**Supply and Demand**

Readings: Chapter 2 (including the appendix)

**Objective: Understand what a demand and supply curve/function is and what the law of supply and demand tells us about how they look.**

*Definition*
Product: A good or service.

*Definition*
Real Price: The price of a product relative to the price of other products.

The price of a product has little meaning unless it can be compared to the price of other products. For example, if I told you I spent 65 Euro per night for a room in Ravello Italy last summer, can you tell me if that was good or bad? If I told you I spent $45 a night for a room in Ravello, can you tell me if that was good or bad? Why does knowing I spent $45 a night mean more to you than knowing I spent 65 Euro? It means more because you know that $45 is worth 3 large pizzas, a dinner with a friend at pretty good restaurant, or the price of a pretty bad motel room in downtown Minneapolis.

When I use the word price from now on, I will be talking about the real price.

*Definition*
Buyer: A person who wants to purchase a product.

*Definition*
Seller: A person who wants to sell a product.

*Definition*
Demand (Curve/Function): The relationship between the price of a product and the quantity buyers want to purchase.

Demand reflects how much buyers are willing to pay for a product.

*Definition*
Quantity Demanded: The amount of product buyers want to purchase at a given price.

*Definition*
Supply (Curve/Function): The relationship between the price of a product and the quantity sellers want to offer.

Supply reflects how much sellers are willing to accept for a product.

*Definition*
Quantity Supplied: The amount of product sellers want to offer at a given price.

Law of Demand: The observation that when the price of a product falls, people buy more of it.

Law of Supply: The observation that when the price of a product rises, people sell more of it.

It is important to realize that the laws of supply and demand are not assumptions. They are observations of how things tend to be. There are historical and contemporary examples of when the laws of supply and demand have been broken. Later we will consider the theoretical explanations for these violations, which provide some insight into why they are rare.

There are lots of ways to describe supply and demand:

i) Tabular
ii) Graphical
iii) Specific Function
iv) General Function
v) Really General Function

However, the laws of supply and demand do place some restrictions on what they commonly look like. For demand, we want to make sure that the quantity demanded is lower for higher prices (inverse relationship). For supply, we want to make sure that the quantity supplied is higher for higher prices (direct relationship).

Example Demand for the Prius

Tabular:

Table 1

| Price (P/1000) | Quantity Demanded ($Q_D$) |
|---|---|
| \$50 | 0 |
| \$45 | 100 |
| \$40 | 200 |
| \$35 | 300 |
| \$30 | 400 |
| \$25 | 500 |
| \$20 | 600 |
| \$15 | 700 |
| \$10 | 800 |
| \$5 | 900 |
| \$0 | 1,000 |

Graphical: See Figure 1

Note that the law of demand implies the demand curve drawn in Figure 1 is downward sloping.

Specific Function:

$Q_D = 1{,}000 - 20P$

We could just as well written

$P = 50 - 0.05Q_D$

General Linear Function:

$Q_D = a_D - b_DP$

Note that the law of demand implies $b_D > 0$.

Also, note we could write

$P = a_D/b_D - Q_D/b_D$

Really General Function:

$Q_D = D(P)$ or $P = D^{-1}(Q_D)$

The law of demand implies the derivative of demand with respect to price is negative, $D'(P) < 0$ and $D^{-1}'(Q_D) < 0$.

Example Supply for the Prius

Tabular:

Table 2

| Price (P/1000) | Quantity Supplied ($Q_S$) |
|---|---|
| \$50 | 1,000 |
| \$45 | 900 |
| \$40 | 800 |
| \$35 | 700 |
| \$30 | 600 |
| \$25 | 500 |
| \$20 | 400 |
| \$15 | 300 |
| \$10 | 200 |
| \$5 | 100 |
| \$0 | 0 |

Graphical: See Figure 2

Note that the law of supply implies the supply curve drawn in Figure 2 is upward sloping.

Specific Function:

$Q_S = 20P$ or $P = 0.05Q_S$

General Linear Function:

$Q_S = a_S + b_SP$ or $P = a_S/b_S + Q_S/b_S$

Note that the law of supply implies $b_S > 0$.

General Function:

$Q_S = S(P)$ or $P = S^{-1}(Q_S)$

The law of supply implies the derivative of supply with respect to price is positive, $S'(P) > 0$ and $S^{-1}'(Q_S) > 0$.

**Objective: Understand what a market is and how we describe it.**

*Definition*

Market: A collection of buyers and sellers voluntarily exchanging a product.

The function of a market is to determine how much of a product will be voluntarily exchanged between buyers and sellers and at what price.

It is important to emphasize that in the markets we talk about all transactions are voluntary. No buyer can be forced to make a purchase and no seller can be forced to make a sale. Transactions result from the free will of buyers and sellers.

Combining Supply and Demand gives us a Market

Tabular:

Table 3

| Price (P) | Quantity Demanded ($Q_D$) | Quantity Supplied ($Q_S$) |
|---|---|---|
| \$50 | 0 | 1,000 |
| \$45 | 100 | 900 |
| \$40 | 200 | 800 |
| \$35 | 300 | 700 |
| \$30 | 400 | 600 |
| \$25 | 500 | 500 |
| \$20 | 600 | 400 |
| \$15 | 700 | 300 |
| \$10 | 800 | 200 |
| \$5 | 900 | 100 |
| \$0 | 1,000 | 0 |

Graphical: See Figure 3

Specific Functions:

$Q_D = 1{,}000 - 20P$

$Q_S = 20P$

General Linear Functions:

$Q_D = a_D - b_D P$

$Q_S = a_S + b_S P$

Really General Functions:

$Q_D = D(P)$

$Q_S = S(P)$

**Objective: Understand the concept of market equilibrium and the function of price.**

A market is said to be in equilibrium when both buyers and sellers are satisfied. But what does it mean to be satisfied?

*Definition*
Excess Demand/Shortage: The amount by which the quantity demanded exceeds the quantity supplied at a given price.

When there is a shortage, buyers are not satisfied because there is not enough product for sale at the given price. Some buyers will have to go without even though they are willing to pay the going price for the product.

*Definition*
Excess Supply/Surplus: The amount by which the quantity supplied exceeds the quantity demanded at a given price.

When there is a surplus, sellers are not satisfied because there are not enough buyers for their product at the given price. Some sellers will not be able to make a sale even though they are willing for the going price of the product.

*Definition*
Equilibrium Price: The price at which there is no surplus or shortage.

*Definition*
Equilibrium Quantity: The quantity at which there is no surplus or shortage.

At the equilibrium price and quantity, there is no shortage, so buyers are satisfied and there is no surplus, so sellers are satisfied.

To identify market equilibrium you need to identify the equilibrium price. You can find it by looking for the price where quantity supplied equals to quantity demanded. At this price, there is no shortage or surplus. The equilibrium quantity is then just the quantity supplied and demanded at this equilibrium price.

Consider our example of the market for the Prius.

Tabular:

Table 4

| Price (P) | Quantity Demanded ($Q_D$) | Quantity Supplied ($Q_S$) | Shortage | Surplus |
|---|---|---|---|---|
| \$50 | 0 | 1,000 | - | 1,000 |
| \$45 | 100 | 900 | - | 800 |
| \$40 | 200 | 800 | - | 600 |
| \$35 | 300 | 700 | - | 400 |
| \$30 | 400 | 600 | - | 200 |
| **P*=\$25** | **Q*=500** | **Q*=500** | **0** | **0** |
| \$20 | 600 | 400 | 200 | - |
| \$15 | 700 | 300 | 400 | - |
| \$10 | 800 | 200 | 600 | - |
| \$5 | 900 | 100 | 800 | - |
| \$0 | 1,000 | 0 | 1000 | - |

Graphical: See Figure 4

Specific Functions:

$Q_D^* = Q_S^* = Q^*$
$Q_D^* = 1{,}000 - 20P^*$
$Q_S^* = 20P^*$

$1{,}000 - 20P^* = 20P^*$
$1{,}000 = 40P^*$
$P^* = 25$
$Q^* = 20 \times 25 = 1{,}000 - 20 \times 25 = 500$

General Linear Functions:

$Q_D^* = Q_S^* = Q^*$
$Q_D^* = a_D - b_D P^*$
$Q_S^* = a_S + b_S P^*$

$a_D - b_D P^* = a_S + b_S P^*$
$(b_S + b_D) P^* = a_D - a_S$
$P^* = (a_D - a_S)/ (b_S + b_D)$
$Q_D^* = a_D - b_D ((a_D - a_S)/ (b_S + b_D)) = (a_D b_S + a_S b_D)/ (b_S + b_D)$
$Q_S^* = a_S + b_S ((a_D - a_S)/ (b_S + b_D)) = (a_D b_S + a_S b_D)/ (b_S + b_D)$

Really General Functions:

We cannot solve explicitly for the equilibrium price and quantity with really general functions, we can only say

$Q_D^* = Q_S^* = Q^*$

$Q_D^* = D(P^*)$

$Q_S^* = S(P^*)$

$P^*$ solves $D(P^*) = S(P^*)$

$Q^* = D(P^*) = S(P^*)$

How does a market find the equilibrium price?

Suppose the price for a Prius is \$15K. At this price, sellers offer 300, but buyers want 700. This results in a shortage of 400 (see Table 4 or Figure 5). If you want to buy a Prius and it was worth \$25K to you, but you cannot find a seller because the going price is \$15K, what are you to do? Why not offer to buy it for \$20K? By bidding up the price, you are likely to have lots of sellers ringing your phone and since it is worth \$25K to you, buying it for \$20K instead of not at all is certainly agreeable. But at \$20K, there are still 600 prospective buyers and only 400 prospective sellers (a shortage of 200). Therefore, in order to avoid losing a Prius, other prospective buyers will meet or beat your price. This meet it or beat it price increase can continue as long as there is a shortage at the proposed price.

It works in the other direction too. Suppose the price on the table for a Prius is \$35K. At this price, sellers offer 700, but buyers only want 300. This results in a surplus of 400 (see Table 4 or Figure 6). If you have a Prius for sale that is worth \$20K to you, but you cannot find a buyer because the going price is \$35K, what are you do? Why not offer to sell it for \$30K? By under cutting the current price, you are likely to make a sale and since it is only worth \$20K to you, selling it for \$30K instead of not at all is certainly agreeable. But at \$30K, there are still only 400 prospective buyers and 600 prospective sellers (a surplus of 200). Therefore, in order to avoid losing a sale, other prospective sellers will meet or beat your price. This meet it or beat it price-cutting can continue as long as there is a surplus at the proposed price.

Once the equilibrium price is proposed, there is no reason for buyers to try to bid up the price or sellers to bid down the price. All parties will be satisfied with the outcome.

The two examples of adjustment to market equilibrium we have considered highlight two important functions of price.

The ***Rationing Function*** directs the existing supply of product to those who value it most.

The ***Allocative Function*** directs resources toward the production of product whose price exceeds cost and away from product whose cost exceeds price.

When a market shortage exists, a buyer can let the market know that the product is more important to him by offering a higher price. This directs available product to those who value it

the most. It also tells sellers that they need to reallocate resources to make more product available.

**Objective: Understand what consumer and producer surplus are and how they can be used to show market equilibrium is efficient.**

*Definition*
Efficiency: People doing the best they can with what they have.

*Definition*
Consumer Surplus: The dollar amount consumers benefit from purchases.

The consumer surplus from a trade is the difference between how much the buyer is willing to spend on the product and the price actually paid (See Figure 7).

*Definition*
Producer Surplus: The dollar amount sellers benefit from sales.

The producer surplus from a trade is the difference between how much the seller is willing to accept for a product and the price actually received (See Figure 7).

The total consumer and producer surplus is equal to sum of individual surpluses for each trade. For buyers, this is equal to the triangle denoted by area **abd** below the demand curve and above the equilibrium price up to the equilibrium quantity (See Figure 8). For sellers, this is equal to the triangle denoted by the area **bcd** above the supply curve and below the equilibrium price up to the equilibrium quantity (See Figure 8).

But what happens to consumer and producer surplus if the equilibrium price is not obtained? Suppose for instance the price of a Prius stayed at $35K, instead of being undercut by some sellers until equilibrium is obtained. Because all exchanges are voluntary, only 300 are traded. Figure 9 shows consumer and producer surplus when only 300 are exchanged at the price of $35K. Total consumer surplus is denoted by the area **abg**. Total producer surplus is denoted by the area **bdge**. Notice that compared to the market equilibrium, consumer surplus is lower by the areas **bch** and **bhfg**. Alternatively, producer surplus is lower by area **cdh** and higher by area **bhfg**. Consumer surplus is unequivocally smaller so buyer benefits from trade are lower. However, it is not clear whether seller benefits from trade are higher or lower. If area **bhfg** is larger than area **bch** (as appears to be the case), seller benefits are higher. But, if area **bch** is larger than area **bhfg**, seller benefits are lower. Overall, however, total producer and consumer surplus has declined by the area **bcd**.

Now suppose the price of a Prius stayed at $15K, instead of being bid up by some buyers until equilibrium is obtained. Because all exchanges are voluntary, only 300 are traded. Figure 10 shows consumer and producer surplus when only 300 are exchanged at the price of $15. Total consumer surplus is denoted by the area **abdf**. Total producer surplus is denoted by the area **def**. Notice that compared to the market equilibrium, producer surplus is lower by the areas **cdh** and

**dfgh**. Alternatively, consumer surplus is lower by area **bch** and higher by area **dfgh**. Now, producer surplus is unequivocally smaller so seller benefits from trade are lower. It is not clear whether buyer benefits from trade are higher or lower. If area **dfgh** is larger than area **cdh** (as appears to be the case), buyer benefits are higher. But, if area **cdh** is larger than area **dfgh**, buyer benefits are lower. Overall, however, total producer and consumer surplus has declined by the area **bcd**.

Whether the price is $35K or $15K, total consumer and producer surplus is lower than with the equilibrium price of $25K. Therefore, the prices of $35K or $15K are inefficient. But, why? How could people do better with what they have?

By letting the price fall from $35K to $25K, buyers are certainly better off and sellers may be better or worse off. However, since total consumer and producer surplus increases, it is possible for buyers to compensate sellers for any potential loss in producer surplus and still have more consumer surplus at the end of the day.

By letting the price increase from $15K to $25K, sellers are certainly better off and buyers may be better or worse off. However, since total consumer and producer surplus increases, it is possible for sellers to compensate buyers for any potential loss in consumer surplus and still have more producer surplus at the end of the day.

**Objective: Understand the equity of market equilibrium and why fooling with markets is not the most efficient way to deal with possible inequities.**

*Definition*
Equity: The state of being fair or reasonable.

Is market equilibrium equitable? It is easy to look at the homeless or malnourished in the U.S. and reach the conclusion that market equilibrium is not equitable. Economists claim that market equilibrium is efficient. But, the efficiency does not imply equity. They are two different concepts. Economists do not claim market equilibrium is necessarily equitable.

So, if we can all agree that market equilibrium may not be equitable, why not fool with it to make it more equitable? People do, to the exasperation of most economists, by trying to manipulate market prices.

*Definition*
Price Floor: Minimum statutory price.

*Definition*
Price Ceiling: Maximum statutory price.

For example, in some cities there are limits (price ceiling) on the amount landlords can charge for rent. In the past, U.S. corn producers could borrow against their crop at a loan rate (price

floor) per bushel and deliver their crop to the government instead of paying back the loan if they do not get a high enough price to cover the principal and interest of the loan.

While you might not have recognized it, you have already seen why most economists think price ceilings and floors are a bad idea for dealing with issues of inequity.

Let me take an example that fits with our previous analysis. What can we do with the price of a Prius to make sure poor college students can obtain affordable (and stylish?) transportation to class and work? $25K is certainly too much for them to afford, so lets tell Toyota they can only charge $15K. What will happen? As we see in Figure 10, students might indeed be better off, but Toyota is certainly worse off. Furthermore, Toyota will be worse off by more than students are better off. Who cares? Toyota is a rich foreign corporation and we are talking about helping out poor college students in the U.S. As an economist, I care because there is another way to help students just as much if not more, without hurting Toyota so much. For example, we could tax Toyota's profits and give the proceeds of the tax to students. A Prius will cost more, but students will have extra income to pay the higher price of a Prius or any other car they desire. Toyota will be willing to sell more cars and more college students will be able to afford those cars.

Figure 9 shows how the U.S. government could help U.S. car manufacturers who are struggling with a price ceiling, but it also shows why this would be inefficient because total surplus would fall.

These are just two examples of why we can do better without messing with market equilibrium. The text provides others. If we are concerned that some people cannot afford their fair share of food, housing, transportation, or whatever, it is certainly reasonable to do something about it. But fooling with market equilibrium to make the world a more equitable place is seldom the most efficient way to deal with inequity. The question is whether there is the political will to use more efficient ways.

**Objective: Understand how taxes affect market equilibrium and efficiency.**

Another common way we mess with market equilibrium is through the use of sales taxes or subsidies. Taxes and subsidies drive a wedge between the amount a buyer pays for a product and the amount a seller receives. For a tax, buyers pay more than sellers receive. For a subsidy, buyers pay less than sellers receive.

There are two different types of taxes and subsidies: (i) unit and (ii) Ad Valorem. For a unit tax or subsidy, the amount of the tax or subsidy does not depended on the price of the product. For example, the Federal government collects a tax of about $0.18 on every gallon of gas that is sold. For an Ad Valorem tax or subsidy, the amount of tax you pay is a percentage of the price. For example, if you buy your new Prius in Minnesota, you will have to pay a tax equal to 6.5% of the purchase price.

Suppose $P_S$ is the price a seller receives, $P_D$ is the price the buyer pays, $t_U$ is a unit tax, $t_A$ is an Ad Valorem tax rate, $s_U$ is a unit subsidy, $s_A$ is an Ad Valorem subsidy rate.

For a unit tax, the relationship between the price a buyer pays and the price a seller receives is:

$P_S = P_D - t_U$ or $P_S + t_U = P_D$.

The wedge, difference between the price that is paid and received, $t_U$.

For an Ad Valorem tax, the relationship between the price a buyer pays and the price a seller receives is:

$P_S = P_D(1 - t_A)$.

The wedge being $P_D t_A$.

Alternatively, the relationship between the price a buyer pays and the price a seller receives could be written as:

$P_S / (1 - t_A) = P_D$.

For a unit subsidy, the relationship between the price a buyer pays and the price a seller receives is:

$P_S = P_D + s_U$ or $P_S - s_U = P_D$.

In both cases, the wedge is $s_U$.

For an Ad Valorem subsidy, the relationship between the price a buyer pays and the price a seller receives is:

$P_S = P_D (1 + s_A)$.

The wedge is $P_D s_A$.

Alternatively, the relationship between the price a buyer pays and the price a seller receives could be written as:

$P_S / (1 + s_A) = P_D$.

When a tax is imposed, revenues are generated from the difference in price the buyer pays and the price the seller receives. When a subsidy is imposed, revenues are needed to pay the difference between the price the buyer pays and the price the seller receives. For the time being, we will not worry about where these revenues go to or come from. But, we will be interested in how much revenue is generated by a tax or needed to pay the subsidy.

Let us take an example of a unit tax. Suppose there is a $10K tax on the Prius. How does this affect the market?

Tabular:

Table 5

| $P_S$ | $t_U$ | $P_B$ | $Q_D$ | $Q_S$ | Shortage | Surplus |
|---|---|---|---|---|---|---|
| $50 | $10 | $60 | 0 | 1,000 | - | 1,000 |
| $45 | $10 | $55 | 0 | 900 | - | 900 |
| $40 | $10 | $50 | 0 | 800 | - | 800 |
| $35 | $10 | $45 | 100 | 700 | - | 600 |
| $30 | $10 | $40 | 200 | 600 | - | 400 |
| $25 | $10 | $35 | 300 | 500 | - | 200 |
| $20 | $10 | $30 | 400 | 400 | 0 | 0 |
| $15 | $10 | $25 | 500 | 300 | 200 | - |
| $10 | $10 | $20 | 600 | 200 | 400 | - |
| $5 | $10 | $15 | 700 | 100 | 600 | - |
| $0 | $10 | $10 | 800 | 0 | 800 | - |

Graphical: See Figure 11.

Specific Function:

$Q_D = 1{,}000 - 20P_D$

$Q_S = 20P_S$

$P_S + 10 = P_D$

General Linear Functions:

$Q_D = a_D - b_D P_D$

$Q_S = a_S + b_S P_S$

$P_S + t_U = P_D$

Really General Function:

$Q_D = D(P_D)$

$Q_S = S(P_S)$

$P_S + t_U = P_D$

How is market equilibrium changed?

Tabular:

Table 5

| $P_S$ | $t_U$ | $P_B$ | $Q_D$ | $Q_S$ | Shortage | Surplus |
|---|---|---|---|---|---|---|
| \$50 | \$10 | \$60 | 0 | 1,000 | 0 | 1,000 |
| \$45 | \$10 | \$55 | 0 | 900 | 0 | 900 |
| \$40 | \$10 | \$50 | 0 | 800 | 0 | 800 |
| \$35 | \$10 | \$45 | 100 | 700 | 0 | 600 |
| \$30 | \$10 | \$40 | 200 | 600 | 0 | 400 |
| \$25 | \$10 | \$35 | 300 | 500 | 0 | 200 |
| **$P_S$*=\$20** | **\$10** | **$P_D$*=\$30** | **Q*=400** | **Q*=400** | **0** | **0** |
| \$15 | \$10 | \$25 | 500 | 300 | 200 | 0 |
| \$10 | \$10 | \$20 | 600 | 200 | 400 | 0 |
| \$5 | \$10 | \$15 | 700 | 100 | 600 | 0 |
| \$0 | \$10 | \$10 | 800 | 0 | 800 | 0 |

Graphical: See Figure 12and 13.

Specific Function:

$Q^* = Q_D^* = Q_S^*$

$Q_D^* = 1{,}000 - 20P_D^*$

$Q_S^* = 20P_S^*$

$P_S^* + 10 = P_D^*$

$1{,}000 - 20 ( P_S^* + 10) = 20 P_S^*$

$800 = 40 P_S^*$

$P_S^* = 20$

$P_D^* = 30$

$Q_S^* = Q_D^* = 20 \times 20 = 1{,}000 - 20 \times 30 = 400$

General Linear Functions:

$Q^* = Q_D^* = Q_S^*$

$Q_D^* = a_D - b_D P_D^{**}$

$Q_S^* = a_S + b_S P_S^*$

$P_S^* + t_U = P_D^*$

After not too much algebra

$P_S^* = (a_D - a_S - t_U b_D)/ (b_S+b_D)$

$P_D^* = (a_D - a_S + t_U b_S)/ (b_S+b_D)$

$Q^* = (a_S b_D + b_S a_D - b_S t_U b_D)/(b_S+b_D)$

Really General Function:

$Q^* = Q_D^* = Q_S^*$

$Q_D = D(P_D^*)$

$Q_S = S(P_S^*)$

$P_S^* + t_U = P_D^*$

$P_S^*$ solves $S(P_S^*) = D(P_S^* + t_U)$
$P_D^* = P_S^* + 10$
$Q^* = D(P_D^*) = S(P_S^*)$

The effect of the tax on market equilibrium is to reduce the sale of Prius by 100 from 500 to 400. Furthermore, the price buyers have paid has increased from $25K to $30K, while the price sellers receive has declined from $25K to $20K.

Question: Is market equilibrium different if sellers are required to pay the tax instead of buyers?

The legal incidence of a tax falls upon people with the statutory responsibility for paying the tax: the people who write the check for the tax. The economic incidence of a tax falls upon the people who actually pay the tax. Specifically, it represents the difference in the pre and post tax price paid by a buyer or received by a seller. Minnesota requires the buyer of a car to pay a 6.5 percent tax on the purchase price to the state. Therefore, the legal incidence of the Minnesota state car tax falls on the buyer. But, does this mean the buyer is simply out 6.5 percent of the purchase price? No, because buyers realizing they are going to have to come up with the tax offer to pay sellers less for the car. However, offering less for the car in order to pay for the tax will decrease how many cars sellers are willing to offer.

Figure 12 and 13 show that adding a $10K unit tax on the Prius increases the price buyers pay by $5K not $10K and reduces the price sellers receive by $5K not $10K. Regardless of whether we ask the seller to come up with the tax or the buyer, both will ultimately pay some portion of the tax. In Figure 12, the legal incidence of the tax was $10K on the buyers of a car, but the economic incidence was shared equally among buyers and sellers. In Figure 13, the legal incidence of the tax was $10K on the sellers of a car, but the economic incidence was shared equally among buyers and sellers.

***Important Note**: The economic incidence of a tax will not always be shared equally among buyers and sellers as in our current example. Later we will explore exactly what factors determine the economic incidence of the tax for buyers and sellers.*

How does the tax affect the efficiency of market equilibrium?

In Figure 14, consumer surplus without a tax is equal to area **acg**. Producer surplus without a tax is equal to area **ceg**. Therefore, the total consumer and producer surplus without the tax is area **ace**.

With a tax, consumer surplus is equal to area **abh**, which is also equal to area **dfi**. Producer surplus is equal to area **def**. The revenues of the tax are equal to the tax times the quantity sold ($4M), which is equal to area **bdfh** or **abdi**. Combining consumer and producer surplus with tax revenues yields area **abde**, which is the total market surplus with a tax.

Area **abde** is smaller than area **ace** by the area **bcd**. Therefore, the market equilibrium with a tax is inefficient. The inefficiency that results from the tax is due to a decrease in the equilibrium

quantity. If we could devise a tax that did not change the equilibrium quantity, it would be possible to increase consumer and producer surplus, without changing the amount of tax revenues collected.

As an aside, area **bjgh** represents the total economic incidence of the tax to buyers, while area **dfgj** represents the total economic incidence of the tax to sellers.

An Ad Valorem tax works much in the same way, see Figure 15 for an example. The only real difference is that the tax is higher when the price is higher.

**Objective: Understand the determinants of supply and demand and the importance of the distinction between demand and quantity demanded; and supply and quantity supplied.**

We have been talking a lot about demand and supply, but have not said very much about where precisely this demand and supply comes from. This is what much of the remainder of the class will focus on, but before jumping in it is useful to think a little more about what factors will influence demand and supply and how changes in these factors affect market equilibrium.

What determines how much product people want to buy at any given price?

i) Income
ii) Tastes
iii) Price of other goods
iv) Expectations
v) Population

How do all these factors affect demand?

To avoid confusing the issue too much, let us only worry about income (M) for now. Earlier when we wrote demand in its various forms, income was nowhere to be found. Actually, it was there all along, we just hid it. It was OK to hide it because we were assuming that income was always the same. This of course becomes problematic if we want to ask the question: How will the sales of the Prius change if income increases? If we want to address this more complicated question, we are going to have to quit hiding income.

So, how do we quit hiding income?

Tabular:

Table 6: Quantity Demanded of the Prius by Price and Income.

| | | **Average Weekly Income** | | | | |
|---|---|---|---|---|---|---|
| | | $300 | $400 | $500 | $600 | $700 |
| | $70 | 0 | 0 | 0 | 0 | 0 |
| | $65 | 0 | 0 | 0 | 0 | 100 |
| | $60 | 0 | 0 | 0 | 0 | 200 |
| | $55 | 0 | 0 | 0 | 100 | 300 |
| | $50 | 0 | 0 | 0 | 200 | 400 |
| | $45 | 0 | 0 | 100 | 300 | 500 |
| | $40 | 0 | 0 | 200 | 400 | 600 |
| **Price** | $35 | 0 | 100 | 300 | 500 | 700 |
| ($/1000) | $30 | 0 | 200 | 400 | 600 | 800 |
| | $25 | 100 | 300 | 500 | 700 | 900 |
| | $20 | 200 | 400 | 600 | 800 | 1,000 |
| | $15 | 300 | 500 | 700 | 900 | 1,100 |
| | $10 | 400 | 600 | 800 | 1,000 | 1,200 |
| | $5 | 500 | 700 | 900 | 1,100 | 1,300 |
| | $0 | 600 | 800 | 1,000 | 1,200 | 1,400 |

It is easy to see why we will seldom use tabular descriptions of Demand. They are cumbersome.

Graphical: See Figure 16 and 17.

> In Figure 16, we have a three-dimensional, description of demand. Economists seldom use this type of representation because it is too hard to draw and if we add something else like the price of other goods it becomes impossible to draw.
>
> The contour plots in Figure 17 are what we will use more commonly because they are easy to draw and we can just hide contours for levels of income we don't care about.

Specific Function:

$Q_D = 2M - 20P$

General Linear Function:

$Q_D = a_D + b_D P + c_D M$

Really General Function:

$Q_D = D(P, M)$

Earlier, we made a point to distinguish Demand from the Quantity Demanded. The reason for this careful distinction is due to all the factors other than price that make up demand.

When we talk about demand, we are talking about the relationship between the price and quantity demanded given income, tastes, the price of other goods, expectations, and population. When we talk about a change or shift in demand, we are talking about the change in the relationship between price and the quantity demanded due to a change in income, tastes, the price of other goods, expectations, or population. What this means in Figure 17 is that we are switching from one contour to another because something other than the price has changed. For example, if we consider and increase in income from $300 to $500 per week, the relationship between price and the quantity demanded shifts up (Figure 18).

When we talk about the quantity demanded, we are talking about how much people purchase given price, income, tastes, the price of other goods, expectations, or population. A change in the quantity demanded results from a change in price holding income, tastes, the price of other goods, expectations, and population constant. This appears as a movement along a demand curve. For example, if the price of a Prius falls from $50K to $30K and weekly income is $600, the quantity demanded increases from 200 to 600.

What determines how much product people will sell at any given price?

i) Technology
ii) Factor/Input/Raw Material Prices
iii) Number of Suppliers
iv) Expectations
v) Weather

Just as we hid a lot of factors that influence demand, we have also been hiding a lot of factors than influence supply. If any of these factors change, the relationship between price and quantity supplied will change resulting in a shift in supply. For example, if factor prices increase, it will cost sellers more to make a product. Therefore, they will have to charge a higher price regardless of how much they supply.

Increasing the price holding Technology, Factor Prices, Number of Suppliers, Expectations, and Weather constant will increase the quantity supplied and result in a movement along the supply curve.

**Objective: To understand how to use supply and demand to predict changes in price when the determinants of supply and demand other than price change.**

Question: How will the price for the Prius change if an increase in income increases demand?

Before an increase in income, the market equilibrium can be found where demand (D in Figure 20) and supply (S) are equal, P* and Q*. An increase in income shifts demand up (from D to $D_1$). Now, for every given price, buyers will want more Prius. The new equilibrium price and quantity can be found where $D_1$ and S are equal, $P_1$* and $Q_1$*. Note that $P^* < P_1^*$ and $Q^* < Q_1^*$. Therefore, an increase in demand due to an increase in income will lead to a higher equilibrium price and quantity.

Question: How will the price for the Prius change if a decrease in the price of gas decreases demand?

Before a decrease in the price of gas, the market equilibrium can be found where demand (D in Figure 21) and supply (S) are equal, P* and Q*. An increase in the price of gas shifts demand down (from D to $D_1$). Now, for any given price, buyers want fewer Prius. The new equilibrium price and quantity can be found where $D_1$ and S are equal, $P_1$* and $Q_1$*. Note that $P^* > P_1^*$ and $Q^* > Q_1^*$. Therefore, a decrease in demand due to a decrease in gas prices will lead to a lower equilibrium price and quantity.

Question: How will the price for the Prius change if an increase in the price of steel decreases supply?

Before an increase in the price of steel, the market equilibrium can be found where demand (D in Figure 22) and supply (S) are equal, P* and Q*. An increase in the price of steel shifts supply up (from S to $S_1$). Now, for any given price, Toyota offers fewer Prius. The new equilibrium price and quantity can be found where D and $S_1$ are equal, $P_1$* and $Q_1$*. Note that $P^* < P_1^*$ and $Q^* > Q_1^*$. Therefore, a decrease in supply due to an increase in the price of steel will lead to a higher equilibrium price and lower equilibrium quantity.

Question: How will the price for the Prius change if a decrease in the price of steel increases supply?

Before a decrease in the price of steel, the market equilibrium can be found where demand (D in Figure 23) and supply (S) are equal, P* and Q*. A decrease in the price of steel shifts supply down (from S to $S_1$). Now, for every given price, Toyota offers more Prius. The new equilibrium price and quantity can be found where D and $S_1$ are equal, $P_1$* and $Q_1$*. Note that $P^* > P_1^*$ and $Q^* < Q_1^*$. Therefore, an increase in supply due to a decrease in the price of steel will lead to a lower equilibrium price and higher equilibrium quantity.

Note from our four examples, when demand changed, the change in the equilibrium price and quantity moved in the same direction. Alternatively, when supply changed, the change in the equilibrium price and quantity moved in the opposite directions.

**Figure 1: Demand for the Prius**

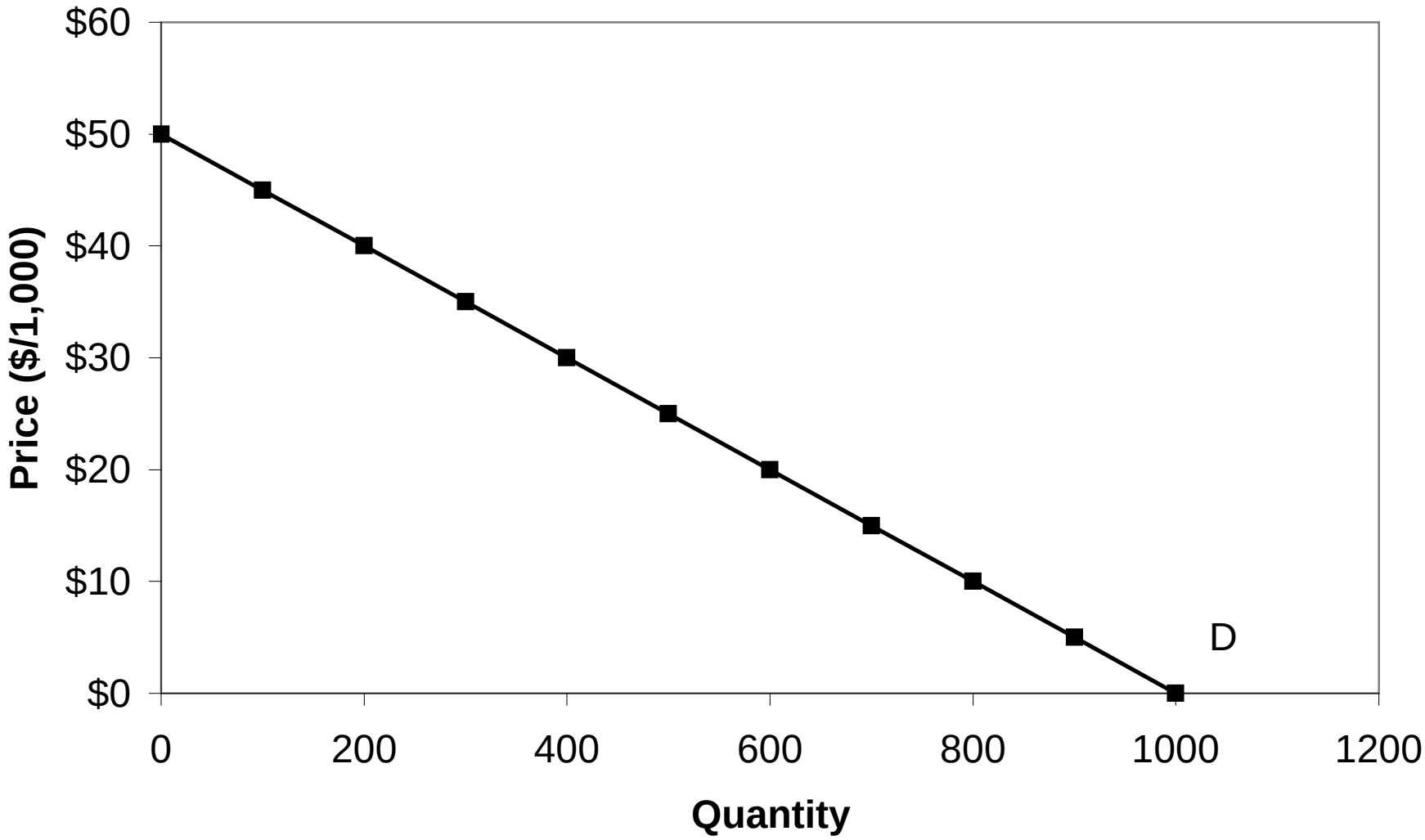

**Figure 2: Supply of the Prius**

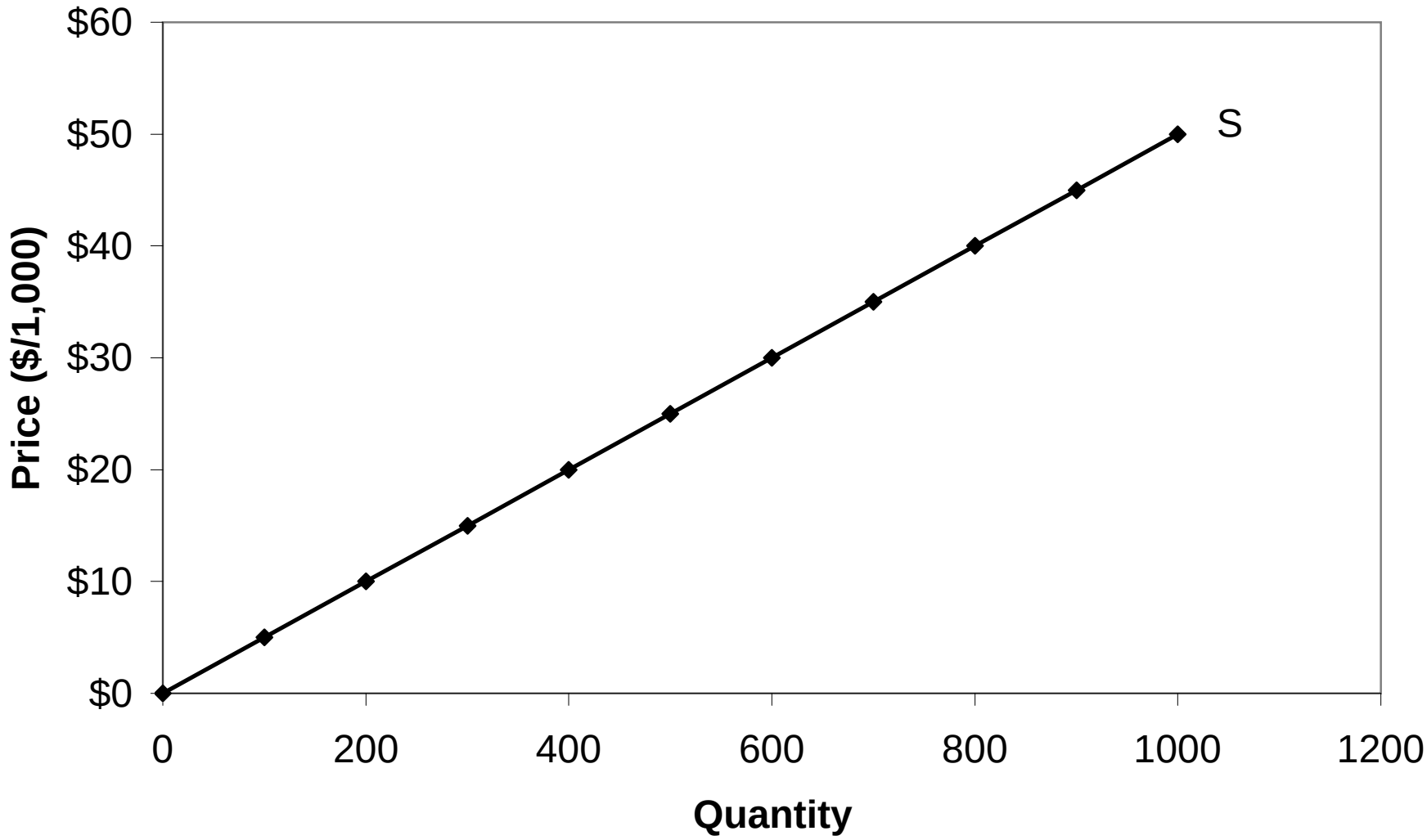

**Figure 3: Market for the Prius**

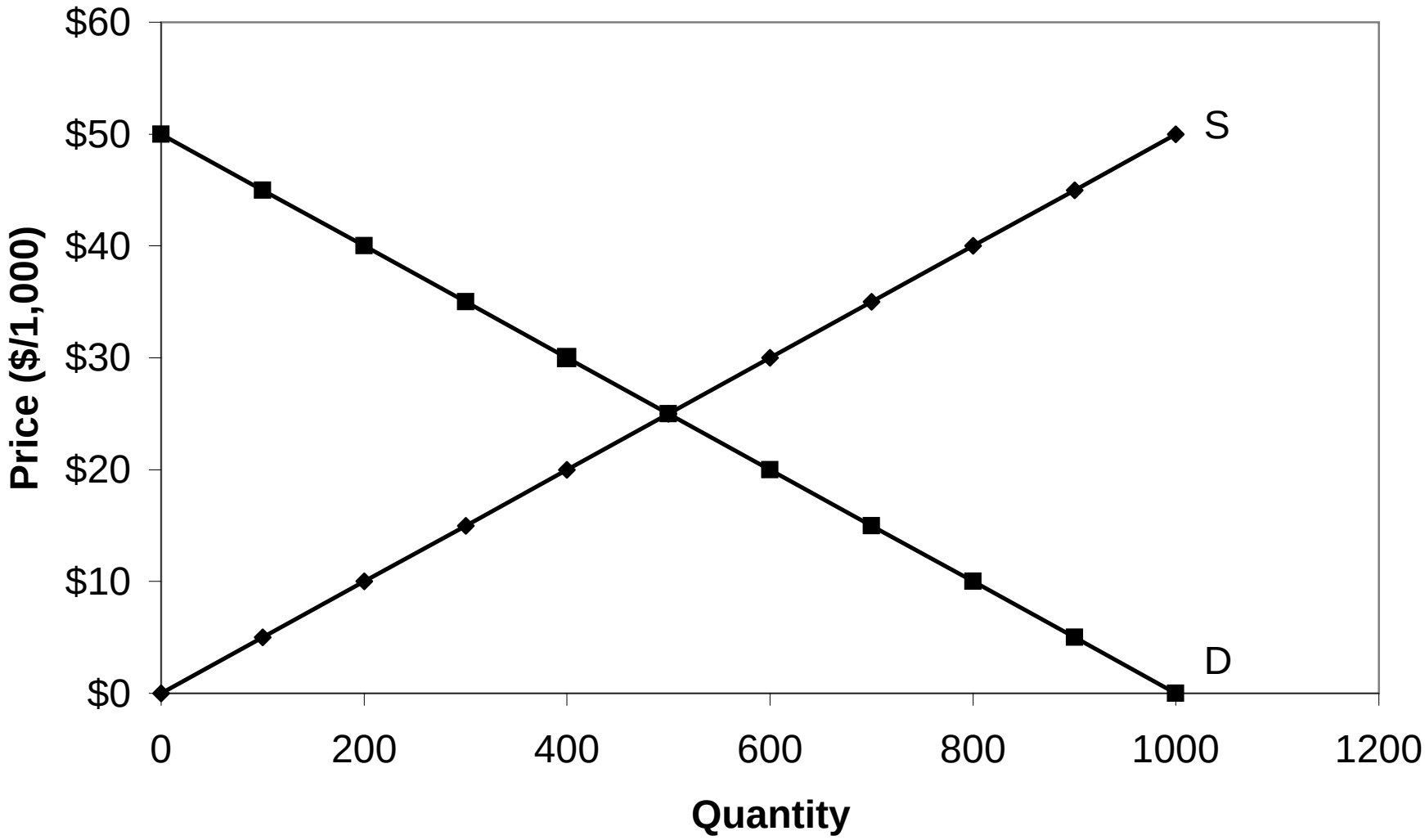

**Figure 4: Market Equilibrium for the Prius**

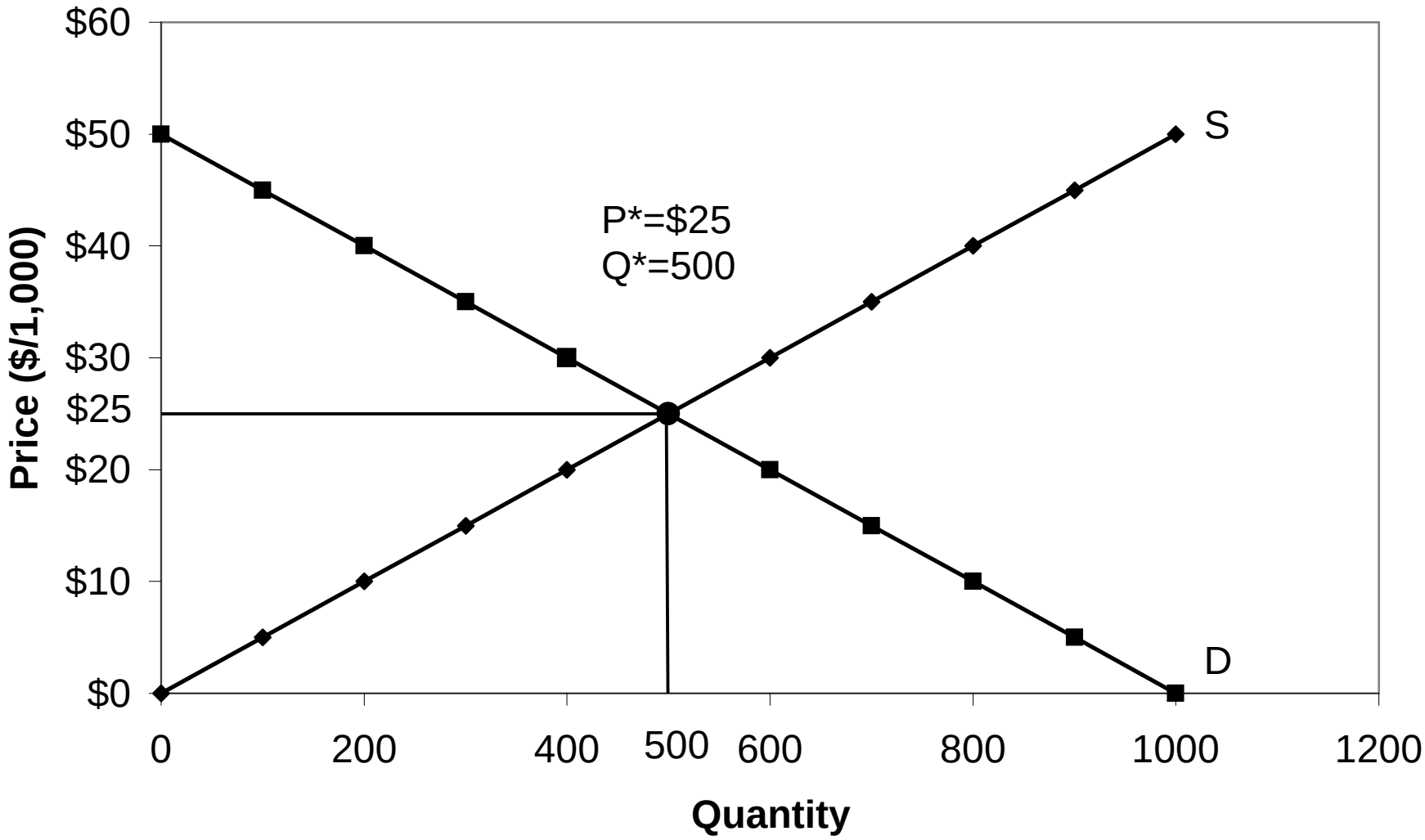

**Figure 5: Market Shortage for the Prius**

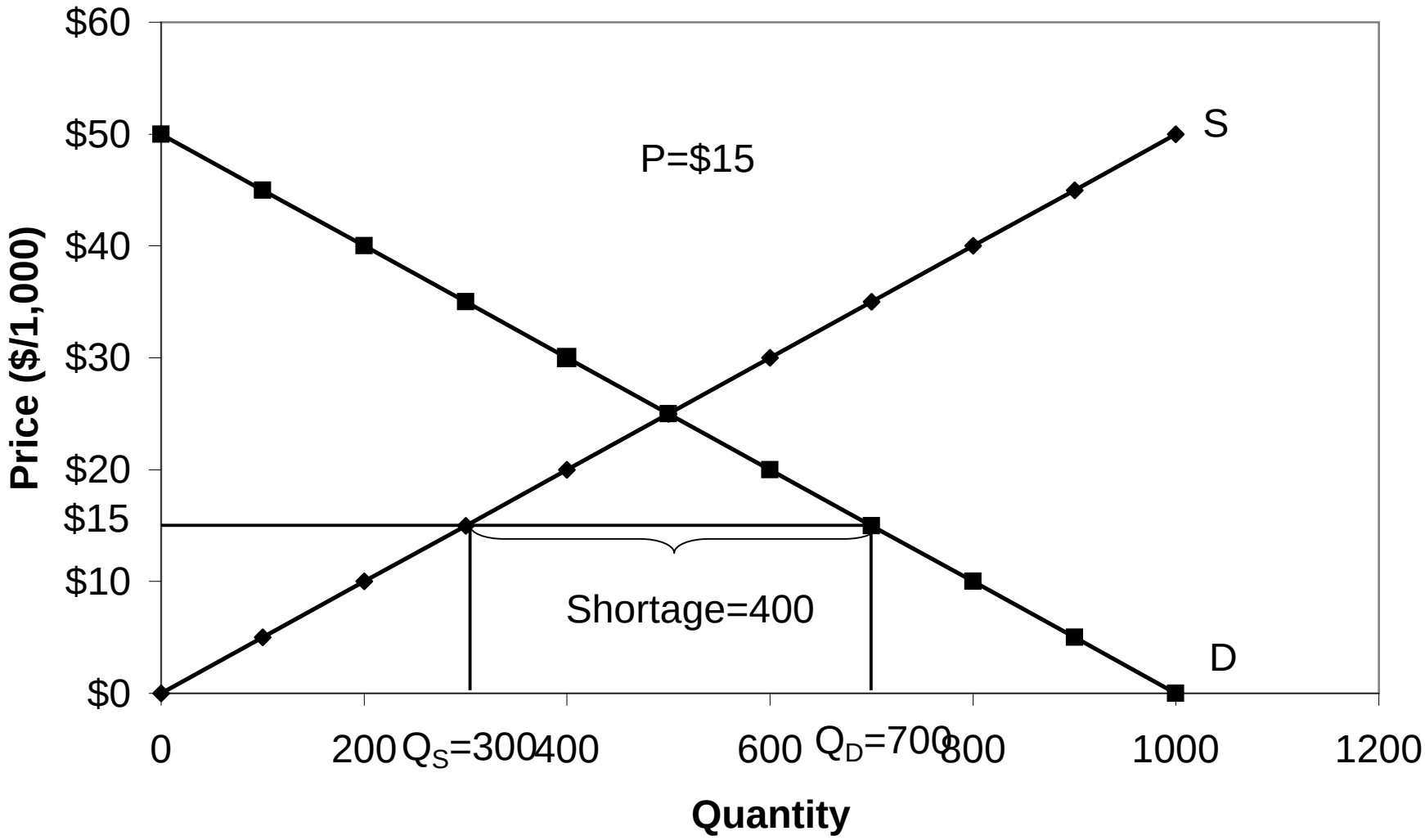

**Figure 6: Market Surplus for the Prius**

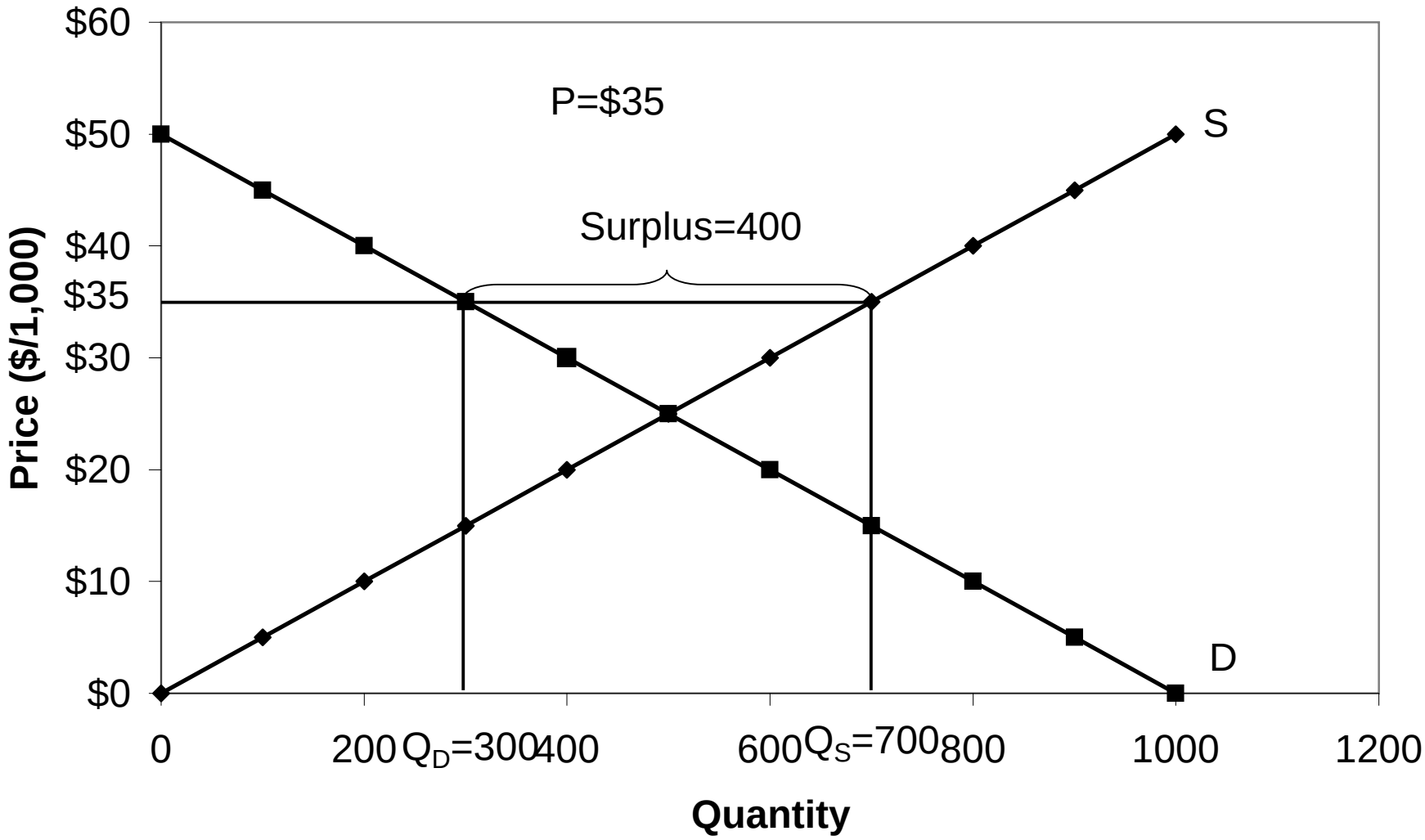

**Figure 7: Consumer and Producer Surplus for the Sale of 300th Prius**

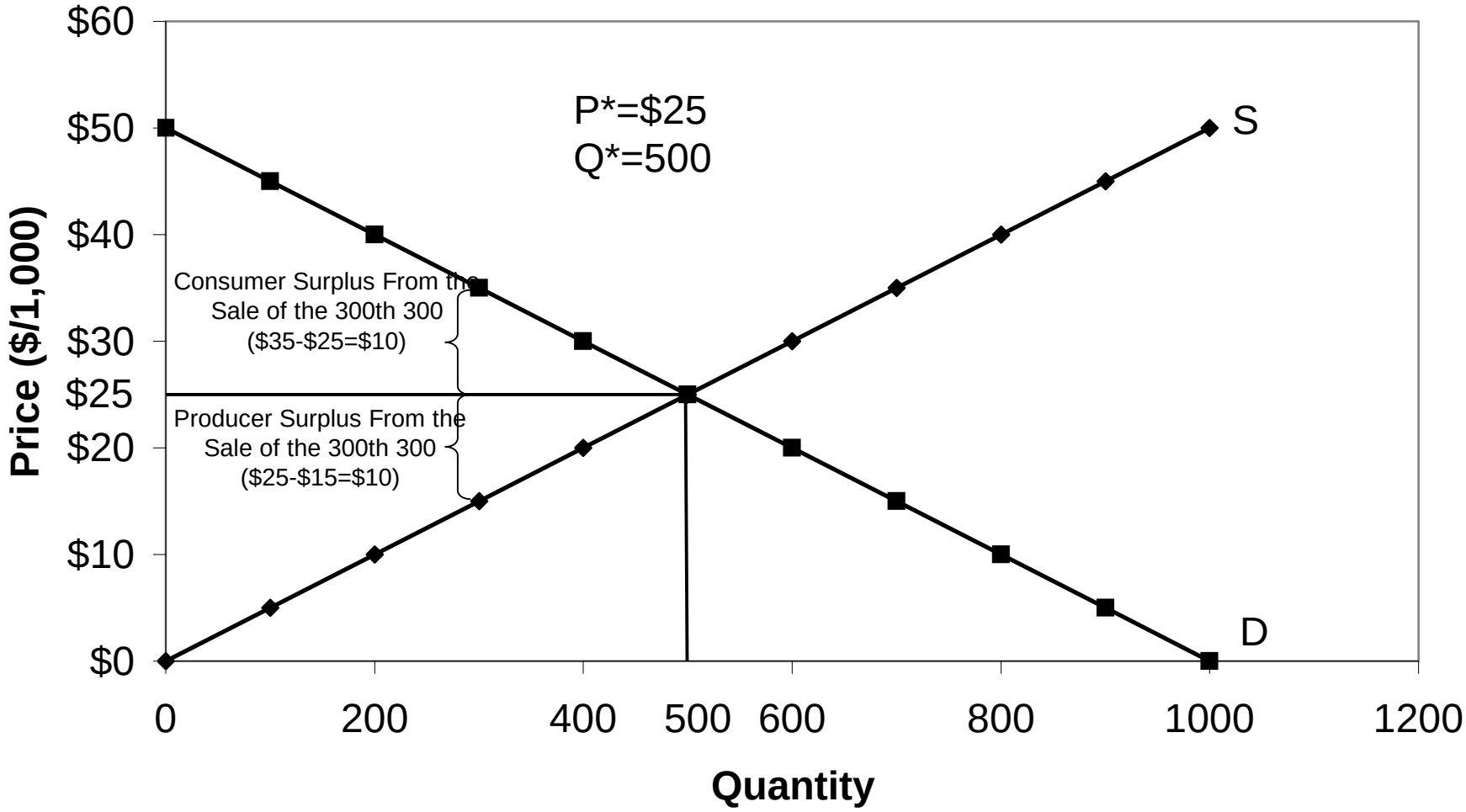

**Figure 8: Total Equilibrium Consumer and Producer Surplus for the Prius**

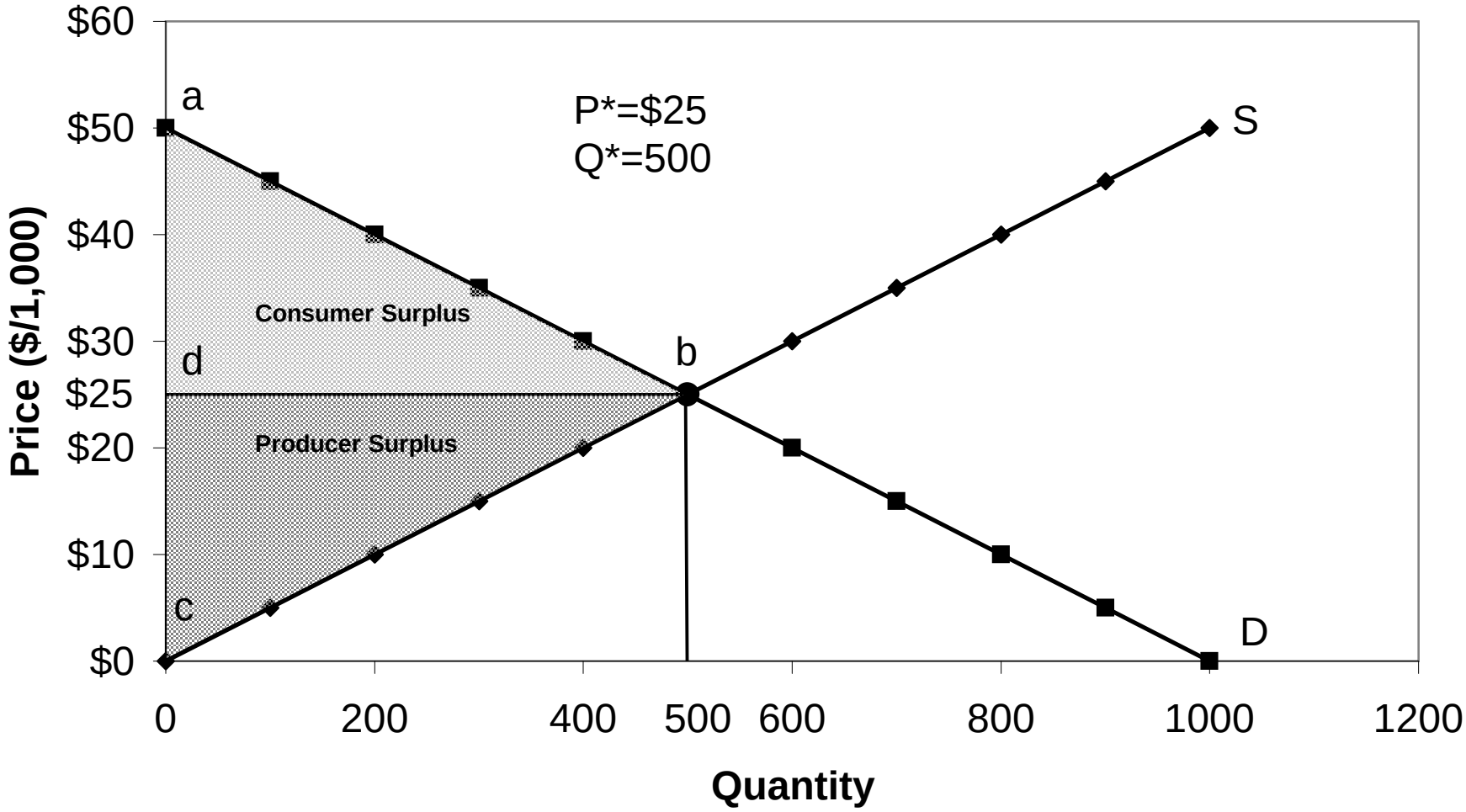

**Figure 9: Market Surplus With Price Above Equilibrium**

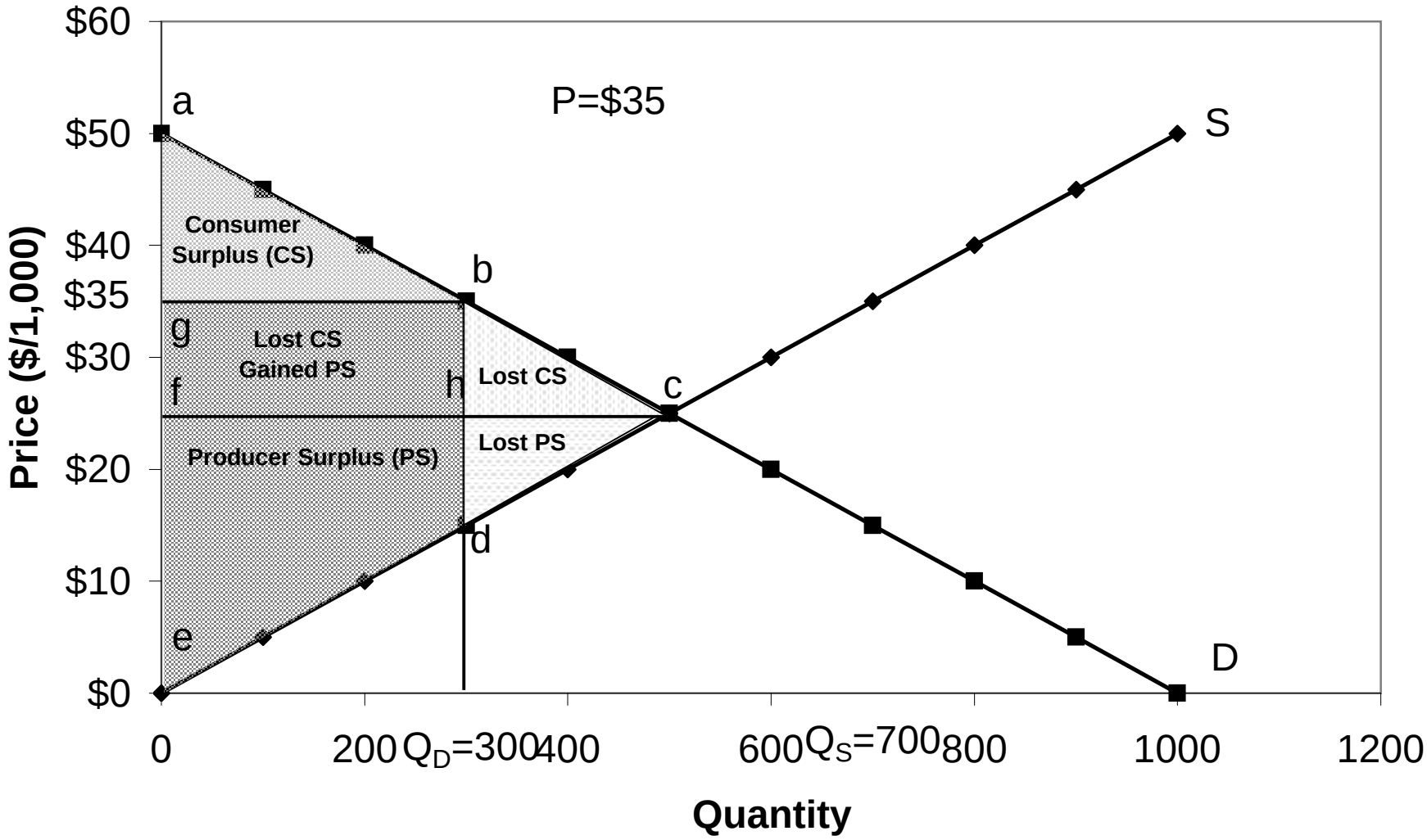

**Figure 10: Market Surplus With Price Below Equilibrium**

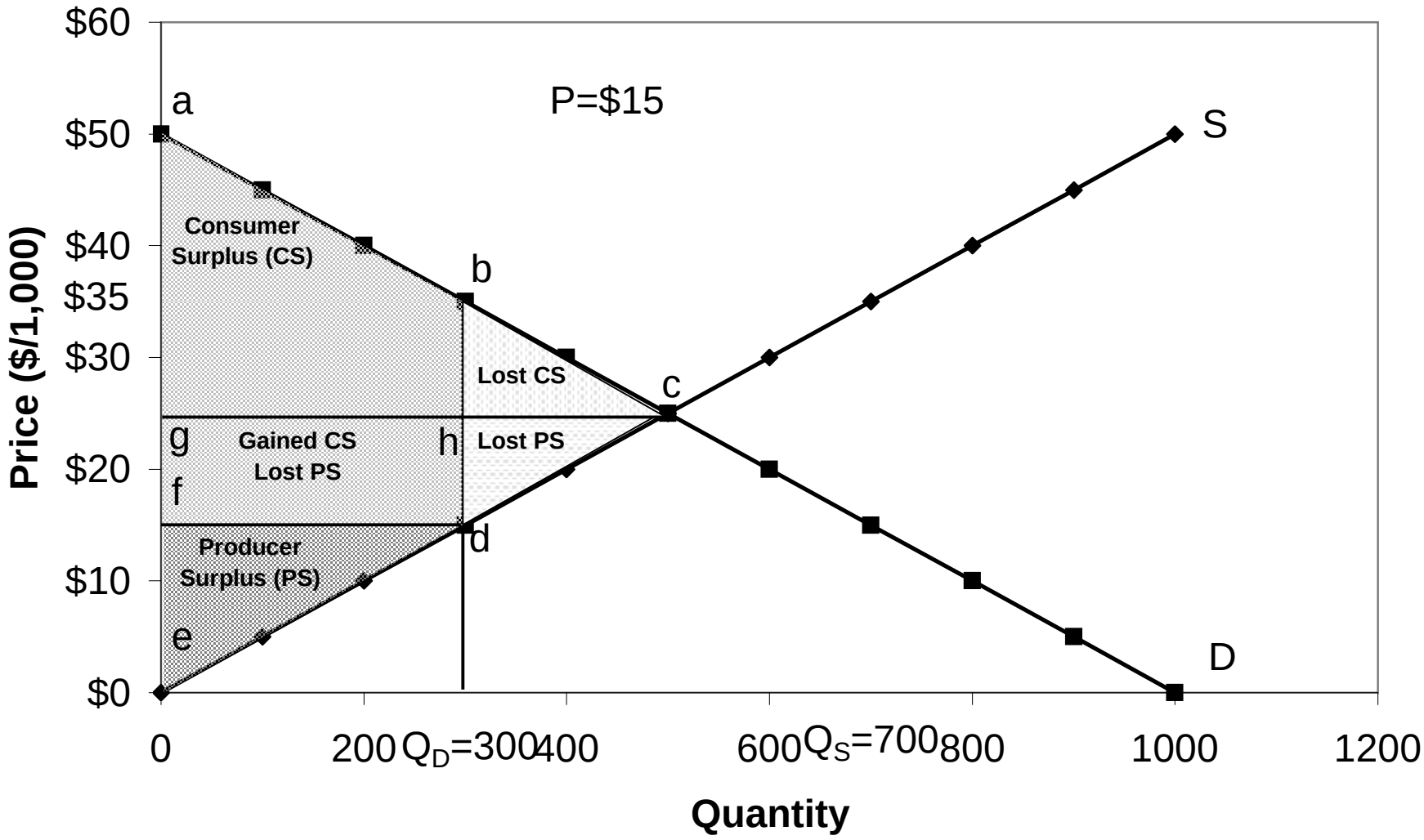

**Figure 11: Market With $10K Unit Tax on Buyers**

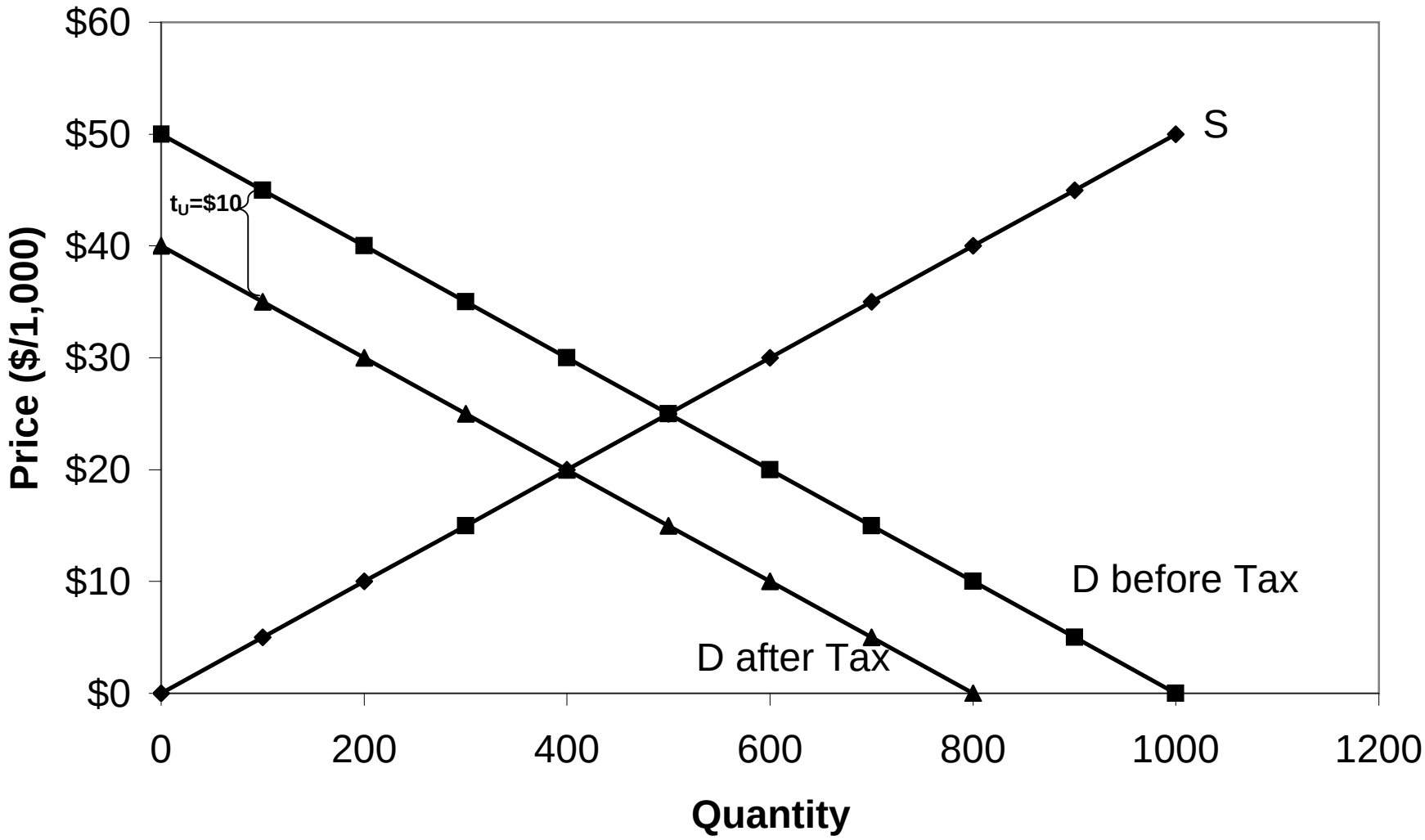

**Figure 12: Market Equilibrium With $10K Unit Tax on Buyers**

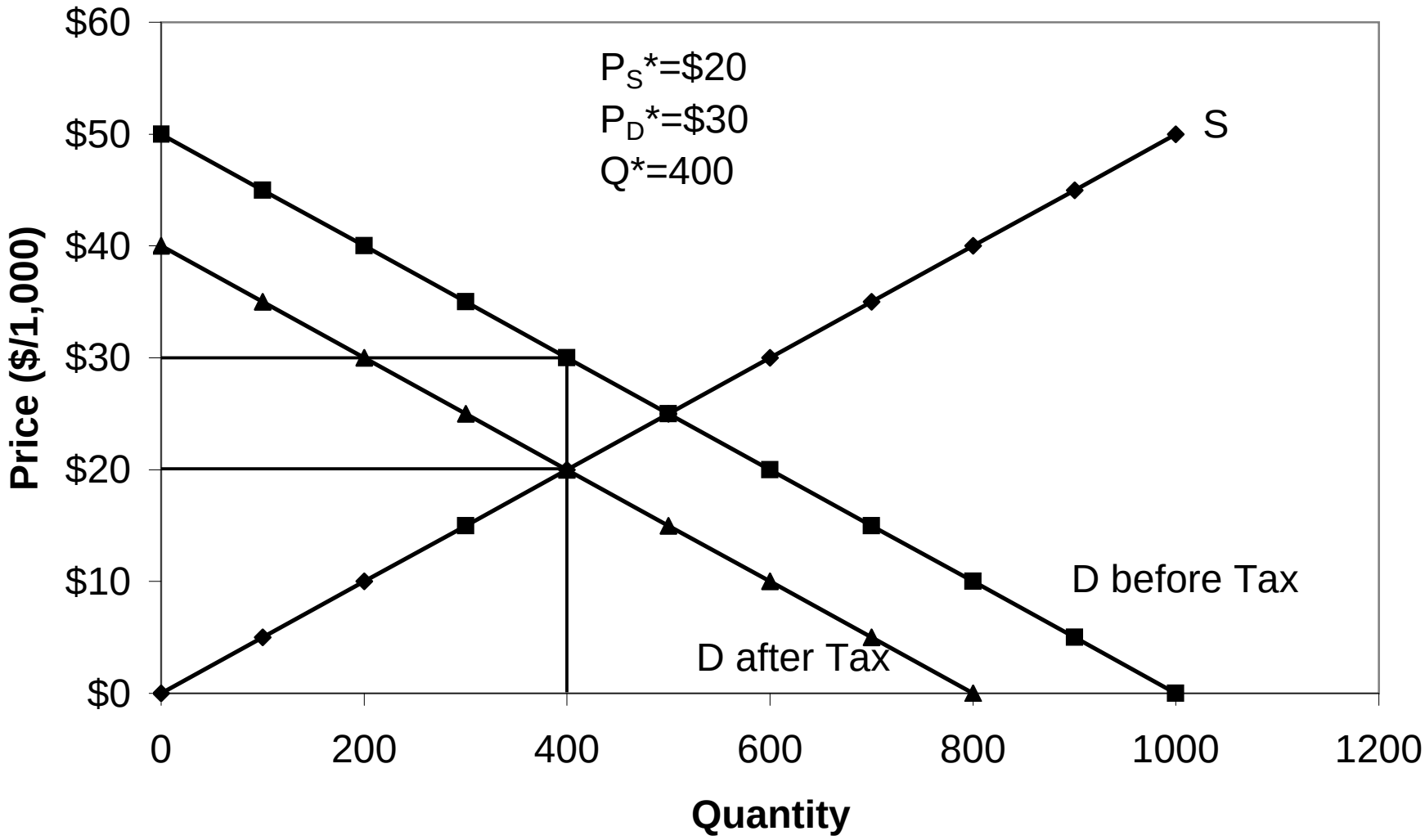

**Figure 13: Market Equilibrium With $10K Unit Tax on Sellers**

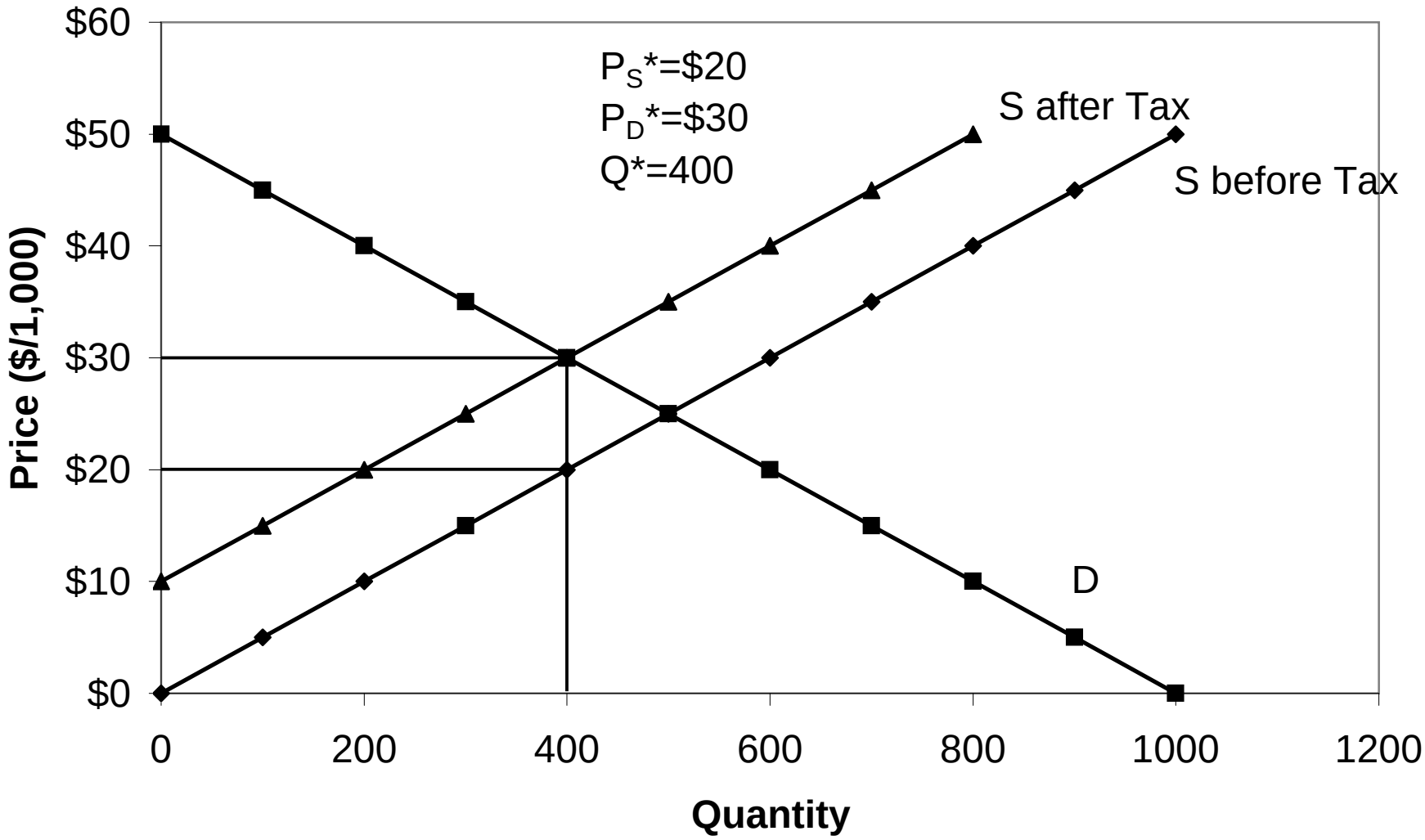

**Figure 14: Efficiency of Market Equilibrium With $10K Unit Tax on Buyers**

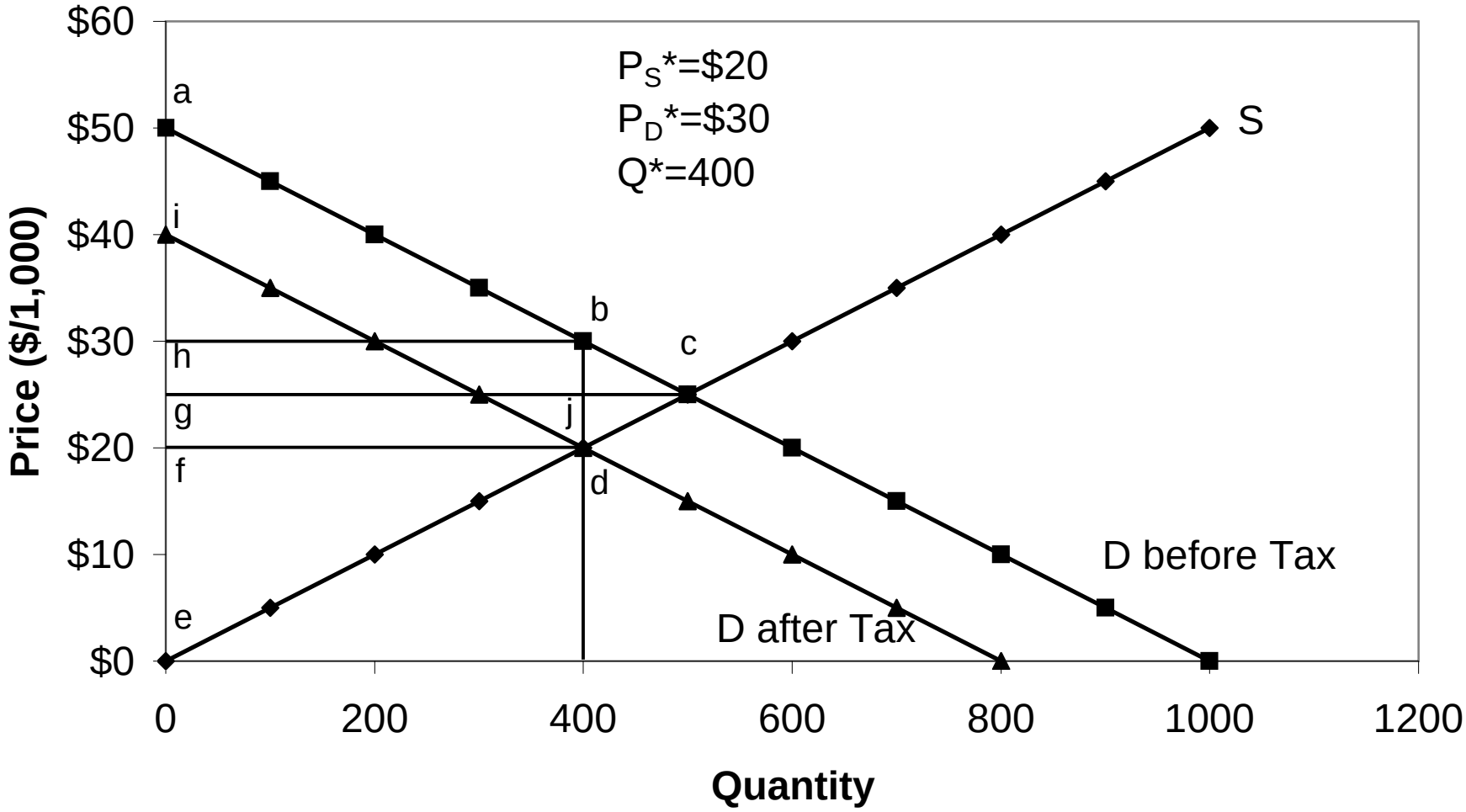

**Figure 15: Market Equilibrium With an Ad Valorem Tax on Buyers**

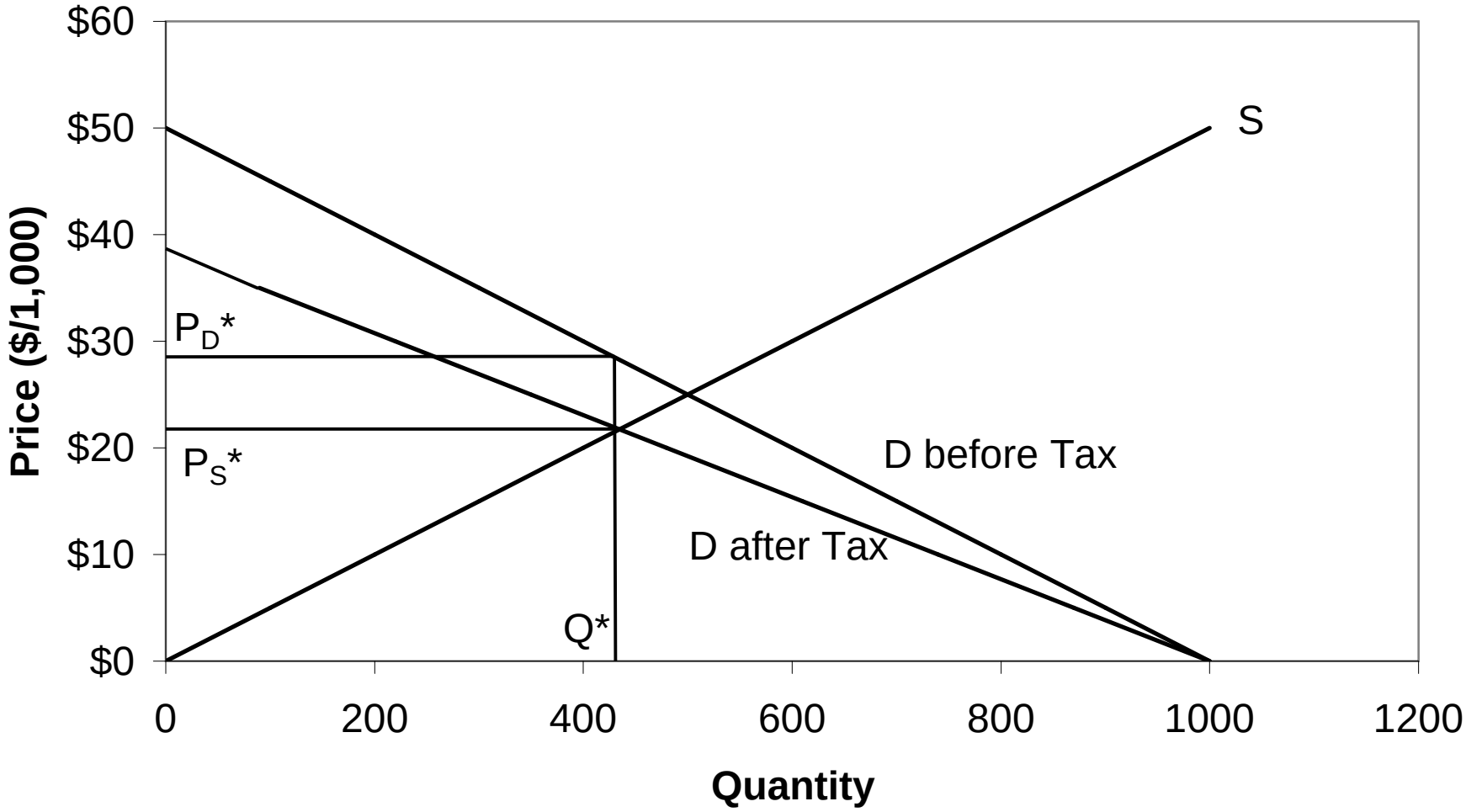

**Figure 16: Demand for the Prius (Surface Plot)**

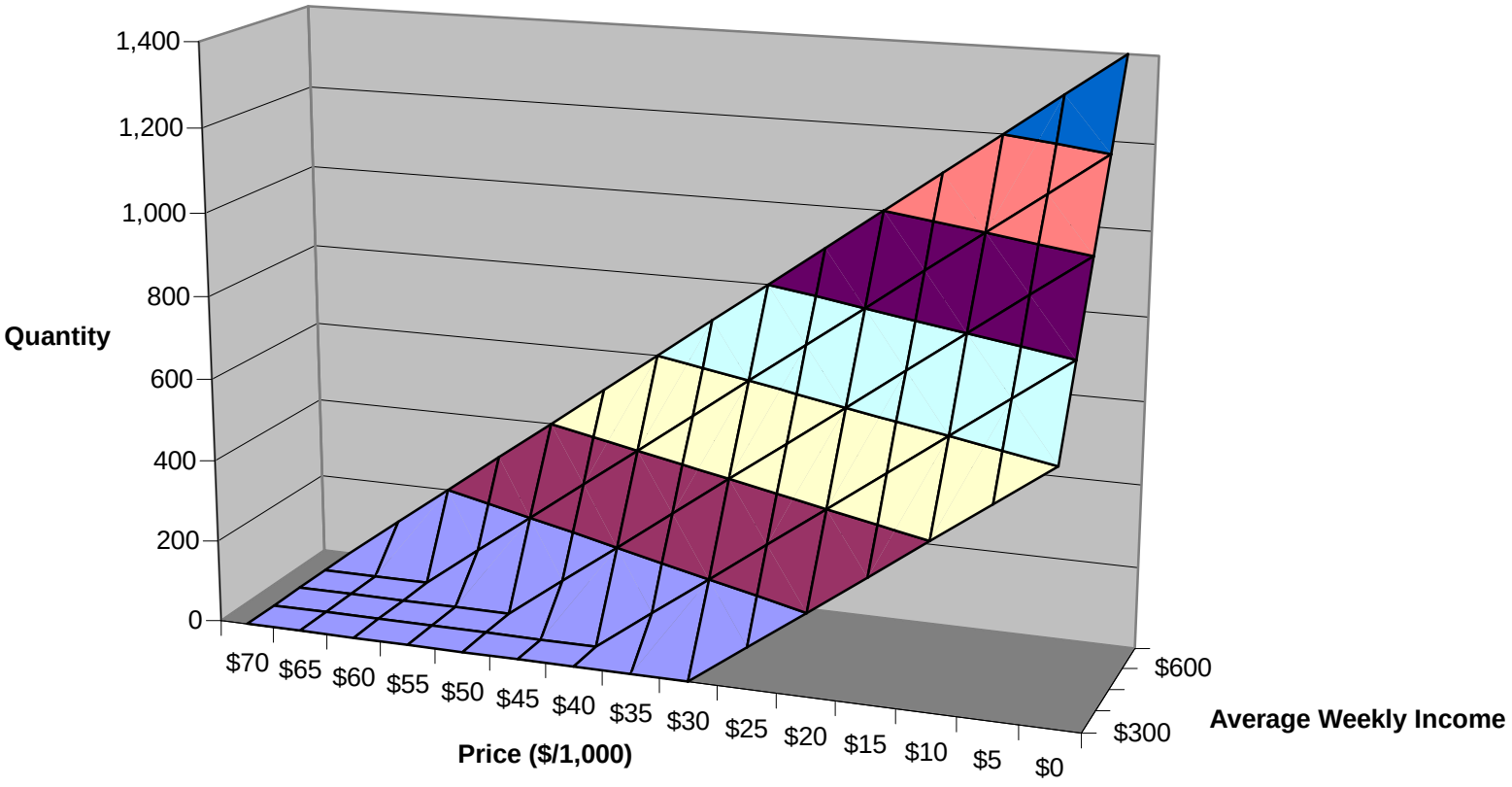

**Figure 17: Demand for the Prius (Contour Plot)**

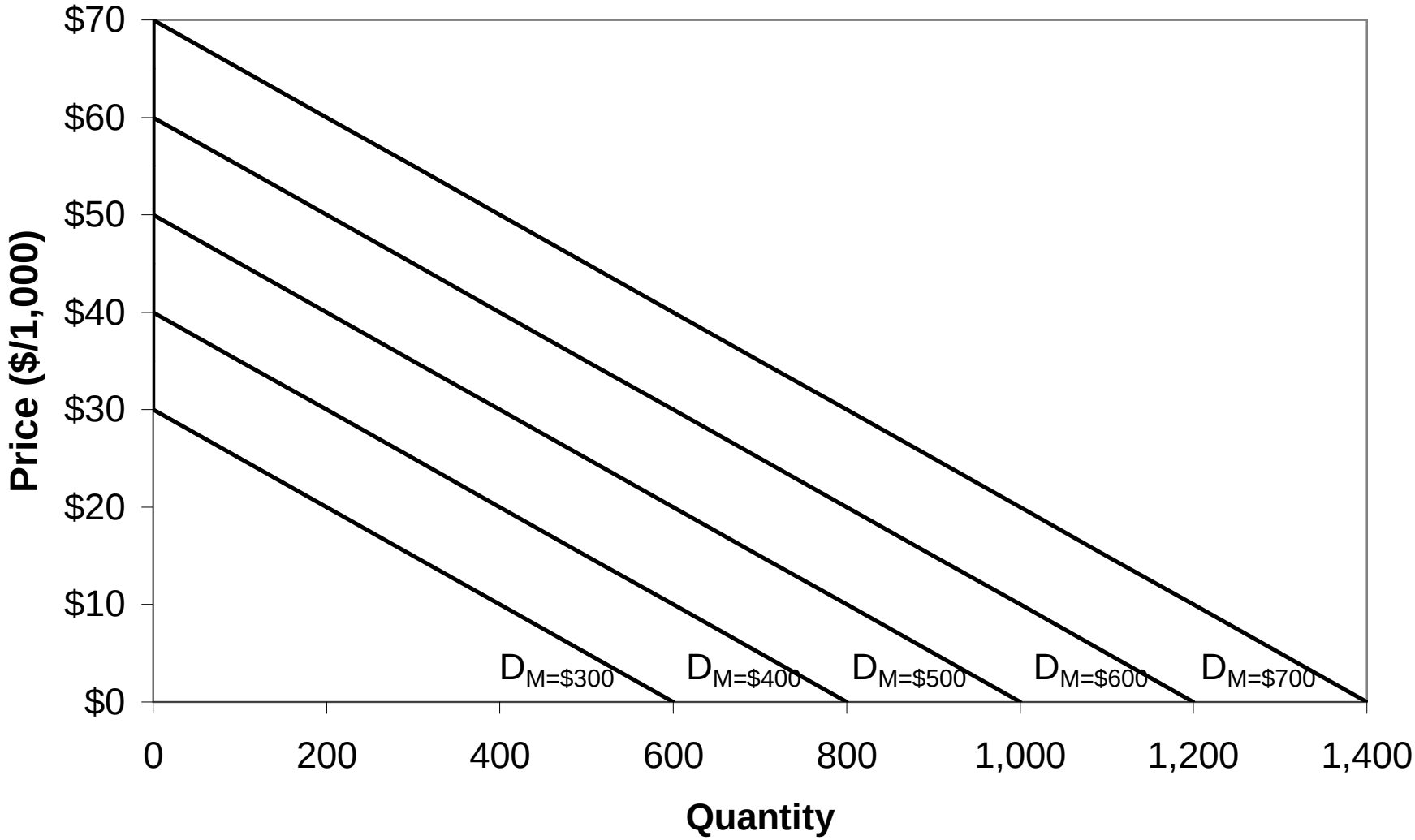

**Figure 18: Effect of an Increase in Income on the Demand for the Prius**

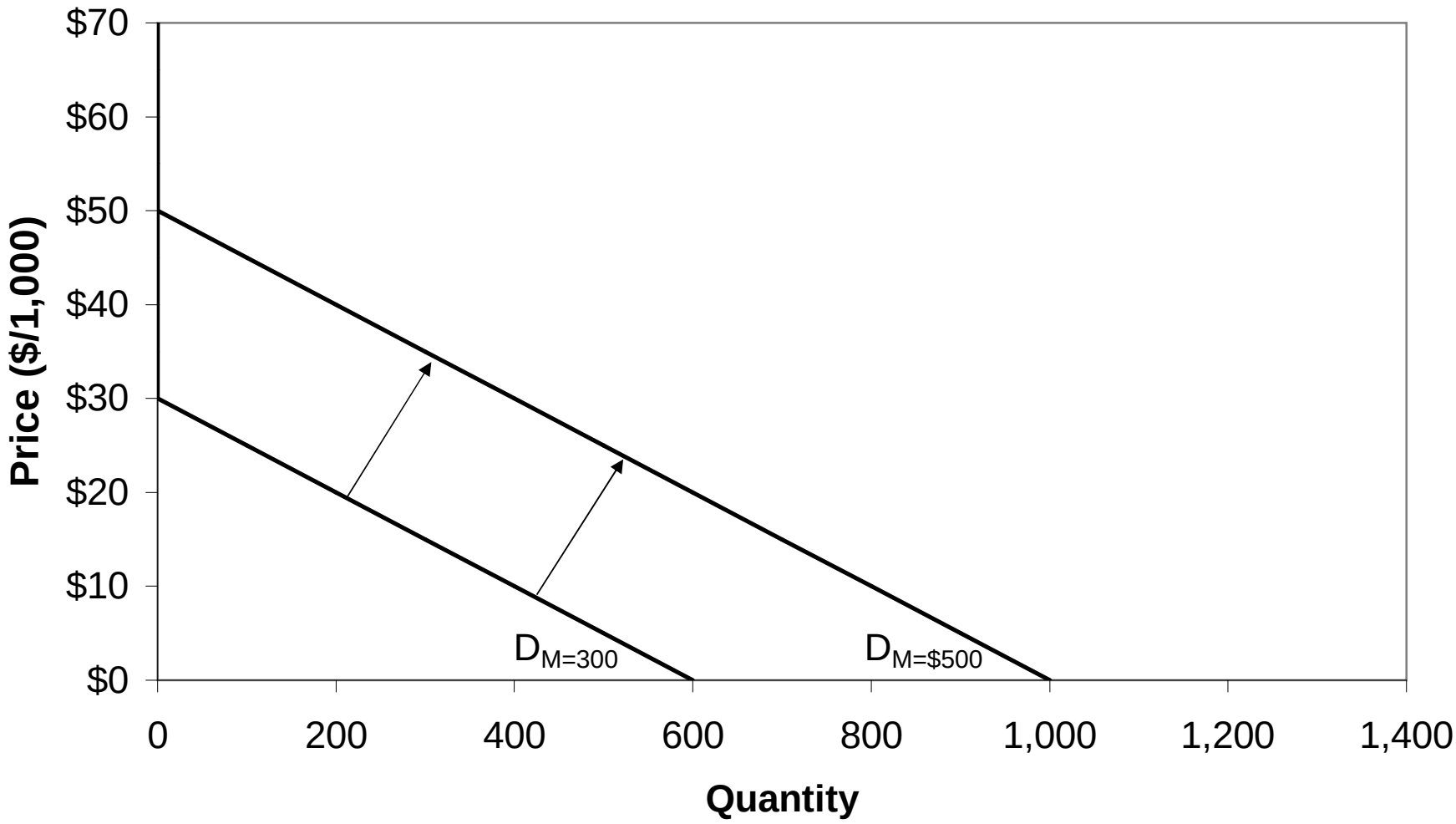

**Figure 19: Demand for the Prius (Contour Plot)**

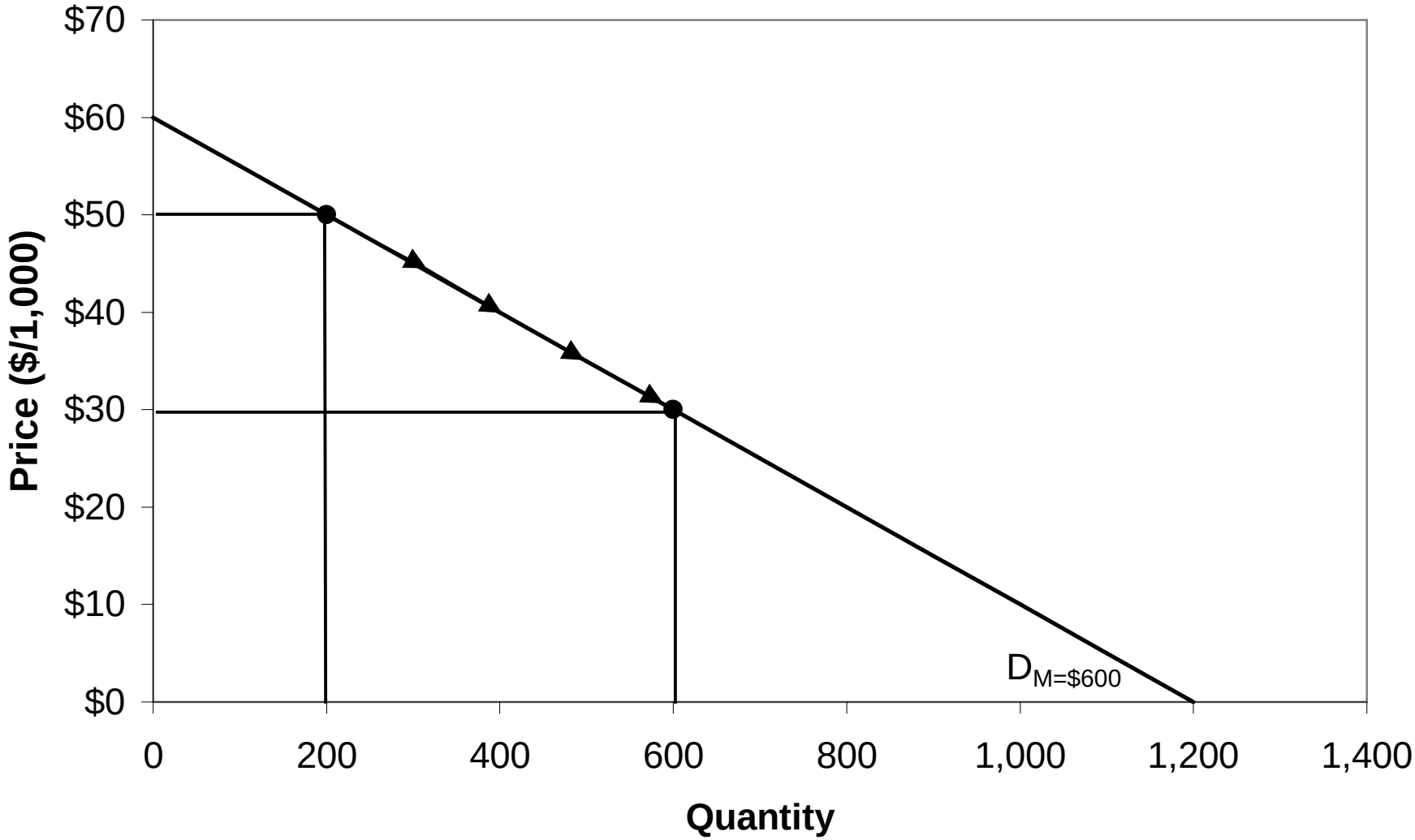

Figure 20: Effect of an Increase in Demand on Equilibrium Price and Quantity

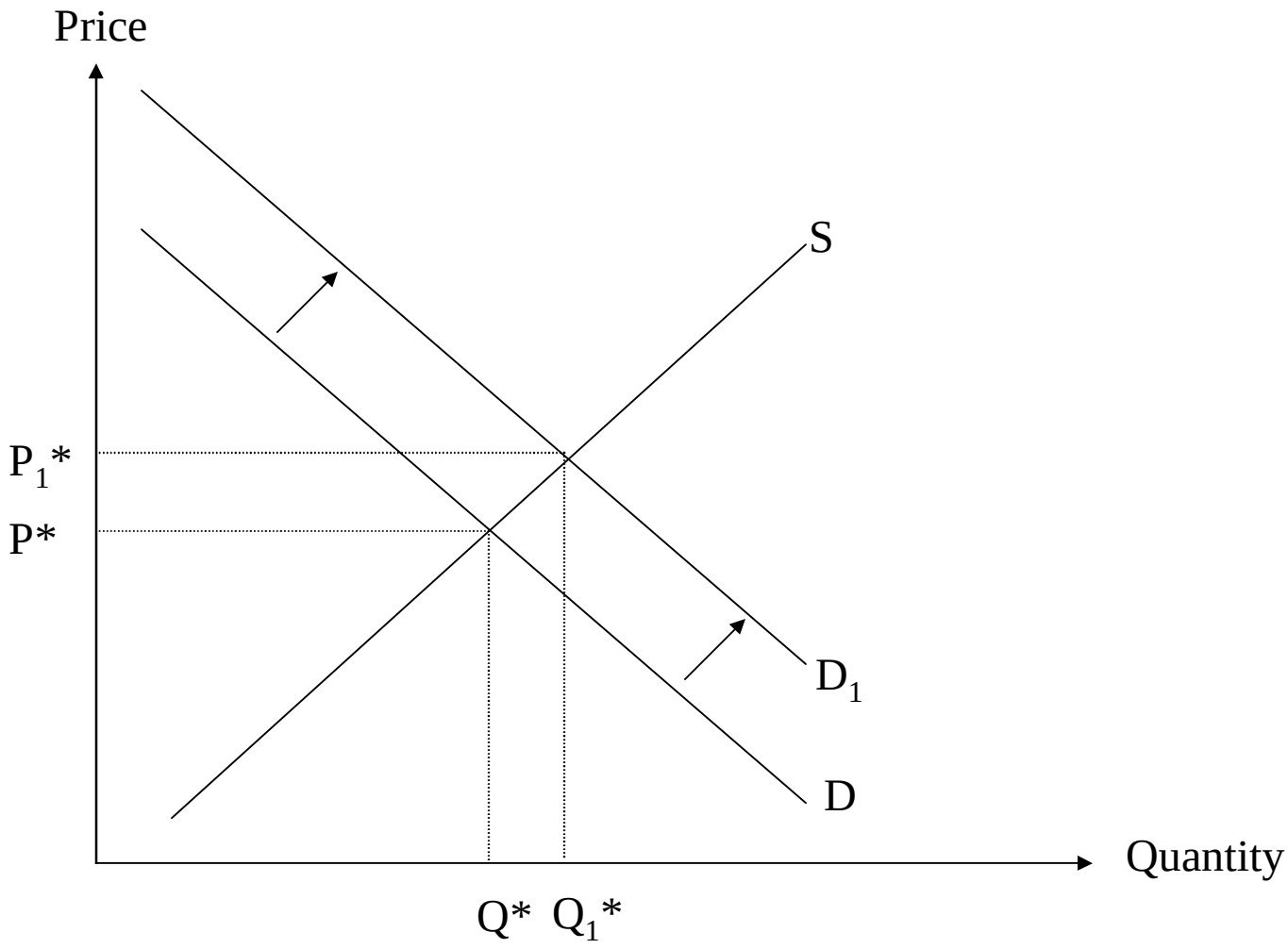

Figure 21: Effect of a Decrease in Demand on Equilibrium Price and Quantity

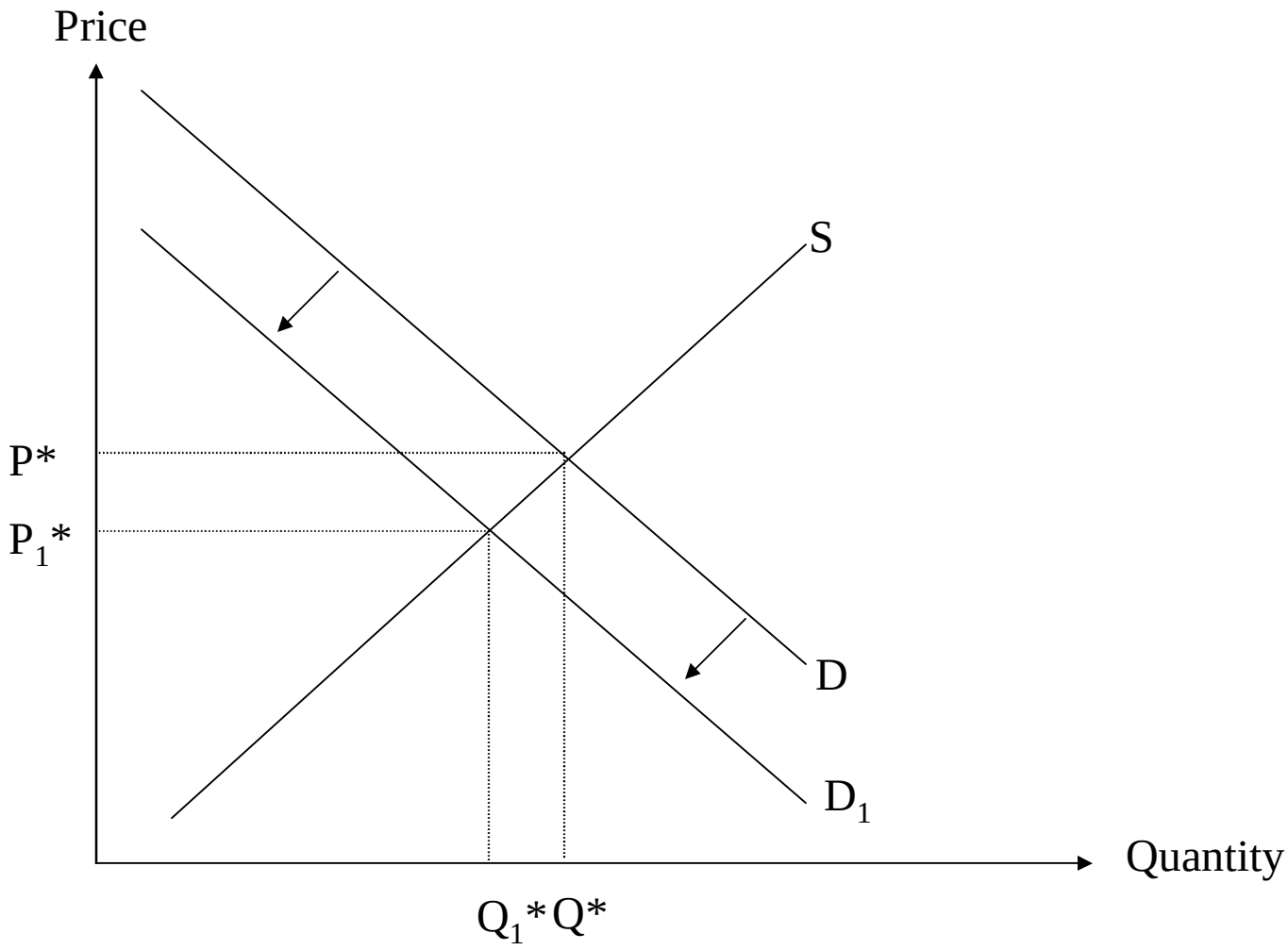

Figure 22: Effect of an Increase in Supply on Equilibrium Price and Quantity

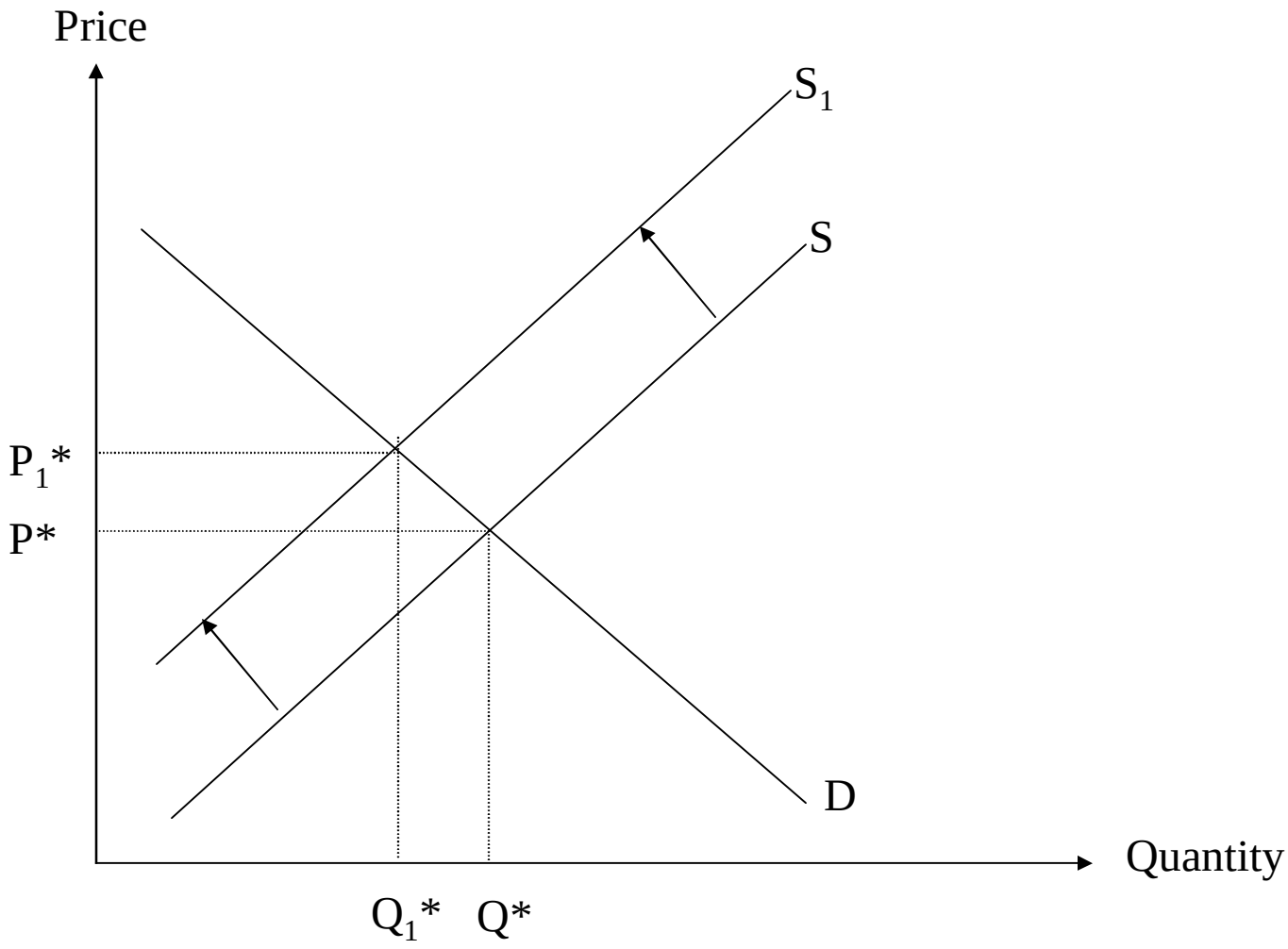

Figure 23: Effect of a Decrease in Supply on Equilibrium Price and Quantity