The Analysis of Markets
Evaluating the Gains and Losses from Government Policies—Consumer and Producer Surplus

In this chapter, we return to supply–demand analysis and show how it can be applied to a wide variety of economic problems—problems that might concern a consumer faced with a purchasing decision, a firm faced with a long-range planning problem, or a government agency that has to design a policy and evaluate its likely impact.

We begin by showing how consumer and producer surplus can be used to study the welfare effects of a government policy—in other words, who gains and who loses from the policy, and by how much.

We also use consumer and producer surplus to demonstrate the efficiency of a competitive market.

You will see how to calculate the response of markets to changing economic conditions or government policies and to evaluate the resulting gains and losses to consumers and producers.
CONSUMER AND PRODUCER SURPLUS

Consumer $A$ would pay $10$ for a good whose market price is $5$ and therefore enjoys a benefit of $5$.

Consumer $B$ enjoys a benefit of $2$, and Consumer $C$, who values the good at exactly the market price, enjoys no benefit.

Consumer surplus, which measures the total benefit to all consumers, is the yellow-shaded area between the demand curve and the market price.
CONSUMER AND PRODUCER SURPLUS

Producer surplus measures the total profits of producers, plus rents to factor inputs.

It is the benefit that lower-cost producers enjoy by selling at the market price, shown by the green-shaded area between the supply curve and the market price.

Together, consumer and producer surplus measure the welfare benefit of a competitive market.
Application of Consumer and Producer Surplus

- **welfare effects**  Gains and losses to consumers and producers.

- **deadweight loss**  Net loss of total (consumer plus producer) surplus.

**CHANGE IN CONSUMER AND PRODUCER SURPLUS FROM PRICE CONTROLS**

The price of a good has been regulated to be no higher than $P_{\text{max}}$, which is below the market-clearing price $P_0$.

The gain to consumers is the difference between rectangle $A$ and triangle $B$.

The loss to producers is the sum of rectangle $A$ and triangle $C$.

Triangles $B$ and $C$ together measure the deadweight loss from price controls.
EFFECT OF PRICE CONTROLS WHEN DEMAND IS INELASTIC

If demand is sufficiently inelastic, triangle $B$ can be larger than rectangle $A$. In this case, consumers suffer a net loss from price controls.
EFFECTS OF NATURAL GAS PRICE CONTROLS

The market-clearing price of natural gas was $6.40 per mcf, and the (hypothetical) maximum allowable price is $3.00.

A shortage of $29.1 - 20.6 = 8.5 \text{Tcf}$ results.

The gain to consumers is rectangle $A$ minus triangle $B$,

and the loss to producers is rectangle $A$ plus triangle $C$.

The deadweight loss is the sum of triangles $B$ plus $C$. 

Supply: $Q^S = 15.90 + 0.72PG + 0.05PO$

Demand: $Q^D = 0.02 - 1.8PG + 0.69PO$
EFFECTS OF NATURAL GAS PRICE CONTROLS

\[ A = (20.6 \text{ billion mcf}) \times ($3.40/\text{mcf}) = $70.04 \text{ billion} \]
\[ B = (1/2) \times (2.4 \text{ billion mcf}) \times ($1.33/\text{mcf}) = $1.60 \text{ billion} \]
\[ C = (1/2) \times (2.4 \text{ billion mcf}) \times ($3.40/\text{mcf}) = $4.08 \text{ billion} \]

The annual change in consumer surplus that would result from these hypothetical price controls would therefore be \( A - B = 70.04 - 1.60 = $68.44 \text{ billion} \).

The change in producer surplus would be \( -A - C = -70.04 - 4.08 = -$74.12 \text{ billion} \).

And finally, the annual deadweight loss would be \( -B - C = -1.60 - 4.08 = -$5.68 \text{ billion} \).
WELFARE LOSS WHEN PRICE IS HELD ABOVE MARKET-CLEARING LEVEL

When price is regulated to be no lower than $P_2$, only $Q_3$ will be demanded.

If $Q_3$ is produced, the deadweight loss is given by triangles $B$ and $C$.

At price $P_2$, producers would like to produce more than $Q_3$. If they do, the deadweight loss will be even larger.
THE MARKET FOR HUMAN KIDNEYS

Even at a price of zero (the effective price under the law), donors supply about 16,000 kidneys per year. It has been estimated that 8000 more kidneys would be supplied if the price were $20,000.

We can fit a linear supply curve to this data—i.e., a supply curve of the form $Q = a + bP$. When $P = 0$, $Q = 16,000$, so $a = 16,000$. If $P = 20,000$, $Q = 24,000$, so $b = (24,000 - 16,000)/20,000 = 0.4$.

Thus the supply curve is $Supply$: $Q^S = 16,000 + 0.4P$

Note that at a price of $20,000, the elasticity of supply is 0.33. It is expected that at a price of $20,000, the number of kidneys demanded would be 24,000 per year. Like supply, demand is relatively price inelastic; a reasonable estimate for the price elasticity of demand at the $20,000 price is $-0.33$. This implies the following linear demand curve:

$Demand$: $Q^D = 32,000 - 0.4P$
Economics, the dismal science, shows us that human organs have economic value that cannot be ignored, and prohibiting their sale imposes a cost on society that must be weighed against the benefits.
Minimum Prices

PRICE MINIMUM

Price is regulated to be no lower than $P_{\text{min}}$.
Producers would like to supply $Q_2$, but consumers will buy only $Q_3$.
If producers indeed produce $Q_2$, the amount $Q_2 - Q_3$ will go unsold and the change in producer surplus will be $A - C - D$. In this case, producers as a group may be worse off.

The total change in consumer surplus is: $\Delta \text{CS} = -A - B$
The total change in producer surplus is: $\Delta \text{PS} = A - C - D$
THE MINIMUM WAGE

Although the market-clearing wage is $w_0$, firms are not allowed to pay less than $w_{\text{min}}$. This results in unemployment of an amount $L_2 - L_1$ and a deadweight loss given by triangles $B$ and $C$. 
Price Supports and Production Quotas

Price Supports

- **price support** Price set by government above free-market level and maintained by governmental purchases of excess supply.

**PRICE SUPPORTS**

To maintain a price $P_s$ above the market-clearing price $P_0$, the government buys a quantity $Q_g$. The gain to producers is $A + B + D$. The loss to consumers is $A + B$. The cost to the government is the speckled rectangle, the area of which is $P_s(Q_2 - Q_1)$. 

![Diagram showing price supports and production quotas](image)
Let’s examine the resulting gains and losses to consumers, producers, and the government.

**CONSUMERS**

Some consumers pay a higher price, while others no longer buy the good.

\[ \Delta CS = -A - B \]

**PRODUCERS**

Producers are now selling a larger quantity \( Q_2 \) instead of \( Q_0 \), and at a higher price \( P_s \).

\[ \Delta PS = +A + B + D \]

**THE GOVERNMENT**

The cost to the government (which is ultimately a cost to consumers) is

\[ (Q_2 - Q_1)P_s \]

The total change in welfare is

\[ \Delta CS + \Delta PS - \text{Cost to Govt.} = D - (Q_2 - Q_1)P_s \]
SUPPLY RESTRICTIONS
To maintain a price $P_s$ above the market-clearing price $P_0$, the government can restrict supply to $Q_1$, either by imposing production quotas (as with taxicab medallions) or by giving producers a financial incentive to reduce output (as with acreage limitations in agriculture).

For an incentive to work, it must be at least as large as $B + C + D$, which would be the additional profit earned by planting, given the higher price $P_s$. The cost to the government is therefore at least $B + C + D$. 

![Diagram of supply restrictions showing the market equilibrium at $P_0$ and the government-imposed price $P_s$ above the market-clearing price. The area $B + C + D$ represents the additional profit earned by planting, and the cost to the government is also at least $B + C + D$.](image_url)
INCENTIVE PROGRAMS

In U.S. agricultural policy, output is reduced by incentives rather than by outright quotas. *Acreage limitation programs* give farmers financial incentives to leave some of their acreage idle. Figure 9.11 also shows the welfare effects of reducing supply in this way.

As with direct production quotas, the change in consumer surplus is

\[ \Delta CS = -A - B \]

Farmers receive a higher price, produce less, and receive an incentive to reduce production. Thus, the change in producer surplus is now

\[ \Delta PS = A - C + \text{Payments for not producing} \]

The cost to the government is at least \( B + C + D \), and the total change in producer surplus is

\[ \Delta PS = A - C + B + C + D = A + B + D \]

An acreage-limitation program is more costly to society than simply handing the farmers money. The total change in welfare

\[ \Delta \text{Welfare} = -A - B + A + B + D - B - C - D = -B - C \]
THE WHEAT MARKET IN 1981

To increase the price to $3.70, the government must buy a quantity of wheat $Q_g$.

By buying 122 million bushels of wheat, the government increased the market-clearing price from $3.46 per bushel to $3.70.

1981 Supply: $Q_S = 1800 + 240P$

1981 Demand: $Q_D = 3550 − 266P$

1981 Total demand: $Q_D = 3550 − 266P + Q_g$

$Q_g = 506P − 1750$

$Q_g = (506)(3.70) − 1750 = 122$ million bushels

Loss to consumers = $−A − B = $624 million

Cost to the government = $3.70 \times 122$ million = $451.4$ million

Total cost of the program = $624$ million + $451.4$ million = $1075$ million

Gain to producers = $A + B + C = $638$ million
WHY CAN’T I FIND A TAXI?

The city of New York limits the number of taxis by requiring each taxi to have a medallion (essentially a permit), and then limiting the number of medallions. In 2011 there were 13,150 medallions in New York—roughly the same number as in 1937. Why not just issue more medallions? The reason is simple. Doing so would incur the wrath of the current owners of medallions. Medallions can be bought and sold by the companies that own them.

In 1937, there were plenty of medallions to go around, so they had little value. By 1947, the value of a medallion had increased to $2,500, by 1980 to $55,000, and by 2011 to $880,000. That’s right—because New York City won’t issue more medallions, the value of a taxi medallion is approaching $1 million!

But of course that value would drop sharply if the city starting issuing more medallions. So the New York taxi companies that collectively own the 13,150 available medallions have done everything possible to prevent the city from issuing any more—and have succeeded in their efforts.

If the city were to issue another 7,000 medallions for a total of about 20,000, demand and supply would equilibrate at a price of about $350,000 per medallion—still a lot, but just enough to lease cabs, run a taxi business, and still make a profit.
WHY CAN’T I FIND A TAXI?

**Figure 9.13**

**TAXI MEDALLIONS IN NEW YORK CITY**

The demand curve $D$ shows the quantity of medallions demanded by taxi companies as a function of the price of a medallion.

The supply curve $S$ shows the number of medallions that would be sold by current owners as a function of price.

New York limits the quantity to 13,150, so the supply curve becomes vertical and intersects demand at $P^* = $880,000, the market price of a medallion in 2011.
Import Quotas and Tariffs

- **import quota**  Limit on the quantity of a good that can be imported.
- **tariff**  Tax on an imported good.

**IMPORT TARIFF OR QUOTA THAT ELIMINATES IMPORTS**

In a free market, the domestic price equals the world price $P_w$.

A total $Q_d$ is consumed, of which $Q_s$ is supplied domestically and the rest imported.

When imports are eliminated, the price is increased to $P_0$.

The gain to producers is trapezoid $A$.

The loss to consumers is $A + B + C$, so the deadweight loss is $B + C$. 
IMPORT TARIFF OR QUOTA
(GENERAL CASE)

When imports are reduced, the domestic price is increased from $P_w$ to $P^*$. This can be achieved by a quota, or by a tariff $T = P^* - P_w$.

Trapezoid $A$ is again the gain to domestic producers.

The loss to consumers is $A + B + C + D$.

If a tariff is used, the government gains $D$, the revenue from the tariff. The net domestic loss is $B + C$.

If a quota is used instead, rectangle $D$ becomes part of the profits of foreign producers, and the net domestic loss is $B + C + D$. 
In recent years, the world price of sugar has been between 10 and 28 cents per pound, while the U.S. price has been 30 to 40 cents per pound. Why? By restricting imports, the U.S. government protects the $4 billion domestic sugar industry, which would virtually be put out of business if it had to compete with low-cost foreign producers. This policy has been good for U.S. sugar producers, but bad for consumers.

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<table>
<thead>
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<tbody>
<tr>
<td>U.S. production:</td>
<td>15.9 billion pounds</td>
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<tr>
<td>U.S. consumption:</td>
<td>22.8 billion pounds</td>
</tr>
<tr>
<td>U.S. price:</td>
<td>36 cents per pound</td>
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<tr>
<td>World price</td>
<td>24 cents per pound</td>
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\[
U.S. \ supply: \ Q_S = -7.95 + 0.66P
\]

\[
U.S. \ demand: \ Q_D = 29.73 - 0.19P
\]

At the 24-cent world price, U.S. production would have been only about 7.9 billion pounds and U.S. consumption about 25.2 billion pounds, of which 25.2 – 7.9 = 17.3 billion pounds would have been imported. But fortunately for U.S. producers, imports were limited to only 6.9 billion pounds.
SUGAR QUOTA IN 2010
At the world price of 24 cents per pound, about 25.2 billion pounds of sugar would have been consumed of which all but 7.9 billion pounds would have been imported. Restricting imports to 6.9 billion pounds caused the U.S. price to go up by 12 cents. The cost to consumers, $A + B + C + D$, was about $2.9 billion. The gain to domestic producers was trapezoid $A$, about $1.4 billion. Rectangle $D$, $836$ million, was a gain to those foreign producers who obtained quota allotments. Triangles $B$ and $C$ represent the deadweight loss of about $614$ million.
The Impact of a Tax or Subsidy

THE EFFECTS OF A SPECIFIC TAX

• **specific tax**  Tax of a certain amount of money per unit sold.

INCIDENCE OF A TAX

$P_b$ is the price (including the tax) paid by buyers. $P_s$ is the price that sellers receive, less the tax.

Here the burden of the tax is split evenly between buyers and sellers.

Buyers lose $A + B$.

Sellers lose $D + C$.

The government earns $A + D$ in revenue.

The deadweight loss is $B + C$.

Market clearing requires four conditions to be satisfied after the tax is in place:

$$Q^D = Q^D(P_b) \quad (9.1a)$$

$$Q^S = Q^S(P_s) \quad (9.1b)$$

$$Q^D = Q^S \quad (9.1c)$$

$$P_b - P_s = t \quad (9.1d)$$
IMPACT OF A TAX DEPENDS ON ELASTICITIES OF SUPPLY AND DEMAND

(a) If demand is very inelastic relative to supply, the burden of the tax falls mostly on buyers.

(b) If demand is very elastic relative to supply, it falls mostly on sellers.

By using the following “pass-through” formula, we can calculate the percentage of the tax that is “passed through” to consumers: Pass-through fraction = $\frac{E_s}{E_s - E_d}$
The Effects of a Subsidy

- **subsidy**  Payment reducing the buyer’s price below the seller’s price; i.e., a negative tax.

**SUBSIDY**

A subsidy can be thought of as a negative tax. Like a tax, the benefit of a subsidy is split between buyers and sellers, depending on the relative elasticities of supply and demand.

Conditions needed for the market to clear with a subsidy:

\[ Q^D = Q^D(P_b) \]  
\[ Q^S = Q^S(P_s) \]  
\[ Q^D = Q^S \]  
\[ P_s - P_b = s \]
A TAX ON GASOLINE

\[ Q^D = 150 - 25P_b \]  
(Demand)

\[ Q^S = 60 + 20P_s \]  
(Supply)

\[ Q^D = Q^S \]  
(Supply must equal demand)

\[ P_b - P_s = 1.00 \]  
(Government must receive $1.00/gallon)

\[
150 - 25P_b = 60 + 20P_s \\
P_b = P_s + 1.00 \\
150 - 25P_b = 60 + 20P_s \\
20P_s + 25P_s = 150 - 25 - 60 \\
45P_s = 65, \text{ or } P_s = 1.44 \\
Q^D = 150 - (25)(2.44) = 150 - 61, \text{ or } Q = 89 \text{ bg/yr}
\]

Annual revenue from the tax \( tQ = (1.00)(89) = $89 \) billion per year

Deadweight loss: \( \frac{1}{2} \times (1.00/\text{gallon}) \times (11 \text{ billion gallons/year}) = $5.5 \) billion per year
**A TAX ON GASOLINE**

**IMPACT OF $1 GASOLINE TAX**

The price of gasoline at the pump increases from $2.00 per gallon to $2.44, and the quantity sold falls from 100 to 89 bg/yr.

Annual revenue from the tax is \((1.00)(89) = $89\) billion (areas \(A + D\)).

The two triangles show the deadweight loss of $5.5 billion per year.