bill failed. There has been continued reluctance in recent years to attempt such a broad legislative approach to climate change. ■

The Paris Agreement and the Future

The most significant recent step toward incorporating developing countries into a worldwide plan to reduce emissions was the Paris Agreement of 2015. On December 12, 2015, 195 countries agreed to the Paris Agreement.[56] In doing so, these countries committed to strengthening "the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels" according to UN Climate Change. Ahead of its signing, 186 countries submitted plans for how they would limit their own emissions by 2025 or 2030. Under the agreement, countries were required to submit new, more aggressive plans for curbing their climate impact in 2020. Starting in 2023, a global progress evaluation would occur every five years so that the global community could assess each country's success at holding up their commitment.[57]

The United States pledged to reduce greenhouse gas emissions by 26 to 28% below 2005 levels and to make a best effort of cutting emissions by 28%.[58] This commitment was reflected in the Obama administration's Climate Action Plan, which included the CPP discussed in the introduction to this chapter. Goals outlined in the Paris Agreement were jeopardized in 2017, however, when President Trump announced his intention to remove the United States from the agreement.

The United States' official withdrawal from the Paris Agreement took effect on November 4, 2020, making it the first nation to back out of the agreement.[59] In his statement announcing the country's departure, President Trump remarked on the impact the agreement had as a burden on U.S. workers and industry, as well as the progress the United States has already made toward reducing emissions. Despite the decision to withdraw from the agreement, many states vowed to uphold their original commitments, and President Biden reentered the United States into the Paris Agreement during his first day in office.

In contrast, the world's largest emitter of greenhouse gases, China, made ambitious commitments in Paris. In order to fulfill them, China is set to launch what will be the largest emissions trading scheme in the world. In its first phase, this plan will encompass 1,400 companies and 3 billion tons of CO_2 annually.[60] The scheme will set maximum allowable emissions for companies, and then those companies will be able to buy and sell emissions credits below that cap. Over time, the maximum limit will decline, and the program will expand to include all of China's high-emitting industries.

In addition to this trading scheme for CO_2 emissions, China launched a campaign to curb pollution in 2014. A main focus of the campaign was to increase air quality monitoring and public awareness of the harm caused by pollution. Just four years later, cities had 32% less particulate matter in the air. China has imposed stricter rules and spent more money than most countries can fathom—the city of Beijing set aside $125 billion when the government mandated that they cut pollution by 25%.[61] The money appears to have worked: in the winter of 2017, the evidence was everywhere. The sky was blue, instead of gray with smog. Greenpeace estimated that there were 116,000 fewer premature deaths from environmental causes across China in 2017 than in 2016.[62]

Analysis of the program's effect on individual decision making have also shown it to be a success. As the public has become more aware of the issues of air pollution,

be a success. As the public has become more aware of the issues of air pollution, they have bought more air filters and limited their exposure to pollution-heavy areas, as reflected by housing prices and purchasing activities. At a minimum, these behaviors are beneficial for public health; the risk-compensating behavioral changes have been found to yield annual mortality benefits of at least RMB 122 billion (about $20 billion), greatly exceeding the costs of program implementation and forgone consumption.[63]

An important question for future debates about climate change is whether the international community should continue with quantity-based policy or move toward a price-based policy that would include internationally coordinated taxes on carbon usage, as advocated, for example, by Nordhaus (2006). The uncertainty model presented in Chapter 5 clearly suggests that taxation would dominate regulation (even with trading) in this context. This is because the benefits of emissions reduction are related to the existing stock of greenhouse gases in the atmosphere so that the marginal benefits of any given emissions reduction are constant: given the enormous boulder that must be moved to stop climate change, each additional person pushing on the boulder has a fairly constant effect. But the marginal costs of emissions reduction are both uncertain and not constant across nations; for some countries, reduction is low cost, while for others, it is expensive. As we learned in Chapter 5, in such a situation (i.e., one with uncertain and varying marginal costs, with flat marginal benefits), taxation dominates regulation because regulation can lead to excessive deadweight loss when emissions reduction gets very expensive.[64] Price and quantity approaches could even be combined in the future by pairing the quantity goals with a "safety valve" rule that allows countries to reduce their required emission reductions if the cost gets too high so that there is a price ceiling on quantity restrictions.

Of course, this discussion focuses on just two types of approaches to addressing climate change. There are a variety of other policy tools as well, ranging from changing how we eat (because methane from cows is a major source of greenhouse gases) to developing new "clean" technologies that can produce goods and services with a lower rate of emissions of gases. Indeed, the Global Calculator project sponsored jointly by the British and U.S. governments, as well as others, allows the user to assess the impact of alternative policy interventions on global temperature patterns.[65]

It is important to remember, however, that the use of these alternatives will ultimately be driven by government price and quantity policies. For example, one recent study found that use of clean technologies in automobiles is highly

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6.3 The Economics of Cigarette Smoking

All externalities are not large-scale environmental problems. Some of the most important externalities are local and individualized. Many of these arise in the arena of personal health, and one of the most interesting is cigarette smoking.

Cigarette smoking is the single greatest self-imposed health hazard in the United States today. The percentage of Americans who smoke has declined substantially over the past few decades, as shown in Figure 6-4, yet 14.2% of Americans still smoke. This is despite the fact that smoking causes more than 480,000 deaths each year, more than HIV, illegal drug use, alcohol use, motor vehicle injuries, and firearm-related incidents combined. More than ten times as many U.S. citizens have died prematurely from cigarette smoking than have died in all the wars fought by the United States during its history.[67]

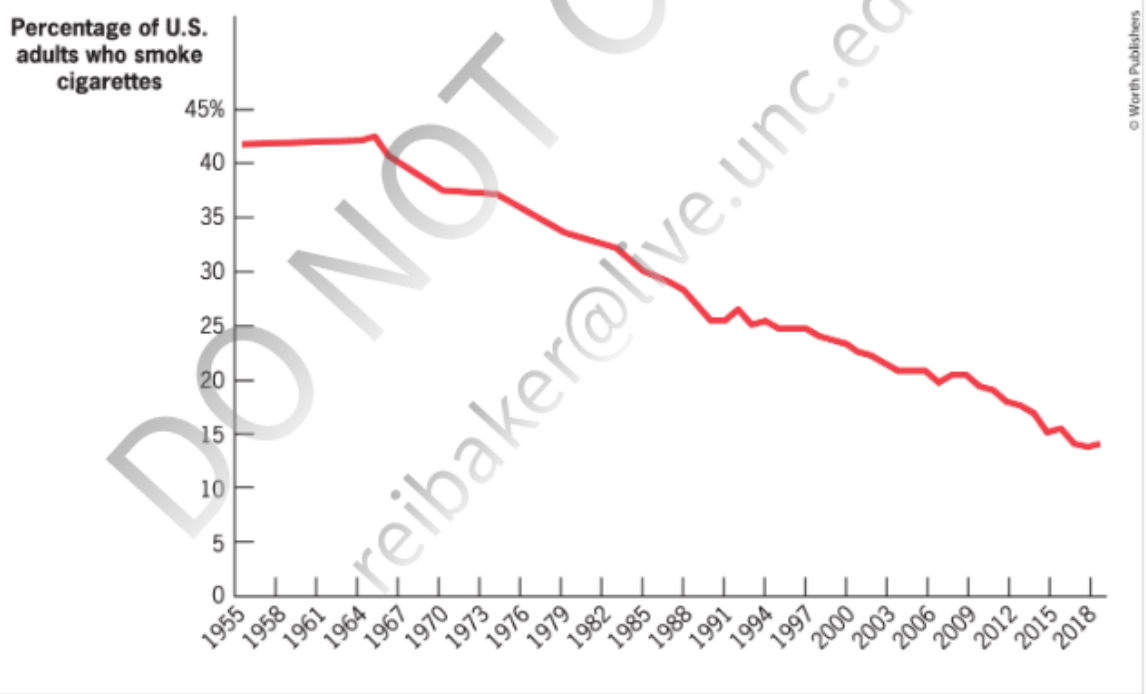

FIGURE 6-4 Annual Percentage of U.S. Adults Who Smoke Cigarettes, 1955–2019 • Before the U.S. Surgeon General's report on the harmful effects of smoking came out in 1964, the rate of smoking in the United States was fairly flat. After, the rate fell steadily.

Data from: Centers for Disease Control and Prevention (2015, 2019).

Worldwide, the problem is even worse. Of the 1.3 billion smokers alive today, up to half will die of smoking-related disease. Over 8 million persons will die annually from smoking-related diseases, and soon it is expected that cigarette smoking will

be the leading cause of overall death (not just preventable death) throughout the world.[68]

Are these dire facts a cause for regulating cigarette smoking? Not in the view of traditional microeconomics. In the standard utility maximization model, any damage that individuals do to themselves from dangerous activities such as smoking results from a rational choice of trading off benefits against potential costs. The health hazards of smoking are now well known. The fact that smokers smoke given these risks, economists say, reveals their preference for the current pleasure of smoking over the distant costs of a shorter life.

Doesn't this argument ignore the fact that cigarette smoking is highly addictive? After all, leading experts on addiction rate nicotine as more addictive than either caffeine or marijuana and, in some cases, comparable to cocaine: among users of both tobacco and cocaine, about half say that the urge to smoke is as strong as the urge to use cocaine. Doesn't this mean that the damage that individuals do to themselves is a call to government action?

Once again, the answer from traditional economics is no. As postulated in a highly influential article by Becker and Murphy (1988), "rational addicts" understand that each cigarette they smoke today increases their addiction, leading them to smoke more tomorrow. As a result, when they buy a pack of cigarettes, they consider not only the cost of that pack but also the cost of all additional future packs that will now be purchased because their addiction has deepened. Moreover, the smoker understands that lighting up doesn't just reduce health through the current cigarette, but through all the future cigarettes that will be consumed as a result of that addiction. If the smoker consumes the cigarette anyway, then this is a rational choice that does not call for government intervention.

The Externalities of Cigarette Smoking

The key public finance implication of the traditional economics approach is that the appropriate role for government is solely a function of the externalities that smokers impose on others. Like all other consumption decisions, cigarette smoking is governed by rational choice. That smokers impose enormous costs on themselves is irrelevant to public finance; only the costs smokers impose on others call for government action. Measuring the externalities from smoking is complicated, however, as we discuss next (and summarize in Table 6-1).

TABLE 6-1 The Effects of Smoking: Externalities or Not?

Effect	Not an externality if ...	An externality if ...
Increased health care costs	Insurance companies actuarially raise premiums for smokers.	Many individuals are insured by entities that spread the health costs of smokers among all of the insured; also, the health costs of the uninsured are passed on to others.
Less-productive workers	Employers adjust individuals' wages according to productivity.	Employers do not adjust wages according to individual productivity, so that they must lower wages for all workers to offset productivity loss.
Increased number of fires	Smokers set fire only to their own property, requiring no help from the fire department, and insurance companies adjust premiums according to smoking status.	The fires damage nonsmokers' property, raise the cost of the local fire department, or raise fire insurance premiums for all.
Earlier deaths	Smokers do not pay Social Security taxes or would not incur medical costs later in life.	Nonsmokers save money because smokers die too early to collect full Social Security benefits and because their deaths reduce the high health costs near the end of life (a positive externality).
Secondhand smoke effects	The effects are minimal or smokers account for their families' utility when deciding to smoke.	The effects are serious and smokers do not account for their families' utility when deciding to smoke.

Cigarette smoking has a number of physical and financial effects, but in many cases, they may not be externalities. The first column of this table lists examples of the effects of smoking. The second column discusses the situations under which these are not externalities, and the third column discusses the situations under which they are externalities.

Increased Health Costs from Smoking

By one estimate, smoking-related disease increases U.S. medical care costs by $176 billion, about 8.7% of the total cost of health care in the United States (Xu et al., 2015). This enormous number alone does not, however, justify government intervention. Suppose that all individuals in society had health insurance that they purchased on their own and that the price of that health insurance was set by insurance companies as a function of smoking status. Insurance companies would compute the extra amount they expect to spend on the medical care of smokers and charge smokers a higher premium to compensate the insurance company for those extra costs. Such increases in insurance prices to compensate for expected expense differences are called **actuarial adjustments**. Actuarial adjustments internalize the medical cost externality from smoking. In this simplified model, there are no health externalities because smokers pay for the high medical costs associated with smoking through actuarial adjustments: society (in this case, the insurance

companies) is fully compensated for the extra costs due to smoking through these higher premiums.

actuarial adjustments
Changes to insurance premiums that insurance companies make in order to compensate for expected expense differences.

The external effects of increased health costs due to smoking arise because the real world deviates from this simplified example in three ways. First, insurance is not always actuarially adjusted for smoking behavior. At MIT, the price that I pay for my group insurance is independent of my smoking behavior. If I smoke, and if I have high medical costs, then the insurance company will have to raise the premiums that it charges to everyone at MIT by a small amount to compensate for this loss. In this case, I have exerted a negative externality on my coworkers, which I do not internalize because I do not fully pay the higher premiums associated with my smoking. This externality is falling over time, however, as companies are more frequently charging an insurance surcharge to their employees who smoke;[69] in addition, the Patient Protection and Affordable Care Act (ACA) allows insurance rates to vary across individuals only by age and by smoking status (but not other health measures).

Quick Hint

Externalities can be financial as well as physical. My smoking creates an externality because the social marginal benefit of my consumption of cigarettes is below my private marginal benefit by the extra amount that my coworkers have to pay for insurance.

Second, individuals who receive their insurance from the government do not pay higher premiums if they smoke. In this case, the negative externality occurs because the medical costs incurred by smokers are borne by all citizens through higher taxation. Finally, some individuals are uninsured and will not pay the cost of their medical care. Medical providers will typically make up these costs by increasing the amount they charge to other medical payers, exerting a negative financial externality on those payers.

Workplace Productivity

There are many reasons smokers may be less productive in the workplace: they may require more sick leave or more frequent breaks (for smoking) when at work. One study found that smokers impose $600 to $1,100 per year in productivity and

absenteeism costs on businesses, and another found that smokers miss 50% more workdays each year due to illness than do nonsmokers.[70] Is this a negative externality to the firm? Once again, the answer is a qualified maybe. In this case, it depends on whether these workers' wages adjust to compensate for their lower expected productivity. That is, actuarial adjustments aren't necessarily found only in insurance markets; they may exist in labor markets as well. If wages fall to compensate the firm for a smoker's lower productivity, then the firm can internalize the productivity externalities associated with smoking. If not, these externalities will not be internalized.

Fires

Smokers are much more likely to start fires than nonsmokers, mostly due to falling asleep with burning cigarettes. In 2011, for example, fires started by smokers caused 540 deaths and $621 million in property damage in the United States, and Markowitz (2010) reported that cigarettes caused 3 to 4% of all residential fires in the United States.[71] Does this death and destruction represent an externality? If a smoker lived by himself on a mountain and burned down his house, killing himself, but with no damage to any other person, flora, or fauna, then there is no externality. But, in reality, externalities from such fires abound. There is the cost of the fire department that combats the fire, the damage that the fire may do to the property of others, and the increased fire insurance premiums that everyone must pay unless there is appropriate actuarial adjustment in the fire insurance market to account for whether or not a policy holder is a smoker.

The "Death Benefit"

An interesting twist on the measurement of smoking externalities is presented by the positive externalities that the early deaths of smokers create for taxpayers. Consider, for example, the Social Security program, which collects payroll tax payments from workers until they retire and then pays benefits from that date until they die. Smokers typically die around retirement age so that they do not collect the retirement benefits to which their tax payments entitled them. In this situation, smokers are exerting a positive financial externality on nonsmokers: smokers pay taxes to finance the retirement benefits but do not live long enough to collect their benefits, leaving the government more money to pay benefits for nonsmokers. Thus, through the existence of the Social Security program, smokers benefit nonsmokers by dying earlier.

Moreover, the fact that smokers die earlier also offsets many of the medical cost effects of smoking. If smokers die at 65, then they won't impose large nursing home and other medical costs at very advanced ages. These avoided medical costs offset much of the additional medical costs from treatment for cancers and heart disease at younger ages.

Externality Estimates

The effects of these four components, along with some other minor negative externalities, make the estimate of the external costs of smoking roughly $0.56 per pack in 2020 dollars.[72] This figure is sensitive to many factors, most importantly how one takes into account that the costs are often in the distant future while the benefits of smoking are current. Nevertheless, by most estimates, the external cost of smoking is well below the average federal plus state cigarette tax in the United States, which is more than $1 per pack. Of course, these estimates leave out another externality that is potentially important but very difficult to quantify: **secondhand smoke**.

secondhand smoke
Tobacco smoke inhaled by individuals in the vicinity of smokers.

What About Secondhand Smoke?

The damage done to nonsmokers by breathing in secondhand cigarette smoke is a classic externality because individuals do not hold property rights to the air. Without clearly defined property rights, complete Coasian solutions to this problem are not available. Yet the costs of secondhand smoke are not easily added to the list of external costs we have noted for two reasons. First, there is considerable medical uncertainty about the damage done by secondhand smoke. As a result, estimates of the externalities from secondhand smoke vary from $0.01 to $1.39 per pack![73]

Second, most of the damage from secondhand smoke is delivered to the spouses and children of smokers. And this damage can be significant: a recent study found that when cigarette taxes increase, reducing parental smoking, child sick days, doctor visits, and other medical care use falls as well.[74] If a smoking parent includes the utility of their family members in their utility function (maximizing family rather than just individual utility), they will take into account the damage they do to their spouse and children by smoking. In this case, in making the choice to smoke, the smoker has decided that their benefits from smoking exceed the health costs both to themselves and to their family members. When the externality is internalized in

themselves and to their family members. When the externality is internalized in

this way, the cost to other family members from being made ill must be offset by the large benefit the parent receives from smoking, or else they wouldn't smoke. But, if the smoking parent fails to account fully for the costs to their family members (fails to maximize family utility), then some of the damage that they do to others will not be internalized and should be counted in the externality calculation. Existing evidence suggests that family utility maximization is, in fact, incomplete, so these secondhand smoke costs are, to some extent, externalities.[75]

Should We Care Only About Externalities, or Do "Internalities" Matter Also?

The traditional economics approach suggests that the only motivation for government intervention in the smoking decision is the externalities that smokers impose on others because any damage that smokers do to themselves has been accounted for in the smoking decision. But this model ignores some key features of the smoking decision that suggest that there may be other rationales for government intervention.

Two such features are particularly important: the decision by youths to smoke and the inability of adults to quit. After reviewing these features, we turn to how they challenge the traditional view of cigarette taxes based solely on externalities by suggesting that self-inflicted smoking damage matters for government policy as well.

Youth Smoking

Of all adults who smoke, more than 75% begin smoking before their 19th birthday, but economics does not yet have a satisfactory model of the behavior of teenagers (as a matter of fact, neither do parents!).[76] The traditional model of smoking presumes that the decision to initiate this addictive behavior is made with a fully rational trade-off in mind between current benefits and future costs. If teens who begin to smoke do not correctly and rationally evaluate this trade-off, then government policy makers might care about the effect of the smoking decision on smokers themselves.

Indeed, there is some evidence that this monumental decision may not be made in the forward-looking fashion required by rational addiction models. A survey asked high school seniors who smoked a pack a day or more whether they would be smoking in five years and then followed up with the seniors five years later. Among

those who had said they would be smoking in five years, the smoking rate was 72%—but among those who said they would *not* be smoking in five years, the smoking rate was 74%! This result suggests that teens who smoke may not account for the long-run implications of addiction. And this overconfidence about quitting is not restricted to youth—a recent study found that adult smokers overestimate their likelihood of future abstinence by more than 100%.[77]

Adults Are Unable to Quit Smoking Even If They Have a Desire to Do So

Another key fact about smoking is that many adults who smoke would like to quit but are unable to do so. Consider the following facts:

- Eight in ten smokers in the United States express a desire to quit the habit, but many fewer than that actually do quit.
- According to one study, more than 80% of smokers try to quit in a typical year, and the average smoker tries to quit every eight and a half months.
- 54% of serious quit attempts fail within one week.

These facts are worrisome because they hint that smokers may face a **self-control problem**, an inability to carry out optimal strategies for consumption. Economic theory assumes that individuals can not only optimize their utility function but that they can also then carry out those optimal plans. There is much evidence from psychology, however, that contradicts this assumption: individuals are often unable to carry out long-term plans that involve self-control when there are short-term costs to doing so. An excellent example of this is smoking, where there is a short-term cost of quitting (in terms of physical discomfort and mental distress created by withdrawal) but a long-term health benefit. Other examples include retirement savings (short-term cost in terms of forgone consumption today, but long-term benefits in terms of a higher standard of living in retirement) or whether to diet and/or exercise (short-term costs in terms of less food or more work today, but long-term benefits in terms of a longer life). In many arenas, individuals appear unable to control their short-term desires for their own long-term well-being.

self-control problem
An inability to carry out optimal strategies for consumption.

There are two types of evidence for the existence of self-control problems. The first is from laboratory experiments in psychology. In laboratory settings, individuals consistently reveal that they are willing to be patient in the future but are impatient today, the defining characteristics of self-control problems. A person with self-

today, the defining characteristics of self-control problems. A person with self-

control problems has the right long-run intentions (they rationally optimizes their utility function given their budget constraint), but they just can't carry them out. For example, in one experiment, most people preferred a check for $100 that they could cash today over a check for $200 that they could cash two years from now. Yet the same people prefer a $200 check eight years from now to a $100 check six years from now, even though this is the same choice—it's just six years in the future.[78] This is consistent with self-control problems: individuals are willing to be patient in the future, but not today when faced with the same choice.

The second type of evidence for self-control problems is the demand for **commitment devices**. If individuals have self-control problems and are aware of those problems, they will demand some type of device that helps them fight these problems. And the search for such commitment devices is the hallmark of most recommended strategies for quitting smoking: people regularly set up systems to refrain from smoking by betting with others, telling others about the decision, and otherwise making it embarrassing to smoke. These practices help individuals combat their self-control problems by raising the short-run costs of smoking to offset the short-run benefits of smoking. The use of self-control devices is widespread in other arenas as well: individuals set up holiday club accounts at their banks to make sure they have enough money to buy holiday presents, and they buy memberships at gyms to commit to working out when it would generally be cheaper to just pay each time they go.[79]

commitment devices
Devices that help individuals who are aware of their self-control problems fight their bad tendencies.

Implications for Government Policy

Both irrationalities among youth smokers and self-control problems among older smokers seem to be sensible features of any model of the smoking decision: we all know (or were) irrational youths, and we all know (or are) individuals with problems of self-control. Yet these sensible psychological additions to the standard economic model have dramatic implications for government policy because, in either case, it is not only the external damage from smoking that matters for government intervention but also some of the damage that smokers do to themselves. If smokers make mistakes when they are young, or would like to quit but cannot, the damage from smoking is a **negative internality**, which refers to the damage done to oneself through adverse behavior that is not fully accounted for in decision making. This internality justifies government regulation of smoking in the

same way that externalities do in the traditional model. The government is once again addressing a failure; in this case, it is not an externality on others, but rather a cost imposed on one's long-run health by one's short-run impatience or teen irrationality. If the government can make individuals better off in the long run by addressing short-run failings, then it can increase efficiency as if it were correcting a market failure.

negative internality
The damage done to oneself through adverse behavior that is not fully accounted for in decision making.

The stakes here are high. While the damage that smokers do to others is, on net, small, the damage that smokers do to themselves is extensive. Consider just one aspect of that damage: shortened lives. The average smoker is estimated to live about six fewer years than nonsmokers. A year of life is typically valued by economists at about $200,000 (using methods discussed in detail in Chapter 8). At this estimate, the value of life lost from smoking is about $35 per pack! This is an enormous figure, on the order of 75 times larger than the typical estimate of the external damage done by smoking.

The government has several policy tools at its disposal for addressing internalities. One tool is information. Much of the decline in smoking over the past 30 years has been traced to the release of information about the dangerous health implications of smoking. Information about long-run health effects will not, however, effectively combat problems of self-control or teen irrationality.[80]

The government can also solve the inability of the private market to provide sufficient commitment. Private commitment mechanisms are not fully successful for smokers, as highlighted by the facts on self-control earlier. More generally, private commitment mechanisms don't show promise in getting individuals to invest in preventive care.[81] But an excellent commitment device is available to the government: taxation, which raises the price of cigarettes to smokers. A large body of evidence shows that smokers are fairly sensitive to the price of cigarettes, with smoking falling by about 5% for each 10% rise in prices (and by even more among especially price-sensitive youth smokers). By raising taxes, the government can force smokers to face higher costs that lower their smoking, providing the desired self-control.[82] Gruber and Koszegi (2004) calculated that, for the type of self-control problems documented in laboratory experiments, the optimal tax would be on the order of $5 to $10 per pack, above and beyond any taxes imposed to combat externalities. This is a high level that is well above taxation rates today.

The notion that government policy should be determined not just by externalities, but by internalities as well, is a major departure from traditional microeconomic policy analysis. As such, much more research is needed to decide how large internalities really are. Nevertheless, the enormous health costs of smoking ($35 per pack) suggest that even if such internalities are small, they might justify large government interventions.

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6.4 The Economics of Other Externality-Creating Behaviors

While cigarette smoking is a particularly interesting application, it is by no means the only health behavior in which externalities (or internalities) potentially cause market failure. We briefly consider three others.

Alcohol Use

Alcohol consumption presents an interesting alternative example to cigarette smoking because the externalities associated with alcohol use are much larger than those associated with smoking. This is mostly because the major externality associated with alcohol consumption is damage due to drunk driving. Every day, almost 30 people in the United States die in motor vehicle crashes that involve an alcohol-impaired driver. This amounts to one death every 48 minutes. In 2019, 10,142 people were killed in alcohol-impaired driving crashes, accounting for nearly one-third (28%) of all traffic-related deaths in the United States.[83] Overall, the estimated social costs of excessive drinking are about $250 billion per year or about $2,000 per U.S. household.[84] Even though the drunk driver may lose their license and see their insurance premiums rise, they are unlikely to bear the full costs to society of their action. An estimate for the externalities due to alcohol use is $2.05 per drink,[85] which is much higher than current alcohol taxes that amount to an average of $0.21 per ounce of ethanol and depends on the type of drink (taxes per ounce of ethanol vary across beer, wine, and other alcoholic drinks).[86]

These figures do not include another potentially important externality from alcohol use: the increased tendency toward violence and crime. A total of 55% of violent crimes and two-thirds of victims attacked by a significant other report that the perpetrator had consumed alcohol before committing the crime.[87] A series of articles by Sara Markowitz and colleagues document strong effects of anti-alcohol policies (such as higher taxes on alcohol) in lowering violence, crime, risky sexual behavior, and sexually transmitted diseases.[88] A study in India found that alcohol prohibition was associated with large reductions in violence against women.[89] And after implementation of the 24/7 Sobriety Program in South Dakota, which sentences drunk driving offenders to mandatory abstinence with constant monitoring, there was a sizable reduction in DUI arrests, domestic violence, and deaths.[90] Once again, if this violent behavior only involves family members, it may

or may not be an externality; when it involves others, such as through criminal acts, the behavior is clearly an externality.

The internalities due to alcohol use may be much smaller than those due to smoking, however. Drinking in small quantities may impair one's driving, but it may actually be good for long-run health. And it is only a small share of alcohol users who damage their health or otherwise harm themselves by drinking. Thus, the major rationale for government regulation of alcohol use is the standard one, from externalities. That said, drinking does have at least some internalities through reduced health; one recent study in Russia showed a powerful effect of alcohol liberalization in raising death rates and of higher alcohol taxes in lowering mortality.[91]

The appropriate role for government in regulating alcohol use is difficult because the externalities due to drinking arise from the share of alcohol use that results in drunk driving and violence, which is relatively small. In theory, the optimal policy would target drunk driving and violence with steeper fines and penalties. But it is impossible to realistically raise the cost of drunk driving or violence enough to account for the externalities of that activity. At the other extreme, raising taxes on all alcohol consumption is a very blunt instrument that will lower drinking too much among those who aren't going to drive drunk or commit violent acts and not enough among those who are at risk for driving drunk or alcohol-related violence.

Nevertheless, given the enormous damage done by alcohol use, higher alcohol taxes would raise social welfare overall, relative to a system that leaves taxes at a level so far below the externalities of drinking.[92] As Lopez (2018) argues persuasively, a higher tax would have huge benefits to society, and taxes would be borne disproportionately by those who consume the most alcohol. Thus, there would be relatively little cost on the casual drinker, but enormous benefits of reduced externalities from heavy drinking.

Illicit Drugs

Another addictive behavior that raises government concern is the use of illicit drugs, such as marijuana, cocaine, ecstasy, and heroin. In the United States, as in most countries, the government regulates these activities by prohibiting illicit drug consumption, subject to criminal penalty. This is a particularly interesting case because most of the externalities associated with illicit drugs arise because of their illegality. Indeed, legal consumption of some illicit drugs is likely to have much

lower externalities than consumption of alcohol. Thus, the rational addiction model would suggest that there is no more call for regulating illicit drug use than for regulating smoking. As the famous economist Milton Friedman wrote in 1972, in advocating the legalization of drugs, "The harm to us from the addiction of others arises almost wholly from the fact that drugs are illegal. A recent committee of the American Bar Association estimated that addicts commit one-third to one-half of all street crime in the U.S. Legalize drugs, and street crime would drop dramatically."[93] And a group of 22 medical experts convened by Johns Hopkins University in 2016 called for the decriminalization of all nonviolent drug use and possession, instead moving gradually toward regulated drug markets.[94]

This type of argument has been influential in the recent wave of marijuana legalization in the United States. Marijuana has been legalized for medical purposes or decriminalized in 44 states and the District of Columbia. Full legalization for recreational use is in place in 18 of those states (Alaska, Arizona, California, Colorado, Illinois, Maine, Massachusetts, Michigan, Montana, Nevada, New Jersey, New Mexico, New York, Oregon, South Dakota, Vermont, and Washington) and the District of Columbia, beginning with Colorado in 2014.[95] Since the law passed, there has been a 59% decrease in marijuana arrests.[96] At the same time, past studies of states with medical marijuana laws have found significant rises in the likelihood of initiating use of marijuana by teens and a rise in the odds of frequent smoking by adults.[97]

Yet, despite the move to legalize marijuana, broader drug legalization remains a radical idea in most nations, including the United States. Thus, policy makers clearly don't believe that the rational addiction model applies equally to illicit drugs and other potentially addictive activities, such as drinking and smoking. For illicit drugs, but not for smoking and drinking, the government appears to have concluded that individuals are not making the right long-term decisions for themselves—otherwise, it is difficult to rationalize the public policies pursued in most industrialized nations.[98] In 2020, Oregon became the first state to decriminalize all drugs, a significant step toward broader drug legalization.

EMPIRICAL EVIDENCE

The Effect of Legal Drinking at Age 21

In the United States today, the legal drinking age is 21, but in many states, it was lowered to 18, 19, or 20 during the early 1970s, before being normalized back to age 21 in the late 1980s. One concern with a lower drinking age is that youths are particularly susceptible to the internalities and externalities of

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drinking, particularly with respect to drunk driving. At the same time, others argue that a drinking age of 21 doesn't stop youth drinking and may even make it worse. Vice-chancellor and president of University of the South, John McCardell, said in a *New York Times* op-ed, "those against whom the law is directed routinely evade it, and often with life-threatening results." McCardell says the law has created a dangerous culture of irresponsible and reckless behavior and unsupervised binge and extreme drinking.[99] So does the drinking age matter? Addressing this question by simply comparing drinking rates above and below age 21 would not be convincing because those over age 21 may have different tastes for drinking than those below age 21. Suppose, for example, that the taste for alcohol rises with age. Then we might find that drinking rises after age 21 but that this increase has nothing to do with legality. If noncomparability due to differing tastes for drinking by age is the source of the difference, rather than the difference in legal status, then our estimates of the effect of the drinking age on drinking would be biased. Research, however, has suggested two interesting empirical strategies for addressing this noncomparability issue.

The first is to use the fact that states changed their drinking ages at different times in the 1980s as they moved from lower drinking ages toward a nationally uniform standard of age 21. This provides an excellent quasi-experiment, in which the treatment group is states that raised their drinking ages and the control group is states that didn't. If the drinking age matters for drinking, then drinking should have fallen among those people between the old drinking age and age 21 when the law changed, relative to states where the law did not change.

A number of studies have assessed this quasi-experiment and have found that raising the drinking age not only deterred youth drinking but also had other important effects. Carpenter and Dobkin (2011) summarized the evidence and reported that a lower drinking age led to 6 to 17% more drinking among 18- to 20-year-olds. Cook and Moore (2001) found that a lower drinking age led not only to more drinking among youths but also that as those youths aged, they drank more. That is, those who started earlier were more likely to drink later in life. Carpenter and Dobkin (2011) found that lower drinking ages were associated with a 17% increase in the rate of motor vehicle deaths for 18- to 20-year-olds. And Fertig and Watson (2009) found that lower drinking ages led to worse outcomes for births to teen mothers, including low birth weight and premature births.[100]

The second empirical strategy is to contrast outcomes in recent data right around the 21st birthday. While those who are over 21 may be different in general than those under age 21, those who are observed in the few days before their 21st birthday should be very similar to those in the few days after their 21st birthday—except for the fact that the latter group can drink legally. By comparing the outcomes among those comparable groups just before and after their 21st birthday, researchers can derive a causal estimate of the impact of legal drinking on outcomes through what is called a regression discontinuity approach.

This approach is illustrated in Figure 6-5, from Carpenter and Dobkin (2009). The *x* axis of this figure shows age in monthly intervals. The bottom line (in red) graphs the proportion of days on which individuals had a drink (and the quantities are denoted on the left-hand vertical axis). The points in the figure are the actual monthly averages by month of age. The solid line is a regression line of the type discussed in Chapter 3, but where the regression line is estimated separately for ages up to 21 and ages over 21. What is clear from this diagram is that there is a discontinuous shift at age 21—a clear jump in the proportion of days drinking at the 21st birthday. Regression analysis that uses the actual birthday, rather than just month of birth, shows that those individuals just over age 21 spend about 30% more days drinking than those just below age 21.[101] This sizeable discontinuity suggests that there is an effect of legalization at age 21.

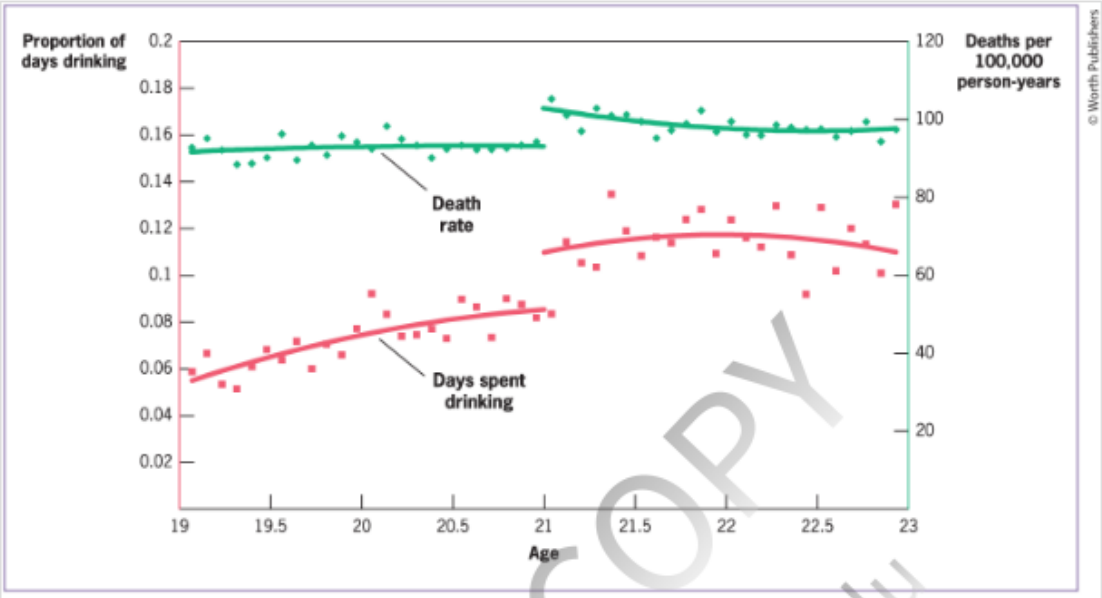

FIGURE 6-5 Changes in Drinking and Mortality Around Age 21 • There is a strong "regression discontinuity" around age 21 for both the proportion of days spent drinking and the death rate.

Data from: Carpenter and Dobkin (2009).

The top line (in green) repeats this exercise for a different outcome: death rates (the quantities denoted on the right-hand vertical axis). Once again, there was a striking jump in death rates at age 21, with death rates just after the 21st birthday being 9% higher than just before. That is, the higher numbers of people drinking just after becoming legal was associated with higher rates of mortality. The authors also show that these mortality effects derived largely from higher alcohol-related driving deaths.

Other studies confirm the importance of age 21 for the damage done by drinking. Carrell et al. (2011) found that academic performance suffered upon reaching the drinking age. Yoruk (2015) found that young adults worked less when drinking became legal. Ahammer et al. (2020) found a similar jump in alcohol consumption days by 39% upon reaching legal drinking age in countries where the drinking age is 16. And Hansen and Waddell (2016) found that crime increased right at age 21, with increases due to assaults lacking in premeditation and alcohol-related nuisance crimes. It is clear from these empirical analyses that the drinking age in the United States does matter, and that lowering it would have serious adverse effects on those aged 18 to 20.[104]

As scientific discovery and medical advancements have allowed us to cure disease, increase life expectancy, and live healthier, certain preventable deaths, such as drug overdose deaths, have not followed this positive trend. In fact, overdose deaths have generally been on the rise—with drug overdose deaths surpassing motor vehicle crashes in fatalities for the first time in the modern era in 2009.[102]

The major driver of this trend in overdoses was abuse of opioids. Throughout much of the twentieth century, use of prescription opioids was limited by the medical

profession due to concerns about addiction.[105] But an increased realization that physicians were undertreating pain, as well as advancement in "slow-release" opioid formulations such as OxyContin led to much more aggressive use starting in the late 1990s.

Unfortunately, it became apparent within about a decade that this change in treatment modality had enormous negative consequences. There was massive oversubscribing of prescription opioids, as the new formulations provided to be highly addictive. Moreover, it was easy to increase the potency of these drugs by crushing and snorting pills, which fueled addiction and created a massive illegal market for prescription painkillers. By 2009, over 37,000 Americans were dying annually from opioid overdoses.[106]

In reaction, a number of states passed laws that made it much harder to obtain prescription opioids, and the federal government mandated in 2010 that oxycodone move to an "abuse-deterrent" formulation. Unfortunately, these well-meaning policies exacerbated the crisis, as already addicted users moved on to a now-cheaper but much more dangerous alternative: heroin. Things got even worse after 2013, after fentanyl, a much more potent synthetic opioid, began appearing in drug markets. This led to the enormous peak of deaths seen in Figure 6-6. This episode highlights the need for careful regulation of potentially addictive drugs even when they are legal.

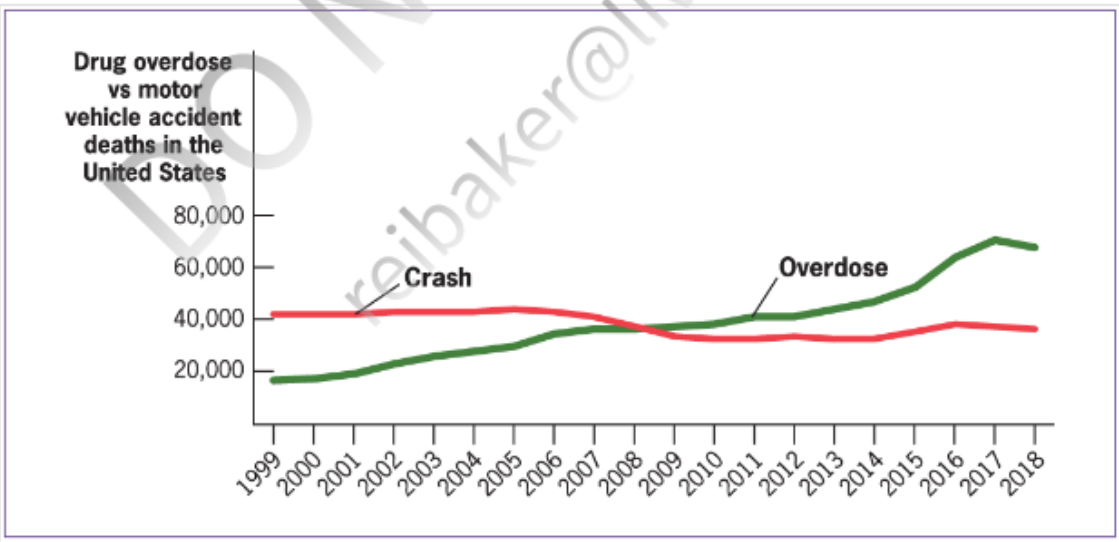

FIGURE 6-6 Drug Overdoses Surpass Motor Vehicle Deaths • Driven largely by the increase in opioid addiction, drug overdose deaths have been on the rise since the 1990s, even as other preventable deaths, such as motor vehicle accidents, have decreased.

Data from: https://www.cdc.gov/nchs/data/databriefs/db356_tables-508.pdf#1
https://www.iihs.org/topics/fatality-statistics/detail/yearly-snapshot

APPLICATION

Public Policy Toward Obesity

An important health externality that has been gaining attention in the United States and elsewhere is obesity. *Obesity* is defined as having a body mass index (BMI) well above the norm for one's age. The BMI measures the ratio of height to weight. There has been an enormous rise in obesity in the United States: the share of the adult population classified as obese has risen from 13.4% in 1960 to 42.8% in 2018.[107] While obesity is increasing in the United States at a more rapid rate than in other developed countries, the general rise in obesity is a global phenomenon. The World Health Organization (WHO) reports that about 650 million adults worldwide are obese, or more than one of every ten adults on the planet.[108]

Why is obesity on the rise? Studies have shown that the blame lies with increased caloric intake and reduced physical activity. Caloric intake is rising naturally as incomes rise, and there has been a shift over time from healthy foods (which tend to be preparation intensive) to unhealthy ones (which are readily available and easier to prepare). The ready availability may especially contribute to obesity when individuals suffer from the kind of "self-control" problems described earlier in the chapter, which leave them susceptible to easy, low-cost avenues for weight gain. A number of studies show that individuals will eat more, for example, if more food is placed in front of them, or if the plate is larger so that it appears that there is less food. Downs et al. (2009) argue that many individuals are irrationally sensitive to external cues (how full their plate is) relative to their internal cues (how full they are), which should matter most. Another study by Read and van Leeuwen (1998) found that individuals were willing to commit to eating healthier in the future, but when faced with immediate choices, they chose less healthy options.

In addition, just as caloric intake is rising, physical activity is falling. Industrialized societies have moved from a situation in which individuals were paid to exercise (through jobs that require physical labor and activity) to one in which individuals must pay to exercise (because jobs are sedentary and exercise must come at the cost of forgone leisure time and often at the cost of paid gym memberships). Public policy makers should care about this rise in obesity because it has both enormous externalities and internalities. Indeed, the fastest growing public health problem in the United States over the past several decades is diabetes, a disease whereby the body is unable to regulate its glucose (sugar) intake. Diabetes is a progressive and often fatal disease with no known cure. It can attack every organ in the body, resulting in higher risk of heart failure, stroke, and poor circulation, which can lead to amputation of toes and limbs. In 2018, 34 million Americans, or 10.5% of the U.S. population, had diabetes, and 34.5% of the adult population was prediabetic.[109] The number one factor driving the rise in diabetes is the rise in obesity and inactive lifestyles.

When all the negative health effects associated with obesity are taken into account, estimates suggest that obesity-related illness may cost the United States $342 billion per year in medical costs.[110] By 2055, obesity will likely shorten the average life-span by at least two to five years, a higher impact than that of cancer or heart disease.[111] Thus, under either traditional models or models that take into account self-control problems, there may be a large role for the government in addressing this problem.

Understanding why obesity is rising and the harm it is causing is easy, however, compared to deriving

proper policy responses to the problem. There have been a number of different approaches to using public policy tools to reduce obesity, but successes have been limited.

The first is to change the nature of food supply by making healthier foods more readily available, particularly in low-income "food deserts" where options for healthy eating had previously been limited. But such efforts have so far failed to change eating behavior. For example, major investments in new grocery stores in low-income areas of Philadelphia have had little impact on eating habits.[112]

Another approach is to tax unhealthy foods. Addressing obesity through taxing food, however, is much more difficult than addressing smoking because while every cigarette is bad for you, clearly some food consumption is good for you! This suggests that taxes focus on the particularly unhealthy aspects of food products. A particularly popular target for policies in this area has been sugary drinks. Studies show that soft drink consumption increased by 300% from 1988 to 2008.[113] Recent evidence on such taxes in U.S. cities such as Berkeley, California and Philadelphia, Pennsylvania has not found consistently large impacts on consumption of sugary beverages, but the sizeable externalities and internalities from consumption of sugary beverages may justify a much higher tax than exists in those cities.[114]

A more successful approach may be to engage consumers directly in self-control strategies. Studies have found that when consumers are directly offered the opportunity to downsize their starchy side portions at a Chinese restaurant, a sizeable fraction chose to do so and did not offset this with more calories consumed elsewhere in the meal; that when a children's menu at a chain restaurant was changed to be more healthy, there was a resulting increase in healthy orders; and that labeling receipts with personalized, lower-calorie ordering suggestions (e.g., substituting ham for sausage or frozen yogurt for ice cream) led to a modestly sized switch to the suggested alternative in future visits to the restaurant.[120]

In a more aggressive approach, some nations have moved to directly penalize individuals for being obese. In 2008, Japan's Ministry of Health passed mandates requiring local governments and employers to add a "waist measurement test" to mandatory annual checkups for adults. Those who fail the test with waistlines exceeding preset limits must take corrective measures, while local governments and companies whose populations do not meet specified guidelines face financial penalties.[121] Some U.S. states and employers are using rewards to address obesity, for example, by providing financial incentives to employees to enroll in wellness programs that will help them manage their weight. Studies of such workplace wellness programs, however, have found little lasting effect.[122]

Summary

Regulating other health behaviors raises many issues similar to those we raised for smoking. For alcohol use and obesity, however, existing taxes are already so far below the level of negative externalities that assessing the role of self-control problems and internalities is not critical: virtually any economic model would imply that if these externality calculations are correct, taxes should be higher. Yet there are challenges in raising taxes in both cases, ranging from the fact that a moderate amount of consumption may actually be good for people to the fact that it is difficult to design taxes that properly target the externality.

A more successful approach may be to engage consumers directly in self-control strategies. Studies have found that when consumers are directly offered the opportunity to downsize their starchy side portions at a Chinese restaurant, a sizeable fraction chose to do so and did not offset this with more calories consumed elsewhere in the meal; that when a children's menu at a chain restaurant was changed to be more healthy, there was a resulting increase in healthy orders; and that labeling receipts with personalized, lower-calorie ordering suggestions (e.g., substituting ham for sausage or frozen yogurt for ice cream) led to a modestly sized switch to the suggested alternative in future visits to the restaurant.[120]

In a more aggressive approach, some nations have moved to directly penalize individuals for being obese. In 2008, Japan's Ministry of Health passed mandates requiring local governments and employers to add a "waist measurement test" to mandatory annual checkups for adults. Those who fail the test with waistlines exceeding preset limits must take corrective measures, while local governments and companies whose populations do not meet specified guidelines face financial penalties.[121] Some U.S. states and employers are using rewards to address obesity, for example, by providing financial incentives to employees to enroll in wellness programs that will help them manage their weight. Studies of such workplace wellness programs, however, have found little lasting effect.[122]

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6.5 Conclusion

This chapter has shown that the externality theory developed in Chapter 5 has many interesting and relevant applications. Public finance provides tools to help us think through the regulation of regional externalities such as particulates, global externalities such as climate change, and even the "internalities" of smoking. Careful analysis of public policy options requires distinguishing truly external costs from costs that are absorbed through the market mechanism; understanding the benefits and costs of alternative regulatory mechanisms to address externalities; and considering whether externalities only, or externalities *and* internalities, should count in regulatory decisions.

Highlights

- Particulates are a clear negative externality exerted primarily by power plants on wildlife, trees, structures, and (through associated particulate emissions) human health.
- The original CAA significantly (but inefficiently) reduced the amount of particulates in the air (and thus reduced acid rain). Regulation became much more efficient with the trading regime imposed by the 1990 amendments to the act.
- Climate change is a difficult problem because the effects are truly global and very long lasting.
- The Kyoto treaty would be a costly (for the United States) first step in addressing climate change, but trading and developing country participation could lower costs significantly.
- The net external costs of smoking are fairly low, suggesting a limited government role under the traditional model. Alternative models, which account for consumers' self-control problems, suggest that the government role may be larger.
- Alcohol consumption and obesity have much larger externalities, but it is difficult to design regulatory mechanisms to target the exact source of the externality (drunk driving and unhealthy diet and exercise habits, respectively).

Questions and Problems

1. There is concern that California's cap-and-trade system for greenhouse gases, implemented in 2012, has led to "hot spots" of pollution—localized areas with very high concentrations of hazardous pollutants such as air toxics and particulate matter. A recent study by Cushing et al. (2018) showed that socioeconomically disadvantaged communities have been disproportionately exposed to these air pollutants under California's cap-and-trade program. This has happened despite the fact that overall greenhouse gas emissions and exposure to pollutants in the state have been reduced significantly under the program. How might a cap-and-trade system lead to such "hot spots"? Are these "hot spots" necessarily a bad thing from an overall social welfare perspective? Explain.
2. Consider the environmental damage that results from the emissions of coal-fired power plants. These plants produce pollutants such as sulfur

dioxide (SO_2) and nitrogen oxide (NO_x), which combine with hydrogen to make acid rain. They release mercury into the environment and emit other particulate matter such as soot, as well. Which of these externalities are highly localized, and which are borne by society at large? Explain.

3. Comment on the free rider problem in the context of global climate agreements. How does recent historical experience with the Kyoto Treaty and the Paris Agreement relate to this problem?
4. Think about the concerns about the original 1970 CAA described in the text. To what degree did the 1990 amendments to the act address these concerns? Explain your answer.
5. The Obama administration calculated a figure for the social cost of carbon of $47 per metric ton of CO_2, while the Trump administration revised this figure to $1 to $6. Some of the discrepancies arose from disagreements about whether to include the global benefits of cutting carbon emissions or only domestic benefits. What economic justification might there be for including global benefits in the social cost of carbon used in developing policies for the U.S. population? What reasons might there be for excluding global benefits?
6. Every year, the federal government conducts the Monitoring the Future survey to study trends in teenage substance use. The survey covers cigarette smoking, alcohol use, and use of other drugs. Navigate to https://www.drugabuse.gov/drug-topics/trends-statistics/monitoring-future. Or you can search the National Institute on Drug Abuse website for the most current year's DrugFacts summary report on the Monitoring the Future survey. Look for graphs or statistics that report trends in the prevalence of various drugs.

   Answer the following questions using the most current year's Monitoring the Future survey.

   a. What substances have teenagers used the most and the least in the past year?
   b. Over the past four years, what changes have been observed in use of alcohol, marijuana, and in vaping?
   c. Use the interactive chart found at https://teens.drugabuse.gov/teachers/stats-trends-teen-drug-use to produce a two-panel graph of past-year heroin use alongside past-year use of narcotics other than heroin, for all grades, for the past four years. Comment on similarities and differences in use of the two categories of substances by teenagers.

7. As of 2017, the majority of states have enacted smoking bans in public places such as workplaces, restaurants, and bars. What is the economic rationale behind these bans in public places? Would a similar rationale exist for banning smoking in private settings such as cars, apartment buildings, and private homes?
8. In Problem 7, we considered the externalities of secondhand smoke in public places. Concerns about these externalities motivated policy makers in most U.S. states to enact smoking bans in bars and restaurants, despite concerns that the bans would have a negative economic impact on the restaurant and bar industry. Whether those negative economic effects have occurred has been the subject of debate. Several economic studies have shown that these laws have had a null or positive economic effect. Shafer (2017) posits that these laws might create differential economic effects for different kinds of establishments. His study tests the hypothesis that the null or positive average effect of these laws might mask the fact that some establishments are harmed economically.

   Discuss the behavior of smokers and nonsmokers when moving from a smoking permissive regime to a smoking ban. What would need to be true for a ban to have a net positive economic impact? A net negative economic impact? Explain how Shafer's hypothesis might be true.
9. How can cigarette smoking exert a *positive* externality on others?
10. Some policy experts from states with the highest adult obesity rates have argued that since obesity causes so many serious health problems, fatty foods should be regulated. Do you agree with them?

The e icon indicates a question that requires students to apply the empirical economics principles discussed in Chapter 3 and the Empirical Evidence boxes.

ADVANCED QUESTIONS

11. e Why does Chay and Greenstone's (2003b) approach to measuring the effects of acid rain reduce the identification problems associated with more "traditional" approaches?
12. e Imagine that in your first job out of college you have been hired as a legislative aide to a congresswoman who is crafting a new antipollution law, intended to be her signature legislative accomplishment. She tasks you with doing historical research on the Clean Air Act of 1970 in order to

gain historical perspective on key past legislative efforts. You find that some writers of the period made the interesting argument that the CAA might actually make the air dirtier, since it only covers new plants.

a. What did these writers mean when they made this argument?

b. Other writers support the act and are unconcerned that this effect would materialize in practice. How would you construct an empirical test to distinguish between these hypotheses?

13. Caffeine is a highly addictive drug found in coffee, tea, and some sodas. Unlike cigarettes, however, there have been very few calls to tax it, regulate its consumption, or limit its use in public places. Why the difference? Can you think of any economic arguments for regulating (or taxing) its use?

14. When Wisconsin had lower drinking ages than its neighboring states, it experienced higher levels of alcohol-related crashes in its border counties than in other counties in its interior. What does this finding imply for the spillover effects of the policies of one state (or country) on other jurisdictions?

15. In Becker and Murphy's (1988) "rational addiction" model, smokers are perfectly aware of the potential for smoking to cause addiction, and they take this into account when deciding whether or not to smoke. Consider the emergence of nicotine replacement therapies in the 1970s and 1980s (e.g., nicotine gums and patches) that make quitting smoking much easier and less costly. If Becker and Murphy's model is correct, what effect would you expect the invention of these technologies to have on tobacco cigarette smoking rates? How would your answer be different for younger and older cohorts?

The e icon indicates a question that requires students to apply the empirical economics principles discussed in Chapter 3 and the Empirical Evidence boxes. arbuz/Shutterstock