UNIVERSITY OF ZAMBIA
DEPARTMENT OF MINING ENGINEERING

COURSE OUTLINE FOR MINERAL ECONOMICS AND MANAGEMENT (MIN 5099)

Dr. Stephens M Kambani (PhD; M.Eng, B.Min.Sc)

Email: skambani@unza.zm
Phone: 0977273204

MIN 5099

TOPIC 1 COURSE DETAILS

COURSE RATIONALE

The course is designed to equip learners with an understanding in two key areas namely:

- **The application of economic theories in the mineral industry and**
- **Introduces learners to elements in management functions**.

COURSE LEARNING OUTCOMES

At the end of the course, students are expected to understand:

- The role of minerals in economic development: issues of mining and sustainable development
- How mineral markets function: factors affecting the supply and demand of mineral resources
- Structural makeup of Mineral policies and their impact on mineral resource development
- Basic principles of management functions
- Project management and monitoring
- Industrial relations and conflict management.
- Mining and climate change

METHODS OF TEACHING

Lectures – 2hrs/week

COURSE ASSESSMENT

Assignments: 10%

Tests: 20%

Final Examination: 70%

PRESCRIBED TEXTBOOKS:

1. Melanie Franklin (2017), “Agile Change Management: A Practical Framework for Successful Change Planning and Implementation”. ISBN-13: 978-0749470982, ISBN-10: 0749470984.

2. Stephen Baker (2017), “Brilliant Project Management”, ISBN-13: 978-1292083230, ISBN-10: 1292083239.

3. Massie, J.L (1964), “Essentials of Management”, Publisher: Prentice Hall (1964), **SIN:** B007QBG7F8.

4. P. J. Smit, G. J. Cronje, T. Brevis, M. J. VrbaJuta, (2011), “Management Principles: A Contemporary Edition for Africa”. Publisher Juta Limited. ISBN 0702172812, 9780702172816.

TOPIC 2

BASIC ECONOMIC CONCEPTS

What is Economics?

SOME DEFINITIONS

- *Economics asks what goods are produced, how these goods are produced, and for whom they are produced.*

- *Economics analyses movements in the overall economy – trends in prices, output, unemployment, and foreign trade. Once such trends are understood, economics helps develop the policies by which governments can improve the performance of the economy*

- *Economics is the study of commerce among nations. It helps explain why nations export some goods and import others, and analyses the effects of putting economic barriers at national frontiers.*

SOME DEFINITIONS

- *Economics is the science of choice. It studies how people choose to use scarce or limited productive resources (labour, equipment, technical knowledge), to produce various commodities (such as mineral resources, missiles, and concerts).*

- *Economics is the study of money, banking, capital, and wealth.*

- ***In a nutshell, "economics is the study of how societies use scarce Resources to produce valuable commodities and distribute them among different people".***

BRANCHES OF ECONOMICS

Economics normally studied under two branches:

- ***MACROECONOMICS***
- ***MICROECONOMICS***

INTRODUCTION

Mineral Economics defined

- ***Mineral Economics*** **is the academic discipline that investigates and promotes understanding of Economic and policy issues associated with the production and use of mineral commodities.**

- **It focusses on improving the understanding of economic, social, environmental and political implications of natural resources.**

INTRODUCTION

- Mineral economics is the academic discipline that investigates and promotes understanding of economic and policy issues associated with the production and use of mineral commodities. While its origins can be traced back at least 200 years to the writings of David Ricardo and other early Classical economists, it emerged as a separate academic field only after World War II and then primarily in the United States. As a separate academic discipline, its roots are found in mining schools that needed to consider the milieu in which minerals are sold.
- Mineral economics is the academic discipline that examines the economic and policy issues associated with the discovery, extraction, processing, use, recycling, and disposal of mineral commodities. As Robinson (1989) shows, its roots can be traced back to the early development of economics as a formal discipline. Chapter III of Ricardo's *Principles* is “On the Rent of Mines.” Malthus's fears about resources are a still-recalled preliminary to the resource pessimism of subsequent years

What is Macroeconomics?

- *Studies the functioning of the economy as a whole – examining the economy through a wide-angle lens.*

- *Macroeconomics examines how the level of growth of output are determined, analyses inflation and unemployment, asks about the total money supply and investigates why some nations thrive while others stagnate.*

Macroeconomics

To evaluate the success of an economy's overall performance, economists look at four areas:

- Output measured by the Gross Domestic Product (GDP)
- Employment (level of unemployment)
- Price stability
- International trade

GOALS AND INSTRUMENTS OF MACROECONOMIC POLICY

Objectives **(Major goals of macroeconomic policies – wish list)**	**Instruments** **(Tools available to accomplish the wish list)**
Output (as measured by the GDP): High level of output Rapid growth rate of output	Fiscal policy: Government expenditure Taxation
Employment: High level of employment Low involuntary unemployment	Monetary policy: Control of money supply affecting interest rates
Price level stability with free markets _____	Foreign economics: Trade policies Exchange-rate Intervention
International trade: Export and import equilibrium (preferably the existence of trade surplus) Exchange-rate stability (not too strong or too weak)	Income policies: From voluntary guidelines to mandatory controls

What is Gross Domestic Product (GDP)?

Definition: GDP is the final value of the goods and services produced within the geographic boundaries of a country during a specified period of time, normally a year. GDP growth rate is an important indicator of the economic performance of a country.

What is GDP per capita? – It is a metric that breaks down a country's economic output per person and is calculated by dividing the GDP of a country by its population (GDP/population size).

What is Fiscal Policy?

- These are measures governments employ to stabilize the economy. They do so by manipulating tax levels and government expenditure usually in conjunction with the monetary policy.

- **Simply put:** High taxes results may stifle businesses and affect employment and output (GDP). On the other hand, **low taxes** may cripple government expenditure on critical sectors such as health, education, etc.

What are the Main Objectives of Fiscal Policy?

- Boosting employment levels.
- Maintain or stabilize the economy's growth rate.
- Maintain or stabilize the price levels.
- Encourage economic development. Raising the standard of living.
- Maintaining equilibrium in Balance of Payments.

What is Monetary Policy?

- The policy regulates the amount of money in circulation. Too much money fuels inflation and too little increases the cost of money and hence ability to invest (result in low employment, low GDP, low government revenues).

What happens at Macro-economic Level?

At macro level, government sets sectoral policies (in this case the national mineral policy) which may affect the sector (positively or negatively depending on its structure and promotional aspects).

- Taxation
- Employment regulations
- Environmental, safety and health regulations
- Ownership, etc

The basic structural make up of global national mineral policies will be discussed later in the course.

HOW DOES MACRO-ECONOMICS AFFECT THE MINERAL SECTOR?

- Trade policies may affect the manner in which mineral products are traded. Do mine owners retain all the forex? Do they market through government agencies? No limitations on externalization of profits?
- How is the forex rate fixed? Free floating or government controlled? Exchange rate mechanisms affect trade.
- Do employment policies restrict expatriate workers?
- Interest rates have a bearing on the cost of capital and hence affect investment in the sector.
- Do foreign investors have access to local borrowing?
- Etc…

MICRO-ECONOMICS

What is Micro-economics?

Word “micro” comes from Greek word “Mikros” which means millions of parts.

- ***Microeconomics*** *is the study of particular markets, and segments of the economy. It looks at issues such as consumer behaviour, individual labour markets, and the theory of the firms.*

- *Analyses the behaviour of individual components of the economy like industries, firms and households. The focus is on trees not the forest. The study is about among other things, how individual prices are set, consider what determines the price of land, labour and enquire into the strengths and weaknesses of the market mechanism. Microeconomics is economics through the microscope.*

MICRO-ECONOMICS

In reviewing the subject of micro-economics, we examine the mining firm and the market place.

- *The concept of the market place*
- *How a market functions*
- *The firm and its corporate strategy*
- *The firm and technological change*
- *Cost functions and economies of scale:*
  - *Cost-output relationships in short-run*
  - *Cost-output relationships in long-run*

THE MINING FIRM AND THE MARKET PLACE

Conventional economic theory instructs that the firm and its business are governed by forces in the market place.

The firm is depicted as reacting and responding to market supply and demand conditions – conditions that are beyond its purview to control. The market, not the firm is held to be hub of economic activity and the focus of analytical concern.

Three Basic Economic Systems

1. A traditional economic system

- Relies on custom, habit, social mores, and tried and true methods of achieving economic goals;

- Technology is primitive, changes are slow and production is undertaken in the same way as last year and year before. Tradition and status quo are perpetuated.

- Examples are abound in most rural areas (life among the Kombai tribe in Papua New Guinea, Pigmies in Congo forests)

Kombai tribe – Papua New Guinea

Kombai tribe – Papua New Guinea

Pigmies in Central African rain forests

Bushmen of Kalahari - Desert Botswana

Bushmen in Namibia

2. Command Economy System

- Relies upon public ownership and centralized control of the basic means of production; severe limitations are placed upon individual choice when such choices conflict with government determined economic priorities.
- Economic plans and activities are under the control of government. Heavy use is made of governmental directives, the assumption being that the government is in the best position to decide what economic choices and policies are beneficial for the economy and its component parts.
- Both socialistic and communistic nations are examples of command economies.

Three basic economic systems

A Capitalistic or Market (free market) Economic System

Emphasizes private ownership, individual economic freedom, competition, the profit motive, and the price system in the achievement of economic goals. Each economic unit decides what choices and policies are best for it, the thesis being that in encouraging the drive for individual economic self-interest, the outcome proves also to be in the overall best interests of society because of the *strong incentives for efficiency, productivity, and satisfaction of consumers*.

TOPIC 3: HOW MARKETS FUNCTION – THE MARKET MECHANISM

The concept of the market

What is a market?

- In a competitive enterprise system, “the market” is held to be the supreme over all other economic units.
- Its importance is like that of the sun in the solar system – all economic activity revolves around the market.
- The market is where buyers and sellers conduct business. Therefore the market is two sided: it reflects both demand and supply conditions and does so simultaneously.
- A market is seldom a single, precisely defined geographical place. Think of e-commerce!

HOW A MARKET FUNCTIONS
(*The market mechanism)*

The Law of Supply and Demand

The prime movers in our perfect market model are the forces of supply and demand. The interaction of these market forces determine the price of the mineral commodity and the quantity exchanged.

What is 'Perfect Competition‘

Perfect competition is a market structure in which the following five criteria are met:

1) All firms sell an identical product;
2) All firms are price takers - they cannot control the market price of their product;
3) All firms have a relatively small market share;
4) Buyers have complete information about the product being sold and the prices charged by each firm; and
5) The industry is characterized by freedom of entry and exit. Perfect competition is sometimes referred to as "pure competition".

BREAKING DOWN 'Perfect Competition‘

- Perfect competition is a theoretical market structure. It is primarily used as a benchmark against which other, real-life market structures are compared. The industry that most closely resembles perfect competition in real life is agriculture.

- Perfect competition is the opposite of a monopoly, in which only a single firm supplies a particular good or service, and that firm can charge whatever price it wants because consumers have no alternatives and it is difficult for would-be competitors to enter the marketplace.

- Under perfect competition, there are many buyers and sellers, and prices reflect supply and demand. Also, consumers have many substitutes if the good or service they wish to buy becomes too expensive or its quality begins to fall short.
- Limited barriers to entry: New firms can easily enter the market, generating additional competition. Companies earn just enough profit to stay in business and no more, because if they were to earn excess profits, other companies would enter the market and drive profits back down to the bare minimum.

- Real-world competition differs from the textbook model of perfect competition in many ways.
- Real companies try to make their products different from those of their competitors.
- They advertise to try to gain market share.
- They cut prices to try to take customers away from other firms.
- They raise prices in the hope of increasing profits.
- And some firms are large enough to affect market prices.
- Consequently, the perfect competition model is not an ideal that we should try to achieve in the real world.

The demand side of the Market:

The following figure represents the demand curve DD.

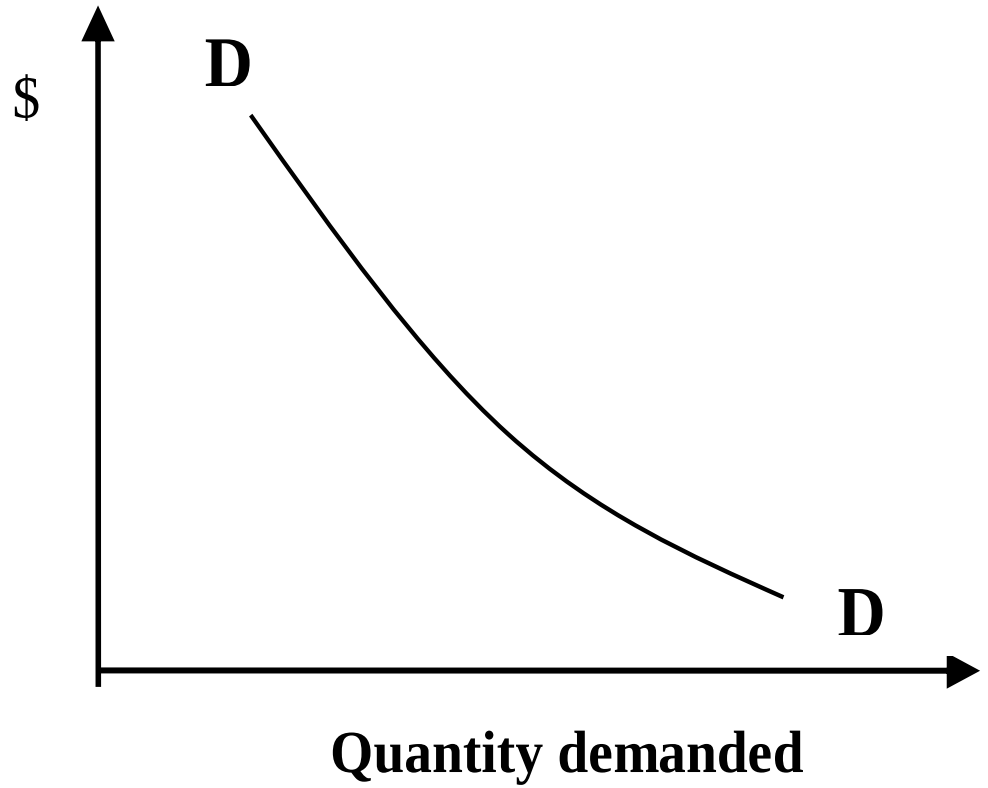


Fig. 1 Demand curve

Demand curve

- Reflects the intensity with which buyers want and are willing to pay for the product in question.
- Represented by a curve showing the various quantities which buyers are willing to purchase at each of various quantities which buyers are willing to purchase at each of various possible prices, all things being equal.
- Conceptually, the curve slopes downward because typically buyers are willing to purchase less at higher prices than lower prices.
- Events such as rising income, changes in the prices of substitute products and shifts in preferences and life styles can and do shift the shape and position of the curve.

What factors affect demand for a mineral?

Determinants of demand can generally be represented by the function:

$$Q_d = f(P, P_r, T, I, E, R, N, O)$$

Where,

Q_d = quantity demanded of a particular mineral product

P = market price of the mineral product

P_r = price of related products

T = consumer tast*es* and preferences

What factors affect demand for a product (mineral)?

***I* =** Level of consumer incomes (or purchasing power)

E = consumer expectations about future prices, incomes and product availability

R = range of products available to consumers

N = number of potential consumers (market size)

O = all other factors which may influence $\boldsymbol{Q_d}$

Factors affecting demand

Market price of the mineral product

The interrelationship between the product price and quantities demanded with all factors remaining constant is as shown in Fig. 1 above. Generally more quantities are demanded at lower prices and vice versa.

Factors affecting demand

Price of related (mineral) products:

This is an important demand variable because of interrelationshionships that exist among mineral products. Two types of relatiionships may exist;

i) **Substitutes**

A substitute material must functionally replace the product.

Examples:

- Aluminum has been used to replace copper when the price is high in electrical application.
- Synthetic gemstones and imitations have been used in place of natural ones (emerald, tanzanite, spinel, quartz, diamonds, ruby, etc.)
- Plastics have replaced pipings, car radiators, etc.

Factors affecting demand

ii) **Complimentary**

In the case of complimentary products, the products are demanded jointly.

Examples

- The demand for steel alloys will increase the demand for iron.
- The demand for chrome will increase with demand for chrome alloys
- The demand for jewellerly will increase the demand for gemstones.
- Demand for butter increases with demand for bread.

Factors affecting demand

Consumer Tastes and Preferences

- When consumer perceptions of a good or service become less favourable, market demand for the item lessens and vice versa.
- Consumer taste and preference patterns undergo continuous review and are subject to change, sometimes gradual and sometimes rapid, over time.
- The emergence of new and better products, changing values and life styles, new information about health and safety features of products, business cycles, rising standards of living, higher levels of affluence, and advertising, to mention a few, all exert a pervasive influence upon consumer tastes and preferences

Factors affecting demand

Consumer Income

- Willingness to buy is in itself insufficient; consumers must be able to pay for the commodities they want.
- Typically, the greater is consumer income the greater will be demand for goods in general and for some items in particular.
- Only in the case of inferior goods is rising income accompanied by a weakening demand.
- **Inferior good**: One whose demand drops when people's incomes rise. Generally, if incomes are low or the economy contracts, inferior goods become a more affordable substitute for more expensive goods. Inferior goods are the opposite of normal goods, whose demand decreases when incomes increase.

Normal and Inferior Goods

Normal Goods

Steak
Laptops
TV
Holiday tours

Inferior Goods

Kapenta
Secondhand clothing
Costume jewerly (imitations)

Factors affecting demand

Consumer Expectations

Expectations with respect to future prices, income levels, product availability can have an effect on the demand for a mineral commodity.

Factors affecting demand

All other factors that may affect demand

- Is a good a luxury or necessity? This is largely a function a function of life styles and value judgements
- Degree of market saturation for a product
- Discretionary income – This is the residual amount of income remaining after subtracting necessary living expenses and fixed payment charges from disposable personal income. Demand for some goods depends on discretionary income (e.g. Holidays)
- Disasters
- Changing safety, health and environmental concerns (use of asbestos roofing)
- Recycling

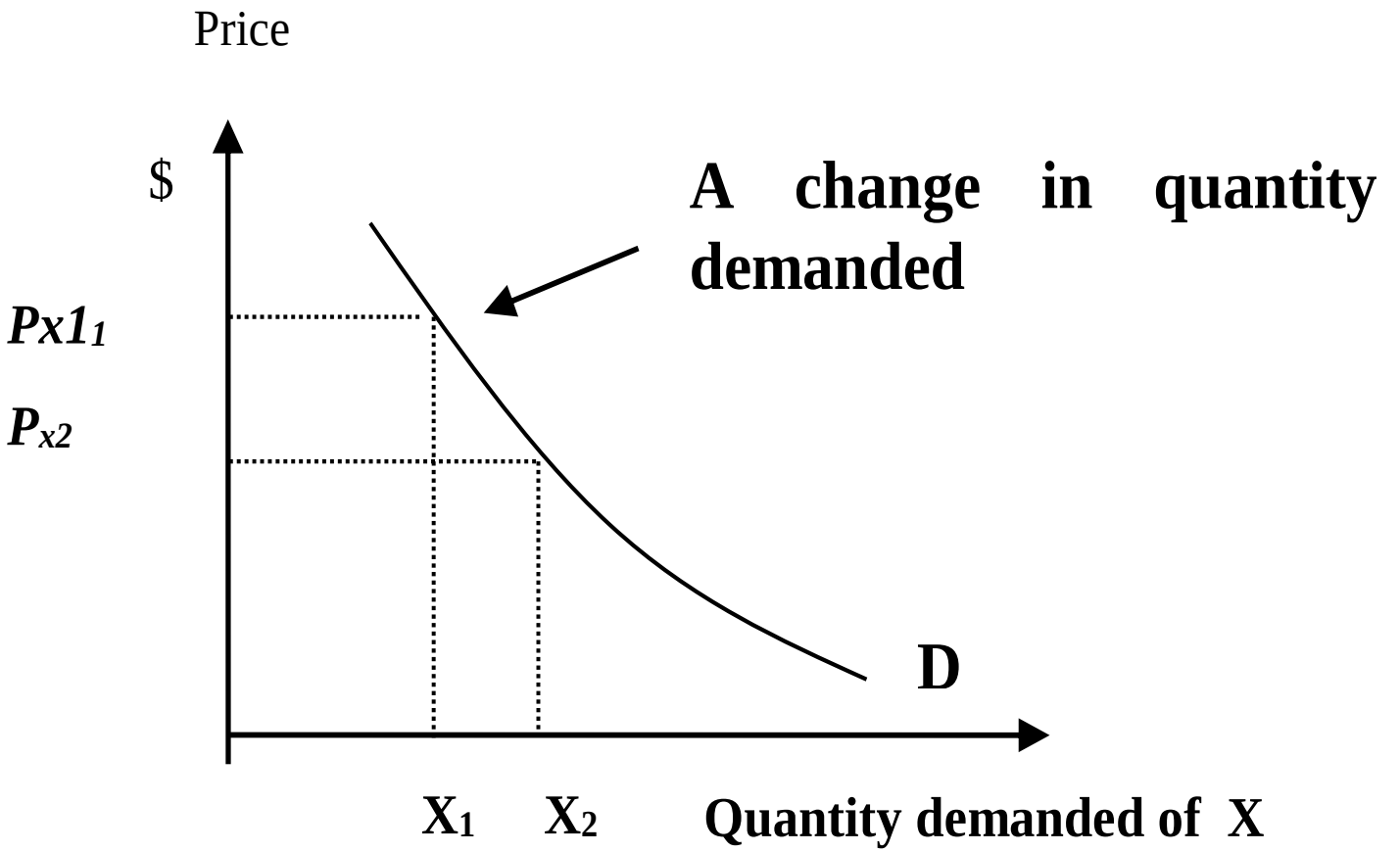


Fig. 2 Demand curve – change in demand

Demand function

- In the demand function, with all other factors held constant, the quantities demanded may relate to its market price as indicated in Figure 2.
- A reduction in the price from P_{x1} *to* P_{x2} results in an increase in the quantity demanded. There is a change in quantity demanded.

- Shift in demand may also happen if there is a change in one of the determinants of demand.
- In this case the entire demand curve may shift outward or inward depending on the causating factor. For instance, if all other factors are held constant and the income level increases, the demand curve may shift outward and vice versa as shown in the figure 3 below.

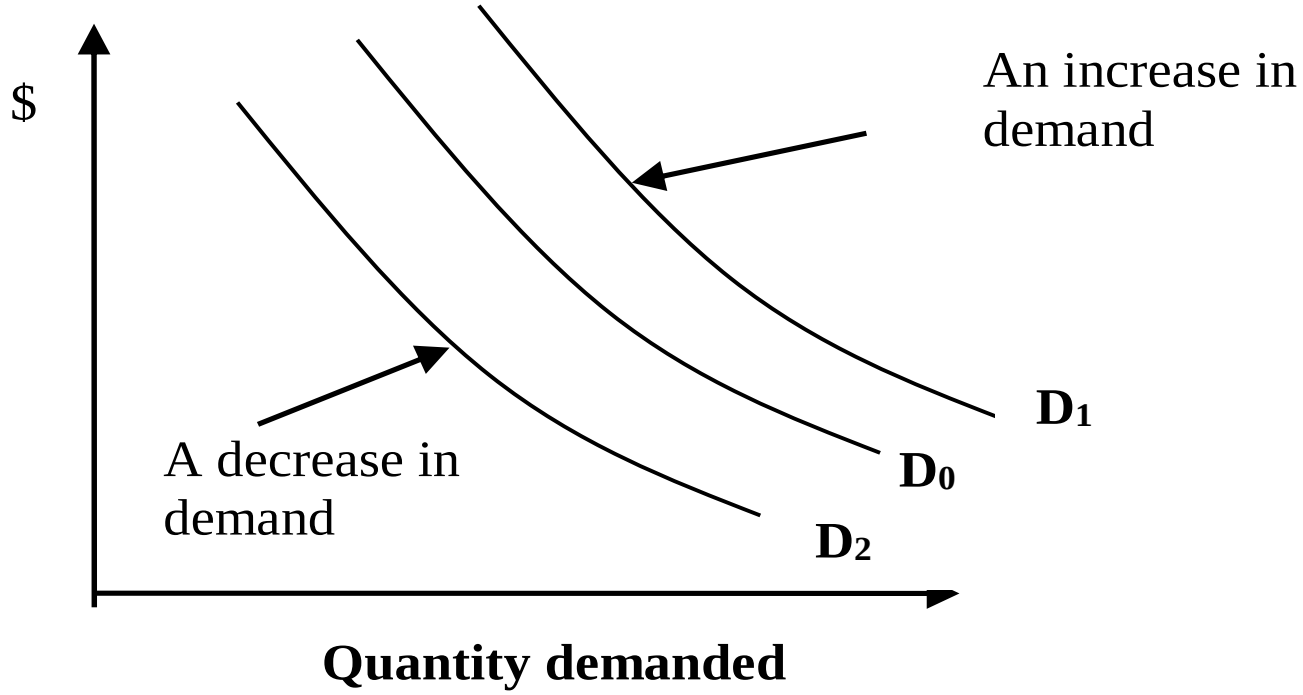


Fig. 3 Demand curve – shifts in demand

Elasticity of demand

The concept of elasticity of demand is one of the most important aspects of demand analysis. In general terms, elasticity of demand measures the magnitude of the responsiveness or sensitivity of the quantity demanded of a commodity to a change in some demand determinant. More specifically, elasticity concerns the extent to which a percentage change in one demand variable causes a percentage change in the quantity demanded.

$$\varepsilon = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in any demand determinant}}$$

Elasticity of demand

There are as many kinds of elasticity of demand as there are numbers of demand determinants for a commodity (price elasticity, income elasticity, etc).

Price elasticity of demand

The relation of a commodity price to sales volume is of major interest to business firms as a basis for pricing policy, sales strategy, and achievement of profit and market share objectives.

Price elasticity of demand can be defined as:

$$\varepsilon = \frac{\%\ \text{change in quantity demanded}}{\%\ \text{change in price}}$$

Elasticity of demand

The coefficient of price of elasticity is always negative. This is because the price and quantity demanded are inversely related.

Two methods of calculating price elasticity exist – the arc elasticity method and the point elasticity method.

Arc method: This is a measure of the responsiveness of the quantity demanded between two seperate points on the demand curve.

Example:

Determine the degree of responsivess of the quantity demanded to a decrease in price from $12 to $10.

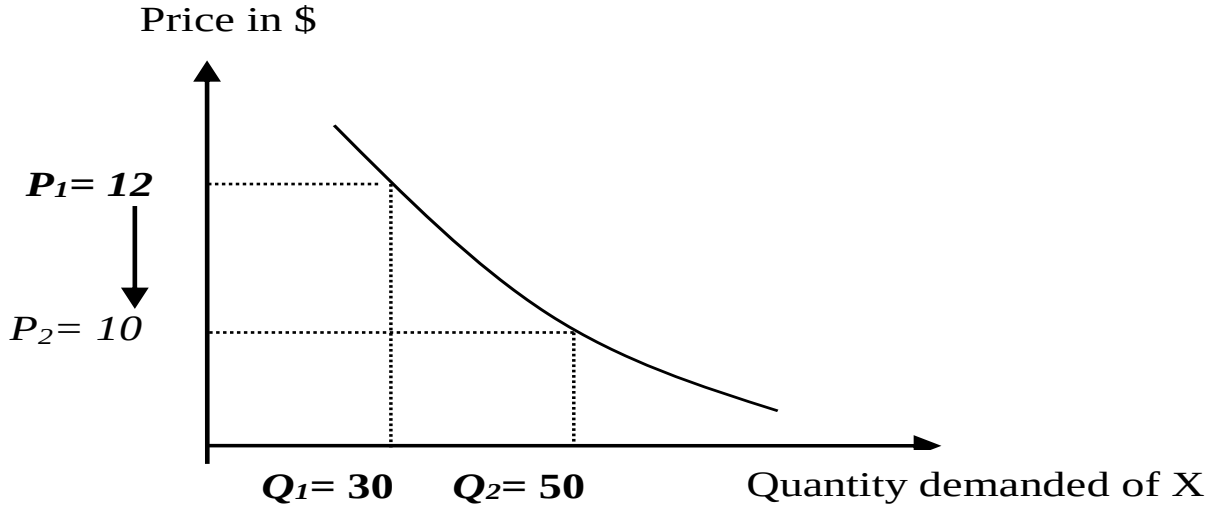


Fig. 4 Elasticity of demand

$$\varepsilon_p = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}}$$

$$= \frac{[(Q_2 - Q_1)/Q_1]\ x\ 100}{[(P_2 - P_1)/P_2]\ x\ 100}$$

Where the pairs (Q_1, P_1) *and* (Q_2, P_2) represent respectively, the quantity and price values before and after their change.

Substituting the appropriate values into the formula gives:

$$\varepsilon_p = \frac{[(Q_2 - Q_1)/Q_1] \times 100}{[(P_2 - P_1)/P_2] \times 100} = \frac{(50 - 30)/30}{(10 - 12)/12} = -4.0$$

However, if we compute the sensitivity of the quantity demanded to an increase in price from $10 to $12 (equivalent to moving up the demand curve), the coefficient of price elasticity is

$$\varepsilon_p = \frac{[(Q_2 - Q_1)/Q_1] \times 100}{[(P_2 - P_1)/P_2] \times 100} = \frac{(30 - 50)/50}{(12 - 10)/10} = -2.0$$

Price elasticity of demand

- The discrepancy in the two elasticiy coefficients arises because the percentage changes going from $12 to $10 are not the same as those from moving from $10 to $12.
- This is a troublesome matter but not without a remedy. The ambiquity of arbitrarily using one of the two points as the original or base values for calculating the percentage changes can be partially overcome by using averages of the quantity values as the base for calculating the percentage change in Q and the average of the two prices as the base for calculating the percenatge change in P.
- Making this adjustment gives the more satisfactory formula

$$\varepsilon_p = \frac{\dfrac{Q_2 - Q_1}{\left[\dfrac{Q_1 + Q_2}{2}\right]}}{\dfrac{P_2 - P_1}{\left(\dfrac{P_1 + P_2}{2}\right)}}$$

In terms of our previous example, the coefficient of price elasticity for a decline in price from $12 to $10 becomes;

$$\varepsilon_p = \frac{\dfrac{50 - 30}{\left(\dfrac{30 + 50}{2}\right)}}{\dfrac{10 - 12}{\left(\dfrac{12 + 10}{2}\right)}} = -2.75$$

Price elasticity

- A price elasticity of –2.75 should be interpreted as meaning that over the indicated range of prices and quantities, a 1% change in price will be followed by approximately a 2.75% change in quantity demanded in the opposite direction (verify that the same coefficient is obtained by moving from $10 to $12).

Price elasticity

- In general, the further apart the two points between which arc elasticity is computed, the greater is the discrepancy between the price elasticity coefficients obtained from the two-point arc formula.
- Since the sign of the price elasticity of demand is always negative (in accordance with the law of demand), it is the size of the coefficient itself which is most relevant. By convention if:

$\varepsilon_p > 1$ demand is elastic (quantity demanded is sensitive to price changes)

$\varepsilon_p = 1$ demand is unitary or of unitary elasticity

$\varepsilon_p < 1$ demand is inelastic (quantity demanded is relatively unresponsive or insensitive to price changes.

Point Elasticity: Measuring elasticity at a point eliminates the imprecision of the arc elasticity concept. Point elasticity refers to the responsiveness of quantity demanded to very small price changes from a given point.

$$\varepsilon_p = \frac{\Delta Q/Q}{\Delta P/P} = \frac{\Delta Q}{Q} \cdot \frac{P}{\Delta P} = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q}$$

As the changes in price get smaller and smaller and actually approach zero, the ratio of $\Delta Q/\Delta P$ becomes equivalent to the derivative of the demand function with respect to price.

$$\lim_{\Delta P \to 0} \frac{\Delta Q}{\Delta P} = \frac{dQ}{dP}$$

Therefore the formula for point elasticity becomes

$$\varepsilon_p = \frac{dQ}{dP} \cdot \frac{P}{Q}$$

Similarly, the income elasticity may be derived as

$$\varepsilon_I = \frac{dQ}{dI} \cdot \frac{I}{Q}$$

Cross elasiticity of demand

Cross elasiticity of demand : Mineral commodities can be treated in three ways in as far as their demand is concerned:

i). They may be ***competing products or substitutes***. In this case an increase in the purchase of one is at the expense of the other. Consider plastics substituting metals in motor vehicles and construction.

ii). They may be ***complimentary products***, in which case an increase of one causes a rise in the purchase of another. Complimentary means that commodities are consumed together. Consider the demand for gemstones and gold in demand for jewellery.

iii). Commodities may be ***independent*** implying that the purchase of one mineral commodity has no direct bearing on the demand of another. In this case the commodities are neither consumed together nor in place of one another.

Cross elasticity of demand is a measure for interpreting the relationship between products. For two products X and Y, cross elasticity measures the percentatge change in the quantity demanded of product Y in response to a percentage change in the price of product X.

$$\varepsilon_{y\,x} = \frac{\%\text{ change in quantity of Y}}{\%\text{ change in price of X}}$$

Where $\varepsilon_{y\,x}$ is the coefficient of cross elasticity between X and Y. Again there are two ways of calculating the coefficient of cross elasticity of demand.

The arc formula is:

$$\varepsilon_{yx} = \frac{\dfrac{Q_{y2} - Q_{y1}}{\left[\dfrac{Q_{y1} + Q_{y2}}{2}\right]}}{\dfrac{P_{x2} - P_{x1}}{\left[\dfrac{P_{x1} + P_{x2}}{2}\right]}}$$

The point elasticity formula is

$$\varepsilon_{yx} = \frac{dQ_y}{dP_x} \cdot \frac{P_x}{Q_v}$$

The cross elasticity coefficient may be either positive or negative. Note that when

$\varepsilon_{yx} > 0$	Commodities are substitutes
$\varepsilon_{yx} < 0$	Commodities are complimentary
$\varepsilon_{yx} = 0$	Commodities are independent

Partial Elasticities of Demand:

A more rigorous Concept of Demand Elasticity

In its most general form, the demand function for a good can be expressed as

$$Q_1 = f(P_1, P_2, \ldots\ldots\ldots P_n, T, I, E, R, N, O)$$

Where, Q_1 = quantity demanded of good 1
P_1 = market price of the good
$P_2, \ldots\ldots P_n$ = prices of other goods
T = consumer tast*es* and preferences
I = Level of consumer incomes (or purchasing power)
E = consumer expectations about future prices, incomes and product availability
R = range of products available to consumers
N = number of potential consumers (market size)
O = all other factors which may influence Q_d

The elasticity of demand with respect to any demand determinant refers to the degree of responsivess of the quantity demanded relative to some percentage change in that demand determinant *when the values of all other demand determinants are held fixed.*

FACTORS AFFECTING SUPPLY

Determinants of Supply

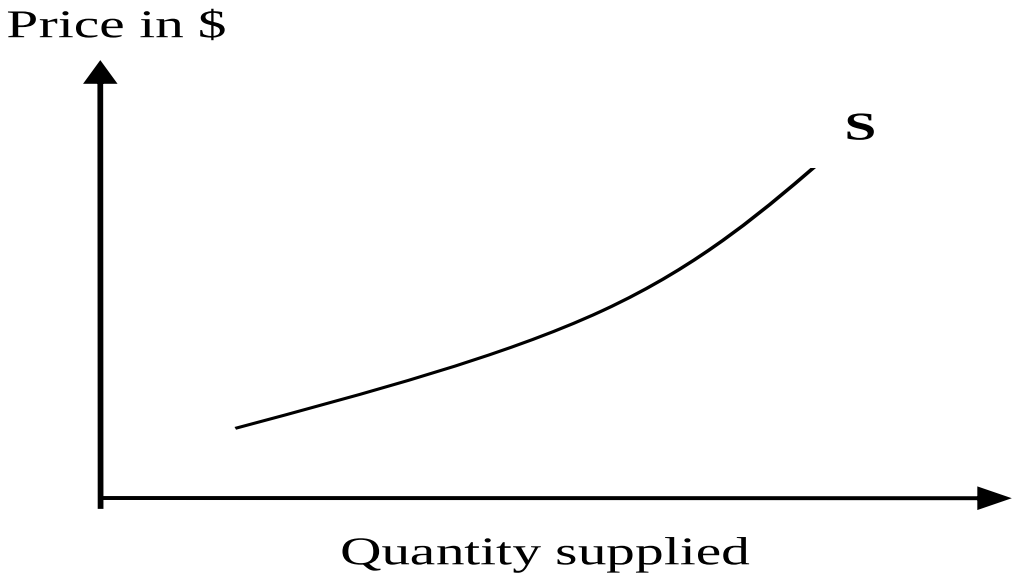


Fig. 5 Supply curve

The supply curve (S) in Fig. 5 represents the marginal cost curve for the industry supplying a particular mineral commodity. Conceptually, supply increases with increase in the market price of the commodity. This is expected because with an increase in the market price, some of the marginal deposits become viable and contribute to the expansion of supply. If the price falls on the market, some marginal mines will become unprofitable and forced to close down thereby reducing the overall supply. Thus the market mechanism regulates supply.

Factors affecting the supply of mineral commodities in the long term are:

- Major new discoveries (e.g., oil in Ghana, oil in Uganda, oil in Angola, oil in Congo Brazzaville, copper in Zambia, etc)
- Depletion (coal in UK, coal and iron in Germany, etc).
- Advance in processing technology (that has made it possible to process low grade ores or enhancement methods used in the treatment of low grade ores, e.g., Lumwana Cu; gemstones, oil tar sands in Canada, etc.)
- Recycling (secondary supply)
- Enviromental controls (progressive increase in regulations have rendered mining of some deposits uneconomic).
- Development of substitutes (e.g., plastics in place of metals, synthetic gems, solar, etc).
- Development of new product markets (e.g., use of Cu as insulator and not electricity conductor; metals Evs, etc).

Metal Recycling

- Metals are essential, versatile and can be used in a number of ways.
- Metals can be used for industrial purposes such as manufacture of trucks, cars, airplanes, ships, and railways.
- They can also be used to manufacture domestic items such as cutlery, crockery and even in packaging.
- The good thing about metal recycling is that, metal can be recycled over and over without altering its properties.
- The most common recyclable metals include lead, aluminum and steel.
- The other metals for example silver, copper, brass and gold are so valuable that they are rarely thrown away to be collected for recycling. Therefore, they do not create a waste disposal crisis or problem.

Updated January 27, 2016.

The United States recycles 150 million metric tons of scrap materials annually, including 85 million tons of iron and steel, 5.5 million tons of aluminum, 1.8 million tons of copper, 2 million tons of stainless steel, 1.2 million tons of lead and 420,000 tons of zinc, according to the Institute of Scrap Recycling Industries (ISRI). Other metals such as chrome, brass, bronze, magnesium and tin are recycled as well.

U.S. Exports Recycled Metal

- In 2008, the scrap recycling industry generated $86 billion and supported 85,000 jobs. The recycled materials that the industry processes into raw material feedstock every year are used for industrial manufacturing around the world. ***For example, 25% of the steel used in production car panels (doors, hood, etc.) is obtained from recycled materials.*** For copper, used in the home building industry for electric wires and plumbing pipes, that proportion surpasses 50%.

- Each year, the United States exports staggering amounts of scrap metals - called scrap commodities - contributing significantly to U.S. trade balances. For example, in 2012 the U.S. exported $3 billion worth of aluminum, $4 billion of copper, and $7.5 billion of iron and steel.

Importance of Metal Recycling (Saves Energy and Natural Resources)

- Recycling scrap metal reduces the substantial amounts of greenhouse gas emissions produced during the various smelting and processing operations used when making metal from virgin ore. At the same time, the amount of energy used is also much smaller. Energy savings using various recycled metals compared to virgin ore is up to:

-- 92 percent for aluminum
-- 90 percent for copper
-- 56 percent for steel

- These savings are significant, especially when scaled up to large production capacities. Indeed, according to the U.S.Geological Survey, 60% of steel production comes directly from recycled iron and steel scrap. ***For copper, the proportion coming from recycled materials reaches 50%.***
- Recycled copper is almost as valuable as new copper, making it a common target for scrap metal thieves.

In the short-term, supply may be affected by

- Labour strikes
- Changes in producer and consumer inventories
- Mine production cut-backs
- Government stockpiles
- Business cycles

In addition to changes in along the supply curve, there could be shifts in the supply curve.

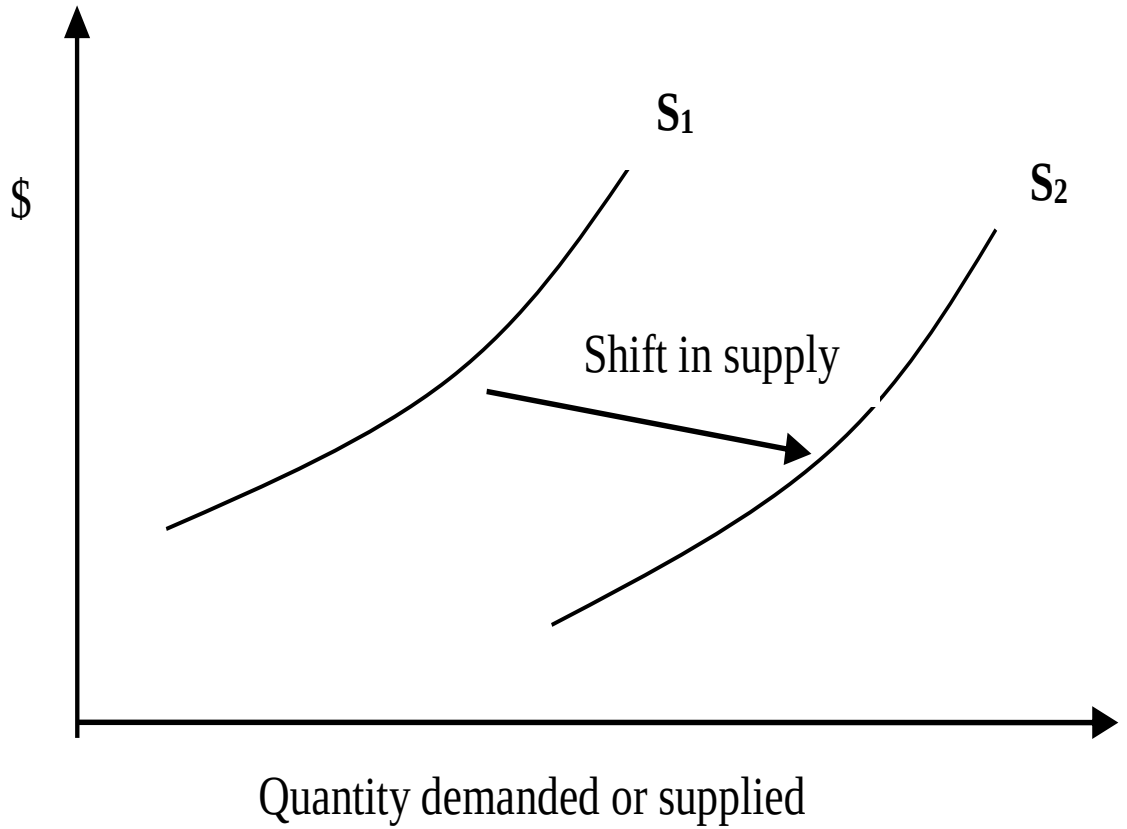


Fig. 6 Supply curve – shifts in supply

MINERAL MARKETS

We have already defined a market as a collection of individual decision making units, some of which desire to buy (demand) and some of which desire to sell (supply) a particular good or service.

In analysing the structure and functioning of markets, we shall first deal with a special kind of theoretical market model. It is a market that is both perfect and competitive.

Perfect Market:

Assumes that buyers and sellers have complete knowledge of market conditions, that any change in market conditions will be immediately known and acted on.

Competitive Market:

- The concept of a competitive market, like that of a perfect market, is an abstraction. The most important characteristic of a competitive market is that no single participant has power to affect the market outcome in an significant way. All participants are price takers and not price makers

- The second characteristic of a competitive market is that there is no obstruction or restriction placed on supply (that is, no barriers to entry), demand or the level of price.

- The final characteristic of a competitive market is that only one homogeneous commodity is sold in any given market.

- The prime movers in our model are the forces of supply and demand. They determine the price of the good and the quantity exchanged in any given market.

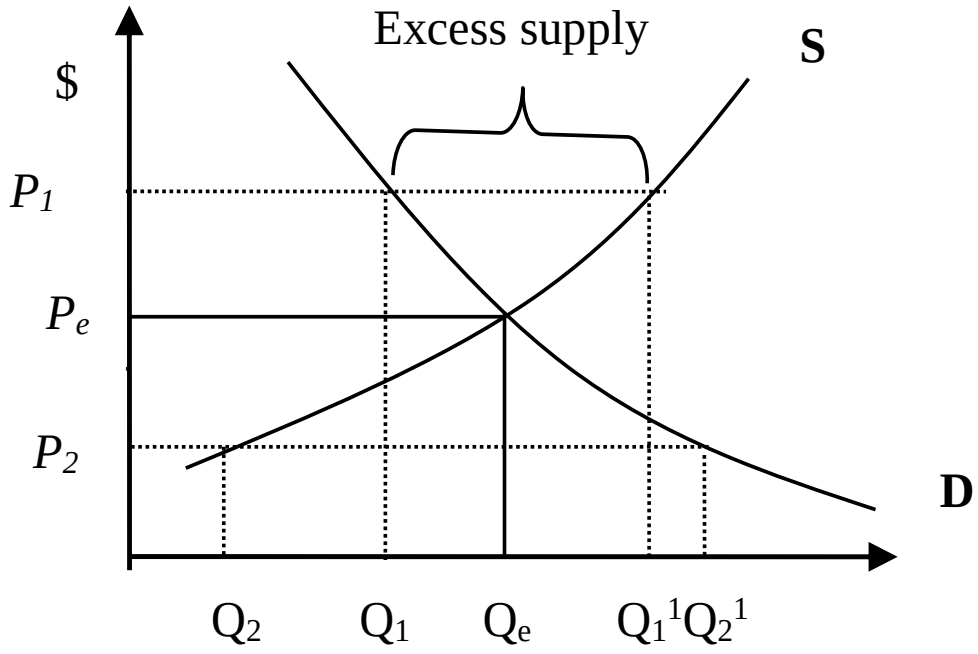


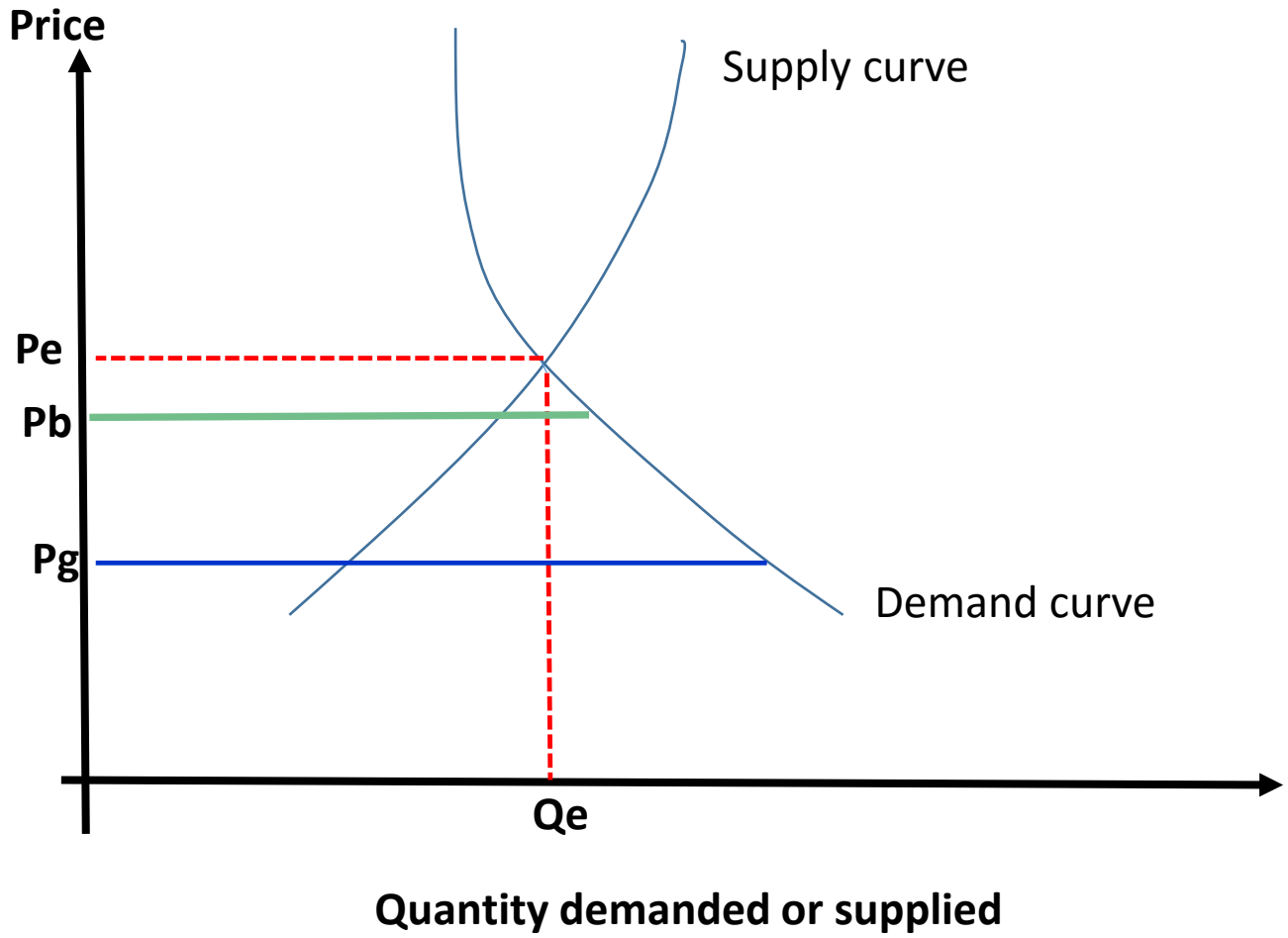
Figure 7: Excess Supply condition

- At price P_1, the quantity supplied (Q_1^1) is greater than the quantity demanded (Q_1) by the market.
- Therefore there is excess supply that will result in forcing the price down because competitive price bidding by sellers will continue.
- Excess supply is (Q_1^1 - Q_1). Such a situation is a *buyers' market*. Similarly at a price P_2, the quantity demanded (Q_2^1) is greater than the quantity being supplied on the market. There is excess demand, a situation that will eventually force the price to move up because there will be competitive bidding by demanders. Buyers are the ones now scrambling and in the process force the price up – a situation which is favourable to sellers. Excess demand is (Q_2^1- Q_2).

- At both prices (P_1 *and* P_2), the market is not in equilibrium. At a price P_e, the quantity supplied is equal to the quantity demanded by the market. The market is said to be *equilibrium.* The price P_e is the market equilibrium price. What conditions would facilitate the emergence of a black market?

- However, all these changes affecting the demand and supply conditions are superiposed. All we actually see is the overall result.

However, control of prices or the setting of prices for certain goods may have the undesirable outcome of creating parallel markets or black markets. In figure below, a government may set the regulated buying price of gold at a price Pg which is well below the market price (Pe) in order to cover its margin that includes high overhead costs. Government can only also resell at market price Pe. This low price attracts a parallel market offering better price than the government often with less overheads at Pb and still be able to make a margin of (Pe-Pb). The larger this difference the bigger the attraction for a black market to emerg



TYPES OF MARKET POWER

- There are three basic kinds of market power.
- Two of them deal with control over the supply or demand of a product.
- The third deals with control over its price.

Monopoly and Monopsony Power

- To control the supply or demand of a good or service is to possess market power.
- **Free markets** are rigged and the market system obstructed when either or both of these forces are controlled.
- **Monopoly** - Those who control *supply*, who determine how much of a good or service is to be brought into the market, possess *monopoly power (e.g. ZESCO, rare earths in China).*
- **Monopsony** - Those who control *demand*, who determine how much of a good or service will be taken off the market, possess *monopsony power.*

Market Structure and Market Power

- In principle market structures range from an ideal case of perfect competitive market to a pure monopoly with intermediate market structures called oligopoly and monopolistic competition.
- Monopoly and Monopsony Power result from a particular kind of market structure. ***The existence of either monopoly and Monopsony implies the absence of competition***.

- Competitive markets, we have seen, have a unique set of conditions. There are so many independent buyers and sellers that no one can affect the price, commodity exchanged is homogeneous, and no barriers to entry.

Monopolistic Competition

- In most real world markets, the products of firms are not homogeneous. Ordinarily, the product of each firm is in some way *differentiated* from the product of every other firm.
- In fact, most enterprises devote considerable time and effort to engineering special features into their products and to making their products unique through advertising, packaging, brand names, terms of credit, service , etc.
- Monopolistic competition implies a market environment comprising many firms selling products that are very close (but not perfect) substitutes for each other (cell phones, consumer electronics, cars, etc).

Three factors combine to set monopolistic competition apart:

- Product differention
- presence of large numbers of sellers
- non price competition

Many Models of Oligopoly

- Oligopoly is synonymous with competition among the few. Markets are said to be oligopolistic whenever a small number of firms supply the dominant share of an industry's output (e.g. cobalt: Zambia – 30%; Congo DR 60% of world's supply).

- If the firms produce a standardized product, the industry is called a pure oligopoly. Most common examples of virtually uniform products marketed under oligopoly include steel, aluminun, lead, copper, cement, explosives, fuel oil.

- If a few firms dominate the market for a differentiated product, the industry is called a differentiated oligopoly. Examples include the production of cars, TV sets, mobile phones, cigarettes, computers, soft drinks, etc. Entry into an oligopolistic industry is typically formidable. The most pervasive barrier to entry is the presence of substantial economies of scale.

Price leadership Models

Two major forms of price leadership stand out: *dominant firm leadership and barometric firm leadership.*

Dominant Firm Price leadership: A dominant firm establishes its own preferred price as the going market price and allows the competitive fringe firms to sell all they wish at that price.

Barometric Price leadership: Exists when there are several principal firms (surrounded or not, as the case may be, by a competitive fringe of small firms) and one of the large firms is not powerful enough to impose its will upon the other consistently. In copper, price leadership has been exercised by all the big three – Anaconda, Kennecott, and Phelps Dodge. US Steel, Bethlehem have exercised price leadership in steel.

Cartel Theory of Oligopoly

- A cartel is an organisation established whose purpose is manipulate the price by controlling supply or demand.
- So there can be producer cartels and consumer cartels.

- Cartels tend to arise in markets where there are few firms and each firm has significant share of the market. Cartels are illegal in US. Internationally there are no restrictions on cartel formation.

- By working together, the cartel behaves like a monopolist.

Examples of very successful producer cartels include:

OPEC – the Organization of Petroleum Exporting Countries comprising 12 countries is largely concentrated in the middle east.

In accordance with its Statute, the mission of the Organization of the Petroleum Exporting Countries (OPEC) is to coordinate and unify the petroleum policies of its Member Countries and ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital for those investing in the petroleum industry

CIPEC

The Intergovernmental Council of Countries Exporters of Copper (CIPEC) (French Conseil intergovernmental des pays exportateurs de cuivre) was created in 1967 in Lusaka with the objective of coordinating policies of the country members looking for growth in the revenues coming from copper.

Composition

It was initially constituted with four members, Chile, Peru, Zaire and Zambia. A further four were added to the cartel in 1975 - Australia, Indonesia, Papua New Guinea and Yugoslavia.

CIPEC represented around 30% of the world's refined copper, and more than 50% of the proven reserves of copper. The intent of the members to secure higher prices failed, particularly of increasing the price during the crisis of 1975-1976, and the subsequent change of behavior of Chile finally finished the cartel (1967-1988).

Many experts consider that the market power of this cartel was negligible, because the residual demand that it faced was elastic (much higher than OPEC, for example). The inability of coordinating output cutbacks during the extensive period of life of CIPEC seems to validate this hypothesis. It was dissolved during the 1990s.

CIPEC stages

There were three stages of the CIPEC that economists recognize:

Nationalization stage (1967–1973)
Unilateral Action stage (1973–1976)
Reflux stage (1976–1988)

Copper cartels

Since 1870, there have been several formal attempts to restrict the copper output and raise, in this form, its price.

This is a list of copper cartels in the 20th century:

- Copper Export Association, CEA, 1918–1923
- Copper Exporters, Inc., CEI, 1926–1932
- International Copper Cartel, ICC, 1935-1939 (Also called World Copper Agreement)
- Intergovernmental Council of Copper Exporting Countries, CIPEC, 1967–1988

A Diamond Market No Longer Controlled By De Beers

Thursday June 06, 2013 10:44

Historically the diamond industry was structurally flawed -the De Beers monopoly controlled prices. But, with peak market share reaching almost 90% in the late 1980's, a series of events over the next 25 years led to the erosion of the De Beers monopoly. Today, De Beers no longer has control of the diamond industry, and for the first time in a century, market supply and demand dynamics, not the De Beers monopoly, drives diamond prices.

In the late 19th century a massive diamond discovery in South Africa prompted a diamond rush. Businessman Cecil Rhodes bought as many diamond-mining claims as he could, and his accumulation of properties eventually became De Beers Consolidated Mines Limited. De Beers maintained a hold on what was a relatively small industry at the time by expanding from mining into every facet of the diamond industry, with a focus on monopolizing distribution. De Beers successfully influenced just about all of the world's rough suppliers to sell production through the De Beers channel, gaining control of global supply. This gave De Beers the power to influence diamond supply and thus diamond prices.

The De Beers distribution channel, operating under the unassuming moniker Diamond Trading Co. (DTC), was a system put in place that gave De Beers complete control and discretion to distribute the majority of the world's diamonds. Only buyers or "Sight holders" authorized by De Beers could participate in the non-negotiable DTC sales.

In order to maintain a stable but rising diamond price, De Beers had the power to stockpile inventory in a weak market or raise the prices charged to Sight holders, and then in an excessively strong price environment (with the potential to damage demand), De Beers had the excess supply on hand to release to the market when needed, repressing disorderly price increases.

To keep the DTC system intact, it was necessary for De Beers to maintain control of the worlds rough diamond supply. However, in the second half of the 20th century, as new world-class mines were discovered in Russia, Australia, and Canada, it became increasingly difficult for De Beers to control global supply. The biggest risk to the survival of the De Beers cartel was for these new world-class mines to begin selling directly to the market, bypassing De Beers.

Russia began producing diamonds in the 1950's. At first, the Russians agreed to sell production to De Beers keeping the cartel intact. However, the arrangement was weakened in 1963 when Anti-Apartheid legislation restrained the Soviet Union from dealing with a South African company. Further pressure came during the Soviet Union collapse in the 1990's, when political chaos and a weak rubble further separated Russia's production from De Beers. The De Beers market share began to fall from a peak of almost 90% (See Figure 1.1).

Shortly after losing control of the Russian supply, the Argyle Mine in Australia (at the time the largest diamond producing mine in the world by volume) broke away from De Beers because of the cartel's inflexibility. Over the next few years, other mines followed suit, as new world-class mines in Canada chose to sell their supply independent of De Beers.

In an effort to maintain control of supply, De Beers began buying diamonds in the secondary market at a premium, but the strategy was short lived as the cost was prohibitive. By the end of the 1990's, De Beers' market share had fallen from as high as 90% in the 1980's to less than 60%. In 2000, De Beers announced a shift in strategic initiative focused on independent marketing of the De Beers brand, implying that they no longer had control of the market.

In 2001, several law suits were filed in U.S. courts alleging that De Beers "unlawfully monopolized the supply of diamonds, conspired to fix, raise, and control diamond prices, and issued false and misleading advertising." After multiple appeals, in 2012 the U.S. Supreme Court denied final petition for review, and a settlement in the amount of $295 Million with an agreement to "refrain from engaging in certain conduct that violates federal and state antitrust laws" was finalized.

The way that De Beers did business, revolving around the central concept of controlling market supply, was simply not viable in a more competitive environment. With the company restructuring underway, De Beers liquidated their stock pile from 2000 to 2004, resulting in a modest decline in diamond prices as the liquidation supply more than offset new demand coming out of Asia (see figure 1.2). By 2005, the inventory overhang had been exhausted allowing market forces to drive diamond prices for the first time in a century, resulting in unprecedented price volatility.

Diamond prices made a new high in 2007, followed by a violent sell off in 2008 and 2009 before rebounding to another new high in the summer of 2011. As of June 2013, diamond prices are approximately 15% off the 2011 highs, but remain firm as lower than expected mine output has subdued supply supporting prices.

Why Cartels Fail:

Once established, cartels are difficult to maintain. Problem is that cartel members will be tempted to cheat on agreed limit production. By producing more output than it has agreed to produce, a cartel member can increase its share of cartel's profit. Hence there is a built-in incentive for each cartel member to cheat. OPEC and the now dead CIPEC cartels have suffered this problem.

- Mineral dependent economies. Pressure of financing Development in DCs. Over 20 nations dangerously vulnerable to resource curse. Over 75% of all mineral-dependent countries are now low and medium income countries. ***Mineral-dependent countries defined as countries dependent for at least 25% of their tangible exports.***

- Different production costs favours low cost producers who may not face low price pressure and hence not fully committed to cartel's ideals.

Leonardo DiCaprio's 2006 movie "Blood Diamond" shed light on the sometimes dubious origins of luxury goods.

The movie highlighted increasing concern about human rights violations in the supply chain and the diamond industry has been put under pressure to eliminate minerals of unknown or dubious sources.

Now, attention is shifting to metals and other commodities that are mined using child or slave labor, or in dangerous conditions.

Apple under fire

Cobalt is an insignificant-looking grey metal that risk consultant Verisk Maplecroft says may be the next so-called conflict mineral. It is used to make the rechargeable batteries found in cell phones, laptops, electric vehicles, aircraft and power tools. The metal is predominately mined in the Democratic Republic of Congo (DRC), where critics say children as young as seven-years-old labor in horrendous conditions.

"The glamourous shop displays and marketing of state-of -the art technologies are a stark contrast to the children carrying bags of rocks and miners in narrow manmade tunnels risking permanent lung damage," Mark Dummett, a researcher at human rights charity Amnesty International, said in a report on cobalt mining in the DRC in January.

The term "conflict mineral" carries a lot of legal ramifications. U.S. Securities and Exchange Commission rules mean public companies must track the source of commodities designated conflict minerals in their supply chains in an effort to combat the financing of militia in countries like the commodities-rich DRC.

At present there are only four legally designated conflict minerals ***– tantalum, tin, gold, and tungsten*** – of which the first three are commonly mined in the DRC. Some analysts and human rights bodies say cobalt should be added to the list of minerals for which companies have to conduct heighted supply chain scrutiny.

These calls increased after Amnesty International's report, which alleged that a subsidiary of Chinese mineral giant Zhejiang Huayou Cobalt bought cobalt from mines in the DRC where child labor was rife. Amnesty said Huayou Cobalt sold the processed metal onto battery component manufacturers in China and South Korea, who claimed to supply 16 multinational consumer brands, including Apple.

Complex supply chains spanning several continents present challenges for companies who are required to determine where every commodity and component in their products come from. In response to Amnesty's report, Apple said it was evaluating if the cobalt in its products came from the DRC and if so, whether it was via Huayou Cobalt.

The U.S. company added that it did not tolerate underage labor and that when it had conducted an audit in 2014, 16 underage workers were discovered out of a workforce of 1.6 million. These cases were "successfully addressed," Apple said. Huayou Cobalt said it was unaware that any of its "legitimate suppliers" employed children at their mining sites or operated in unsafe conditions.

Verisk Maplecroft has warned that workers of all ages in the DRC are at "extreme of risk" of exposure to forced labor or trafficking.

The consultancy said this type of modern-day slavery was common across many poorer countries – not just in Africa – and that the goods and components produced might find their way on to shop shelves in Europe and the U.S.
"Companies are heavily reliant on goods and raw materials from India and China. However, sourcing from these countries can come with a substantial risk of association with forced labor," Verisk Maplecroft said in a report.
"The risk is endemic in India's agricultural sector and is prevalent in parts of its garment sector. The exploitation of children in the mining of minerals is also common. Forced labor, including the exploitation of young apprentices, occurs across multiple sectors in China, including electronics production, mining and agriculture," it added.

Making sure
Under-pressure multinationals are turning to outside consultancies to help them understand their own supply chains. One is RCS Global, whose tag line is "making sure" and has bases in Colombia, Rwanda, South Africa, China the U.S. and the U.K.

"If you look at the issue of slave labor or forced labor, I think where there are extremely unregulated supply chains, in countries of weak governance, you are sure to find this issue and that goes for any material," Harrison Mitchell, director of responsible supply chains at RCS Global, told CNBC.
He said companies were typically ignorant of exactly where they sourced their materials, rather than indifferent.
"There is quite a bit of movement on this issue in terms of companies taking the issue seriously," Mitchell told CNBC.