CHAPTER 5

Welfare Economics, Externalities, and Non-Classical Markets

LEARNING OUTCOMES

By the end of this chapter you should understand:

1. Consumer and producer surpluses
2. Efficient market outcomes
3. Taxation and efficiency
4. Market failures and negative externalities
5. Market failures and positive externalities
6. Other types of market failure
7. The economics of the environment
8. Equity, justice, and efficiency

In modern mixed economies, markets and governments together resolve the questions of what, how, and for whom to produce. In this chapter we explore a very broad question that forms the core of welfare economics: Are markets a good way to allocate scarce resources in view of the fact that they not only give rise to inequality and poverty, but also fail to capture the impacts of productive activity on non-market participants? Mining impacts the environment, energy use results in greenhouse gases and global warming, and the market for coal fails to embrace the costs of these external impacts. The analysis of markets in this larger sense involves not just positive economics; appropriate policy is additionally a normative issue because policies can impact the various players in different ways and to different degrees. **Welfare economics**, therefore, deals with both normative and positive issues.

Welfare economics assesses how well the economy allocates its scarce resources in accordance with the goals of efficiency and equity.

Political parties on the left and right disagree on how well a market economy works. Canada's New Democratic Party emphasizes the market's failings and the need for government intervention, while the Conservative Party believes, broadly, that the market

fosters choice, incentives, and efficiency. What lies behind this disagreement? The two principal actors are *efficiency* and *equity*. Efficiency addresses the question of how well the economy's resources are used and allocated. In contrast, equity deals with how society's goods and rewards are, and should be, distributed among its different members, and how the associated costs should be apportioned. Equity is also concerned with how different generations share an economy's productive capabilities: more investment today makes for a more productive economy tomorrow, but more greenhouse gases today will reduce environmental quality tomorrow. Climate change caused by global warming forms one of the biggest challenges for humankind at the present time. As we shall see in this chapter, economics has much to say about appropriate policies to combat warming. Whether pollution-abatement policies should be implemented today or twenty years from now involves considerations of equity between generations.

5.1 Consumer and Producer Surplus

A very powerful analytical tool—economic efficiency—is based on an understanding of two related measures: consumer surplus and producer surplus. Consumer surplus relates to the demand side of the market, producer surplus to the supply side. Producer surplus is also termed supplier surplus. These measures can be understood with the help of a standard example, the market for city apartments.[1]

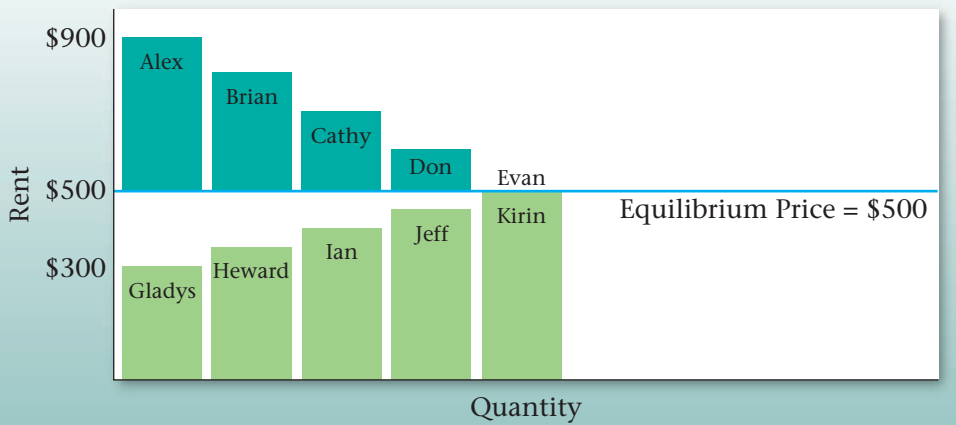
Table 5.1 and Figure 5.1 describe the hypothetical data. We imagine first a series of Vancouver students who are in the market for a standardized downtown apartment.

TABLE 5.1 Consumer and Supplier Surpluses

Demand		
Individual	**Valuation ($)**	**Surplus ($)**
Alex	900	400
Brian	800	300
Cathy	700	200
Don	600	100
Evan	500	0
Frank	400	0
Supply		
Individual	**Reservation Value ($)**	**Surplus ($)**
Gladys	300	200
Heward	350	150
Ian	400	100
Jeff	450	50
Kirin	500	0
Lynne	550	0

[1] For example, see E. Glaeser and E. Luttmer, "The Misallocation of Housing under Rent Control," *American Economic Review*, 2003.

FIGURE 5.1 **The Market for City Apartments**



Demanders and suppliers of apartments are ranked in order of the value they place on an apartment. The market equilibrium is where the marginal demand value of Evan equals the marginal supply value of Kirin, at $500. Five apartments are rented in equilibrium.

These individuals are not identical; they value the apartment differently. For example, Alex enjoys comfort and therefore places a higher value on a unit than Brian. Brian, in turn, values it more highly than Cathy or Don. Evan and Frank would prefer to spend their money on snowboarding at Whistler, and so on. These valuations are represented in the middle column of Table 5.1, and also in Figure 5.1 with the highest valuations closest to the origin. The valuations reflect the willingness to pay of each consumer.

Next we imagine the supply side as made up of different suppliers, who are willing to put their apartments on the market for different prices. Gladys will accept less rent than Heward, who in turn will accept less than Ian. The minimum prices that the suppliers are willing to accept are called *reservation* prices or values, and these are given in the lower part of Table 5.1. Unless the market price is greater than their reservation price, suppliers will hold back.

By definition, as stated in Chapter 3, the demand curve is made up of the valuations placed on the good by the various demanders. Likewise, the reservation values of the suppliers form the supply curve. If Alex is willing to pay $900, then that is his demand price; if Heward is willing to put his apartment on the market for $350, he is by definition willing to supply it for that price. Figure 5.1 therefore describes the demand and supply curves in this market. The steps reflect the willingness to pay of the buyers and the reservation valuations or prices of the suppliers.

In this example, the equilibrium price for apartments will be $500. Let us see why. At that price the value placed on the marginal unit supplied by Kirin equals Evan's willingness to pay. Five apartments will be rented. A sixth apartment will not be rented because Lynne will let her apartment only if the price reaches $550. But the sixth potential demander is willing to pay only $400. Note that, as usual, there is just a single price in the market. Each renter pays $500, and therefore each supplier also receives $500.

The consumer and supplier surpluses can now be computed. Note that, while Don is willing to pay $600, he actually pays $500. His consumer surplus is therefore $100. In Figure 5.1, we can see that each **consumer's surplus** is the distance between the

Review Question 1

Consumer surplus is the excess of consumer willingness to pay over the market price

market price and the individual's valuation. These values are given in the final column of the top half of Table 5.1.

Supplier or producer surplus is the excess of market price over the reservation price of the supplier

Using the same reasoning, we can compute each **supplier's surplus**, which is the excess of the amount obtained for the rented apartment over the reservation price. For example, Heward obtains a surplus on the supply side of $150, while Jeff gets $50.

It should now be clear why these measures are called surpluses. *The suppliers and demanders are all willing to participate in this market because they earn this surplus.* It is a measure of their gain from being involved in the trading.

COMPUTING THE TOTAL SURPLUS

The sum of each participant's surplus in the final column of Table 5.1 defines the total surplus in the market. However, we do not always think of demand and supply functions in terms of the steps illustrated in Figure 5.1. Usually there are so many participants in the market that the differences in reservation prices on the supply side and willingness to pay on the demand side are exceedingly small, and so the demand and supply curves are drawn as continuous lines. So let us see how to compute the surpluses where the forms of the demand and supply curves are known. Let the equations for the curves be given by

$$\text{Demand: } P = 1000 - 100Q \qquad \text{Supply: } P = 250 + 50Q$$

To find the market equilibrium, the two functions are equated and solved:

$$1000 - 100Q = 250 + 50Q \rightarrow 1000 - 250 = 50Q + 100Q$$

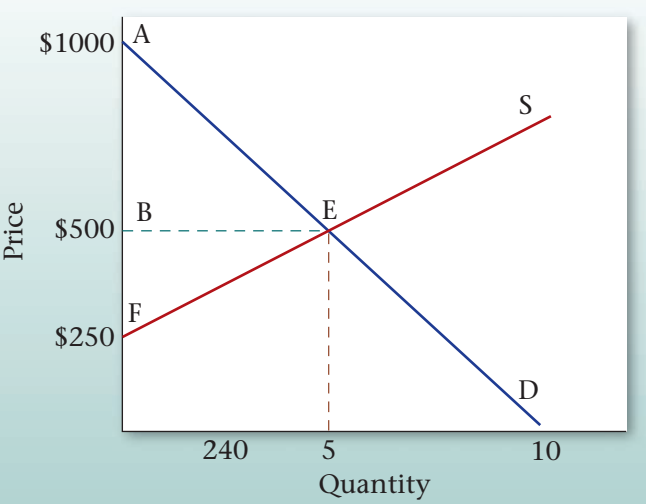
or

$$750 = 150Q \rightarrow Q = 750/150 = 5$$

At a quantity traded of five units, the corresponding demand price is $500, and so too is the corresponding supply price. In fact, in this example we have deliberately used two functions that yield the same equilibrium as the apartment example, and these functions are illustrated in Figure 5.2. The consumer surplus (CS) is the difference

FIGURE 5.2 **Consumer and Producer Surplus Measurement**

The total consumer surplus is given by the area AEB, which is the difference between the price paid and the value placed on all of the units traded. The total supplier surplus is the area FEB, which is the difference between the price and the reservation value placed on each unit supplied.



between the demand curve and the equilibrium price (ABE), and is computed by using the standard formula for the area of a triangle—half the base × the perpendicular height. This yields the value \$1250:[2]

Review Question 2

$$CS = (\text{Demand value} - \text{price}) = \text{Area ABE} = \tfrac{1}{2} \times 5 \times \$500 = \$1250$$

The suppliers' surplus is the area BEF, yielding a value of \$625.

5.2 Efficient Market Outcomes

The definition of the surplus measures is straightforward: Once we have the demand and supply curves, the area between each one and the equilibrium price can be calculated. With straight-line functions, these areas involve triangles. But where does the notion of market efficiency enter? Let us pursue the apartment example.

In addition to these city apartments, there are many others in the suburbs that have not got the desirable "proximity to downtown" characteristic. There are also many more demanders in the market for living space than the number who rented at \$500 in the city. Who are these other individuals? Clearly they place a lower value on city apartments than the individuals who are willing to pay at least \$500.

The equilibrium price of \$500 in Figure 5.1 has two implications. First, individuals who place a lower value on a city apartment must seek accommodation elsewhere. Second, suppliers who have a reservation price above the equilibrium price will not participate. It is implied by this that an **efficient market** maximizes the sum of producer and consumer surpluses. Let us see why.

An **efficient market** maximizes the sum of consumer and producer surpluses.

Instead of a freely functioning market, imagine that the city government rents all apartments from suppliers at the price of \$500 per unit, but decides to allocate the apartments to tenants in a lottery.[3] By doing this, many demanders who place a low value on a city apartment would end up living in one, and other individuals, who were not so fortunate in the lottery, would not obtain an apartment, even if they valued one highly. Suppose, then, that Frank gets an apartment in the lottery and Cathy does not. This outcome would not be efficient, because there are further gains in surplus to be had. Frank and Cathy can now strike a private deal so that *both* gain.

If Frank agrees to sublet to Cathy at a price between their respective valuations of \$400 and \$700—say \$600—he will gain \$200 and she will gain \$100. This is because Frank values the apartment only at \$400, but now obtains \$600. Cathy values it at \$700 but pays only \$600. The random allocation of apartments, therefore, is not efficient, because further gains from trade are possible. In contrast, *the market mechanism, in which suppliers and demanders freely trade, leaves no scope for additional trades that would improve the well-being of participants*.

It is frequently useful to characterize market equilibrium in terms of the behaviour of *marginal* participants—the very last buyer and the very last supplier, or the very last unit supplied and demanded. In addition, *let us introduce the key assumption that the*

[2] The observant student will note that these demand and supply curves lie just at the right-hand corners of the step-function demand and supply curves in Figure 5.1, and therefore yield slightly larger consumer and supplier surplus areas than the area between the price and the step functions.

[3] We can imagine the government getting the money to pay for the apartments from tax revenue.

supply curve represents the full cost of each additional unit of production. It follows that, at the equilibrium, the value placed on the last unit purchased (as reflected in the demand curve) equals the cost of supplying that unit. If one more unit were traded, we can see from Figure 5.2 that the value placed on that additional unit (as represented by the demand curve) would be less than its cost of production. This would be a poor use of society's resources. Phrased another way, resources would not be used efficiently unless the cost of the last unit equaled the value placed on it.

Before applying the concept of efficiency, and the surpluses it embodies, students should note that we have invoked some assumptions. For example, if individual incomes change, the corresponding market demand curve changes, and any market equilibrium will then depend on the distribution of incomes. We will examine this and other assumptions more fully below.

5.3 Taxation and Efficiency

Despite enormous public interest in taxation and its impact on the economy, it is one of the least understood areas of public policy. In this section we will show how an understanding of two fundamental tools of analysis—elasticities and economic surplus—provides powerful insights into the field of taxation.

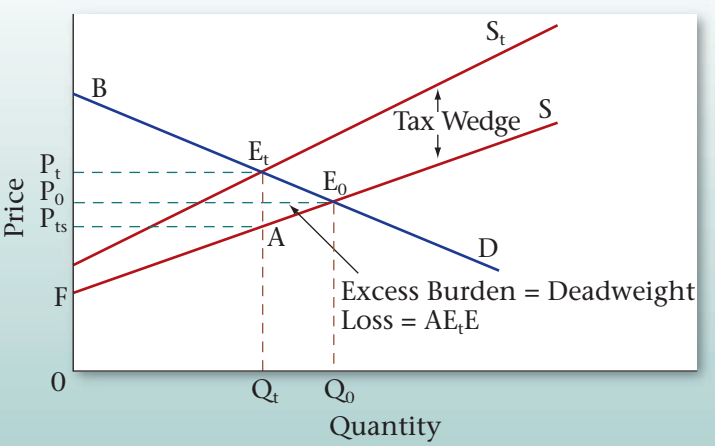
We begin with the simplest of cases, the federal government's goods and services tax (GST) or the provincial governments' sales taxes (PST). These taxes combined vary by province, but we suppose that a typical rate is 13 percent. Note that this is a *percentage*, or *ad valorem*, tax, not a *specific* tax of so many dollars per unit traded. Figure 5.3 illustrates the supply and demand curves for some commodity. In the absence of taxes, the equilibrium E_0 is defined by the combination $\{P_0, Q_0\}$.

A **tax wedge** is the difference between the consumer and producer prices.

A 13-percent tax is now imposed, and the new supply curve S_t lies 13 percent above the no-tax supply S. A **tax wedge** is therefore imposed between the price the consumer must pay and the price that the supplier receives. The new equilibrium is E_t, and the new market price is at P_t. The price received by the supplier is lower than that paid by the buyer by the amount of the tax wedge. The post-tax supply price is denoted by P_{ts}.

FIGURE 5.3 **The Efficiency Cost of Taxation**

The tax placed on the good shifts supply from S to S_t and reduces the quantity traded from Q_0 to Q_t. At this output the demand value placed on an additional unit exceeds the supply valuation by the amount E_tA. Since the tax keeps output at this lower level, the economy cannot take advantage of the additional potential surplus between Q_t and Q_0.



There are two *burdens* associated with this tax. The first is the **revenue burden**, the amount of tax revenue paid by the market participants and received by the government. On each of the Q_t units sold, the government receives the amount $P_t - P_{ts}$. Therefore, tax revenue is the amount $P_tE_tAP_{ts}$. As illustrated in Chapter 4, the degree to which the market price P_t rises above the no-tax price P_0 depends on the supply and demand elasticities.

The **revenue burden** is the amount of tax revenue raised by a tax.

The second burden of the tax is called the *excess burden*. The concepts of consumer and producer/supplier surpluses help us comprehend this. The effect of the tax has been to reduce consumer surplus by $P_tE_tE_0P_0$. This is the reduction in the pre-tax surplus given by the triangle P_0BE_0. By the same reasoning, supplier surplus is reduced by the amount $P_0E_0AP_{ts}$; prior to the tax it was P_0E_0F. Consumers and suppliers have therefore seen a reduction in their well-being that is measured by these dollar amounts. Nonetheless, the government has additional revenues amounting to $P_tE_tAP_{ts}$, and this tax imposition therefore represents a *transfer* from the consumers and suppliers in the marketplace to the government. Ultimately, the citizens should benefit from this revenue when it is used by the government, and it is therefore not considered to be a net loss of surplus.

However, there remains a part of the surplus loss that is not transferred, the triangular area E_tE_0A. This component is called the **excess burden**, for the reason that it represents the component of the economic surplus that is not transferred to the government in the form of tax revenue. It is also called the **deadweight loss**, DWL.

The **excess burden**, or **deadweight loss**, of a tax is the component of consumer and producer surpluses forming a net loss to the whole economy.

The intuition behind this concept is not difficult. At the output Q_t, the value placed by consumers on the last unit supplied is P_t (= E_t), while the production cost of that last unit is P_{ts} (= A). But the potential surplus ($P_t - P_{ts}$) associated with producing an additional unit cannot be realized, because the tax dictates that the production equilibrium is at Q_t rather than any higher output. Thus, if output could be increased from Q_t to Q_0, a surplus of value over cost would be realized on every additional unit equal to the vertical distance between the demand and supply functions D and S. Therefore, the loss associated with the tax is the area E_tE_0A.

Review Question 3

In public policy debates, this excess burden is rarely discussed. The reason is that notions of consumer and producer surpluses are not well understood by noneconomists, despite the fact that the value of lost surpluses can be very large. Numerous studies have attempted to estimate the excess burden associated with raising an additional dollar from the tax system. They rarely find that the excess burden is less than 25 percent. This is a sobering finding. It tells us that if the government wished to implement a new program by raising additional tax revenue, the benefits of the new program should be 25 percent greater than the amount expended on it!

The impact of taxes and other influences that result in an inefficient use of the economy's resources are frequently called **distortions**. The examples we have developed in this chapter indicate that distortions can describe either an inefficient output being produced, as in the taxation example, or an inefficient allocation of a given output, as in the case of apartments being allocated by lottery.

A **distortion** in resource allocation means that production is not at an efficient output, or a given output is not efficiently allocated.

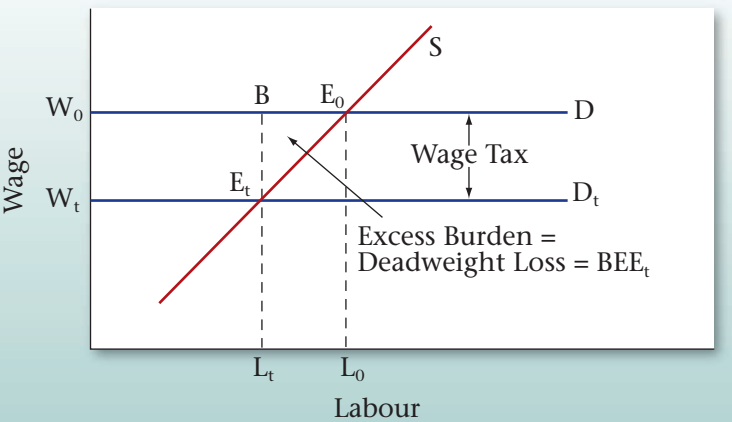
ELASTICITIES REVISITED

We suggested above that elasticities are important in determining the size of the deadweight loss of a tax. Going back to Figure 5.3, suppose that the demand curve through E_0 were more elastic (with the same supply curve, for simplicity). The post-tax equilibrium E_t would now yield a lower Q_t value and a price between P_t and P_0. The resulting tax revenue raised and the magnitude of the excess burden would differ because of the new elasticity.

Review Question 4

FIGURE 5.4 **Taxation and Labour Supply**

The demand for labour is horizontal at the wage W_0. A tax on labour reduces the wage paid to the worker to W_t. The loss in supplier surplus is the area $W_0E_0E_tW_t$. The government takes $W_0BE_tW_t$ in tax revenue, leaving the area BE_0E_t as the excess burden, or deadweight loss, of the wage tax.



A WAGE TAX

A final example will illustrate how the concerns of economists over the magnitude of the DWL are distinct from the concerns expressed in much of the public debate over taxes. Figure 5.4 illustrates the demand and supply for a certain type of labour. On the demand side, the analysis is simplified by assuming that the demand for labour is horizontal, indicating that the gross wage rate is fixed, regardless of the employment level. On the supply side, the upward slope indicates that individuals supply more labour if the wage is higher. The equilibrium E_0 reflects that L_0 units of labour are supplied at the gross wage W_0.

Review Question 5

An income tax is now imposed. If this is, say, 20 percent, then the net wage falls to 80 percent of the gross wage. The new equilibrium E_t is defined by the combination $\{W_t, L_t\}$. Less labour is supplied because the net wage is lower. The government generates tax revenue of $(W_0 - W_t)$ on each of the L_t units of labour now supplied, and this is the area $W_0BE_tW_t$. The loss in surplus to the suppliers is $W_0E_0E_tW_t$, and therefore the DWL is the triangle BE_0E_t. Clearly the magnitude of the DWL depends upon the supply elasticity.

Whereas the DWL consequence of the wage tax is important for economists, public debate is more often focused on the reduction in labour supply and production. Of course, these two issues are not independent. A larger reduction in labour supply is generally accompanied by a bigger excess burden.

5.4 Market Failures—Negative Externalities

An **externality** is a benefit or cost falling on people other than those involved in the activity's market. It can create a difference between private costs or values and social costs or values.

The consumer and producer surplus concepts we have developed are extremely powerful tools of analysis, but the world is not always quite as straightforward as simple models indicate. For example, many suppliers generate pollutants that adversely affect the health of the population, or damage the environment, or both. The term **externality** is used to denote such impacts. Externalities impact individuals who are not participants in the market in question, and the effects of the externalities may not be captured in the market price. For example, electricity-generating plants that use coal reduce air quality, which, in turn, adversely impacts individuals who suffer from asthma or other lung ailments.

APPLICATION BOX 5.1

Deadweight Losses and the Underground Economy

Professor Bernard Fortin of the Université Laval has written several papers on the magnitude of Canada's taxation excess burden. One of his best known was co-authored with Professor Guy Lacroix and published in the *Journal of Public Economics* in 1994. They estimated that if the government were to increase tax revenue by one dollar, the additional DWL would be approximately 40 cents! This cost to the taxpayer is exceedingly high. One of the reasons, the authors propose, is that as income tax rates are increased some individuals allocate more of their work hours to the underground, or "grey" economy, and this decreases the tax revenue dollars further. So the DWL *per dollar of revenue* is high.

We will now show why markets characterized by externalities are not efficient, and also show how these externalities might be corrected or reduced. The essence of an externality is that it creates a divergence between private costs/benefits and social costs/benefits. If a steel producer pollutes the air, and the steel buyer pays only the costs incurred by the producer, then the buyer is not paying the full "social" cost of the product. The problem is illustrated in Figure 5.5.

Review Questions 6 and 7

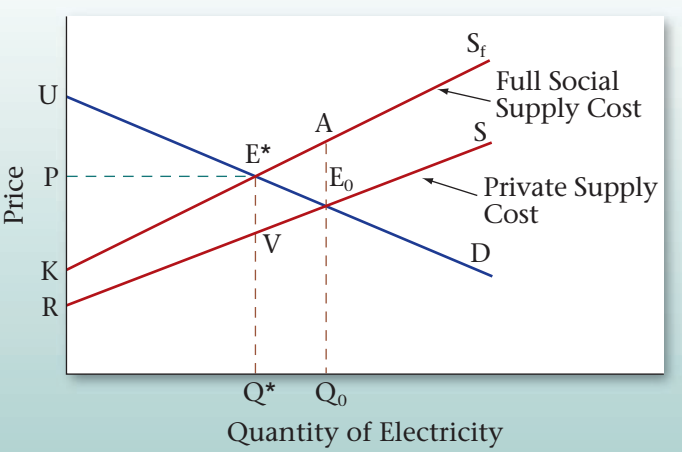
Review Question 8

In Figure 5.5, the supply curve S represents the cost to the supplier, whereas S_f (the *full* cost) reflects, in addition, the cost of bad air to the population. Of course, we are assuming that this external cost is ascertainable, in order to be able to characterize S_f accurately. Note also that the illustration in Figure 5.5 assumes that, as power output increases, the external cost *per unit* rises, because the difference between the two supply curves increases with output. This implies that low levels of pollution do less damage: Perhaps the population has a natural tolerance for low levels, but higher levels cannot be tolerated easily and so the cost is greater.

Despite the externality, *an efficient level of production can still be defined*. It is given by Q*, not Q_0. To see why, consider the impact of reducing output by one unit from Q_0. At

FIGURE 5.5 **Negative Externalities and Inefficiency**

A negative externality is associated with the supply of this good. The supply curve S measures only the value to the producer of supplying various quantities, whereas S_f measures the full social cost of supply. The socially optimal output level is Q*, not the market equilibrium Q_0. Beyond Q* the real supply cost exceeds the real demand value and therefore Q_0 is not an efficient output. A tax that increases the price and therefore reduces output is one solution to the externality.



APPLICATION BOX 5.2

Gasoline Taxes and Coal-Fired Energy Plants

In Canada, gasoline taxes are set at a much higher rate than taxes on other goods. At gas pumps, we frequently see a type of "infomercial" from the distributor, indicating, perhaps, that 44 percent of each consumer dollar goes to the oil company, 11 percent to the distributor, and 47 percent in taxes. These taxes are clearly "corrective"; not only are they designed to generate general tax revenue for governments; they are also set at a punitive level so as to discourage use of the product. However, gasoline taxes in the European Union are twice the Canadian level. The result of such taxation policy is that motor technology is different and that consumers buy smaller, lighter, and more fuel-efficient cars.

In the United States, approximately one half of all electricity is generated by coal-burning power plants. Coal is one of the most abundant sources of energy in the world. It is estimated that the world's coal mines may contain enough coal for another five hundred years. China depends heavily on coal for its power generation, and its citizens pay a high price in terms of respiratory illnesses and premature deaths. In Canada electricity production varies greatly by province: Alberta depends heavily on coal whereas Quebec produces almost all of its electricity from water-powered turbines. When priced disregarding its negative externalities, coal is cheap and very competitive with other sources of energy. Yet coal rarely bears corrective taxes, in developed or less developed economies, despite the environmental damage it causes.

Q_0 the willingness of buyers to pay for the marginal unit supplied is E_0. The (private) supply cost is also E_0. But from a societal standpoint there is a pollution/health cost of AE_0 associated with that unit of production. The full cost, as represented by S_f, exceeds the buyer's valuation. Accordingly, if the last unit of output produced is cut, society gains by the amount AE_0, because the cut in output reduces the excess of cost over value.

Applying this logic to each unit of output between Q_0 and Q*, it is evident that society can increase its well-being by the dollar amount equal to the area E^*AE_0, as a result of reducing production.

Next, consider the consequences of reducing output further from Q*. Note that pollution is being created here, and environmentalists frequently advocate that pollution should be reduced to zero. However, an efficient outcome may not involve a zero level of pollution. If the production of power were reduced below Q*, the loss in value to buyers, as a result of not being able to purchase the good, would exceed the full cost of its production.

If the government decreed that, instead of producing Q*, no pollution would be tolerated, then society would forgo the possibility of earning the total real surplus equal to the area UE*K. Economists do not advocate such a zero-pollution policy; rather, we advocate a policy that permits a "tolerable" pollution level—one that still results in net benefits to society. In this particular example, the total cost of the tolerated pollution equals the area between the private and full supply functions, KE*VR.

Review Questions 9 and 10

As a matter of policy, how is this market influenced to produce the amount Q* rather than Q_0? One option would be for the government to intervene directly with production quotas for each firm. An alternative would be to impose a **corrective tax** on the good whose production causes the externality: With an appropriate increase in the price, consumers will demand a reduced quantity. In Figure 5.5 a tax equal to the dollar value VE* would shift the supply curve upward by that amount and result in the quantity Q* being traded.

A **corrective tax** seeks to direct the market towards a more efficient output.

We are now venturing into the field of environmental policy, and this is developed in section 5.7 below. The most important conclusion of the foregoing analysis is that an efficient working of the market continues to have meaning in the presence of externalities. An efficient output level still maximizes economic surplus where surplus is correctly defined.

5.5 Market Failures—Positive Externalities

Externalities of the *positive* kind enable individuals or producers to get a type of "free ride" on the efforts of others. Real world examples abound: When a large segment of the population is inoculated against disease, the remaining individuals benefit on account of the reduced probability of transmission.

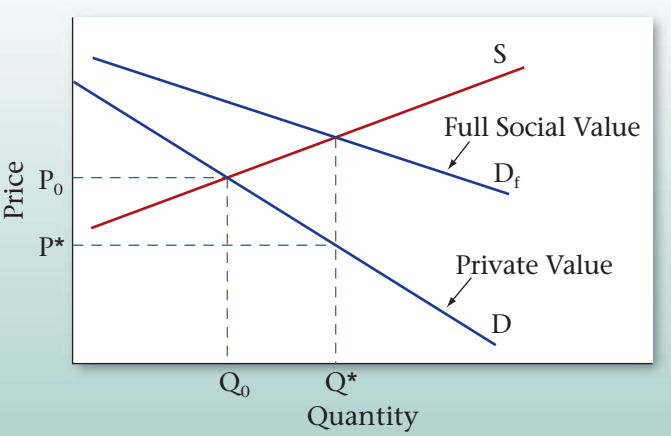
A less well recognized example is the benefit derived by many Canadian firms from research and development (R&D) undertaken in the United States. Professor Dan Treffler of the University of Toronto has documented the positive spillover effects in detail. Canadian firms, and firms in many other economies, learn from the research efforts of U.S. firms that invest heavily in R&D. In the same vein, universities and research institutes open up new fields of knowledge, with the result that society at large, and sometimes the corporate sector, gain from this enhanced understanding of science, the environment, or social behaviours.

The free market may not cope any better with these positive externalities than it does with negative externalities, and government intervention may be beneficial. For example, firms that invest heavily in research and development would not undertake such investment if competitors could have a complete "free ride" and appropriate the fruits. This is why *patent laws* exist, as we shall see later in discussing Canada's competition policy. These laws prevent competitors from copying the product development of firms that invest in R&D. If such protection were not in place, firms would not allocate sufficient resources to R&D, which is a real engine of economic growth. In essence, the economy's research-directed resources would not be appropriately rewarded, and thus too little research would take place.

While patent protection is one form of corrective action, subsidies are another. We saw in section 5.4 that an appropriately formulated tax on a good that is associated with negative externalities can reduce demand for that good, and thereby reduce pollution. A subsidy can be thought of as a negative tax. Consider the example in Figure 5.6.

FIGURE 5.6 **Positive Externalities—The Market for Flu Shots**

The value of vaccinations to society is greater than the value to individuals because the greater the number of individuals vaccinated, the lower the probability of others contracting the virus. D_f reflects this additional value. Consequently this is a case of a positive externality where the socially optimal output level Q* exceeds the market equilibrium Q_0. To achieve this higher output the government may choose to subsidize producers or consumers.



APPLICATION BOX 5.3

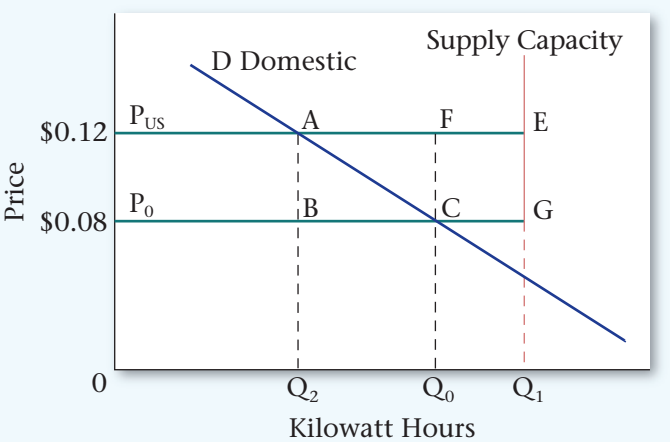
Subsidies and Opportunity Costs

Governments subsidize many goods, but such subsidies may be inefficient, just like taxes. Consider Hydro Quebec, which sells electricity to domestic consumers and a relatively small amount to U.S. consumers. Let its supply capacity be defined by Q_1 in the adjoining figure—this is the limit of what it can supply in a given time period. Let us also assume that up to that capacity it can supply electricity at a constant price of 8 cents per kilowatt hour. So Hydro's supply curve is given by the line P_0GE. On the demand side Quebecers have a regular downward sloping demand curve denoted by D. However, adjoining consumers in New York and other New England states are willing to buy as much electricity as Hydro Quebec will sell them at a price of 12 cents. This means that the U.S. demand curve faced by Hydro is horizontal at this value.

The efficiency question here is how Hydro Quebec will sell its electricity in the two markets. One option is to sell at 8 cents domestically and sell the residual amount to the United States: Domestic consumers would purchase Q_0 kilowatt hours at this price, and the remaining amount ($Q_1 - Q_0$) would be purchased by U.S. buyers. In fact this is very like what is done at the present time. However, with this pricing scheme, Quebecers effectively get a subsidy from Hydro Quebec, because they pay 8 cents for a good that is really valued at 12 cents—the opportunity cost.

Suppose now that Hydro Quebec charged 12 cents domestically and sold electricity only to those domestic consumers who valued it at 12 cents. Domestic quantity demanded would fall to Q_2 from Q_0, and a larger amount could now be sold to New Yorkers at the 12-cent price. In this new scenario, the sum of consumer and producer surpluses increases. This is because the loss in surplus to Canadian consumers ($P_{US}ACP_0$) is less than the gain to Hydro Quebec. The latter gets more from domestic consumers ($P_{US}ABP_0$) and from the foreign market (AFCB), for a total of $P_{US}FCP_0$ additional revenue. Since this is greater than the loss in consumer surplus to Canadian consumers, the original "subsidized" pricing scheme was not efficient, in essence because the supplier ignored opportunity costs. The amount ($Q_0 - Q_2$), when supplied at a price of 8 cents, is being sold at less than the willingness of consumers to pay in the marketplace.

Hydro Quebec's Inefficient Pricing



Individuals have a demand for flu shots given by D. This reflects their private valuation, their personal willingness to pay. But the social value of flu shots is greater. When a given number of individuals are inoculated, the probability that others will be infected falls. Additionally, with higher rates of inoculation, the health system will incur fewer costs in treating the infected. Therefore, the value to society of any quantity of flu shots is greater than the sum of the values that individuals place on them. Suppose, then, that D_f reflects the full social value of any quantity of flu shots. If S is the supply curve, the socially optimal, efficient, market outcome is Q*. How can we influence the market to move from Q_0 to Q*? One solution is a subsidy that would reduce the price from P_0 to P*. Rather than shifting the supply curve upwards, as a tax does, the subsidy would shift the supply *downward*, sufficiently to intersect D at the output Q*. In some real world examples, the value of the positive externality is so great that the government may decide to drive the price to zero, and thereby provide the inoculation at a zero price. For example, children typically get their MMR shots (measles, mumps, and rubella) free of charge.

5.6 Other Market Failures

There are many other ways in which markets can fail to reflect accurately the social value or social cost of economic activity. Monopolies that restrict output in order to increase profits, create inefficient markets, and we will see why in the chapter on monopoly. Or the market may not deal very well with what are called public goods. These are goods, like radio and television service, national defence, or health information: with such goods and services many individuals can be supplied with the same good at the same total cost as one individual. We will address this problem in our chapter on government. And, of course, there are international externalities that cannot be corrected by national governments because the interests of adjoining states may differ: One economy may wish to see cheap coal-based electricity being supplied to its consumers, even if this means acid rain or reduced air quality in a neighbouring state. Markets may fail to supply an "efficient" amount of a good or service in all of these situations.

Review Questions 11 and 12

5.7 Climate Change, the Environment, and Policy

The 2007 recipients for the Nobel Peace Prize were the United Nation's Intergovernmental Panel on Climate Change (IPCC), and Al Gore, former vice president of the United States. The Nobel committee cited the winners "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change." While Al Gore is best known for his efforts to bring awareness of climate change to the world, through his book and associated movie (*An Inconvenient Truth*), the IPCC is composed of a large, international group of scientists that has worked for many years in developing a greater understanding of the role of human activity in global warming. Reports on the extent and causes of the externality that we call global warming are now plentiful. The best known economic report is the "The Stern Review on the Economics of Climate Change." It takes its name from the economist Sir Nicholas Stern, and can be downloaded from the Web free of charge.

THE CONSEQUENCES OF GREENHOUSE GASES

Greenhouse gases that accumulate excessively in the earth's atmosphere prevent heat from escaping and lead to **global warming.**

The emission of **greenhouse gases** (GHGs) is associated with a wide variety of economic activities such as coal-based power generation, oil-burning motors, wood-burning stoves, etc. The most common GHG is carbon dioxide. The gases, upon emission, circulate in the earth's atmosphere and, if their build-up is excessive, prevent sufficient heat from escaping. The result is a slow warming of the earth's surface and air temperatures. It is envisaged that such temperature increases will, in the long term, increase water temperatures, hasten glacial meltdown, and reduce the polar ice cap, with the result that water levels worldwide will rise. In addition to the impact of higher water levels on low-lying areas and economies such as The Netherlands and Bangladesh, the economies of the world will experience changes in their seasonal patterns. The changes will be latitude-specific and vary by economy and continent, and will impact the agricultural production abilities of economies considerably if GHGs continue to accumulate at present rates.

While most scientific findings and predictions are subject to a degree of disagreement, there is surprisingly little disagreement in the scientific community on the very long-term impact of increasing GHGs in the atmosphere. There is some disagreement as to whether the generally higher temperatures experienced in recent decades are attributable to anthropogenic activity since the industrial revolution, or whether they simply reflect a natural cycle in the earth's temperature; but scientists agree that a continuance of the recent rate of GHG emissions will ultimately lead to serious climatic problems. And since GHG emissions are strongly correlated with economic growth, the very high rate of economic growth in many large-population economies such as China and India mean that GHGs could accumulate at a faster rate than considered likely in the 1990s.

THE KYOTO PROTOCOL

Following several earlier developments, the world's first major response to climate concerns came in the form of the United Nations–sponsored Kyoto Protocol in 1997, in which a group of countries committed themselves to reducing their GHG emissions relative to their 1990 emissions levels by the year 2012. Canada's Parliament subsequently ratified the Kyoto Protocol, and thereby agreed to meet Canada's target of a 6 percent reduction in GHGs relative to the amount emitted in 1990. On a per-capita basis, Canada is one of the world's largest contributors to global warming, even though Canada's percentage of the total is just 2 percent. Many of the world's major economies refrained from signing the Protocol—most notably China, the United States, and India. The next round of negotiations will commit countries to new targets for the post-2012 period. Despite Canada's agreement to participate in Kyoto, Canada has no possibility of meeting its target, and will likely have a GHG-emission level 25 to 30 percent *above* its 1990 level. In contrast, the U.S. will likely fare better, despite not having signed.

The sources of Canada's GHGs are documented on Environment Canada's Web site. Canada, like many economies, has become more efficient in its use of energy (the main source of GHGs) in recent decades—its *use of energy per unit of total output* has declined steadily. However, Canada's *production* of oil and gas, which has created considerable wealth and been largely responsible for the appreciation of the Canadian dollar in the last decade, is still a very GHG-intensive process. Such production is also concentrated in a limited number of provinces (Alberta in particular), and policies aimed at the emitters therefore have a regional and political component. Agriculture, transportation, and electricity generation are the other major contributors to Canada's GHG emissions.

THE STERN REVIEW

The Stern Review, on the basis of a considerable body of scientific evidence, proposed a set of economic policies and strategies aimed at maintaining the concentration of atmospheric GHGs at a below-critical level. GHG concentrations are measured in parts per million. Current levels in the atmosphere are below 400 parts per million, and long-term levels above 500 parts per million could lead to serious economic and social disruption. GHGs are augmented by the annual additions to the stock already in the atmosphere, and at the same time they decay—though very slowly. GHG-reduction strategies that propose an immediate reduction in emissions are more costly than those aimed at a more gradual reduction. For example, in-place production and transportation equipment need not be scrapped, but can be replaced by equipment that generates fewer GHGs at the end of its life. Policies that focus upon the longer term may therefore be cheaper in terms of replacing old capital.

While not all economists and policy makers agree on the time scale for attacking the problem, they do agree that, the longer major GHG reduction is postponed, the greater the efforts will have to be in the long term—because GHGs will build up more rapidly in the short and medium term. The Stern Review proposes that, with an increase in technological capabilities, a strategy that focuses on the relative near-term implementation of GHG reduction measures might cost "only" one or two percent of the value of world output. If correct, this appears to be a rather small price to pay: It suggests that a climate policy that would safeguard our environmental future comes at a cost of less than one year's worth of typical economic growth. But such a reduction in gases will require particular economic policies, because, despite the apparently low cost, specific sectors will be impacted more than others, and the annual rate of GHG emission must be reduced substantially.

ECONOMIC POLICIES FOR CLIMATE CHANGE

There are three main ways in which polluters can be controlled. One involves issuing direct controls; the other two involve incentives—in the form of either taxes on each unit of pollution, or on tradable "permits" to pollute.

To see how these different policies operate, consider first Figure 5.7. It is a standard diagram in environmental economics, and is somewhat similar to our supply and demand curves. On the horizontal axis is measured the quantity of environmental damage or pollution, and on the vertical axis its dollar value or cost. The upward-sloping damage curve represents the cost to society of each additional unit of pollution or gas, and it is therefore called a **marginal damage curve**. It is positively sloped to reflect the reality that, at low levels of emissions, the damage of one more unit is less than at higher levels. For example, increasing emissions of GHGs by 20 percent may cause only moderate global warming and moderate damages, but increasing them by 40 percent may trigger water levels to rise substantially with much more than double the economic costs.

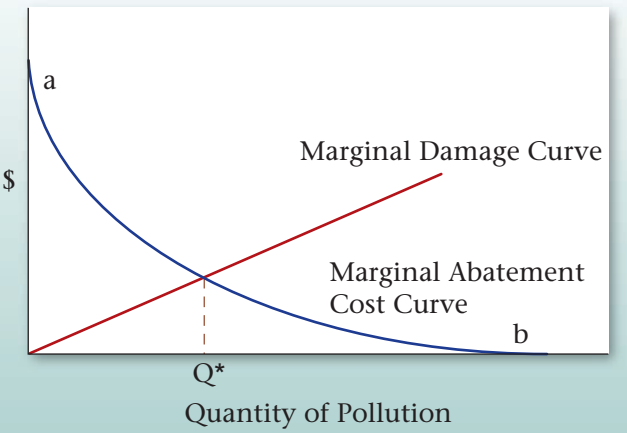
The **marginal damage curve** reflects the cost to society of an additional unit of pollution.

The second curve is the abatement curve. It reflects the cost of reducing emissions by one unit, and is therefore called a **marginal abatement curve**. The least-cost solution for firms is to spend nothing on pollution abatement, and therefore produce **b** units of pollution in Figure 5.7 On the other hand, if firms are required to install pollution-reducing devices, the cost of reducing each additional unit of pollution will increase. The cost of removing the last unit of pollution is given by the dollar value corresponding to point **a** in the figure. The marginal abatement curve indicates that it

The **marginal abatement curve** reflects the cost to society of reducing the quantity of pollution by one unit.

FIGURE 5.7 **The Optimal Amount of Pollution**

The optimal amount of pollution corresponds to where the marginal damage equals the marginal cost of abatement at Q*; more than this and benefits would follow from reduction, less than this and benefits would result from an increase.



becomes progressively more costly to reduce pollution when pollution levels are smaller. For example, halving the emissions of pollutants and gases from automobiles is feasible by adding a catalytic converter and reducing the amount of lead in gasoline. But reducing those emissions all the way to zero requires the development of major new technologies such as electric cars—an enormously more costly undertaking.

The intersection point of these curves defines an equilibrium amount of pollution for the economy. This equilibrium quantity is not zero. Following our earlier DWL analysis, it is clear that at a level of pollution above Q* the cost of reducing it is less than the damage it inflicts, and therefore a net gain accrues to society as a result of the reduction. But to reduce pollution below Q* would involve an abatement cost greater than the reduction in pollution damage and therefore no net gain to society. This constitutes a first rule in optimal pollution policy.

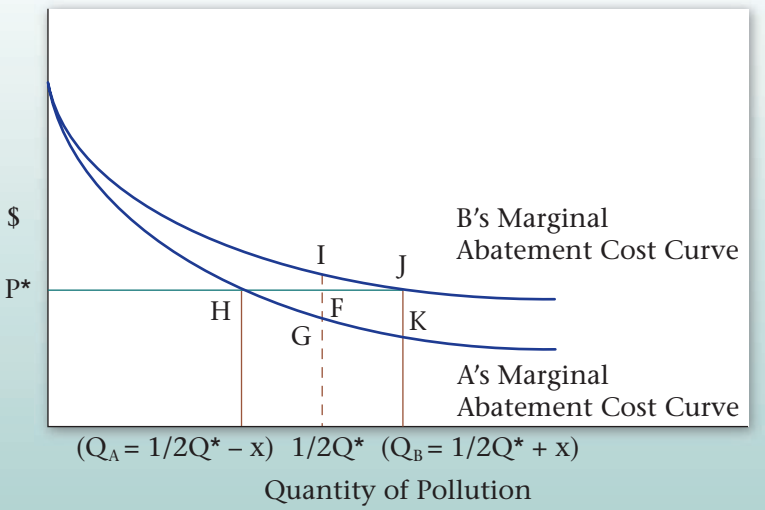
An optimal quantity of pollution occurs when the marginal cost of abatement equals the marginal damage.

A second guiding principle for pollution policy can be illustrated with the help of Figure 5.8. In this figure the marginal abatement cost curves of two firms are presented. Firm B has a higher cost of abating than Firm A; that is, for any level of polluting activity Q, Firm B's cost of reducing pollution by one unit is greater than Firm A's cost. Further, suppose that the economy has a target level of pollution (perhaps Q* from the previous figure). The policy question to be faced is: How much pollution should each firm emit if the objective is to keep total abatement costs associated with the target Q* at the lowest possible level?

With just two firms in the market, one option would be to require each to emit no more than one half of Q*. But this may not be an efficient solution. When each firm emits ½Q* the marginal abatement cost to A (given by the point G) is less than it is to firm B (whose cost is I). If these two firms could make an agreement on how much each would emit they could achieve the same target Q* at a lower cost: If A were to reduce her pollution by one unit from ½Q* (move leftward along A's marginal

FIGURE 5.8 **The Optimal Amount of Pollution for Each Firm**

When each firm emits a level of pollution such that its marginal abatement cost equals the marginal abatement cost of other firms, an efficient allocation of the pollution target occurs. With firms having different abatement costs, it is less costly in total for Firm A to emit Q_A and Firm B to emit Q_B than to have each firm emit ½Q*.



abatement curve) and B were to increase his by one unit (move rightward by one unit along B's curve), the additional cost incurred by A would be less than the cost savings to B. This means that a net gain accrues and it should be possible for the two firms to negotiate a deal on how to share the gain. Suppose A continues to reduce her pollution and B continues to increase his, while together sticking with the Q* target, provided A's abatement cost is less than B's. This process would finally lead to a situation where A emits (½Q* − x) and B emits (½Q* + x), where the amount x is the deviation from ½Q*. At these respective pollution emission levels, each firm incurs the same abatement cost at the margin. Relative to the situation where each emits ½Q*, A has incurred additional costs of Q_AHG½Q* and B has reduced costs by ½Q*IJQ_B. The net social gain is the difference between these amounts: the sum of the triangles HFG and FIJ. The second policy rule, involving the equimarginal principle, is therefore that:

> *To attain a target level of pollution at minimum resource cost, the marginal abatement cost of each firm should be the same.*

Tradable permits and **corrective/carbon taxes** are market-based systems aimed at reducing GHGs

To conclude: Controls that impose the same emission limits on firms may not be the least costly manner of achieving a target level of pollution. Let us now consider the use of **tradable permits** and **corrective/carbon taxes** as policy instruments.

Review Question 13

Incentive Mechanism 1: Pollution Permits

Consider first how pollution permits can enable this two-firm sector of the economy to reach its goal of reducing total emissions to Q*. A system of **tradable permits** is frequently called a "cap and trade" system, because it limits or caps the total permissible emissions, while at the same time allows a market to develop in permits. If the government grants pollution permits to each firm entitling each to emit mo more than ½Q* units of pollution, and the firms are free to trade such permits, then it

should be possible for both firms to gain from the trade. For example, by agreeing on a price of P* per unit of pollution in Figure 5.8, A could sell the right to x pollution units to B, reduce pollution by x units, and gain the dollar amount HFG. By the same process, B could purchase these x pollution rights, increase its pollution by x units, and still gain a net dollar amount of FIJ. Consequently, our third policy rule is:

Tradable pollution permits can attain a pollution target in an efficient manner.

Incentive Mechanism 2: Corrective Taxes

Corrective taxes are frequently called *Pigovian* taxes, after the economist Arthur Pigou. He advocated taxing activities that cause externalities. Consider Figure 5.8 again. We have shown that, if Q* is the target level of pollution, and two firms are emitting pollutants, the least-cost (most efficient) manner of achieving that goal is for each firm to incur the same marginal abatement cost. Suppose now that the government, instead of issuing permits and allowing companies to trade these permits, imposes a tax of P* on each unit of pollution in Figure 5.8. In deciding upon how much pollution to emit, each firm will consider the tax it must pay per unit and compare that tax with the alternative of reducing its pollution level. Such an analysis should induce Firm A to emit the amount Q_A and Firm B to emit Q_B: A will not emit less than Q_A because its abatement cost is higher than the tax per unit; nor will it emit more than Q_A, because it would be less costly to reduce emissions to the level Q_A with the tax P* in place. By the same reasoning, it is optimal for Firm B to emit Q_B units of pollution. This leads to our fourth policy rule:

Corrective taxes, if set at the appropriate level, can induce an efficient pattern of pollution reduction/emissions

It is noteworthy that the federal Liberal Party formulated a carbon tax proposal as the centrepiece of its economic policy platform in the 2008 election. Whatever the reason for the Liberal Party's failure to win the election, the carbon tax proposal was not accepted by a sufficiently wide spectrum of the population to propel the Party to office. In contrast, the provincial Liberal Party in British Columbia introduced a carbon tax in July 2008 on all carbon-based fuels. The initial tax levy was 2.4 cents per litre of gasoline and is scheduled to increase to 7.2 cents by 2012. The carbon tax is "revenue neutral," in the sense that the revenues generated are either being returned to individual and corporate taxpayers in the form of tax credits or reduced rates of other taxes in the system. This property makes the tax more palatable to the electorate.

POLICY IN PRACTICE

International Markets

In reality governments throughout the world adopt a combination of controls, taxes, and tradable permit systems. The Stern Review has emphasized that international markets in tradable permits are important. GHGs are a global problem because gases emitted in one economy affect climatic conditions worldwide—gases travel without concern for national boundaries. At the same time, the costs of emissions reductions may differ dramatically across countries: Some economies have dirty/old equipment, while others have relatively clean newer equipment. Consequently, pollution reductions can be achieved most efficiently by concentrating on the economies with the old/dirty

APPLICATION BOX 5.4

Stabilizing GHG Emissions

By means of mathematical modelling and computer simulations, the Stern Review analyzes the degree to which GHG emissions must be reduced in the coming decades in order to attain a stable level of GHGs in the atmosphere of no more than 550 parts per million. The results of the computer models suggest that total world production of GHGs will have to be no more than one half to one quarter of their level at the time the report was written—2006. In a world economy that has been experiencing high rates of economic growth by historical standards—primarily because of the emerging economies in Asia, such a reduction will have to be achieved in a context where output may be twice or three times as large in 2050 as it is now. Translated into GHGs per unit of output produced in the world economy, a stable rate of GHG emissions per unit of output in 2050 will have to be perhaps one quarter of their current level. This is a tall order for both science and policy, particularly in a world where China and India (together accounting for one third of the world's population) are growing so rapidly. These economies are reluctant to impose serious emissions standards on themselves, given that they are relatively so poor, and that their per capita emissions are a small fraction of the emissions per head in North America.

equipment. This necessitates that "clean" firms with pollution permits in one economy be able to trade with "dirty" firms in other economies. The political challenges presented by such a system are indeed large.

Controls, Monitoring Costs, and Large Final Emitters

Despite concerns about "controls" and directly imposed emission limits, governments do focus upon individual firms—specifically those who are *large final emitters* (LFEs). Frequently, a relatively small number of producers are responsible for a disproportionate amount of an economy's total pollution, and limits are placed on those firms in the belief that significant economy-wide reductions can be achieved in this manner. A further reason for concentrating on these LFEs is that the monitoring costs are relatively small compared to the costs associated with monitoring *all* firms in the economy. We must keep in mind that pollution permits may be a legal requirement in some jurisdictions, but monitoring is still required, because firms could choose to risk polluting without owning a permit.

As of 2009 the announced policy of the federal Conservative Party (the party in power) is based upon a belief in controls and targets, but not taxes or tradable permits. Details can be found at Environment Canada's Web site.

Revenue from Pollution Rights and Information Requirements

Taxes and tradable permits also differ in that taxes generate revenue for the government from polluting producers, whereas permits may not generate revenue, or may generate less revenue. If the government simply *allocates* permits initially (up to the amount Q* in Figure 5.7) to all polluters, free of charge, and allows a market to develop, such a process generates no revenue. While economists may advocate an *auction* of permits in the start-up phase of a tradable permits market, such a mechanism may run into political objections.

A final challenge relates to information: Setting taxes at the appropriate level requires a knowledge of the cost and damage functions/curves in Figure 5.7.

Despite the monitoring costs and the incomplete information that governments typically have about pollution activities, there exist a number of fruitful tools for reducing pollutants and GHGs. Permits and taxes are market based and are efficient when sufficient information is available. In contrast, direct controls may be fruitful in specific instances. In formulating pollution policy it must be kept in mind that governments rarely have every bit of the information they require. Pollution policy is no exception, but that should not inhibit action on an issue that is critical for future generations.

5.8 Equity, Justice, and Efficiency

Horizontal equity is the equal treatment of similar individuals.

Vertical equity is the different treatment of different people in order to reduce the consequences of these innate differences.

Intergenerational equity requires a balancing of the interests and well-being of different generations and cohorts.

Economists use several separate notions of equity in formulating policy: **horizontal equity**, **vertical equity**, and **intergenerational equity**. Horizontal equity dictates, for example, that people who have the same income should pay the same tax, while the principle of vertical equity dictates that people with more income should pay more tax. Intergenerational equity requires that the interests of different cohorts of individuals—both those alive today and those not yet born—should be balanced by ethical principles.

Horizontal equity rules out discrimination between people whose economic characteristics and performance are similar. Vertical equity is more strongly normative. Most people agree that horizontal equity is a good thing. In contrast, the *extent* to which resources should be redistributed from the "haves" to the "have-nots" to increase vertical equity is an issue on which people disagree.

People have different innate abilities, different capacities, and different wealth. These differences mean people earn different incomes in a market economy. They also affect the pattern of consumer demand. Brazil, with a very unequal distribution of income and wealth, has a high demand for luxuries such as domestic help. In more egalitarian Denmark, few can afford servants. Different endowments of ability, capital, and wealth thus imply different demand curves and determine different equilibrium prices and quantities. In principle, *by varying the distribution of earnings, we could influence the outcomes in many of the economy's markets*.

This is an important observation, because it means that *we can have many different efficient outcomes in each of the economy's markets* when considered in isolation. The position of a demand curve in any market may depend upon how incomes and resources are distributed in the economy. Accordingly, when we say that the demand curve represents the "value" placed on a good or service, we should really think of this value as a measure of willingness to pay, *given the current distribution of income*.

For example, the demand curve for luxury autos would shift downward if we imposed a higher tax rate on those individuals at the top end of the income distribution. Yet the auto market could be efficient with either a low or high set of income taxes. Let us pursue this example further in order to understand more fully that the implementation of a degree of redistribution from rich to poor involves an equity–efficiency trade-off.

EQUITY VERSUS EFFICIENCY

Figure 5.9 describes the market for high-skill labour. With no income taxes, the equilibrium labour supply and wage rate are given by $\{L_0, W_0\}$. If a tax is now imposed that

APPLICATION BOX 5.5

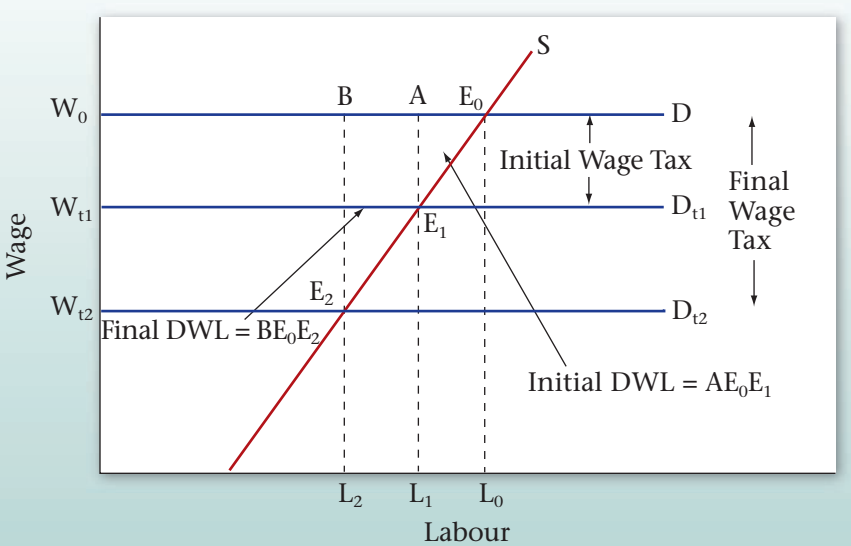
Equity, Ability, Luck, and Taxes

John Rawls, a Harvard philosopher who died recently, has been one of the most influential proponents of redistribution in modern times. He argued that much of the income differences we observe between individuals arises on account of their inherited abilities, their social status, or their good fortune. Only secondarily, he proposes, are income differences due to similar individuals making different work choices.

If this view is accurate, he challenges us to think today of a set of societal rules we would adopt, not knowing our economic status or ability in a world that would begin tomorrow! He proposes that, in such an experiment, we could collectively adopt a set of rules favouring the less fortunate, in particular those at the very bottom of the income heap.

reduces the gross wage W_0 to W_{t1}, the consequence is that less labour is supplied and there is a net loss in surplus equal to the dollar amount E_0E_1A. This is the efficiency loss associated with raising government revenue equal to $W_0AE_1W_{t1}$. Depending on how this money is spent, society may be willing to trade off some efficiency losses in return for redistributive gains.

FIGURE 5.9 **Equity versus Efficiency in the Skilled Labour Market**



A doubling of the wage tax on labour from $\{W_0 - W_{t1}\}$ to $\{W_0 - W_{t2}\}$ increases the deadweight loss from AE_0E_1 to BE_0E_2. The DWL more than doubles—in this case it quadruples when we double the tax.

APPLICATION BOX 5.6

Rent Seeking

In America, lobbyists get the early plane to Washington, D.C; in Europe, they go to Brussels; in Canada, they live in Ottawa. Over expense-account lunches, the business of persuasion is conducted. What does this have to do with efficiency or inefficiency? If the aim of lobbyists is to provide information to policy makers, it is possible that their work may improve decision making. But lobbying goes much further.

Suppose the federal government makes available $1.2 billion each year for "local development" projects and invites submissions from interested communities. We would expect the representatives of communities all across Canada to devote time, energy, and creative thinking into lobbying for such funds. Is this a good use of time and resources? Perhaps not: The government would be encouraging the public to engage in competition for a fixed pie. At the end of the process, many resources will have been spent in an unproductive way. If these lobbyists instead could have been hired by the local school board, or been paid to pave roads, with the funds made available from the federal government, output in the economy would have increased, and resources would have been used more efficiently.

In fact, the federal government does make available approximately $1.2 billion each year to regional development agencies, such as the Atlantic Canada Opportunities Agency and the Western Economic Diversification Agency. The unproductive use of time and resources to securing a bigger share of the pie is termed *rent-seeking*.

Continuing the illustration, suppose the tax is increased further so as to reduce the net wage to W_{t2}. The DWL is now BE_0E_2, much larger than before. Whether we should take this extra step in sacrificing more efficiency for redistributive gains is an ethical or normative issue. The citizens of some economies, most notably in Scandinavia, appear more willing than the citizens of the United States to make efficiency sacrifices in return for other objectives. Canada lies between these extremes, and our major political parties can be placed clearly on a spectrum of willingness to trade equity and efficiency.

Review Question 14

A vital role for the economist, therefore, is to clarify the nature and extent of the trade-offs. The field of public economics views this as a centrepiece in its investigations.

Next

This chapter has developed concepts and tools that enable economists to better analyze the functioning of the marketplace and to formulate appropriate policies for markets where externalities are a feature. The next task is to deepen our understanding of the demand side of the market by developing a basis for individual decision making—utility theory.

SUMMARY

- **Welfare economics** deals with both normative and positive aspects of economics. It is concerned with the efficiency of markets, the fairness of the tax system, equity, and how governments can influence and improve the working of the economy.
- **Consumer surplus** is the excess of consumer willingness to pay over the market price. **Supplier or producer surplus** is the excess of market price over the reservation price of the supplier.
- An **efficient market outcome** is one where the sum of consumer and producer surpluses is maximized. Where demands reflect value, and supply represents cost, the efficient outcome is where demand equals supply.
- A **tax wedge** is the difference between the price a buyer pays and the price the supplier receives after the imposition of a tax. The **revenue burden** of a tax is the amount of tax revenue raised by the tax.
- **Taxes** drive a wedge between marginal value and marginal cost and therefore create an **excess burden**, or **deadweight losses**, in an otherwise efficient market.
- **Distortions** occur where the market outcome is not efficient; the allocation of resources in the economy becomes distorted if too little or too much is produced, or if a given output is not allocated appropriately.
- **Externalities** occur when the market demand or the supply curve does not reflect the full social value or social cost associated with a good or service. Externalities can be negative or positive. If they are negative, the market equilibrium does not reflect the adverse consequences of the behaviour of the participants in the market. If they are positive, it does not reflect the beneficial by-product of the market.
- **A corrective tax** corrects for an externality and can result in an efficient market outcome.
- **Greenhouse gases (GHGs)** accumulate in the atmosphere and inhibit the reflected heat from the earth's surface from completely escaping. An excessive accumulation gives rise to **global warming**.
- The **marginal damage curve** reflects the cost to society of an additional unit of pollution. The **marginal abatement curve** reflects the cost to society of reducing the quantity of pollution by one unit.
- **Government policies**, such as taxes, subsidies, or production quotas, can be used to correct externalities, either partially or fully, in an attempt to reduce market inefficiencies.
- **GHGs** can be controlled through **carbon taxes**, **cap and trade permit systems**, or **direct controls**.
- There **exist many possible efficient outcomes** in any given market. By changing the distribution of income, or spending power, demand conditions may change and thus move the market equilibrium from one efficient outcome to another.
- **Equity** is a goal of government. **Horizontal equity** is the equal treatment of equal individuals, and **vertical equity** involves normative judgements regarding the appropriate degree of redistribution between individuals who are not equal. **Intergenerational equity** balances the interests and well-being of different generations and cohorts.

KEY TERMS

Welfare economics *91*
Consumer surplus *93*
Supplier or producer surplus *94*
Efficient market *95*
Tax wedge *96*
Revenue burden *97*
Excess burden/Deadweight loss *97*
Distortion *97*
Externality *98*
Corrective tax *100*
Greenhouse gases *104*
Global warming *104*
Marginal damage curve *105*
Marginal abatement costs *105*
Tradable permits and corrective carbon taxes *108*
Horizontal equity *110*
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Intergenerational equity *110*

REVIEW QUESTIONS

Review Questions and answers are included in Connect at www.mcgrawhillconnect.ca.

1. Four teenagers live on your street. Each is willing to shovel snow from one driveway each day. Their "willingness to shovel" valuations (supply) are: Jean, $10; Kevin, $9; Liam, $7; Margaret, $5. Several households are interested in having their driveways shovelled, and their willingness to pay values (demand) are: Jones, $8; Kirpinsky, $4; Lafleur, $7.50; Murray, $6.
   a. Draw the implied supply and demand curves as step functions.
   b. How many driveways will be shovelled in equilibrium?
   c. Compute the maximum possible sum for the consumer and supplier surpluses.
   d. If a new (wealthy) family arrives on the block, that is willing to pay $12 to have their driveway cleared, recompute the answers to parts (a), (b), and (c).

2. The market for cappuccino has a regular upward-sloping supply curve and a downward-sloping demand curve.
   a. Illustrate in a diagram the areas that represent total consumer surplus and total supplier surplus.
   b. If the demand for cappuccinos increases so that the demand curve shifts in parallel fashion, illustrate the impact on each surplus value.

3. Consider a market where supply and demand are given by $P = 10$ and $P = 34 - 1Q$ respectively.
   a. Illustrate the market geometrically, and compute the equilibrium quantity.
   b. Impose a tax of $2 per unit on the good so that the supply curve is now $P = 12$. Calculate the new equilibrium quantity, and illustrate it in your diagram.
   c. Calculate the tax revenue generated, and also the deadweight loss.

4. Redo question 3 with the demand curve replaced by $P = 26 - 2/3Q$
   a. Is this new demand curve more or less elastic than the original at the equilibrium?
   b. What do you note about the DWL and tax revenue estimates here, relative to question 3?

5. Next, consider an example of DWL in the labour market. Suppose the demand for labour is given by the fixed gross wage $W = \$16$. The supply is given by $W = 0.8L$.
   a. Illustrate the market geometrically.
   b. Calculate the equilibrium amount of labour supplied, and the supplier surplus.
   c. Suppose a wage tax that reduces the wage to $W = \$12$ is imposed. By how much is the supplier's surplus reduced at the new equilibrium?

6. Governments are in the business of providing information to potential buyers. The first serious provision of information on the consequences of tobacco use appeared in the United States Report of the Surgeon General in 1964.
   a. How would you represent this intervention in a supply and demand for tobacco diagram?
   b. Did this intervention "correct" the existing market demand?

7. In deciding to drive a car in the rush hour, you think about the cost of gas and the time of the trip.
   a. Do you slow down other people by driving?
   b. Is this an externality?

8. Suppose that our local power station burns coal to generate electricity. The demand and supply functions for electricity are given by $P = 12 - 0.5Q$ and $P = 2 + 0.5Q$, respectively. However, for each unit of electricity generated, there is an externality. When we factor this into the supply side of the market, the real social cost is increased, and the supply curve is $P = 3 + 1Q$.
   a. Find the free market equilibrium and illustrate it geometrically.
   b. Calculate the efficient (i.e., socially optimal) level of production.

9. Cassidy rides her mountain bike down Whistler each summer weekend. The value she places on each kilometre is given by $P = 4 - 0.02Q$, where Q is the number of kilometres. She incurs a cost of $2 per kilometre in lift fees and bike depreciation.
   a. How many kilometres will she ride each weekend? [*Hint*: Think of her "value" equation as demand, and her "cost" equation as a (horizontal) supply.]
   b. But Cassidy frequently ends up in the local hospital with pulled muscles and broken bones. On average, this cost to the Canadian taxpayer is $0.50 per kilometre ridden. From a societal viewpoint, what is the efficient number of kilometres that Cassidy should ride each weekend?

10. Your local dry cleaner, Sparkling Brite, is willing to launder shirts at its cost of $1.00 per shirt. The neighbourhood demand for this service is $P = 5 - 0.005Q$.
    a. Illustrate and compute the market equilibrium.
    b. Suppose that, for each shirt, Sparkling Brite emits chemicals into the local environment that cause $.25 damage per shirt. This means the full cost of each shirt is really $1.25. Calculate the socially optimal number of shirts to be cleaned.

11. The supply curve for compact disks is given by $P = 1 + .2Q$. The demand curve is given by $P = 17$.
    a. Illustrate the market equilibrium, and compute the equilibrium price and quantity.
    b. Compute the supplier surplus at this equilibrium.
    c. If the government imposes a price ceiling in this market at a price $P = 15$, calculate the new quantity supplied and the new supplier surplus.
    d. What is the loss in surplus to the supplier?

12. The demand for ice cream is given by $P = 24 - 1Q$ and the supply curve by $P = 12$.
    a. Illustrate the market equilibrium, and compute the equilibrium price and quantity.
    b. Calculate the consumer surplus at the equilibrium.
    c. If the government decides to implement a price floor at a value of $P = 14$, compute the new quantity traded, and calculate the loss in consumer surplus.

13. Two firms, A and B, making up a sector of the economy, emit pollution (pol) and have marginal abatement costs defined by $MA_A = 24 - 1$ pol and $MA_B = 24 - (1/2)$ pol. So the total abatement curve for this sector is given by $MA = 24 - (1/3)$ pol. The marginal damage function is constant at a value of $12 per unit of pollution emitted: MD = $12.
    a. Draw the MD and MA curves and establish the "right" level of pollution for this economy.
    b. If each firm is permitted to emit half of this amount, illustrate your answer in a diagram which contains the MA_A and MA_B curves.
    c. With each firm producing this amount of pollution, how much would it cost each one to reduce pollution by one unit?

14. Are the following statements correct or incorrect? Explain your answers.
    a. Society should ban all toxic discharges.
    b. All inoculations that have positive externalities should be supplied to the public free of charge.
    c. Anything the market can do the government can do better.

15. *Internet* Go to the Health Canada Web site at www.hc-sc.gc.ca and find information that attempts to correct otherwise less-informed demand decisions on (a) drinking water, (b) tobacco, (c) natural health products, (d) pesticides, and (e) air quality.

16. *Internet* In order to learn what tax rate you pay on the last dollar of income you earn, go to the Web site of the Canada Customs and Revenue Agency, www.cra-arc.gc.ca. Among other prompts, you will find "forms and publications," and then "tax packages." Did you previously know your tax rate?

17. *Internet* Go to Environment Canada's Web site and find information on how GHGs have increased in Canada in the last decade, and establish those sectors and regions of the economy that produce a disproportionate percentage of the total.