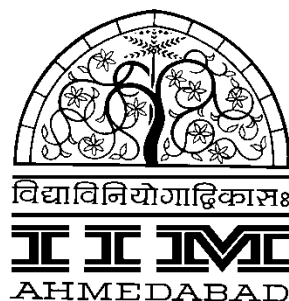


The Elasticity of Demand and Supply

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The responsiveness of the quantity demanded to a change in price is measured by the price elasticity of demand.

The concept of slope tells us how quantity changes as price changes. The drawback of slope, however, is that it is sensitive to the units chosen for quantity and price.

To avoid confusion over units economists use percentage changes when measuring the price elasticity of demand.

Definition: Price **elasticity of demand** is the percentage change in the quantity demanded of a good that results from a 1 percent change in price.

$$\text{Price elasticity of demand } (\eta) = - \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}}$$

Elastic and Inelastic Demand

If the quantity demanded is responsive to changes in price, the percentage change in quantity will be greater than the percentage change in price. – The price elasticity of demand then will be greater than 1 in absolute value. Demand is said to be **elastic**.

Elastic Demand: $\% \text{ change in quantity} > \% \text{ change in price}$
or, $\text{elasticity} > 1$.

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Elastic Demand: % change in quantity > % change in price
or, elasticity > 1.


When the quantity demanded is not very responsive to price, however, the percentage change in quantity demanded will be less than the percentage change in price.
- Demand is then said to be **inelastic**.

Inelastic Demand: % change in quantity < % change in price
or, elasticity < 1.


When the percentage change in quantity demanded is equal to the percentage change in price, the price elasticity of demand equals 1. Demand is **unit elastic**.

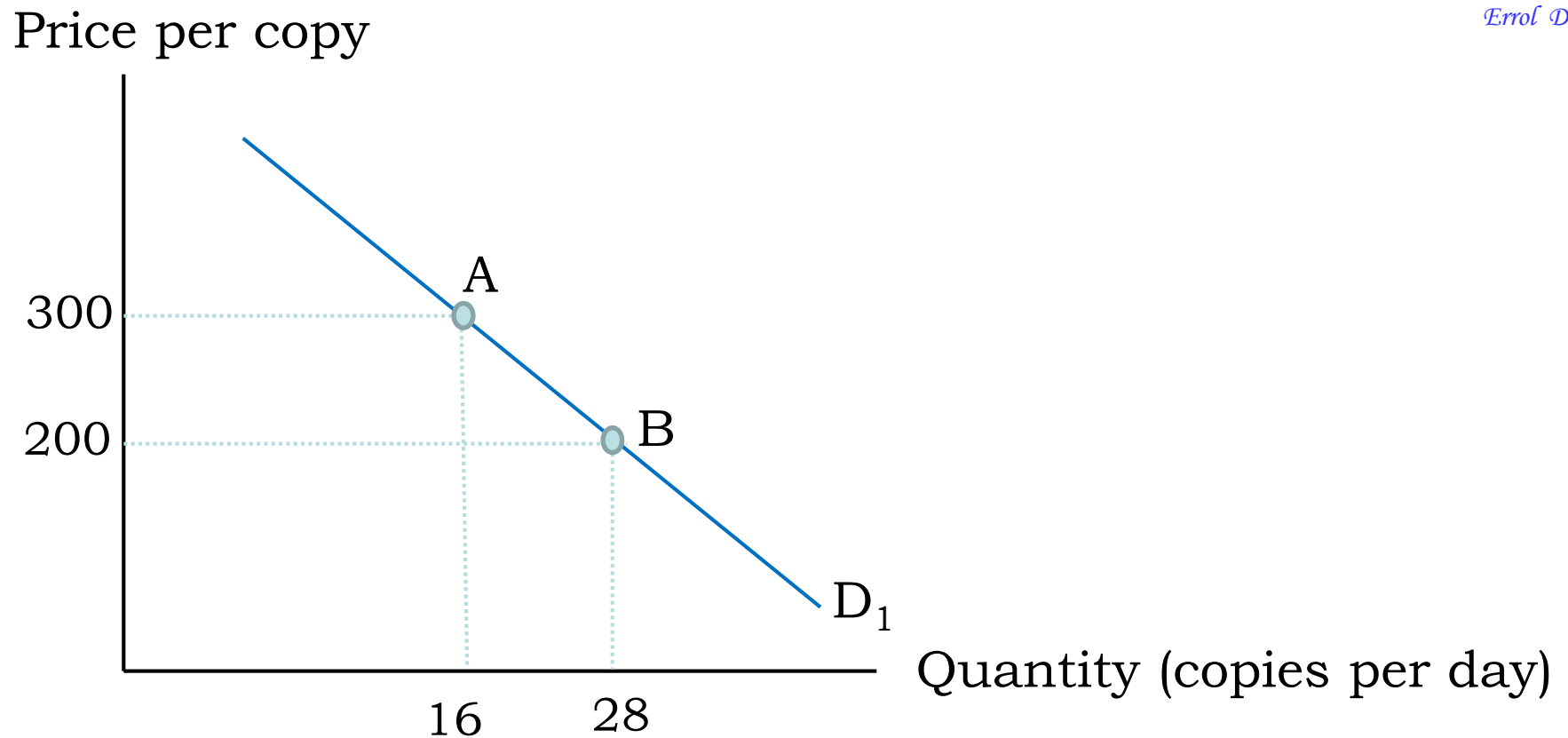
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Suppose you own a bookstore and are trying to decide whether to cut the price you are charging for the new John Grisham mystery novel.

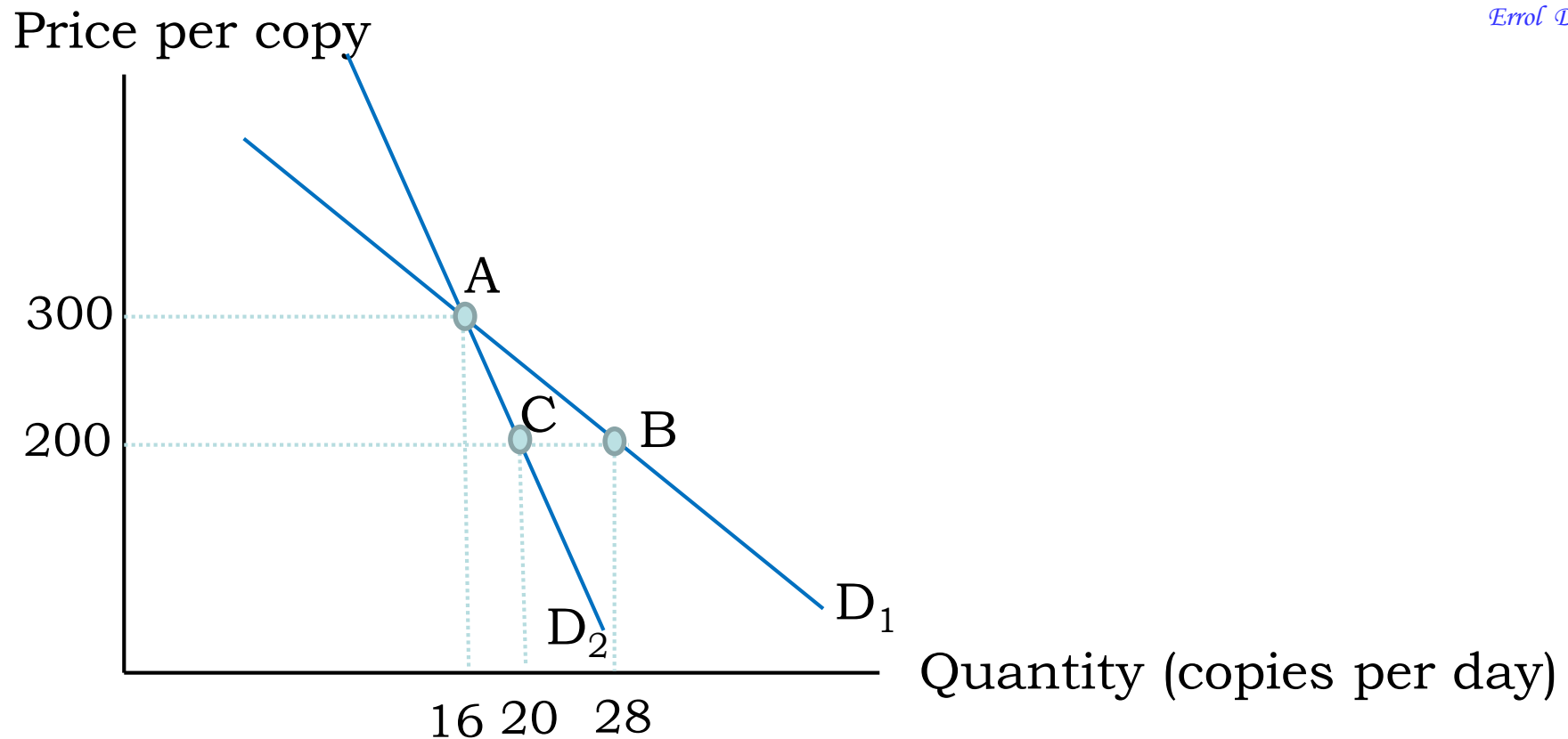
You are currently at point A in the next figure selling 16 copies of the novel per day at a price of Rs 300 per copy. 

How many more copies you will sell by cutting the price to Rs 200 depends on the price elasticity of demand.

We consider two possibilities. If D_1 is the demand curve your sales will increase to 28 copies per day, point B. 



If D_1 is the demand curve your sales will increase to 28 copies per day, point B.



If D_2 is the demand curve, sales will increase to 20 copies per day, point C.

We can expect that demand curve D_1 is more elastic and demand curve D_2 is inelastic.

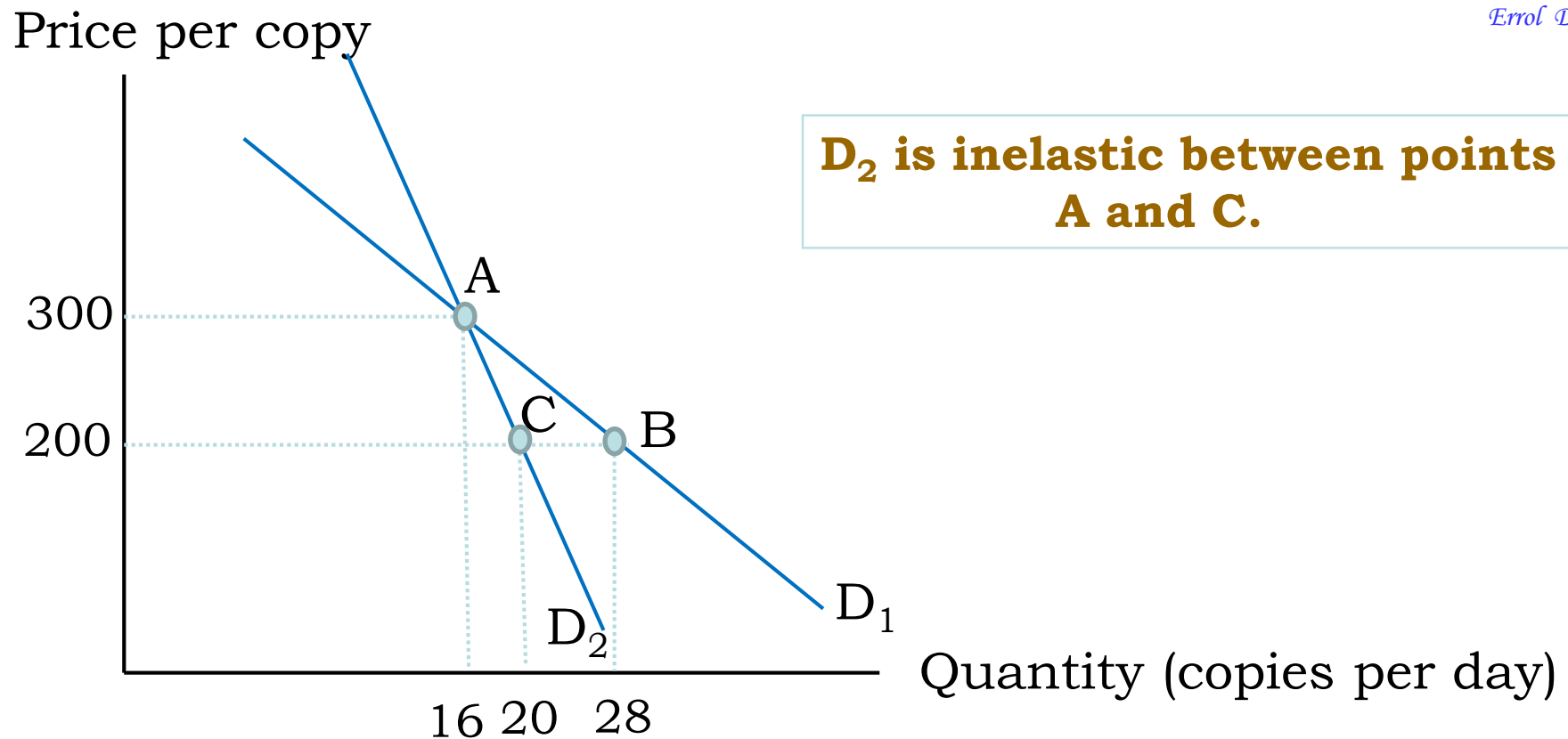
A problem in calculating price elasticity is that we get a different value for price increases than for price decreases.

Suppose we calculate elasticity for D_2 as the price is cut from Rs 300 to Rs 200. This is a 33% reduction. The quantity demanded increases from 16 books to 20 books. This is a 25% increase. Hence the price elasticity between points A and C is $25/33 = 0.8$.

Now calculate price elasticity as the price is *increased* from Rs 200 to Rs 300. This is a 50 percent increase and the quantity of books declines by 20 percent, down from 20 books to 16 books purchased. The measure of price elasticity now is $20/50 = 0.4$.

It is not satisfactory to have different values for price elasticity of demand between the same points on the same demand curve.

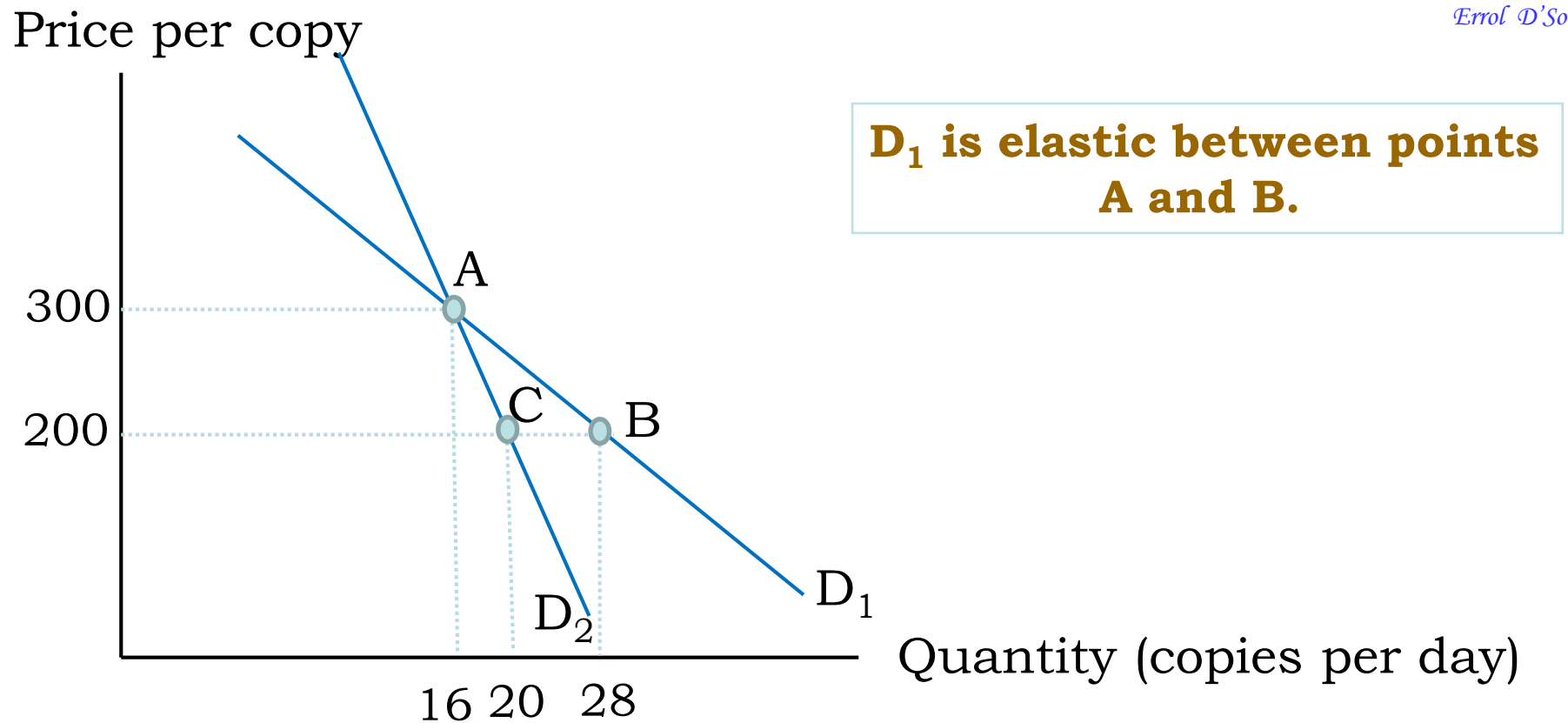
By calculating the **formula at the midpoint** we get the same value whether we are moving from a higher price to a lower price or from a lower price to a higher price.



Between **point A and C** the change in quantity is 4 and the average of the two quantities is 18. Therefore by the midpoint formula the percentage change in quantity is $4/18 = 22.2$ per cent.

The change in price is Rs 100 and the average of the two prices is Rs 250. \therefore the percentage change in price is $100/250 = 40$ per cent.

Hence **price elasticity** is $22.2/40 = 0.6$.



Between **point A and B** the change in quantity is 12 and the average of the two quantities is 22. Therefore by the midpoint formula the percentage change in quantity is $12/22 = 54.5$ per cent.

The change in price is Rs 100 and the average of the two prices is Rs 250. \therefore the percentage change in price is $100/250 = 40$ per cent.

Hence **price elasticity** is $54.5/40 = 1.36$.

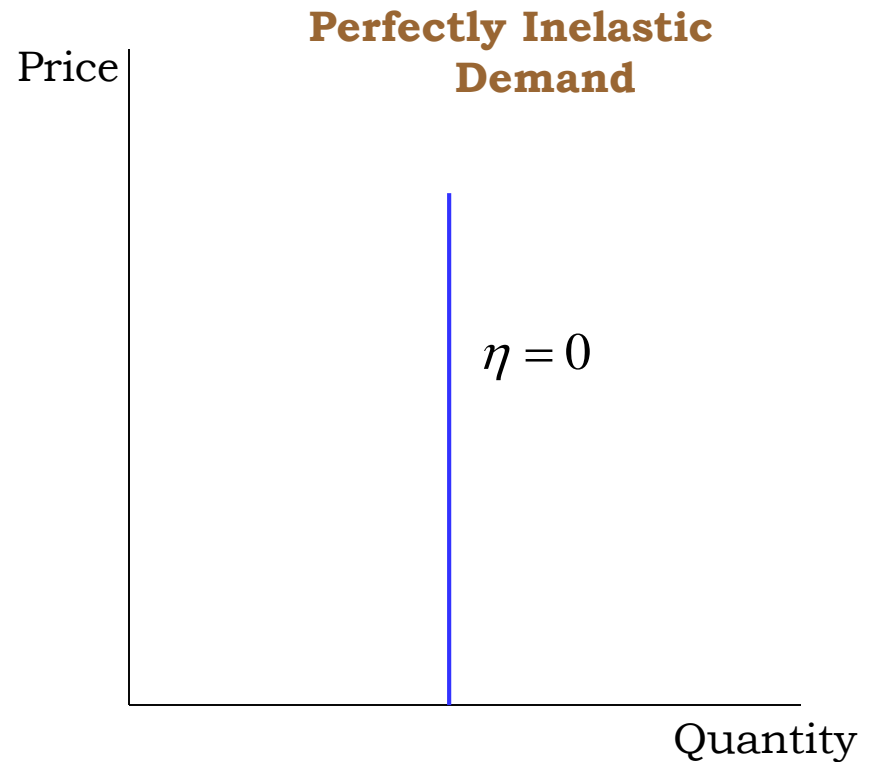
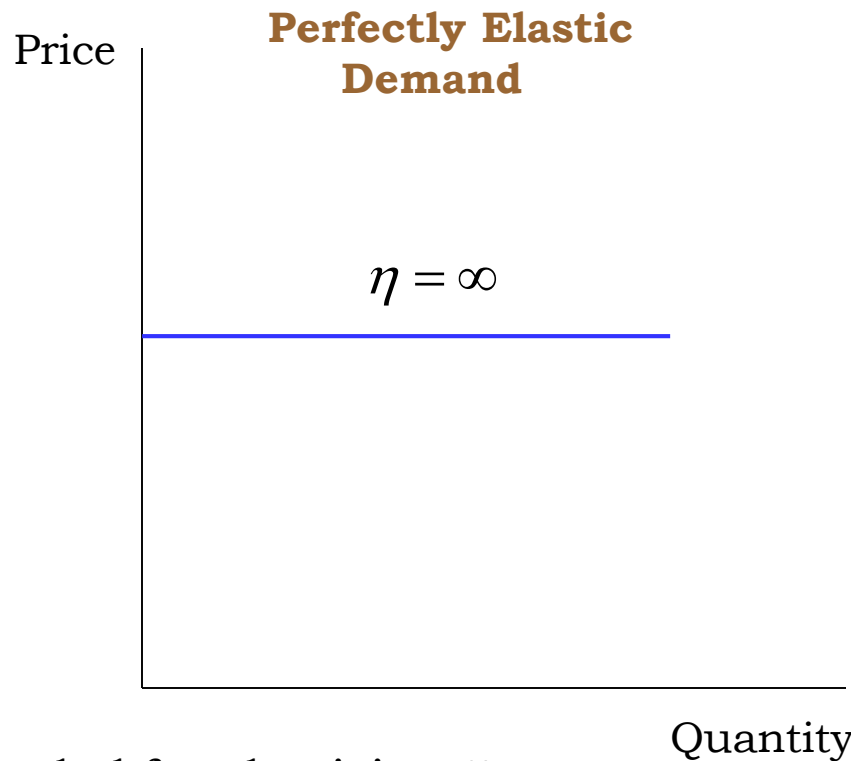
We see that the flatter demand curve is more elastic and a steeper demand curve is less elastic.

Polar Cases: Perfectly Elastic and Inelastic Demand

If a demand curve is a vertical line, it is **perfectly inelastic**. Here quantity demanded is completely unresponsive to price and the elasticity of demand equals zero.



Think of the demand for insulin. Diabetics must take a certain amount of insulin each day. If the price of insulin declines, it will not affect the required dose and thus not increase the quantity demanded.



Symbol for elasticity: η

If a demand curve is a horizontal line, it is **perfectly elastic**. The quantity demanded is infinitely responsive to price and the elasticity of demand equals infinity.

An increase in price causes the quantity demanded to fall to zero for a perfectly elastic demand curve.

The key determinants of elasticity of demand are:

- Availability of close substitutes
- Passage of time
- Necessities versus luxuries
- Definition of the market
- Share of the good in the consumer's budget

Availability of close substitutes –

This is the most important determinant of elasticity as consumers react to a change in price of a product depending on what alternatives they have.

When the price of petrol rises consumers have few alternatives and so the quantity demanded falls only a little.

If Domino's raises the price of pizza, however, consumers have alternatives and so the quantity demanded is likely to fall a lot.

If a product has more substitutes available, it will have more elastic demand. If a product has fewer substitutes available, it will have less elastic demand.

Passage of Time –

It usually takes consumers time to adjust their buying habits when prices change. If the price of chicken falls, it will take a while before consumers decide to change from eating chicken for dinner once a week to eating it twice a week.

If the price of petrol increases, it will also take a while for consumers to decide to shift toward buying more fuel efficient cars.

The more time that passes, the more elastic the demand for a product becomes.

Luxuries versus Necessities –

Goods that are luxuries will usually have more elastic demand curves than goods that are necessities.

For e.g., the demand for milk is inelastic because milk is a necessity and the quantity that people demand is not very dependent on its price.

Tickets to a concert are a luxury, and so the demand for concert tickets is much more elastic.

The demand curve for a luxury is more elastic than the demand curve for a necessity.

Definition of the market –

In a narrowly defined market consumers will have more substitutes available. If the price of Kellogg's Raisin Bran rises, many consumers will start buying another brand of raisin bran such as Baggy's.

If the prices of all brands of raisin bran rise, the responsiveness of consumers will be lower.

If the prices of all breakfast cereals rise, the responsiveness of consumers will be even lower.

The more narrowly we define a market, the more elastic demand will be.

The economist Jerry Hausman divided breakfast cereals into 3 categories: (a) children's cereals, such as Trix and Froot Loops; (b) adult cereals such as Special K or Grape-Nuts; and (c) family cereals, such as Corn Flakes and Raisin Bran.

His estimates of the price elasticity of demand are given below:

Cereal	Elasticity of Demand
Post Raisin Bran	2.5
All family breakfast cereals	1.8
All types of breakfast cereals	0.9

Share of the good in the consumer's basket –

Goods that take only a small fraction of a consumer's budget tend to have less elastic demand.

For e.g most people buy salt in relatively small quantities and even a doubling of the price of salt is likely to result in only a small decline in the demand for it.

“Big-ticket items” such as houses, cars, take up a larger share in the average consumer budget. Such goods are likely to result in significant declines in quantity demanded if they witness increases in price.

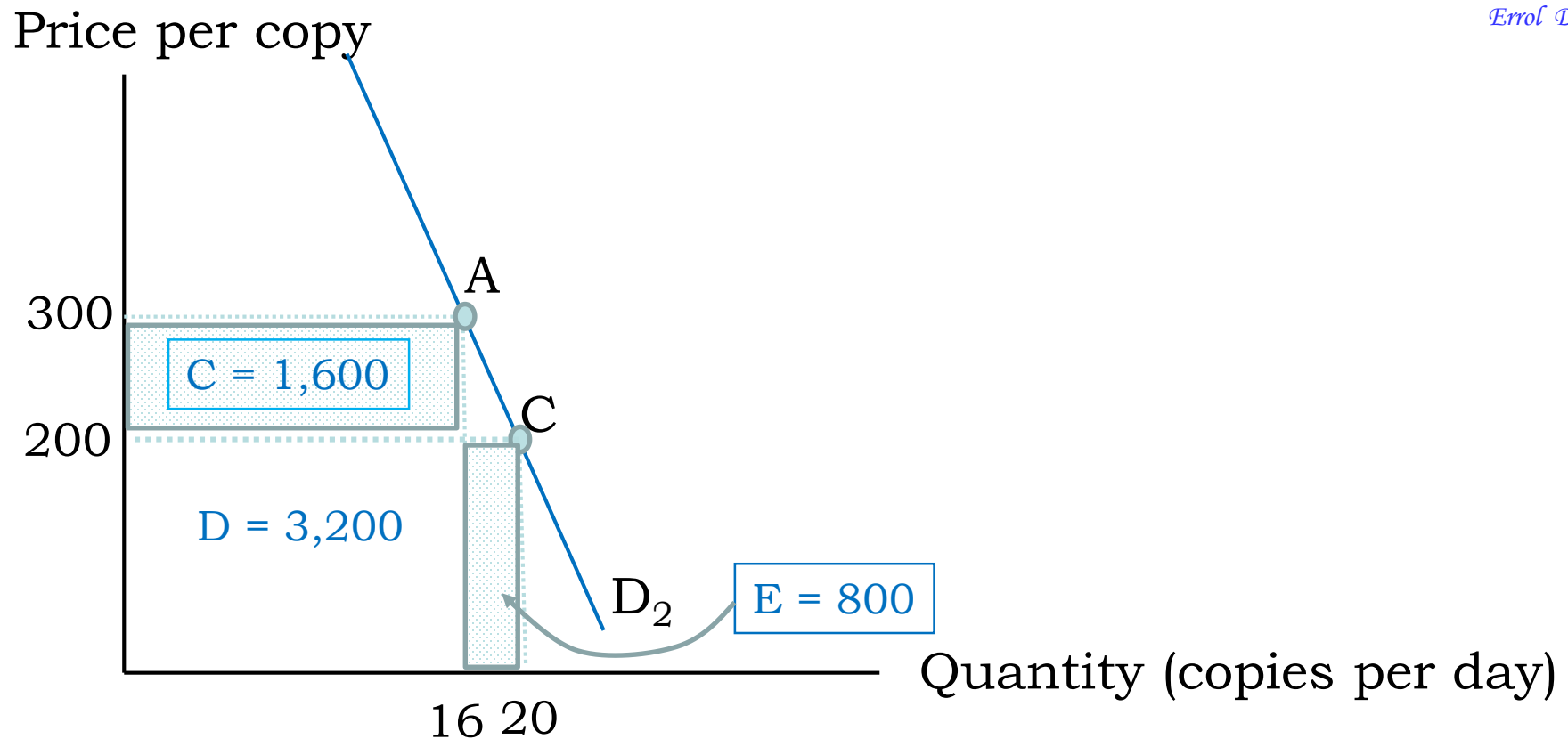
The demand for a good will be less elastic the smaller the share of the good in the average consumer's budget.

Relationship between Price Elasticity and Total Revenue

A firm is interested in price elasticity because it allows it to calculate how changes in price will affect its **total revenue**. Total revenue is the price per unit multiplied by the number of units sold.

When demand is inelastic, price and total revenue move in the same direction. An increase in price raises total revenue.

When demand is elastic, price and total revenue move inversely. An increase in price reduces total revenue.

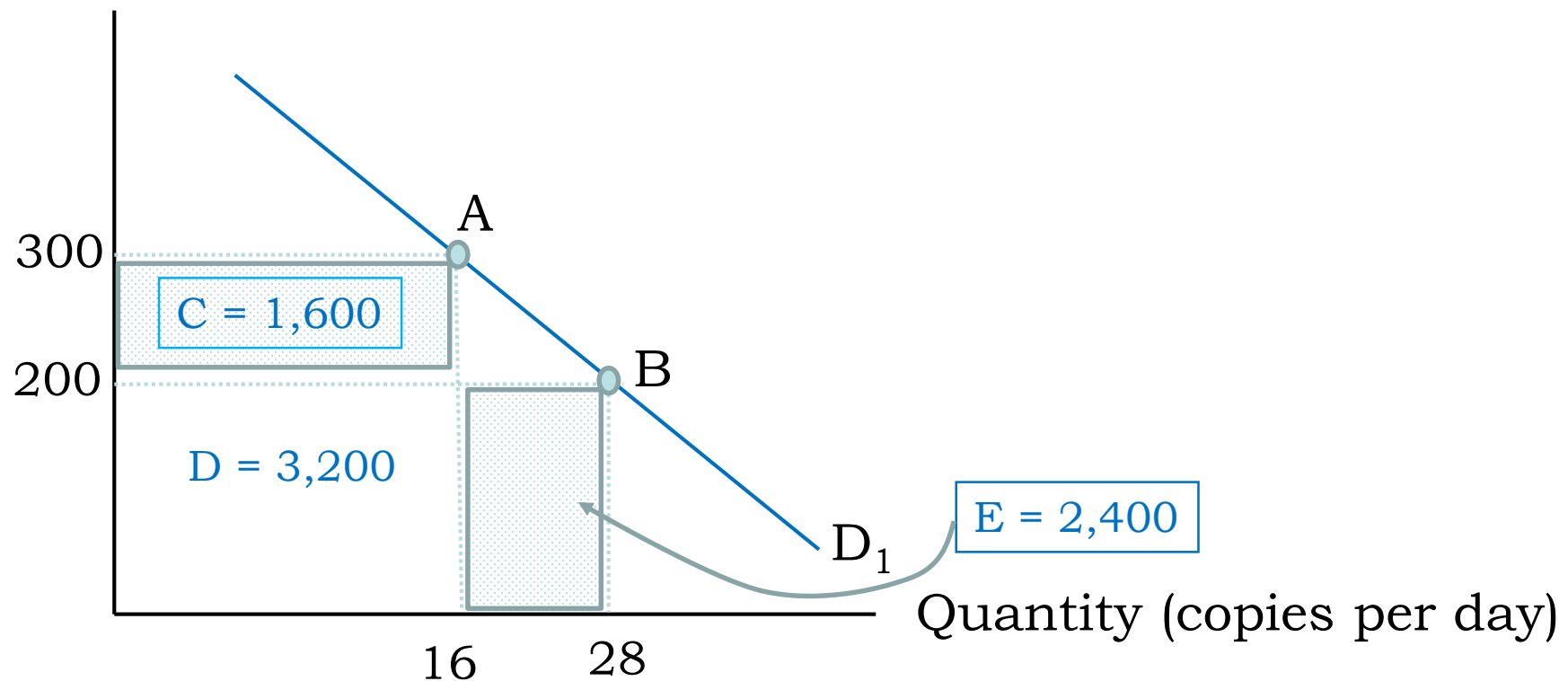


If D_2 is the demand curve, total revenue at point A is Rs 300 multiplied by 16 copies of books sold or Rs 4,800. This is the areas of rectangles C and D.

Cutting the price to Rs 200, the total revenue is the areas of rectangles D and E, or, Rs 4,000.

Total revenue falls as the increase in quantity demanded is not enough to offset the lower price – the demand is inelastic.

Price per copy



If D_1 is the demand curve, total revenue at point A is Rs 300 multiplied by 16 copies of books sold or Rs 4,800. This is the areas of rectangles C and D.

Cutting the price to Rs 200, the total revenue is the areas of rectangles D and E, or, Rs 5,600.

Total revenue rises as the increase in quantity demanded is large enough to offset the lower price – the demand is elastic.

If demand is **unit elastic**: Then a change in price is exactly offset by a proportional change in quantity demanded, leaving revenue unchanged. When demand is unit elastic neither a decrease in price nor an increase in price affects revenue.

IF DEMAND IS..	THEN...	BECAUSE...
elastic	An increase in price reduces revenue	the decrease in quantity demanded is proportionally greater than the increase in price
inelastic	An increase in price increases revenue	the decrease in quantity demanded is proportionally smaller than the increase in price
Unit elastic	An increase in price does not affect revenue	the decrease in quantity demanded is proportionally the same as the increase in price.

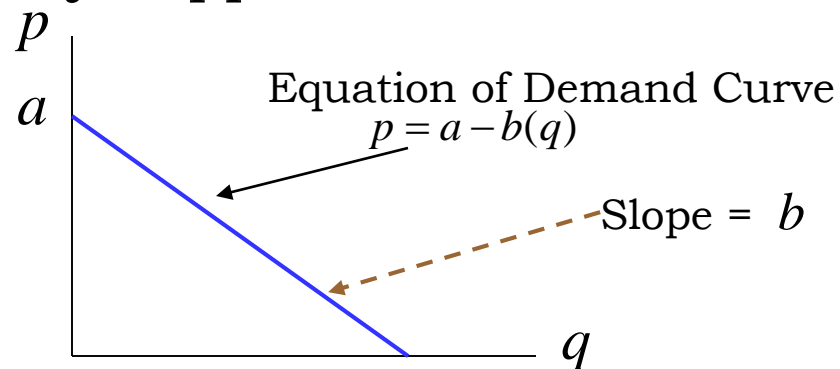
Price elasticity is useful in answering questions of the following type: **If the price of a good changes, by how much will consumer spending on the good be affected ?**

Consumer spending is the price per unit multiplied by the quantity purchased. This expenditure is the total revenue of a firm.

$$\text{Total Revenue} = \text{Expenditure} = pq$$

p = price of the good q = quantity purchased

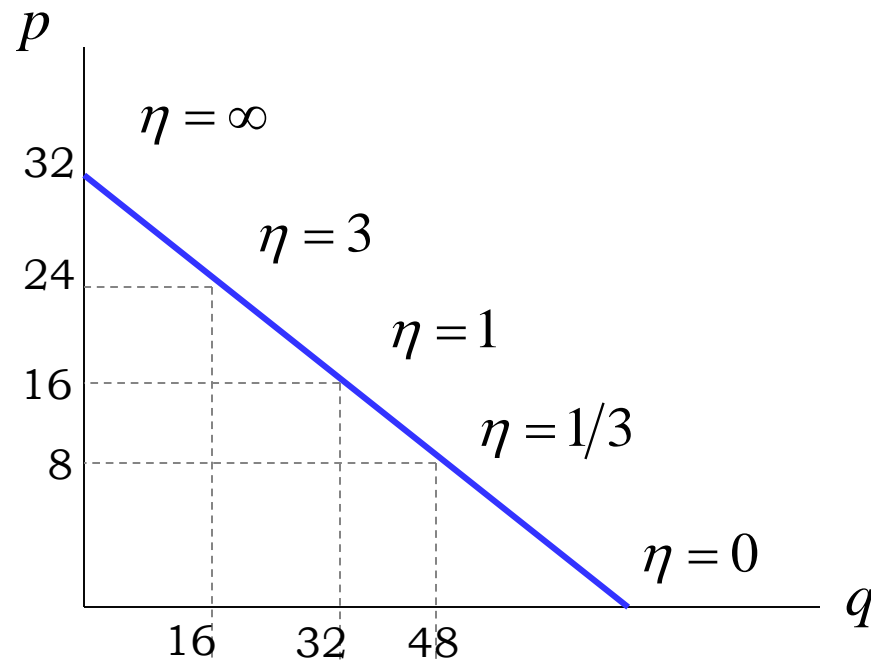
For simplicity suppose the demand curve is linear.



Suppose, $p = 32 - \frac{1}{2}(q)$ Then, $\eta = \frac{2p}{q}$

Then, some of the points on the demand curve are -

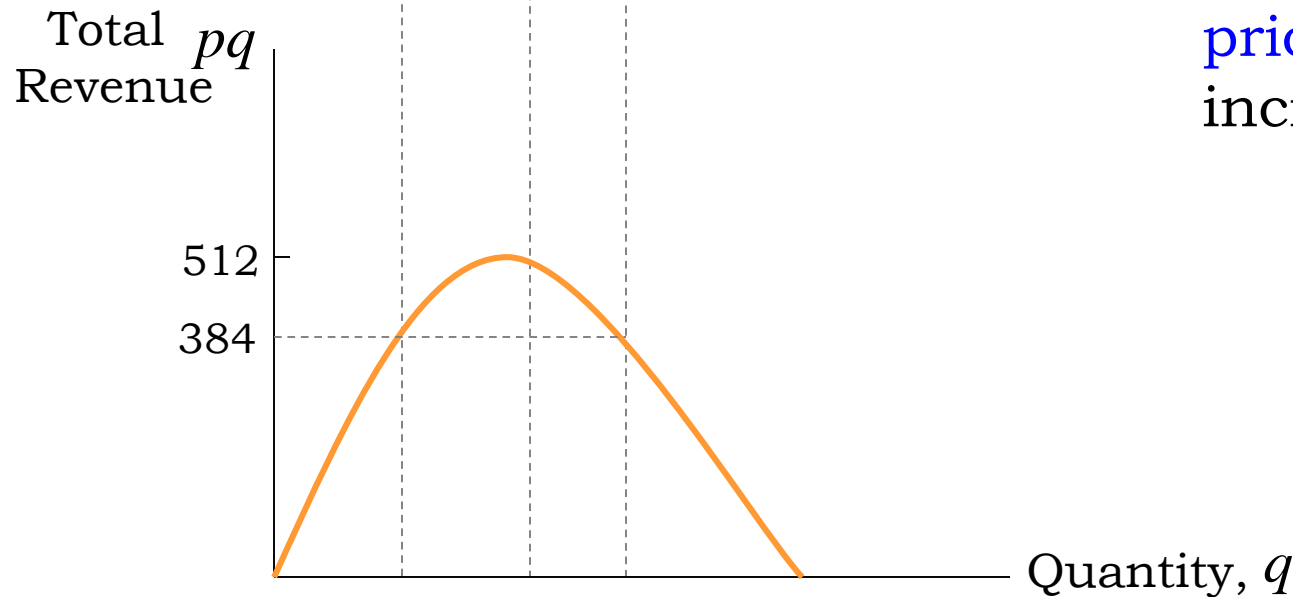
Price (p)	Quantity (q)	Total Expenditure (pq)	Elasticity
32	0	0	∞
24	16	384	3
16	32	512	1
8	48	384	$\frac{1}{3}$
0	64	0	0



The total revenue is maximum where $\eta = 1$

At values of $\eta > 1$, a **price reduction** will increase total revenue.

At values of $\eta < 1$, a **price increase** will increase total revenue.



Cross Price Elasticity of Demand -

Suppose you work at HP and you need to predict the effect of an increase in the price of Canon printers on the quantity of HP printers demanded.

$$\text{Cross price elasticity of demand} = \frac{\% \text{ Change in quantity demanded of one good}}{\% \text{ Change in price of another good}}$$

If products are	Cross price elasticity of demand	Example
Substitutes	Positive	Two brands of printers
Complements	Negative	Printers and toner cartridges
Unrelated	Zero	Printers and peanut butter

Cross-price elasticity of demand is important to firm managers because it allows them to measure whether products sold by other firms are close substitutes for their products.

For e.g., Amazon.com and Barnesandnoble.com are leading online booksellers. We might predict that if Amazon raises the price of a new John Grisham novel, many consumers will buy it from Barnes & Noble instead. But Jeff Bezos, Amazon's CEO, has argued that because of Amazon's reputation for good consumer service and because more customers are familiar with the site, ordering a book from Barnes & Noble is not a good substitute for ordering a book from Amazon. – Jeff Bezos is arguing the cross price elasticity is low.

Economists Judith Chevalier and Austan Goolsbee used data on prices and quantities of books sold on those web sites to estimate cross price elasticity.

They found the cross price elasticity of demand between book at Amazon and books at Barnes & Nobles was 3.5.

This means that if Amazon raises its price by 10 per cent, the quantity of books demanded on Barnes & Noble will increase by 35 per cent.

Income Elasticity of Demand -

$$\text{Income Elasticity of Demand} = \frac{\% \text{ Change in quantity demanded}}{\% \text{ Change in Income}}$$

If Income elasticity of Demand is...	Then the Good is....	Example
Positive but less than 1	Normal and a necessity	Milk
Positive but greater than 1	Normal and a luxury	Caviar
Negative	Inferior	High fat meat

If the quantity demanded of a good increases as income increases, the good is a **normal good**.

Normal goods are further subdivided into luxury goods and necessity goods.

A good is a **luxury good** if the quantity demanded is very responsive to changes in income – a 1% increase in income results in more than a 1% increase in quantity demanded. – Expensive jewelry and vacation homes are examples.

A good is a **necessity** if the quantity demanded is not very responsive to changes in income. – Food and clothing are examples of necessities.

A good is **inferior** if the quantity demanded falls as income rises. – e.g., ground beef with high fat content.

During periods of economic expansion producers can expect the quantity demanded of normal goods to increase. Sellers of luxuries can expect particularly large increases – e.g., meals in expensive restaurants, high performance automobiles, & luxury apartments.

During recessions firms can expect to experience increases in demand for inferior goods – e.g., demand for rail trips will rise as consumers cut back on air travel.

Example -

Price elasticity of demand for beer - 0.23

Cross-price elasticity of demand between
beer and wine 0.31

Income elasticity of demand for beer -0.09

Income elasticity of demand for wine 5.03

Thus,

- demand for beer is inelastic
- wine is a substitute for beer
- 10% increase in income will result in little less than 1% decline in quantity of beer demanded. Beer is an inferior good
- Wine is a luxury good

Why did family farms disappear in the US?

As countries develop the number of farms and the number of farmers begins to dwindle. In 1950 for instance more than 5 mn. Farms were there in the US and more than 23 mn. people lived on farms. By 2004, fewer than 2 mn. Farms remained and fewer than 3 mn. people lived on them.

One reason is that productivity has grown. In 1950, the average wheat farmer harvested about 17 bushels of wheat per acre. By 2004, due to the development of superior strains of wheat and improvements in farming techniques, the average wheat harvest was 43 bushels per acre. – The increase in wheat production resulted in substantial decline in wheat prices.

Two other key factors are responsible for the decline in wheat prices:

- the demand for wheat is inelastic
- the income elasticity of demand for wheat is low.

Even with rising population, the higher incomes in 2004 resulted in a small shift in demand due to the low income elasticity.

For the additional wheat that was produced to be sold the price decline has to be substantial given the demand for wheat is price inelastic.

A ▪ large shift in supply, ▪ a small shift in demand, and ▪ a inelastic demand curve, combined to drive down the price of wheat from \$13.13 per bushel in 1950 to \$ 3.40 per bushel in 2004.

With low prices only the most efficiently run farms have been profitable. Smaller family farms have found it difficult to survive and many of these farms have disappeared.

The Price Elasticity of Supply -

To measure how much quantity supplied increases when prices increase, we use the price elasticity of supply.

$$\text{Price elasticity of supply} = \frac{\% \text{ Change in quantity supplied}}{\% \text{ Change in Price}}$$

If price elasticity of supply is less than 1, then supply is *inelastic*. For e.g., the price elasticity of petrol is around 0.2. – A 10% rise in the price will result in only a 2% increase in the quantity supplied.

If the price elasticity of supply is greater than 1, then supply is *elastic*. If the price elasticity of supply is equal to 1, then supply is *unit-elastic*.

The elasticity of supply depends on the availability of resources required for production. If resources are in fixed supply it is difficult to increase supply.

A French winery that relies on a particular variety of grape will have an inelastic supply of wine if all the land on which that grape can be grown is already planted in vineyards.

Often firms have difficulty increasing the quantity of product supplied during a short period of time. The supply curve will then be inelastic if we measure the elasticity over a short period of time.

Why are oil prices so unstable?

Bringing oil to market is a long process.

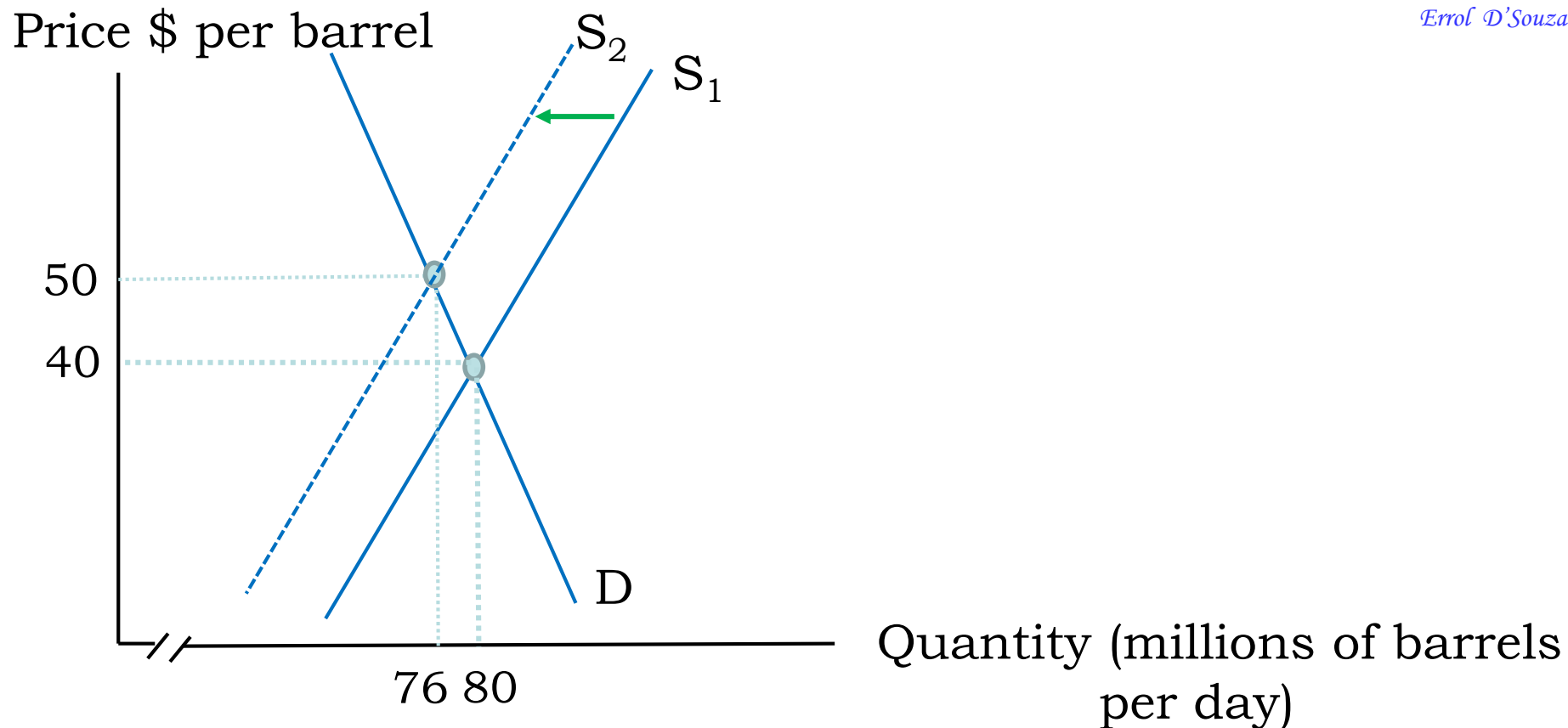
Oil companies hire geologists to search for oil.

Once a likely field has been found the company will drill an exploratory well.

If the exploratory well indicates significant amount of oil is present, full scale development of the field begins.

The whole process from exploration to pumping significant amounts of oil can take years.

Because it takes so long to bring additional quantities of oil to market, the price elasticity of supply of oil is very low.



Oil is characterized by inelastic supply and inelastic demand. A reduction in supply shifts the market supply curve from S_1 to S_2 and causes the equilibrium quantity of oil to fall by only 4 mn. barrels a day – a 5% decrease. The equilibrium price, however, rises by 25% from \$40 per barrel to \$50 per barrel.

The world oil market is heavily influenced by OPEC which has 11 members including Saudi Arabia, Kuwait and other Arab countries, as well as Iran, Venezuela, Nigeria, and Indonesia. Together these countries own 75% of the world's proven oil reserves.

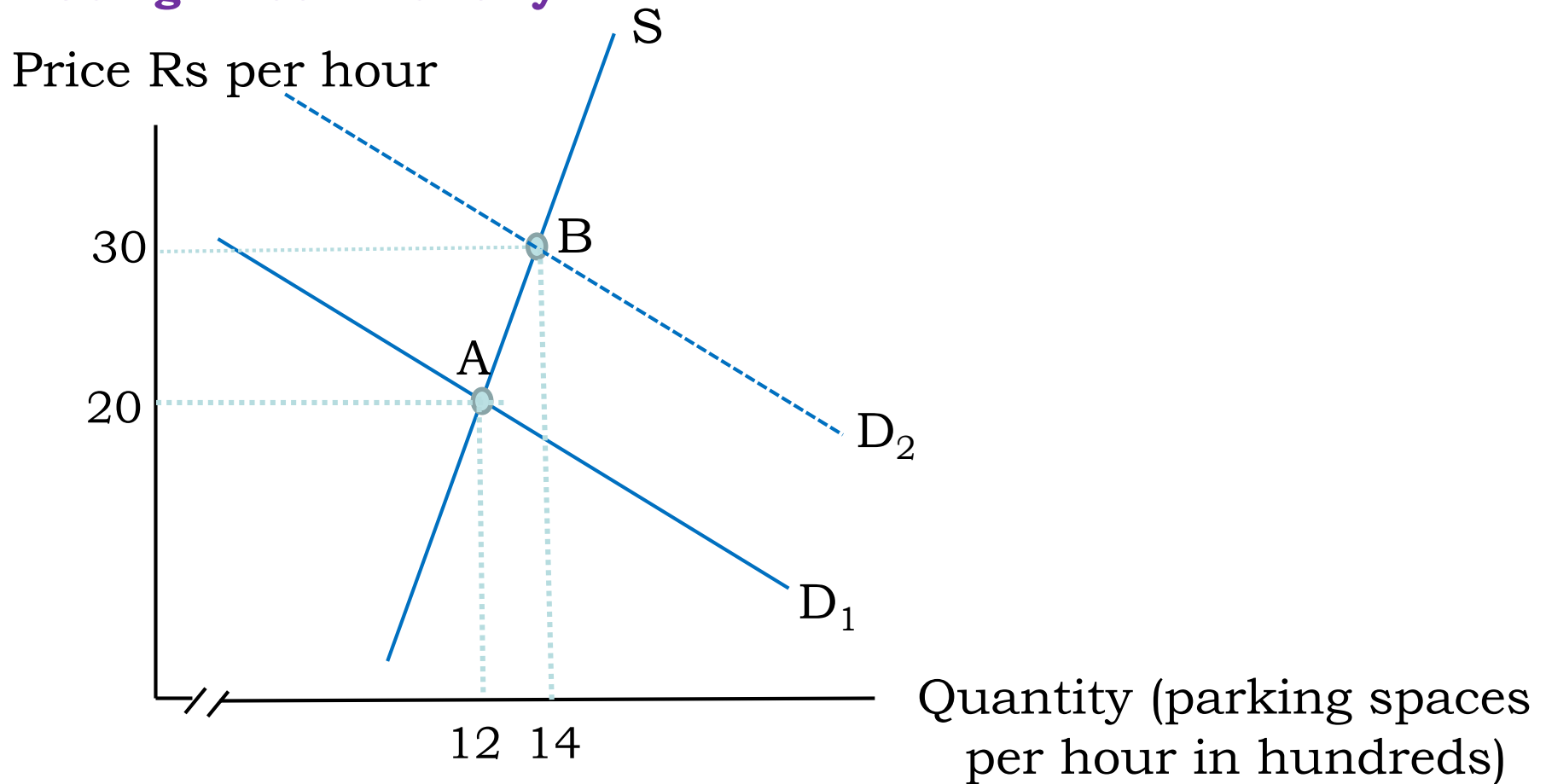
Periodically OPEC has attempted to force up the price of oil by reducing the quantity supplied by its members.

Periods during which OPEC members cooperate and reduce supply alternate with periods in which the members fail to cooperate and supply increases.

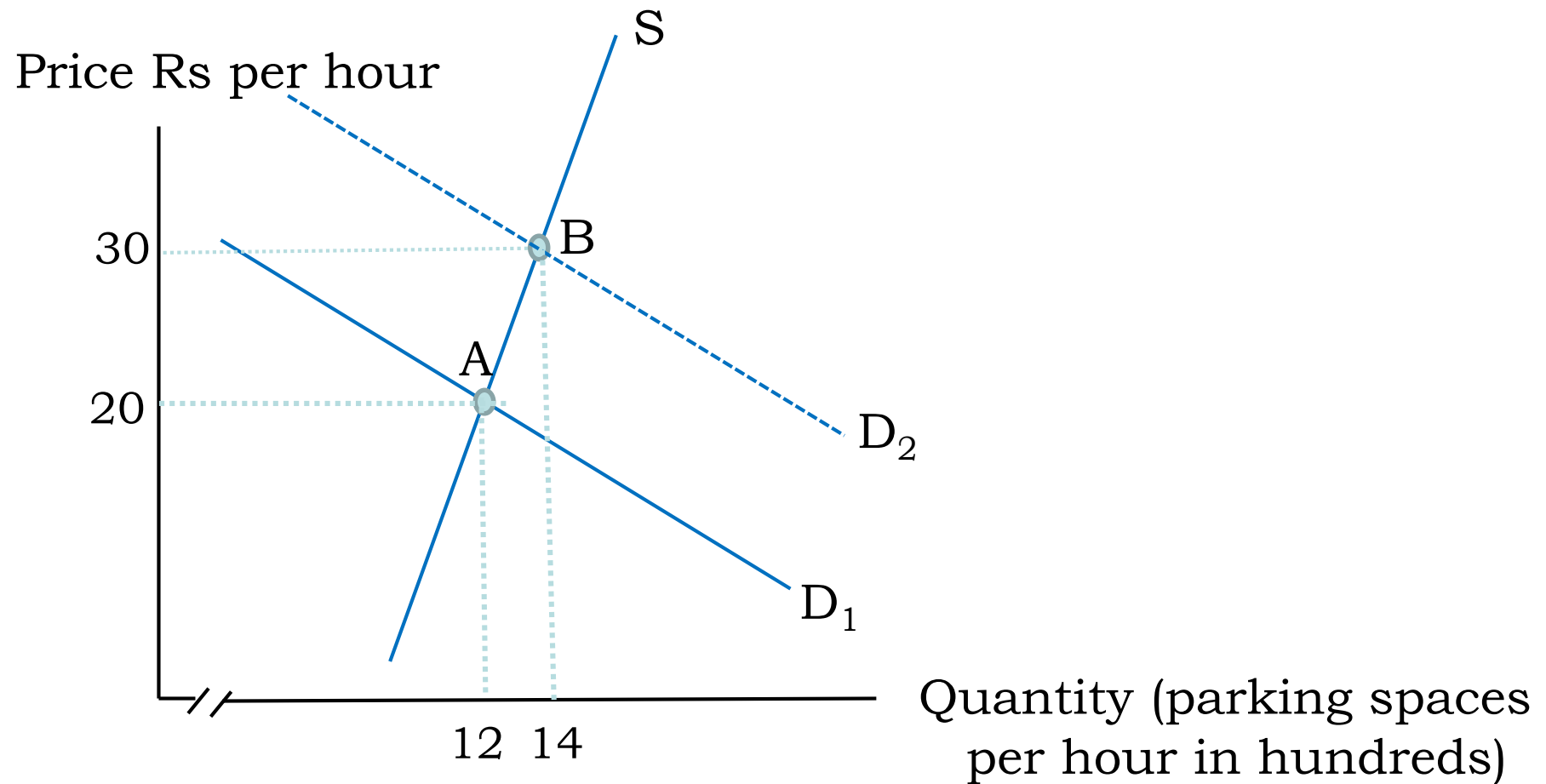
As a result the supply curve for oil shifts fairly frequently.

Combined with low price elasticities of demand & supply the shifts in supply have caused oil prices to fluctuate significantly.

Using Price Elasticity



The figure shows the demand & supply for parking spaces in a mall. On a weekday equilibrium is at point A where demand intersects an inelastic supply curve. On a weekend the demand shifts to D_2 and equilibrium is at point B.



Because supply is inelastic the increase in demand on weekends results in a large increase in price from Rs 20 to Rs 30 per hour (50% increase) but only a small increase in parking spaces supplied from 1,200 to 1,400.

