



Topic 3: Elasticities of Demand & Supply

Theme 2.1
Price Mechanism and its Applications

How to use this set of lecture notes?

1) BEFORE LECTURES – UNDERSTANDING CONTENT

- Reference your notes against your H2 syllabus. Mark out the key concepts so that you know what you **MUST** know
- Read your notes ahead so that you can focus on listening and capturing additional notes during lectures

2) During lectures – APPLYING CONTENT

- Bring your hard copy notes along, and use your PLDs to refer to the lecture slides concurrently
- Capture additional notes, especially the real-world examples where you can note down how concepts are applied and how economic analysis are developed in varying contexts
- You should make use of a notetaking/consolidation tool to take notes during lessons and to consolidate your learning at timely junctures. Examples are MIRO, Notion, Goodnotes, Notability, Microsoft OneNote, KAMI, etc. The choice is yours!

3) After Lectures – TUTORIAL PREPARATION to use content flexibly to show application, analysis and evaluation skills

- Revise concepts relevant for the case study and essay questions
- Refer to the notes and use it flexibly to prepare your answers to meet question requirements. Pure memorisation will not work as it does not involve deep understanding.
- Do share your notes with your friends to multiply learning!

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2. How do economic agents make use of elasticities concepts in their decision-making?

Introduction to Elasticities of Demand and Supply

In the previous topic, we have established that price changes are due to changes in demand and/or supply. Changes in demand and supply can affect equilibrium price and quantity.

In this topic, we employ the concept of elasticity to help us explain the extent of changes in price and quantity of a good or service. Furthermore, we will consider how the concept of elasticity is useful to the various economic agents.

1. Elasticity

1.1 Concept of elasticity

Elasticity in economics refers to the degree of responsiveness. Within our syllabus, there are two broad categories of elasticity concepts, namely elasticity of demand and elasticity of supply.

Generally, there are three elasticities of demand that economists are interested in:

- **Price Elasticity of Demand (PED):** refers to the degree of *responsiveness* of quantity demanded of a good to a given change in the price of the good itself, ceteris paribus.
- **Income Elasticity of Demand (YED):** refers to the degree of *responsiveness* of demand for a good to a given change in consumers' income, ceteris paribus.
- **Cross Elasticity of Demand (XED):** refers to the degree of *responsiveness* of demand for a good to a given change in the price of a related good, ceteris paribus.

Unlike the various elasticities of demand, there is only one elasticity of supply.

- **Price Elasticity of Supply (PES):** refers to the degree of *responsiveness* of quantity supplied of a good to a given change in the price of the good itself, ceteris paribus.

2. Price Elasticity of Demand (PED)

2.1. Definition

Price elasticity of demand (PED) refers to the degree of *responsiveness* of quantity demanded of a good to a change in the price of the good itself, ceteris paribus.

While the law of demand tells us that when the price of a good rises, the quantity demanded for the good falls, ceteris paribus. It does not tell us the extent of the fall in quantity demanded. Therefore, what PED does is to help us determine the extent of the fall in quantity demanded in percentage terms, as a result of a price change.

This helps us to be precise as economists; instead of saying ‘when price increases, then quantity demanded will fall’, we can give precision to the statement by saying ‘a 1% increase in the price of the good will lead to a 10% decrease in quantity demanded’. This also means that when price of a good rises (1%), quantity demanded falls more than proportionately (10%).

2.2. Measurement and Formula

Mathematically, the PED is a numerical value calculated as the percentage change in quantity demanded of a good divided by the percentage change in its own price.

$$\begin{aligned}
 PED &= \frac{\% \Delta \text{Quantity demanded}}{\% \Delta \text{Price}} \\
 &= \frac{\frac{\Delta Qd}{Qd} \times 100\%}{\frac{\Delta P}{P} \times 100\%} \\
 &= \frac{\Delta Qd}{\Delta P} \times \frac{P}{Qd}
 \end{aligned}$$

Where

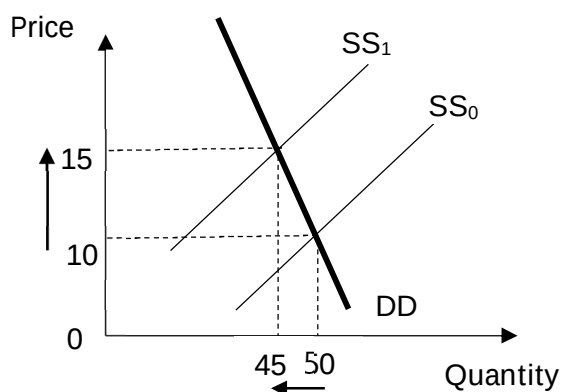
ΔQd = change in quantity demanded of the good

ΔP = change in price of the good

Qd = original quantity demanded of the good

P = original price of the good

Computing the PED for Good X



% change in price due to the fall in supply	50%
% change in quantity demanded as a result	-10%
PED	$\frac{(-) 10\%}{50\%} = -0.2$

Figure 1: Price inelastic demand

Graphically (and mathematically), the smaller the absolute value of PED, the less price elastic the demand, the steeper the demand curve. However, the PED value is **not equal** to the gradient of the slope. Refer to the Annex for information on how PED may differ along a straight line, where the gradient is constant.

2.3. Interpretation of sign and coefficient of PED

As calculated above, the PED sign is **always negative**. This illustrates the Law of Demand, which explains the inverse relationship between price and quantity demanded of a good. In conventional use, we leave out the negative sign in front of the coefficient since PED is always negative.

Demand for a good can be said to be price elastic or inelastic. To know whether the demand for a good is price elastic or inelastic, we look at the coefficient of the PED.

The coefficient of PED lies between 0 and infinity. The higher the magnitude of coefficient of PED, the more price elastic is the demand for the good. This means that quantity demanded is more responsive to changes in the price of the good.

Coefficient	Meaning	Graphical Representation
$\text{PED} > 1$ Demand is price elastic.	A given % change in price of a good will result in a more than proportionate change in quantity demanded, <i>ceteris paribus</i>. This means that consumers are price sensitive and more responsive to price changes. e.g. $\text{PED} = 4$ A 1% increase in price of a good will lead to a 4% fall in quantity demanded. <i>Example: Air-travel for leisure travelers</i>	 Graph: For price elastic demand, the curve is gentle.
$0 < \text{PED} < 1$ Demand is price inelastic.	A given % change in price of a good will result in a less than proportionate change in quantity demanded, <i>ceteris paribus</i>. This means that consumers are price insensitive and are less responsive to price changes. e.g., $\text{PED} = 0.4$ A 1% increase in price of a good, will lead to a 0.4% fall in quantity demanded. <i>Example: Rice in Asian societies</i>	 Graph: When demand is relatively price inelastic, the demand curve is drawn relatively steeper.

Coefficient	Meaning	Graphical Representation
$PED = \infty$ Demand is perfectly price elastic.	A given % change in price of a good will result in an infinitely large change in quantity demanded. E.g. A rise in price of a good leads to quantity demanded falling to 0. Or a fall in the price of a good leads to quantity demanded rising to ∞. <i>Example: Homogeneous goods found in perfectly competitive markets (to be covered in the topic of Firms and Decisions).</i>	 Graph: When demand is perfectly price elastic, the demand curve is horizontal.
$PED = 0$ Demand is perfectly price inelastic.	A given % change in price of a good will result in 0% change in quantity demanded, <i>ceteris paribus</i>. This means that a change in price of a good will lead to no change in the quantity demanded of the good. Same quantity is demanded regardless of the price of good. <i>Example: A patient's demand for certain drugs with no substitutes</i>	 Graph: When demand is perfectly price inelastic, the demand curve is vertical.
$PED = 1$ Demand is unitary elastic.	A given % change in price of a good will result in an equal % change in quantity demanded, <i>ceteris paribus</i>. E.g. A 5% increase in price of a good will lead to a 5% decrease in quantity demanded. The change in quantity demanded is proportionate to the change in price.	 Graph: When demand is unitary elastic, the demand curve is a rectangular hyperbola.

NOTE: In reality, $|PED| > 1$ and $0 < |PED| < 1$ would be more applicable and widely referred to.

2.4. Determinants of PED

P – Proportion of income
A – Availability of close substitutes
N – Degree of necessity
T – Time period

a. Availability of close substitutes

Substitutes are two goods considered by consumers to be alternatives that satisfy the same want/need. A good with **many close substitutes available** tend to have **more price elastic demand** because it is easier for consumers to switch away from consuming that good to others, if there were to be a price change. This is because when the price of a good increases, many consumers can readily switch to its substitutes. Conversely when price of the good decreases, many consumers will easily switch away from its substitutes.

For example, consider Nike shoes which has many close substitutes such as Adidas shoes and other brands of sport shoes. That is, Nike shoes and other shoe brands are easily substitutable. With an increase in the price of Nike shoes, assuming the price of Adidas shoes is held fixed, the quantity demanded for Nike shoes will fall by a large amount, meaning a more than proportionate decrease in the quantity demanded. Hence, we say that the demand for Nike shoes is price elastic.

Take note that the broadness of definition of the good would also determine the availability of close substitutes. For instance, it is possible that the demand for Samsung Galaxy S24 is price elastic because of the availability of many substitutes such as those by Apple and Huawei. However, if we were to use a broader definition such as smartphones, there would not be as many substitutes.

Another example would be fruits for which there is lesser alternatives. However, there are many substitutes to apples such as pears or oranges. Therefore, the absolute value of PED for fruits would be lower than that for apples.

The more widely defined the good, the less the number of substitutes, the lower the absolute value of PED, i.e., the more price inelastic the demand.

b. Degree of necessity of the good

The degree of necessity of a good refers to how strongly the consumer needs the good. If the degree of necessity of the good is high, the demand for the good will be more price inelastic. Even if price of the good were to increase, consumers cannot easily reduce the quantity demanded of the good, and the extent of fall in quantity demanded will be less than proportionate to the rise in price.

For example, diabetic patients need to consume insulin daily to regulate the blood sugar level in their bodies. Even if there is a considerable increase in the price of insulin, the quantity demanded for insulin would fall by less than proportionately because of the high degree of necessity.

Therefore, the greater the degree of necessity for the good is, the lower the absolute value of PED and the more price inelastic the demand.

**Connect, Extend, Challenge****Singapore's Vanishing S\$3 Chicken Rice, 2023**

Breaking for lunch during his work as a handyman in Singapore, Mr Zuo usually heads to the nearest food hall in search of a cheap meal. He's having to look harder these days as inflation hits hawker centres. Prices of everything from satay skewers to seafood noodles have risen over 12% in the past two years. Hainanese chicken rice can rarely be found for around S\$3 as was common several years ago. An average plate now costs more than S\$4. "I have no other choice – I still have to eat," said the 69-year-old, who relies on government cash payouts to augment his monthly income of around S\$800.

From Mr Zuo's response, what can you infer about his PED for chicken rice? Why is this so?

While there are some goods that start with a low degree of necessity, they can be habit-forming and this can become a necessity (addiction). Examples of such goods would be substances such as cigarettes, alcohol and drugs.

Hence, the more addictive the nature of the good or more habitual the consumption of the good, the more price inelastic is the demand for the good. This is because the addictive nature of the good gets consumers 'hooked' onto it, and as such the quantity demanded would fall less than proportionately when there is an increase in price.

c. Proportion of household income spent on the good

The greater the proportion of income spent on purchasing the good, the more price elastic is the demand for the good. This is because a rise in the price of these goods, it would take up a more significant proportion of their income.

Consider the case of an inexpensive item such as salt which accounts for an insignificant proportion of income spent on it. Even if the price of salt were to increase by 50% from (\$1 to \$1.50), the fall in quantity demanded would be less than proportionate to the increase in price. This is because a change in the price of salt does not significantly reduce the consumers' ability to purchase the good.

On the other hand, a similar increase in price by 50% for an expensive item such as a car, for example, from \$100,000 to \$150,000 would lead to a more than proportionate fall in quantity demanded. This is because the increase of \$50,000 takes up a significant portion of the family's income.

The demand for a good tends to be more price inelastic if the proportion of income spent on it is small, and the demand for a good tends to be more price elastic if the proportion of income spent is large.

d. Time period consideration

The longer the time period after a price change, the more price elastic the demand is likely to be. This is because in the longer term, consumers have more time and can think of ways to adapt their consumption pattern and to find substitutes if the time period is longer. In the shorter time period after a price change, the demand is price inelastic, that is the quantity demanded falls only slightly. It takes some time for consumers it takes time for the consumers to change their consumption pattern and find alternatives.

For example, if the price of electricity were to double, consumers would not be able to change their consumption pattern overnight, hence explaining why the demand for electricity is price inelastic. However, given time, consumers may switch their electrical household appliances to those that operate on solar power, natural gas, or wind energy. Hence, the demand for electricity tends to be price elastic only in a longer time period.

In general, long run demand is more price elastic compared to short run demand.



Connect, Extend, Challenge

Identify and explain a relevant determinant contributing to the elasticity of the good below:

Good	Value	Determinant	Explanation
Crude oil	PED between 0 and 1		

2.5. Application of PED to analyse market outcomes and impact on economic agents

The changes in demand and supply can affect equilibrium price and quantity, consumer expenditure and producer revenue. These outcomes can be affected by price elasticities of demand and supply, income and cross elasticities of demand (which will be discussed in the next sections).

a. The effects of changes in supply on equilibrium price and quantity

We know that in the event of a supply change, equilibrium price and quantity will change, as explained through the price adjustment process in Topic 2. The **extent to which price and quantity changes** when **supply changes** can be **explained by the price elasticity of demand**. Similarly, PES is used to analyse the effects of changes in demand, ceteris paribus. This will be discussed in the next section of the notes.

Shift in supply with different PED values

For example, when supply of rice falls from SS_0 to SS_1 , the immediate effect is a shortage at the existing price which puts an upward pressure on the price to rise. Since the demand for rice is likely to be price inelastic, quantity demanded falls less than proportionately from Q_0 to Q_i when the price of rice increases. This means that consumers are not responsive to the rise in price, and it becomes very difficult to clear the shortage. As a result, it requires a very large increase in price from P_0 to P_i to eliminate the shortage.

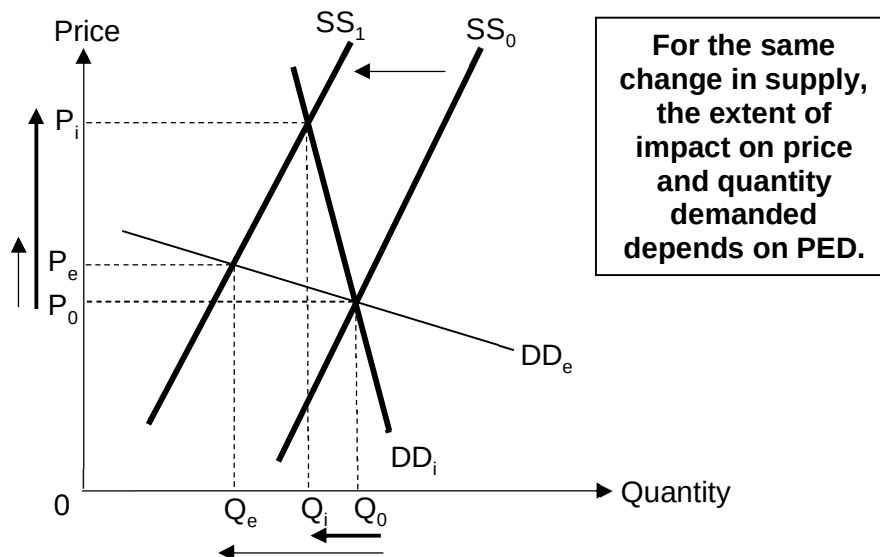


Figure 2: Using PED to analyse the impact of a fall in supply

If the demand of rice were to be more price elastic (represented by DD_e in Figure 2), the rise in price to P_e would lead to a more than proportionate fall in quantity to Q_e .

Therefore, when demand is price inelastic, a fall in supply would have a larger impact on price and a smaller impact on quantity as compared to the case if demand is relatively more price elastic.

b. The effects of changes in supply on producer revenue/consumer expenditure

When studying changes in supply in a market, one outcome we want to study is **producer revenue (also known as total revenue)** or **consumer expenditure (also known as total expenditure)**, the amount paid by buyers and received by sellers of the good. That is,

$$\text{Producer revenue/Consumer expenditure} = \text{Price} \times \text{Quantity}$$

The producer revenue earned in a market is derived by multiplying the price (P) and quantity (Q) at equilibrium (i.e., $P \times Q$). This is also equal to the consumer expenditure in a market, assuming no government intervention.

How changes in price and quantity affect producer revenue/consumer expenditure depends on PED. The following examples illustrate a few general rules:

- When demand is price inelastic ($IPED < 1$), price and producer revenue/consumer expenditure move in the same direction.
- When demand is price elastic ($IPED > 1$), price and producer revenue/consumer expenditure move in opposite directions.
- If demand is unit elastic ($IPED = 1$), producer revenue/consumer expenditure remains constant when the price changes.

(i) When the demand is price inelastic

With reference to Figure 3, when the demand for the good is relatively price inelastic, a fall in supply results in a large rise in price and a less than proportionate decrease in quantity. Since the revenue gained from the increase in price ($P_0P_1E_1A$) outweighs the revenue loss from the fall in quantity ($AE_0Q_0Q_1$), total revenue increases. The new total revenue (area $OP_1E_1Q_1$) is larger than the original area ($OP_0E_0Q_0$). **Hence the RISE in price leads to a RISE in total revenue i.e. price and total revenue move in the same direction.**

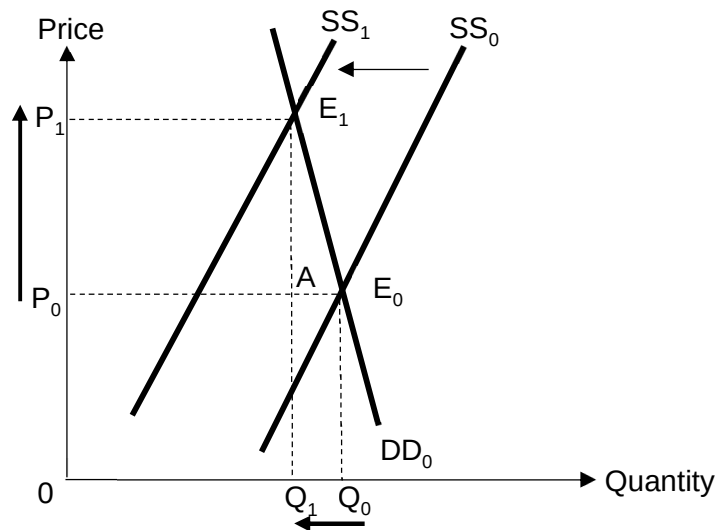


Figure 3: Increase in price increases total revenue when $IPED < 1$

(ii) When the demand is price elastic

However, if demand is relatively price elastic as shown in Figure 4, the rise in price will lead to a more than proportionate decrease in quantity. This means that the revenue gain due to the rise in price ($P_0P_1E_1A$) is less than the revenue loss due to the fall in quantity ($AE_0Q_0Q_1$). As seen from Figure 5, the new total revenue area ($OP_1E_1Q_1$) is smaller than the original area ($OP_0E_0Q_0$). **Hence the RISE in price leads to a FALL in total revenue i.e. price and total revenue move in the opposite directions.**

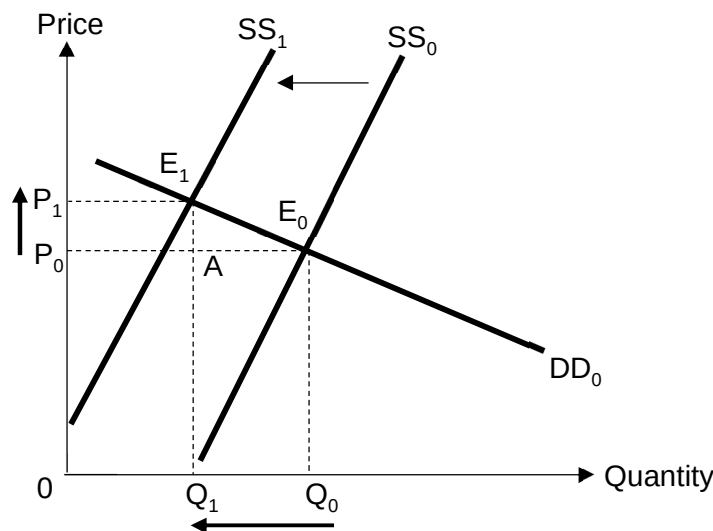


Figure 4: Increase in price decreases total revenue when $|PED| > 1$

c. The implications for households, firms and government

(i) Households/Consumers

The knowledge of PED will allow individual consumers to predict the impact of price changes on their total expenditure on a particular good when there is a supply change. For example, if the government announces an impending increase in taxes on alcohol, supply of alcohol will be expected to fall in the future. With demand for alcohol being price inelastic ($|PED| < 1$) due to its addictive nature, the increase in price of alcohol will only lead to a less than proportionate decrease in quantity, and consumer expenditure on alcohol will increase when the tax policy is enforced. This will affect their decision-making.

(ii) Firms/Producers

As an owner of a firm, will an increase in the price lead to the firm earning more total revenue? The answer depends on PED.

Consider the market for public transportation. This is likely to be a market with price inelastic demand, as public transportation is an essential service for residents to travel for work and leisure. When there is a fall in supply due to rising cost of production (e.g., rising cost of fuel), there would be an increase in price of public transport, resulting in a less than proportionate fall in quantity demanded. As such, there would be an increase in producer revenue (refer to Figure 4).

Therefore, we can conclude **when demand is price inelastic, producer revenue rises when price of the good increases**. Conversely, *ceteris paribus*, when the price falls, the producer revenue will fall too.

Consider the market for airline tickets. Demand for airline tickets is likely to be price elastic, since they take up a significant proportion of income. When there is an increase in the supply arising from falling costs of production, then a decrease in price would cause the number of passengers to rise by more than proportionately such that producer revenue would increase.

In Figure 5, the initial price and quantity sold are P_0 and Q_0 respectively. The initial producer revenue earned = Area A + B. When the price falls from P_0 to P_1 , its quantity demanded rises more than proportionately Q_0 to Q_1 . The new producer revenue earned = Area A + C. Producer revenue decreases by Area B, but increases by a bigger Area C. This means that producer revenue rises when price of the good falls, *ceteris paribus*.

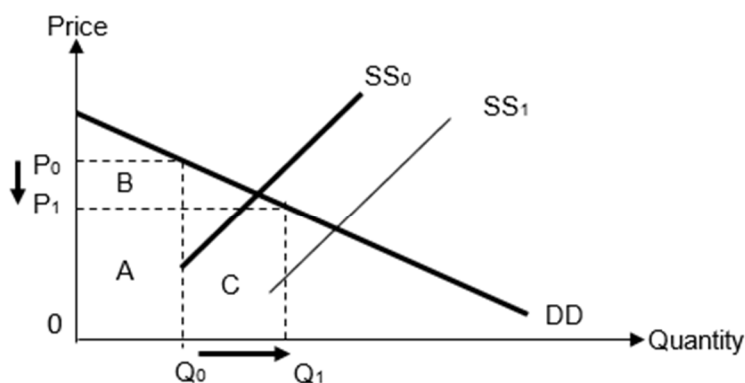


Figure 5 Effect of a fall in price on producer revenue when the demand is price elastic

Therefore, **when demand is price elastic, producer revenue will rise when the price of the good falls**. Conversely, when price rises, *ceteris paribus*, producer revenue of the good will fall.

Therefore, PED is useful for firms when making pricing decisions: whether to increase or decrease price of its good or service to increase producer revenue.

(iii) Government

Government expenditure is financed by the government revenue, which is largely composed of revenue from taxes. The amount of tax revenue that can be collected from indirect taxes on goods and services depends on the PED of the good or service taxed. The more price inelastic the demand of the good taxed, the larger the extent of price increase and the greater the tax revenue collected. The explanation for this will be covered in Topic 4: Government Intervention and the Labour Market.

Make informed policy choices and decisions

When the demand for a particular good is price inelastic, an increase or decrease in the supply of the good is likely to lead to a substantial fall or rise in the price of the good, leading to price volatility in the market. For example, agricultural prices tend to be volatile because supply changes from one time period to the next due to unpredictable weather conditions (which affect the size of the harvest). Given that the demand for agricultural products is price inelastic (the

key reasons are that agricultural products are necessities and the lack of available and close substitutes for them), changes in the supply of agricultural products will lead to sharp price fluctuations in the agricultural markets. Hence, governments often intervene in such markets to stabilise the price of agricultural products to safeguard the interest of both producers and consumers. Such measures to stabilise prices can involve price and quantity controls, which we will discuss in Topic 4: Government Intervention and the Labour Market.

When the demand for a particular good is price inelastic, an increase or decrease in the supply of the good via subsidies or indirect taxes is likely to lead to a limited fall or rise in the quantity of the good. This means that it would limit the effectiveness of the subsidy in encouraging consumption of the good. Conversely, it would limit the effectiveness of the tax in discouraging consumption of the good. The analysis will be discussed in Topic 5: Microeconomic Objectives and Policies.

3. Income Elasticity of Demand (YED)

3.1. Definition

Income elasticity of demand (YED) refers to the **degree of responsiveness of demand** for a good to **a given change in the income of consumers**, *ceteris paribus*.

3.2. Measurement and Formula

YED is calculated as the percentage change in quantity demanded of a good at the given price divided by the percentage change in consumers' incomes.

$$\begin{aligned}
 YED &= \frac{\% \Delta \text{Quantity demanded}}{\% \Delta \text{Income}} \\
 &= \frac{\frac{\Delta Qd}{Qd} \times 100\%}{\frac{\Delta Y}{Y} \times 100\%} \\
 &= \frac{\Delta Qd}{\Delta Y} \times \frac{Y}{Qd}
 \end{aligned}$$

Where

ΔQd = change in quantity demanded of the good at the given price

ΔY = change in income

Qd = original quantity demanded of the good at the given price

Y = original income



Connect, Extend, Challenge

While the definition of YED is about the degree of responsiveness of demand for a good to a given change in the income of consumers, *ceteris paribus*, why is “percentage change in quantity demanded” used in the calculation?

3.3. Interpretation of sign and coefficient of YED

Sign	Coefficient	Meaning	Example
YED > 0 Positive (Normal good)	$0 < YED < 1$ Necessity	Demand is income inelastic . Increase in income leads to a less than proportionate increase in demand, ceteris paribus, and vice versa. E.g., $YED = 0.1$ A 1% increase in income leads to a 0.1% increase in demand.	Rice Water
	$YED > 1$ Luxury good	Demand is income elastic . Increase in income leads to a more than proportionate increase in demand, ceteris paribus, and vice versa. E.g., $YED = 5$ A 1% increase in income leads to a 5% increase in demand.	Sports cars
Negative (Inferior good)	$YED < 0$ Inferior good	Demand is inversely related to income. When income rises, demand falls, vice versa. E.g., $YED = -0.3$ A 1% increase in income leads to a 0.3% decrease in demand.	House-brand household items (as compared to branded ones)

a. Positive YED (Normal goods)

When a good has a positive YED sign, it is considered as a **normal good**. A normal good is one where the demand for the good will increase when there is a rise in income. There are two sub-categories of normal goods:

i. Necessities: $0 < YED < 1$

When the change in demand is **positively related to** and **less than proportionate** to the change in income, the demand for these goods is income inelastic; such goods are known as **necessities**.

Necessities are goods like food, clothing and housing. When there is an increase in income, the demand of necessities such as rice will increase by less than proportionate to the increase in income.

ii. Luxury goods: $YED > 1$

When the change in demand is **positively related to** and **more than proportionate** to the change in income, the demand for these goods is income elastic; such goods are known as **luxury goods**.

When incomes are rising strongly and consumers are confident of the future, they usually go ahead with purchasing 'big-ticket' luxury items like branded watches and overseas holidays. Thus, the demand for luxury goods will rise more than proportionately when incomes rise.

Conversely in a recession or economic downturn, *ceteris paribus*, the demand for luxury goods will fall by more than proportionately relatively to the fall in income.

b. Negative YED (Inferior goods)

When a good has a negative YED sign, it is an **inferior good**. The change in demand is **inversely related** to the change in income, meaning the demand for inferior goods decreases as income increases and vice-versa. Unlike goods with positive YED, there is no further classification of goods with negative YED coefficient.

NOTE: *The use of the term 'inferior' is not an allusion to the quality of the good in this case. When a good is classified as an inferior good, it simply means that its demand falls when income increases (and rises when income decreases). If the demand for beer rises during an economic recession and falls when there is economic growth, beer can be classified as an inferior good.*

When incomes rise, consumers switch from consuming cheaper sources of meat (like minced meat) to premium cuts of fresh meat. This means that rising income levels will decrease demand for minced meat. Since the demand for minced meat is inversely related to income, it is considered an inferior good.



Connect, Extend, Challenge

Adapted from N2013 H2 Paper 1 Question 1

Last year's decline in UK real disposable incomes is the first since 1981, when it fell by 2.2%. A market research company said "there are now clear indications that value for money is driving retailer performance," with discount stores such as Aldi and Lidl showing increases in sales of their own-label products by 5% despite declining real disposable incomes.

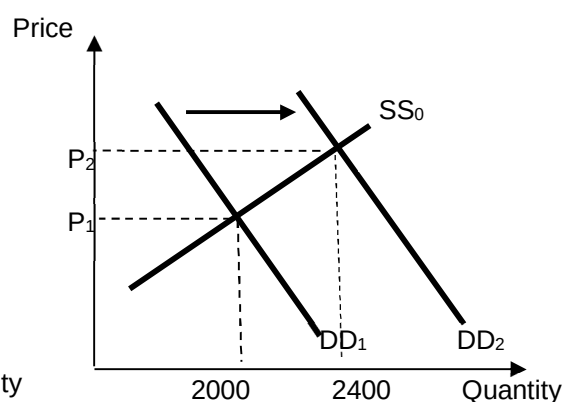
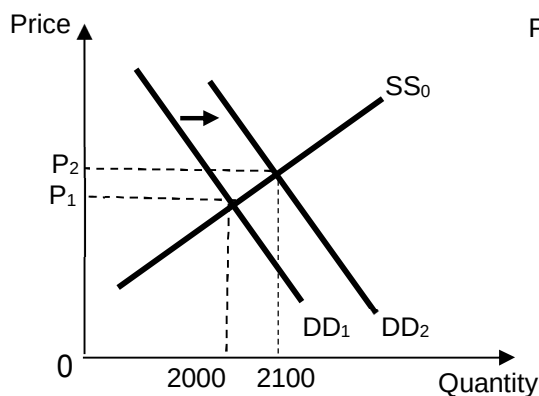
Source: Tom Bawden, guardian.co.uk, accessed 29 March 2011

What do the rising sales of own-label products from Aldi and Lidl, despite the fall in disposable incomes, suggest about the likely YED value and nature of the products sold by these two stores?

3.4. Graphical illustration of YED

3.4.1. Positive YED

Figures 6a and 6b represent the impact of an increase in income on normal goods with positive income elasticity. However, Figure 6a shows income inelastic in demand, while Figure 6b shows income elastic in demand. The key difference between both diagrams is the extent of the shift in demand.



3.4.2. Negative YED

Figure 7 below represents the impact of a rise in income on an inferior good. When income rises, the demand falls instead.

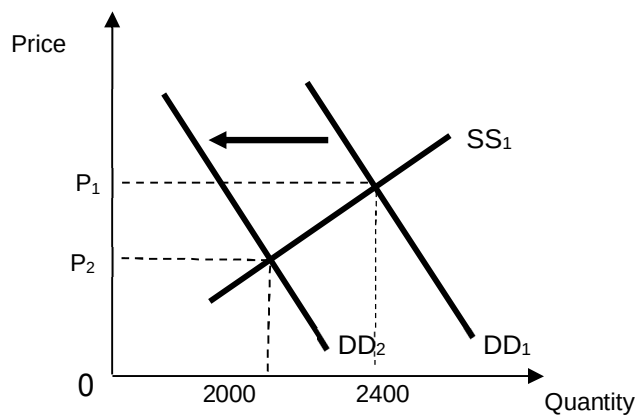


Figure 7: Inferior good

3.5. Determinants of YED

a. Degree of necessity

As consumers' income increases, the demand for basic necessities, such as rice, rises by less than proportionately. This is because there is a limit to how much rice consumers can consume. As such, the increase in demand for rice resulting from an increase in income is likely to be less than proportionate to the increase in income. Conversely, when there is an increase in consumers' income, the demand for luxury goods will increase more than proportionately. Luxury goods and services such as sports cars and holidays in Europe have a YED that is positive and large.

During a recession or economic downturn, the demand for luxury goods will fall by a larger proportion as compared to the necessities; this is because consumers are better able to do without the luxury goods compared to necessities. There is not much room to cut back on expenditure on necessities as consumption of these goods cannot be postponed or delayed.

b. Consumers' income levels/Country's stage of development

It is important to note that whether a good is determined to be a luxury good, necessity or inferior good depends on the level of income of consumers. What might be considered as a luxury good to low-income households might be considered as a necessity or inferior good to high-income households. For example, to a low-income household, a MacBook might be seen as a luxury good, while to a high-income household it can be perceived as a necessity.

In addition, what is perceived as a luxury good today might become an inferior good to the same person as his income rises. This is because as individuals' incomes rise, they would want to consume goods that they perceive to be of better quality. One fine example would be the demand for homes in Singapore. As Singapore's economy continues to prosper, the average income of most households has increased, hence increasing their demand for higher-end residential units like condominiums. The demand for high-end housing is said to

have positive YED, while the smaller public flats (1-room or 2-room HDB flats) are considered as inferior goods.

Empirical studies show that countries at different stages of economic development have widely different income elasticities for the same product. The key reason is because necessity in a developed country can be a luxury good in a developing country. For example, meat tends to have lower YED value in developed countries but can be expected to have higher YED value in developing countries. This is because in developed countries it is deemed as a necessity, while in developing countries are seen as a luxury good.



Connect, Extend, Challenge

Identify and explain a relevant determinant(s) contributing to the elasticity of the goods below:

Good	Value	Determinant	Explanation
Smartphones	Positive YED; Between 0 and 1		
Apple iPhone 15 Pro Max	Positive YED; Greater than 1		

3.6. Application of YED to analyse market outcomes and impact on economics agents

a. How YED affects equilibrium price and quantity

When demand changes in response to a change in income, the extent of the change in demand depends on YED. Thus, the extent of change in price and quantity also depends indirectly on YED.

For example, in the market for business class air travel, economic growth (higher income) will lead to an increase in demand. If business class air travel is a considered by consumers in a country to be a luxury good (YED positive and greater than 1), an increase in income will lead to a more than proportionate increase in its demand. This results in a larger rightward shift of the demand curve from DD_0 to DD_1 in Figure 8, thus causing a larger increase in both equilibrium price and quantity from P_0 and Q_0 to P_1 and Q_1 , ceteris paribus.

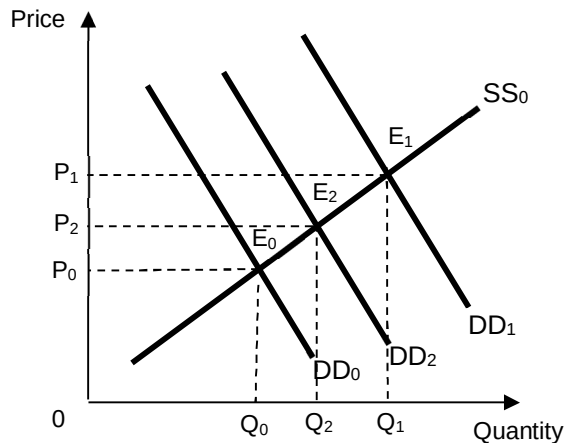


Figure 8: Extent of change in equilibrium price and quantity depending on YED
 (NOTE: Other than for purpose of comparison, one diagram should only be for one market)

However, if consumers in another country consume business class air travel for work or business purposes, then it is considered a necessity in that market (YED positive and between 0 and 1). Economic growth will lead to a less than proportionate increase in demand. This results in a smaller rightward shift of the demand curve from DD_0 to DD_2 in Figure 9, thus causing a smaller increase in both equilibrium price and quantity from P_0 to P_2 and Q_0 to Q_2 , ceteris paribus.

Therefore, an **increase in income** would lead to a **larger increase in price and output** if the good is a **luxury good**, while a **smaller increase in price and quantity** would result from the same increase in income if the good is a **necessity**.

b. How YED affects producer revenue/consumer expenditure?

Consider Figure 9, when the demand for the good is positively income elastic, an increase in income results in a larger rise in equilibrium price and quantity. This will lead to a larger increase in producer revenue from $OP_0E_0Q_0$ to $OP_1E_1Q_1$.

However, when the demand for the good is positively income inelastic, an increase in income results in a smaller rise in equilibrium price and quantity. This will lead to a smaller increase in producer revenue from $OP_0E_0Q_0$ to $OP_2E_2Q_2$.

Hence, the greater the value of the YED, the greater the impact on the producer revenue when income changes.

c. The implications for households, firms and government

(i) Households/Consumers

The knowledge of YED will allow consumers to predict the impact on prices when there is an expected income change. For example, if consumers expect a high year-end bonus for workers due to high economic growth, they will expect the demand for certain types of goods to increase more than others. For example, as private housing are luxury goods, an increase in bonus payments will lead to a more than proportionate increase in demand for private housing during the year end period. Future prices will be expected to increase significantly. The ability to predict the extent of changes in price will better inform consumers in their decision-making.

(ii) Firms/Producers

Output decision/strategy: What to produce

If households' incomes are rising or expected to increase, firms could step up and choose to produce luxury goods. This is because the demand for luxury goods will increase more than proportionately due to a rise in income. For example, with the increasing affluence of people residing in Singapore, Cathay Cineplexes and Golden Village Cinemas introduced Platinum movie suites and GV Gold Class theatres respectively – premium movie seating.

In the event where households' incomes are falling or are expected to fall, firms will cut down on the production of luxury goods and choose to increase their production of lower-end versions of goods (inferior goods) such as house-brands or no-frills brands, since demand for these will increase.

Consider the case of the launch of iPhone SE in the period where US was still in recession. Notably, iPhone SE had features that were of inferior quality compared to some of the previous iPhones that were launched. Apple's decision to launch iPhone SE could be seen as an appropriate decision, while the US was still in the state of recession.

Output decision: Locations and types of shops

The knowledge of YED is useful to producers in deciding the location and types of shops to open for expansion. If producers are able to segment the market, they can strategically locate themselves at high-income districts and will choose to carry goods with demand that is highly positive income elastic. For heartland areas, they would probably stock up more of goods with low and positive YED. By strategic market segmenting, firms are in better position to sell the right types of goods in order to increase their revenue. One example would be the different types of Crystal Jade restaurants across Singapore such as Crystal Jade Kitchen and Crystal Jade Prestige. Interestingly, Crystal Jade Kitchen can be commonly found in heartland shopping malls such as Tampines Mall and Causeway Point. In contrast, Crystal Jade Prestige is strategically located at Marina Bay Financial Centre. Notably, the way the restaurants are branded is influenced by the level of income in that area and the types of food they serve in the different types of restaurants are targeted at different income elasticity groups.

(iii) Government

The government aims to achieve both microeconomic objectives (efficiency and equity) and macroeconomic objectives (sustainable economic growth and low unemployment amongst others).

To achieve allocative efficiency in terms of resources

Allocative efficiency is about producing the amount of goods that society desires. This will be covered in greater depth in Topic 5: Microeconomic Objectives and Policies. For this context, the role of YED can guide government to build what society desires. When there is an increase in income, government can expect the demand for luxury goods (YED positive and greater than 1) to increase. For example, the demand for cars will increase more than proportionately to a rise in income, hence corresponding to a greater usage of roads. To manage the

potential congestion problems, government can review their urban policy planning by introducing more roads such as highways.

Another prime example would be the housing market in Singapore. In the late 90s and early 2000s when demand for more luxurious housing increased with rising national income, instead of building private landed houses that occupied a larger portion of land in land-constrained Singapore, the government introduced luxurious Design, Build and Sell Scheme (DBSS) and Executive Condominiums to meet Singaporeans' rising aspirations.

For luxury goods whose YED is positive and greater than 1, a rise in income would lead to a more than proportionate increase in the demand for luxury goods. With this in mind, when there is a reduction in income tax rate, the increase in disposable income will lead to a more than proportionate rise in demand for luxury goods and a less than proportionate rise in demand for necessities. Consequently, the extent of price increase for luxury goods will be larger than that for necessities. This may result in a situation where firms will allocate relatively more resources to the production of luxury goods compared to necessities. Thus, an unintended consequence could be a more unequal distribution of resources towards to production of luxury goods and lead to an inequitable outcome.

To set relevant policies to achieve economic growth

The knowledge of YED can be useful to governments in identifying potential industries for development to boost economic growth, which will be covered in greater depth in Macroeconomics.

If there is an increase in the income from rise in Gross Domestic Product (GDP)¹ for regional countries, their demand for goods and services such as healthcare, pharmaceuticals and tourism will increase. Singapore has been stepping up its efforts to strengthen its status as a medical tourism hub to attract affluent people residing in other parts of Southeast Asia to seek their treatment in Singapore.

¹ Gross Domestic Product is defined as the total market value of all final goods and services newly-produced within the geographical boundaries of an economy in a given period of time (usually a year).

4. Cross Elasticity of Demand (XED)

4.1. Definition

Cross elasticity of demand (XED) refers to the **degree of responsiveness of demand** for a good to **a given change in the price of a related good**, *ceteris paribus*.

It is sometimes referred to as cross price elasticity of demand as well since it relates to the change in price of a related good.

4.2. Measurement and Formula

XED is calculated as the percentage change in quantity of good demanded divided by the percentage change in the price of the related good.

$$\begin{aligned}
 XED_{AB} &= \frac{\% \Delta \text{Quantity demanded for Good A}}{\% \Delta \text{Price of Good B}} \\
 &= \frac{\frac{\Delta Qd_A}{Qd_A} \times 100\%}{\frac{\Delta P_B}{P_B} \times 100\%} \\
 &= \frac{\Delta Qd_A}{\Delta P_B} \times \frac{P_B}{Qd_A}
 \end{aligned}$$

Where

ΔQd_A = change in quantity demanded of the Good A at the given price

ΔP_B = change in price of Good B

Qd_A = original quantity demanded of Good A at the given price

P_B = original price of Good B

Computing XED

Price of Milo powder	Quantity of Milo powder demanded	Price of chocolate powder	Quantity of chocolate powder demanded
\$10 per tin	4 tins per month	\$10 per tin	2 tins per month
\$13 per tin	3 tins per month	\$10 per tin	3 tins per month

To calculate the XED for chocolate powder with respect to an increase in price of Milo powder, the formula can be applied.

$$\begin{aligned}
 XED_{CM} &= \frac{\% \Delta \text{Quantity demanded for chocolate powder}}{\% \Delta \text{Price of Milo powder}} \\
 &= \frac{\frac{1}{2} \times 100\%}{\frac{3}{10} \times 100\%} \\
 &= \frac{50\%}{30\%} \\
 &= 1.67
 \end{aligned}$$

4.3. Interpretation of sign and coefficient of XED

a. Positive XED (Substitutes)

A positive XED for two goods means that both are substitutes to each other. An increase in the price of one good leads to an increase in demand for the other good, ceteris paribus. Since both goods satisfy the same wants and needs of the consumers, an increase in the price of one good causes consumers to switch to purchase the cheaper substitute. For example, cold weather negatively affects tea yield, thus reducing the supply of tea. The decrease in the supply of tea results in an increase in the price of tea, ceteris paribus. Since coffee and tea are substitutes that satisfy the same want for a caffeinated beverage, the increase in the price of tea causes consumers to **switch away** from consuming tea (fall in quantity demanded for tea) and **substitute** to drinking more coffee (more willingness and ability to consume coffee as it is now relatively cheaper). As a result, the demand for coffee will increase.

If the coefficient of XED for the two goods is greater than one ($XED > 1$), this suggests both goods are **close substitutes**. The larger the coefficient, the greater the substitutability. If the value of XED is positive but less than one ($0 < XED < 1$), then the two goods are **weak substitutes**.

In the News

In a study done in a city in the U.S, it was found that the XED between Pepsi with Coke is 0.8. The value suggest that Pepsi and Coke are weak substitutes.

b. Negative XED (Complements)

If the sign of XED between two goods is negative, an increase in price of one good leads to a decrease in demand for the other good, ceteris paribus. This means that the two goods are complements to each other. When there is an increase in the price of one good, its quantity demanded decreases due to the law of demand. Since complements must be jointly consumed to derive satisfaction, the lower quantity demanded of one good will cause the demand for its complement good to fall. For example, Nintendo Switch Console and Switch Games are complements because Switch Games would depend on Nintendo Switch Console to run the game. If there is an increase in the price of Nintendo Switch Console due to a fall in its supply, the quantity demanded of Nintendo

Switch will fall, *ceteris paribus*. As a result, the demand for Switch Games will fall.

If the XED is negative and its absolute value is less than one ($|XED| < 1$), the two goods are **weak complements**. However, if the absolute value is more than one ($|XED| > 1$), then the two goods are **strong complements**. The larger the coefficient, the greater the strength of complementarity.

c. Zero XED ($XED=0$: unrelated goods)

When the XED is 0, both goods are unrelated.

Sign	Meaning	Coefficient	Interpretation of Value
$XED > 0$ Positive Substitutes	If price of good B rises , quantity demanded of good B falls, and there will be increase in demand for good A . <i>Example: Butter and Margarine</i>	$0 < XED_{AB} < 1$ Weak substitutes	e.g., $XED_{AB} = 0.3$ A 1% increase in price of margarine results in a 0.3% rise in demand for butter
		$XED_{AB} > 1$ Close/Strong substitutes	e.g., $XED_{AB} = 2.1$ A 1% increase in price of margarine results in a 2.1% rise in the demand for butter.
$XED < 0$ Negative Complements	If price of good B rises , quantity demanded of good B falls, and there will be fall in demand for good A . <i>Example: Bread and butter</i>	$0 < XED_{AB} < 1$ Weak complements	e.g., $XED_{AB} = -0.4$ A 1% increase in price of butter results in a 0.4% fall in demand for bread
		$XED_{AB} > 1$ Close/Strong complements	e.g., $XED_{AB} = -3$ A 1% increase in price of butter results in a 3% fall in demand for bread
Zero Independent	If price of good B rises , quantity demanded of Good B falls, but the demand for good A will remain unchanged . <i>Example: Bread and mobile phone</i>		



Connect, Extend, Challenge

Identify and explain a relevant determinant contributing to the elasticity of the good below:

Good	Value	Determinant	Explanation
Laptops and laptop cases	Negative XED; Greater than 1		

4.4. Application of XED to analyse market outcomes and impact on economic agents

a. How XED affects equilibrium price and quantity

When demand for a good A change due to a change in price of its related good (Good B), the extent of change in demand for good A depends on the XED. Thus, the extent of change in price and quantity of good A also depends on XED.

For example, in the market for tablets, new technological breakthroughs that allow firms to lower their costs of production led to an increase in supply of tablets. This results in a rightward shift of supply curve from SS_0 to SS_1 in Figure 9a, thus causing a decrease in equilibrium price of tablets from P_0 to P_1 , ceteris paribus.

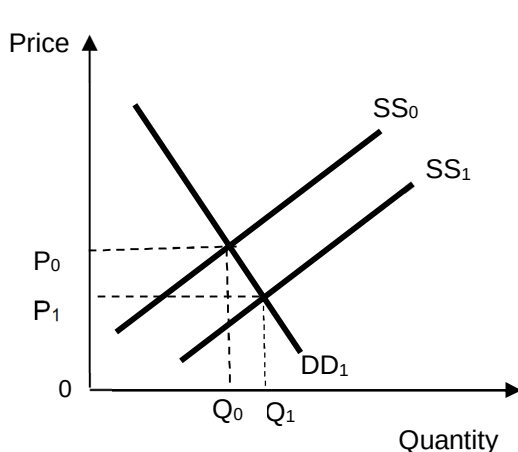


Figure 9a: Market for tablet PCs

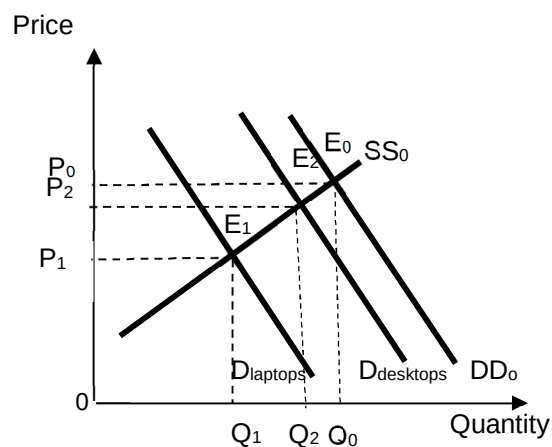


Figure 9b: Extent of change in equilibrium price and quantity depending on XED

Since tablets act as close substitutes to laptops (XED positive and greater than 1), a decrease in price of tablets will lead to a more than proportionate fall in demand for laptops from DD_0 to $DD_{laptops}$ in Figure 9b, thus causing a large

decrease in equilibrium price and output of laptops from P_0 to P_1 and Q_0 to Q_1 , ceteris paribus.

However, a decrease in price of tablets will only lead to a less than proportionate fall in demand for desktop computers because tablets and desktop computers are weak substitutes (XED positive and between 0 and 1). This results in a smaller leftward shift of the demand curve from DD_0 to DD_{desktops} in Figure 9b, thus causing a smaller decrease in equilibrium price and quantity of desktop computers from P_0 and Q_0 to P_2 and Q_2 , ceteris paribus.

Therefore, a change in the price of a close substitute would lead to larger changes in price and output but will only lead to smaller changes in price and quantity if the goods are weak substitutes.

b. How XED affects producer revenue/consumer expenditure

Consider Figure 10b, when the demand for the good is positively cross price elastic relative to its substitute ($XED > 1$), a decrease in price of its substitute results in a larger fall in equilibrium price and quantity. This will lead to a larger decrease in producer revenue from $OP_0E_0Q_0$ to $OP_1E_1Q_1$.

However, when the demand for the good is positively cross price inelastic relative to its substitute ($0 < XED < 1$), a decrease in price of the substitute results in a smaller fall in equilibrium price and quantity. This will lead to a smaller decrease in producer revenue from $OP_0E_0Q_0$ to $OP_2E_2Q_2$. This revenue area is larger than the revenue area ($OP_1E_1Q_1$).

Hence, the impact of a change in the price of a substitute on the producer revenue in the market for the good will be large if the two goods are close substitutes. If they are weak substitutes, a change in the price of substitutes will have a smaller effect on the producer revenue in the market for the good.

c. The implications of XED for households, firms and government

(i) Households/Consumers

Knowledge of XED will allow consumers to predict the impact on prices when there is an expected change in the price of related goods. For example, Xbox and PlayStation consoles are seen as close substitutes (XED positive and greater than 1). If the price of Xbox consoles is expected to fall in the future, consumers will expect that demand for PlayStation consoles will fall more than proportionately in the future. That is, future prices of PlayStation consoles will be expected to fall significantly. This helps to inform consumers' decision-making.

Similarly, consumers can predict the extent to which the price of a good changes when the price of its complement changes. For instance, electric cars and electric charging stations since they are jointly consumed when a driver uses an electric car and needs to charge the electric car daily. Since they are close complements (XED negative and greater than 1), a fall in price of electric cars will lead to a more than proportionate rise in demand for electric charging stations. Consumers thus expect the price of charging their electric cars at the electric charging stations to rise significantly and make decisions with this information in mind.

(ii) Firms/Producers

Non-pricing strategies (*More will be covered in Theme 3 on Firms & Decisions*):

- **Output decision: Increase or decrease in production**

By knowing the value of the XED, it enables producer to know the nature and closeness of the relationship between his goods and that of his rivals. Hence, producers are able to consider the effect on the demand for their good as a result of a change in the price of rival's good, enabling them to have "rival consciousness".

For example, if the XED_{AB} is positive and greater than 1 i.e., close substitute, an increase in price of good B would result to an increase in the demand for good A. Hence, the knowledge of the value of XED will signal to the producer to step up production of good A.

In the same way, if the XED_{CD} value is negative and has an absolute value greater than 1, the goods are strong complements. An increase in price of the related good (good D), will lead to a more than proportionate fall in demand of the good (good C). Hence, producer of good C must be prepared to scale down the production of good C.

- **Product differentiation**

If the XED between two goods, A and B, is positive, they are substitutes. If the price of good A falls, the demand for good B will fall. Therefore, in response to a fall in price of a substitute, producers may try to differentiate their products from their rival firms to lower the XED value and reduce the extent to which demand for their products fall. This can be done through imagined and real product differentiation.

- **Bundling (Joint promotion)**

For goods that are complements, firms can consider joint promotion with other firms that sell complementary goods. This is commonly seen in the bundling of mobile phones and mobile phone plans that different telcos offer. They will tend to sell the mobile phone at a relatively cheaper price, and the catch is consumers will have to purchase the mobile phone plans.

Pricing strategies (*More will be covered in Theme 3 on Firms & Decisions*):

- **Match price-cut**

If the XED value is positive and larger than 1, this signals to the producers that the goods are strong substitutes with the rivals. Hence, if the rival firms choose to reduce their price of the good, then the firm will embark on a similar strategy.

Failure to follow could mean that the demand for its good will decrease, leading to a reduction in revenue and hence profits for the firm.

(iii) Government

Informed policy decisions and choice (*You will learn more of this under the Theme 3.3: Globalisation and the International Economy*):

Knowledge of XED helps a government in her policy-making decisions, especially in international trade.

For example, the government will wish to know how a change in prices of imports will affect the demand for domestically produced goods and vice versa. If the XED for domestically produced goods with respect to the prices of imports is positive and large, this means that the two goods are close substitutes. The imposition of a tariff increases the price of imports, and this will result in a more than proportionate increase in demand for domestically produced goods, *ceteris paribus*. This is particularly important from the country's unemployment perspective.

For example, in its heyday, Proton commanded a more than 70 per cent share of the domestic passenger vehicle market in Malaysia, thanks largely to protectionist measures in the form of tariff and non-tariff barriers which made imported cars less price competitive. Hence the use of tariffs on imports might be effective in improving the country's net exports as import expenditure falls. This improves the country's balance of trade position. In addition, the increase in domestically produced substitutes to meet local demand also provides more jobs in the country, thereby raising the level of employment and incomes in the country.

5. Price Elasticity of Supply (PES)

5.1. Definition

Price elasticity of supply refers to the **degree of responsiveness of quantity supplied** of a good to **a given change in the price of the good itself**, *ceteris paribus*.

5.2 Measurement and Formula

Mathematically, the PES is a numerical value calculated as the percentage change in quantity supplied of a good divided by the percentage change in its own price.

$$\begin{aligned}
 PES &= \frac{\% \Delta \text{Quantity supplied}}{\% \Delta \text{Price}} \\
 &= \frac{\frac{\Delta Q_s}{Q_s} \times 100\%}{\frac{\Delta P}{P} \times 100\%} \\
 &= \frac{\Delta Q_s}{P} \times \frac{P}{Q_s}
 \end{aligned}$$

Where

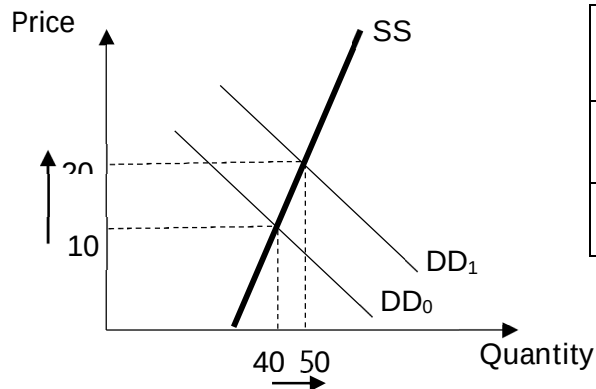
ΔQ_s = change in quantity supplied of the good

ΔP = change in price of the good

Q_s = original quantity supplied of the good

P = original price of the good

Computing the PES for Good X



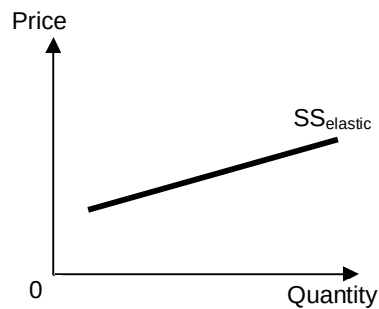
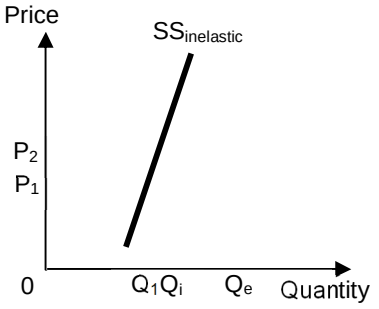
% change in price due to the rise in demand	100%
% change in quantity supplied as a result	25%
PES	0.25

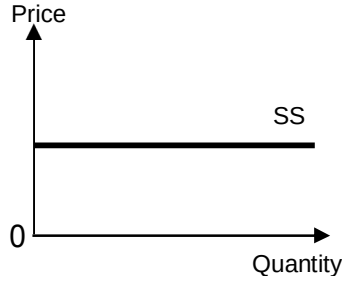
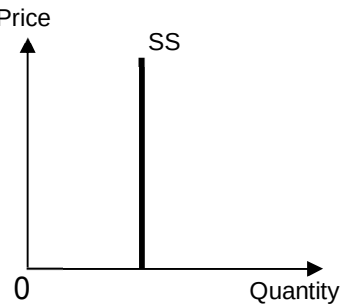
Figure 10: Price inelastic supply

The PES coefficient 0.25 means that a 1% increase in price will lead to a 0.25% increase in the quantity supplied.

5.3 Interpretation of sign and coefficient of PES

The PES is always positive because of the law of supply. If the price of the good were to increase, the quantity supplied will increase and vice versa.

Coefficient	Meaning	Graphical Representation
$PES > 1$ Supply is price elastic	A given % change in price brings about a <u>more than proportionate</u> change in quantity supplied. e.g., $PES = 3$ A 1% rise in price will lead to 3% rise in quantity supplied. The change in quantity supplied is more than proportionate to the change in price. <i>Example: Canned food</i>	 NOTE: Supply that is price elastic has a relatively gently line which must cut the Y-axis.
$0 < PES < 1$ Supply is price inelastic	A given % change in price brings about a <u>less than proportionate</u> change in quantity supplied. e.g., $PES = 0.3$ A 10% rise in price will lead to a 0.3% rise in quantity supplied. The change in quantity supplied	

Coefficient	Meaning	Graphical Representation
	is less than proportionate to the change in price. <i>Example: Agriculture goods</i>	NOTE: We represent the price inelastic supply with a relatively steeper line which must cut the X-axis.
PES = ∞ Supply is perfectly price elastic	Producers are willing to sell at whatever quantity they want at the given price.	
PES = 0 Supply is perfectly price inelastic	A fixed quantity that the producer must sell regardless of the price e.g., concert performance in a fixed capacity venue	

5.4 Determinants of PES

M – Mobility of FOPs
I – Inventory level
N – Nature of the good
T – Time period
S – Spare capacity

a. Time period for producer to adjust production

In Economics, the idea of time period to a firm is not denoted by the length of time, rather it is about the availability of fixed FOPs that the firm is faced with.

i. Very short run

The very short run is when all FOPs are fixed in supply, hence even if the price of the good was to increase, the producers would not be able to increase the quantity supplied. Therefore, in the very short run, the supply would be perfectly price inelastic.

Consider the case of a fisherman's supply of fresh fish in the market in the morning. Even if the price of fish increase because of an increase in demand, the fisherman is not able to respond to the change in price by increasing the quantity of fishes because he only has the fixed quantity of fishes caught in the morning.

ii. Short run

The short run is a period where production is restricted by at least one fixed FOP. A fixed factor is where the input is not able to increase in supply within a given time period. Hence, if there is an increase in price for the final good, the production can still continue but it is done through the variable factor. By doing so, the supply is relatively price inelastic.

In the case of the fisherman, he may hire more labour (variable factor) to use his existing sea boat (fixed factor) to catch more fishes when the price of fish increase. This can be represented by the relatively steeper supply curve. Supply is relatively price inelastic because it is constrained by the fixed factor. Therefore, a rise in price will result in a less than proportionate increase in its quantity supplied.

iii. Long run

The long run is a time period where all FOPs are variable. Hence, an increase in price will allow producers to increase their quantity by more than proportionate. This is because they are able to use the FOPs efficiently to produce the quantity of the good corresponding to the price.

For the fisherman, in the long run all his FOPs are variable. The fisherman can employ more labour and increase the number of boats.

Therefore, in the long run the quantity supplied is more responsive to a price change because it is possible to vary all FOPs. Hence, supply is relatively price elastic.

b. Level of stocks or inventories

If the level of stocks of finished products are high, a producer is able to easily respond to rise in price by releasing those stocks into the market for sale. However, the ability of a producer to be able to keep the stocks is dependent on the ease of keeping the stocks.

For example, if the goods are highly perishable such as vegetables, then it not feasible to keep a larger amount of stocks. As compared to processed products such as canned food that has a longer shelf-life, it can be easily stored. Hence if the firm is able to have a large volume of stocks, it will be more responsive to a given change in price.

c. Availability of spare capacity

If the firm has plenty of spare capacity in terms of factors of production, such as dormant or underutilised machinery, an increase in price the firm will be able to respond readily by utilising the idle machinery to increase quantity. Therefore, the supply of the good will be price elastic i.e., high ability to increase quantity supplied when price rises due to a rise in demand.

d. Factor mobility (Mobility of FOPs)

Factor mobility refers to the extent to which FOPs are able to move from the production of one good to the production of another good. The lower the factor mobility, supply of the good is price inelastic. Examples include the price inelastic

supply of neurosurgeons (due to their specialised training involved). If there is a sudden increase in the demand for brain surgeries, the price of brain surgeries will experience a sharp rise with only a small rise in quantity supplied. Conversely, the higher the factor mobility, the greater the PES value.

e. Nature of the good

The supply of primary and agriculture goods is relatively price inelastic as compared to the supply of manufactured goods. This is because agriculture goods have a longer gestation period. Similarly, primary goods like coal and natural gas require heavy capital investment, and they would take a substantial period of time to be produced. Hence, even if price of the good was to increase, the firm will not be as responsive in increasing the quantity supplied. As compared to manufactured goods that can be produced over a shorter span of time, firms can easily step up the production when there is an increase in price.

Generally, the shorter the production/gestation period, the more price elastic the supply will be. This is because producers are able to adjust their production as a response to the increase in price. On the other hand, goods with longer production period tend to have relatively more price inelastic supply.



Connect, Extend, Challenge

Identify and explain a relevant determinant contributing to the elasticity of the good below:

Good	Value	Determinant	Explanation
Grapes	PES Between 0 and 1		

5.5 Application of PES to analyse market outcomes and impact on economic agents

a. The effects of changes in demand on equilibrium price and quantity

Shift in demand with different PES values

When demand for alcoholic beverages falls, a surplus is created, putting downward pressure on the price to fall. Alcoholic beverages have a price elastic supply since they can be easily stored and stocked up. With reference to Figure 12, the price elastic supply for alcoholic beverages is represented by SS_e . When demand falls from DD_0 to DD_1 , price falls from P_0 to P_e . Quantity falls more than proportionately from Q_0 to Q_e .

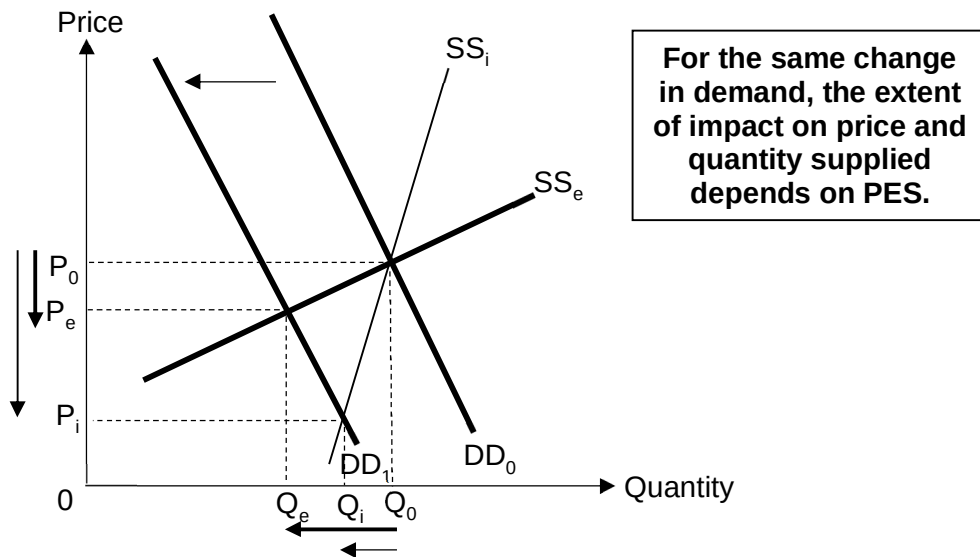


Figure 11: Using PES to analyse the impact of a fall in demand

If the supply of alcoholic beverages were to be more price inelastic, the supply curve would be represented by SS_i in Figure 11. The fall in price from P_0 to P_i would lead to a less than proportionate fall in quantity from Q_0 to Q_i . Therefore, when supply is price elastic, a fall in demand would have a **smaller impact on price** and a **larger impact on quantity** as compared to the case if supply is relatively more price inelastic.

NOTE: The concept of **PES** is **not relevant** in analysing the impact on **producer revenue/consumer expenditure**.



Connect, Extend, Challenge

Why is the concept of PES **not** relevant in analysing the impact on producer revenue/consumer expenditure?

b. Implications of PES for households, firms and government

(i) Households/Consumers

Knowledge of PES will allow consumers to predict the impact on prices when there is an expected change in the demand. For example, the future demand for air purifier is expected to increase if the haze situation is expected to worsen. In the short run, the supply of air purifier is likely to be price inelastic and the increase in demand will lead to a more than proportionate increase in prices. Consumers will expect a large rise in prices in the short-run, and this helps guide them in their decision-making.

(i) Firms/Producers

The knowledge of PES can help producers to plan when to increase production. As explained earlier, the nature of the good will determine the PES value. For example, if producers know that the demand for primary product such as mandarin oranges will increase during Chinese New Year period, they will choose to allocate more resources to the production of mandarin oranges during that period. This allows producers to increase production when there is an increase in price during the season.

(ii) Government

Informed policy decisions to achieve equity

By knowing the value of the PES, it can inform government on various policy decisions they have to make.

- For example, the supply of public housing is relatively price inelastic. If there is an increase in demand, this would lead to a surge in the prices. If the government was not aware of this, then there could potentially be worsen inequity, especially for groups like low-income households. Hence, knowledge of PES will influence government to implement policies that ensure affordability of basic housing.
- As another example, the supply of imported food and raw materials can be price inelastic. To reduce volatility in prices, in particular sharp increases in prices when demand rises, the government has sought to expand national stockpiles of essentials such as food. This would prevent hoarding and panic buying, which can drive up prices and lead to inequity as the lower income groups lack access to necessities.

6. Limitations of Elasticities Concepts

While the various elasticities are useful in analysing how a factor (price/income/price of related good) affect a dependent variable (quantity of the good/demand for the good/quantity demanded of related good/quantity supplied of the good), there are some limitations. This section will consider some of the limitations that might limit its usefulness.

a. *Ceteris paribus* assumption is not realistic

Ceteris paribus assumption states other variables that could possibly affect the outcome remains constant. This assumption is unrealistic because in the real world, there could be a confluence of factors that influence the final outcome.

Likewise the only variable in YED that is allowed to change is income. This does not consider the other demand and supply factors that could be changing concurrently. Moreover, an increase in demand could be due to a variety of factors such as taste and preference, population size and income, instead of solely because of a change in income.

In addition, in our analysis of elasticity of demand, we completely ignore the supply side of the market. Firms should consider the PES because the assumption that firms can step up production easily is unrealistic, an increase in demand does not necessary translate to an increase in revenue because

producers are not able to match up to the increased demand i.e., bottleneck constraints.

b. Constant cost assumption is not realistic

The application of pricing strategies to maximise economic profit assumes constant cost. However, in the real world, total cost is often subjected to changes. If the demand for a good is price elastic, firms should lower price and increase the quantity of the good in the market. While this increases the revenue, we assumed the cost of producing the increased quantity to be constant which is not realistic since additional production incurs cost.

c. Imperfect knowledge

In our analysis, we assumed that economic agents have perfect information about of the various elasticity values. However, in the real world, information is often imperfect and may not be reliable. This is mainly because it is difficult and challenging to collect the information from all consumers.

Even if firms can collect information, there is no certainty consumers will not understate their willingness to pay for a product. On top of that, the sample size of consumers surveyed may be too small to reflect the actual elasticity value that is representative of the whole population.

d. Time lag

Even if producers or the government can collect the information, there might be a time-lag between the collation of the data and the actual implementation of the appropriate production level. By the time the measures are implemented, there is a possibility that the elasticity values might have changed, rendering the intended measures to be ineffective.

Through this set of lecture notes, you have uncovered the following **Enduring Understanding**:

1. Knowledge of elasticities concepts and their applications will help producers make informed decisions so that they maximise profits.
2. Elasticities concepts are also important to government for policy formation, to achieve both efficiency and equity.
3. There are limitations to the use of the elasticities concepts.

Summary on the Use of Elasticity Concepts

To determine	ΔSS	ΔDD			ΔP
		ΔY	ΔP of related good	Δ other DD-related factors	
Direction of ΔP and ΔQ	Don't need PED (use Law of DD instead)	Depends on YED value For a $\uparrow Y$, - If $YED < 0$, $\downarrow P$ and $\downarrow Q$ - If $YED > 0$, $\uparrow P$ and $\uparrow Q$	Depends on XED value For a $\uparrow P$ of related good B, - If $XED_{AB} > 0$, $\uparrow P_A$ and $\uparrow Q_A$ - If $XED_{AB} < 0$, $\downarrow P_A$ and $\downarrow Q_A$	Don't need any elasticity concept - If $\uparrow DD$, $\uparrow P$ and $\uparrow Q$ - If $\downarrow DD$, $\downarrow P$ and $\downarrow Q$	Don't need PED (use Law of DD instead)
*Extent of ΔP and ΔQ	Depends on PED value For a $\downarrow SS$, - If PED between 0 and 1, $\uparrow P > \downarrow Q_d$ - If PED > 1, $\uparrow P < \downarrow Q_d$	Depends on YED For a $\uparrow Y$, - If YED between 0 and 1, $\uparrow P$ and $\uparrow Q$. $\uparrow Q < \uparrow Y$ - If YED > 1, $\uparrow P$ and $\uparrow Q$. $\uparrow Q > \uparrow Y$	Depends on XED value - whether $ XED > 1$ or < 1	Depends on PES value For a $\uparrow DD$, - If PES > 1, $\uparrow P < \uparrow Q$ - If PES between 0 and 1, $\uparrow P > \uparrow Q$	Extent of ΔQ depends on PED value, in response to a ΔP For a $\uparrow P$, - If PED > 1, $\uparrow P < \downarrow Q$. - If PED between 0 and 1, $\uparrow P > \downarrow Q$.
Direction of ΔTR	Depends on PED value For a $\downarrow SS$, - If PED between 0 and 1, $\uparrow TR$ - If PED > 1, $\downarrow TR$	Depends on YED value For a $\uparrow Y$, - If YED > 0, $\uparrow TR$ - If YED < 0, $\downarrow TR$	Depends on XED value For a $\uparrow P$ of related good B, - If $XED_{AB} > 0$, $\uparrow TR_A$ - If $XED_{AB} < 0$, $\downarrow TR_A$	Don't need any elasticity concept - If $\uparrow DD$, $\uparrow P$ and $\uparrow Q$. Hence $\uparrow TR$. - If $\downarrow DD$, $\downarrow P$ and $\downarrow Q$. Hence $\downarrow TR$.	Depends on PED value For a $\uparrow P$, - If PED > 1, $\uparrow P < \downarrow Q$. Hence $\downarrow TR$. - If PED between 0 and 1, $\uparrow P > \downarrow Q$. Hence $\uparrow TR$.

***NOTE:** When comparing the extent of changes, remember that we are referring to the $\% \Delta$. The $\%$ sign is not included in the above table to avoid cluttering it excessively.

Annex

Along the demand curve, the value of price elasticity of demand is not similar and varies along the line.

- In Figure 14, the magnitude of PED decreases as we move down from left to right along the downward sloping linear demand curve.
- Above the midpoint, PED is greater than 1 (price elastic). Any fall in price within this range will cause quantity demanded to increase more than proportionately.
- PED is exactly equal to 1 (unitary price elastic) at the midpoint.
- Below the midpoint, PED is smaller than 1 (price inelastic). Any fall in price within this range will result in a less than proportionate increase in quantity demanded.

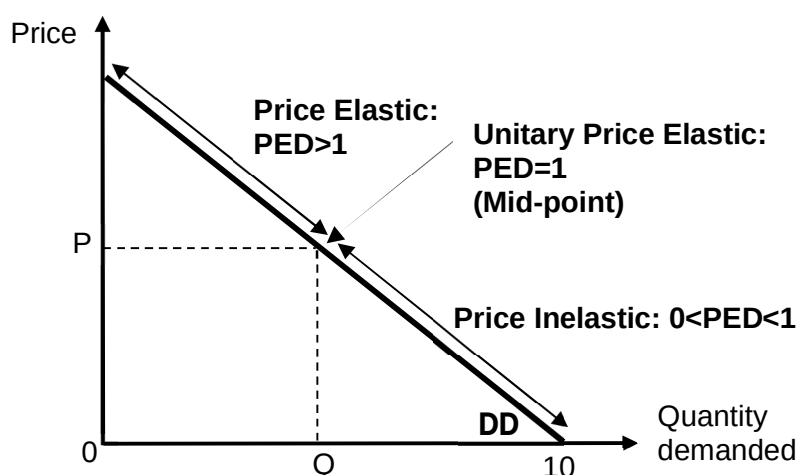


Figure 14: Price elasticity along a Linear Demand Curve



Connect, Extend, Challenge

World Food Expenditure to Rise as China Faces Tough Harvest

China is set for a difficult harvest season as a severe energy crunch hurts the outlook for booming production, a development that risks triggering a renewed surge in world agriculture and food prices.

How do you illustrate the above phenomenon on the market for food? Which portion of the demand curve should your supply curve be on to illustrate a rise in consumer expenditure?