13. Wool Price Determination: Macroeconomic and External Linkages

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Learning objectives

On completion of this topic you should be able to:

- understand economic developments in the wool market
- be able to evaluate the many domestic and foreign developments such as exchange rate fluctuations, changes in government policies, etc that affect the wool market
- be able to make strategic marketing decisions based on analytical evaluations of the market

Key terms and concepts

The individual producer's or firm's supply, the individual consumer's demand, market supply and demand functions, competitive market equilibrium, the concept of elasticity and the distinction between movements along market supply and demand functions on the one hand and movements of the functions on the other hand.

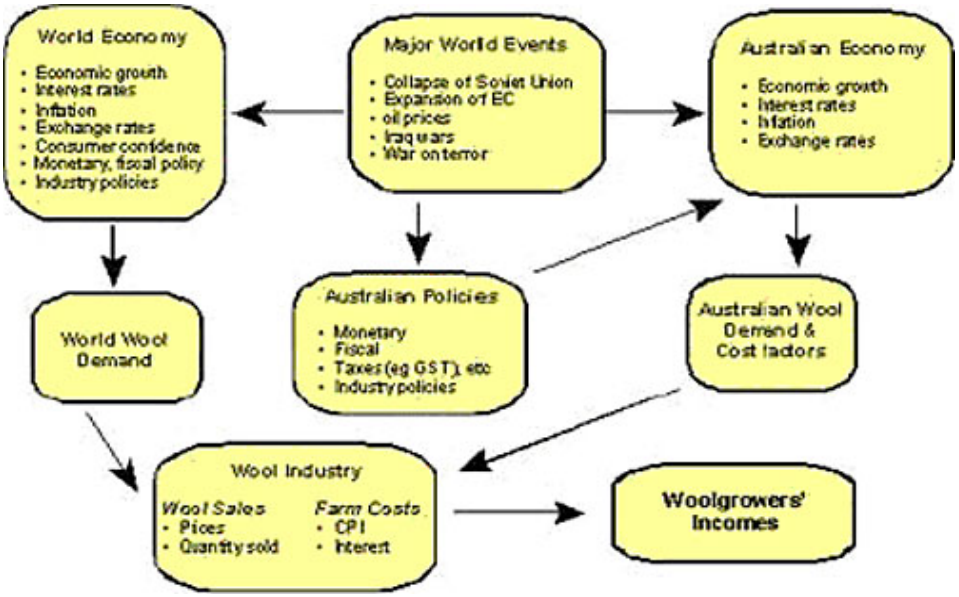
Introduction to the topic

Australian woolgrowers' incomes are influenced by developments in the world and Australian economies within which they exist and within which they have to work. The links between the macroeconomic and external forces summarised in the figure and growers' incomes are not necessarily straightforward, not the least because the effects do not always work in a single direction.

Take a sharp increase in oil prices. At first glance this might appear favourable to wool as it would increase input costs for man-made fibre producers and so would make wool relatively more price competitive. But what if inflation also surged as a result? Central banks might raise interest rates which would dampen economic growth and with it wool demand. If Australian real interest rates rose more than elsewhere, the $A might strengthen and tend to depress wool prices. The story becomes more involved when feedbacks between wool and the Australian economy and between wool and other rural industries (not shown) are considered.

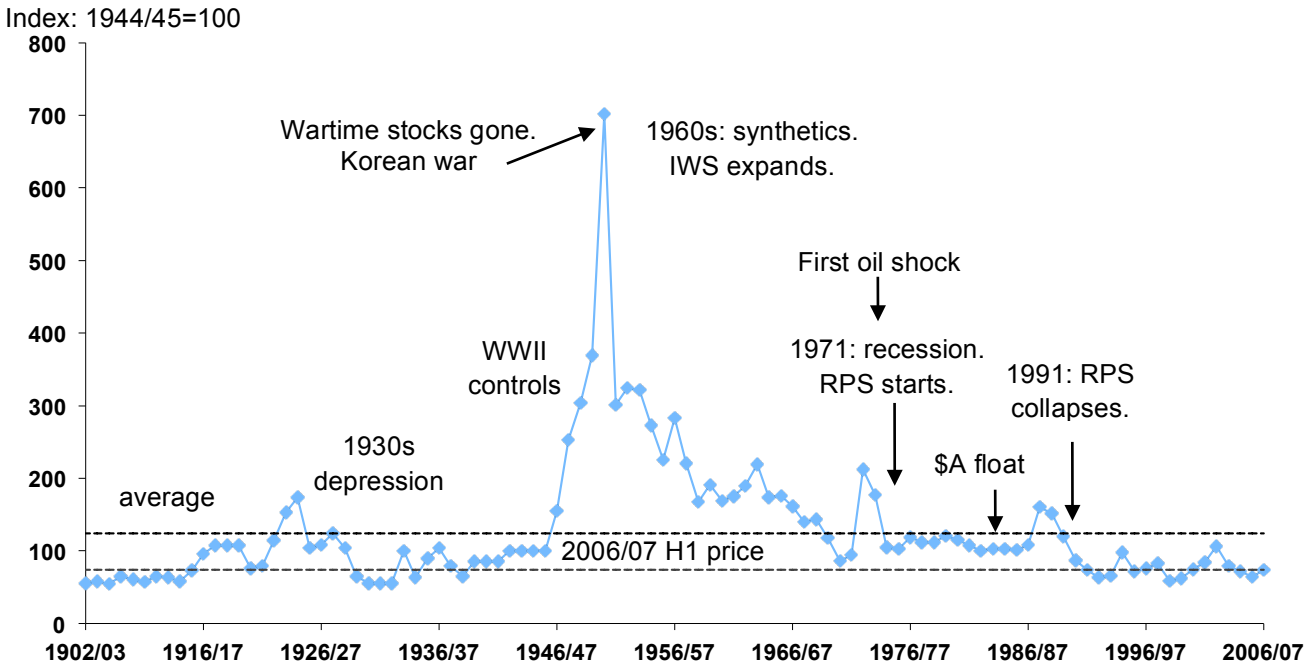
The path of real, or inflation adjusted wool prices reinforces the story of the previous chart. The market's ups and downs can be traced to economic recessions, wars, the advent of new technology, droughts, government controls, policy failures by government, etc. The most striking feature of the wool price history of the 20th century is the phenomenal price boom associated with the Korean War in the early 1950s.

Figure 13.1 Woolgrowers in a World Setting.
Adapted from: Pearce, Vincent and McKibbin (1993).



By the end of 1949-50, wartime wool stocks had dwindled to about 10% of production, well down from 122% of production at the end of 1945-46. The Korean War created a surge in wool demand from the military and, under the circumstances of that war, buyers paid enormously high prices to secure wool. This price boom added significant wealth to Australia and probably sustained investment in the wool industry for years afterwards. This was the period when stories of woolgrowers driving sheep around their paddocks in Rolls Royces surfaced. Unfortunately for Australia, that period has gone.

Figure 13.2 A Long-Term Perspective on Real Wool Prices
Sources: Figures prepared by K. Stott, The Woolmark Company from data supplied by ABARE, AWC, AWEX and ABS.



13.1 Role of economics

Economics provides a logical framework for understanding how the types of events identified in Figure 13.2 interact with the wool market to determine aggregate wool sales and prices and therefore the fortunes of all those dependent on wool for their livelihood.

It is useful to begin at the beginning by recognising that it is scarcity that makes economics useful both in the study of wool marketing and more generally. At any given time the available resources and productive capacity of individual economies and the world as a whole are scarce *relative* to the wants of people. Few would argue with that proposition in relation to developing countries where many people do not even get enough food. But what of countries like Australia, the USA and Japan where companies have to package computer games with their breakfast cereals to make sales? Even in such countries, not everyone who wants one has a job. And of those people who do, some might never afford a holiday while most will just never live in a mansion overlooking Sydney Harbour, wear Armani suits, drive an Aston Martin just for fun in addition to the Mercedes used for family occasions and spend six months of every year holidaying in the world's pleasure spots, no matter how intensely they might want those things.

Economics is a social science concerned with the study of human behaviour, particularly the study of how people and societies can best use scarce resources to make valuable products and how these are distributed among different individuals and groups.

Society's scarce resources include labour, capital, land and other natural resources, all of which have both quantity and quality aspects. These resources are also called factors of production as they include the necessary inputs for making products. The term "products" means both goods and services. Goods and services obviously include tangible items that can be "held" and/or directly bought and sold. They also include intangible items that may never be directly bought or sold such as "environmental services" which, amongst other things, represent the value of unspoiled bushland or a pristine river environment.

It is human behaviour in two principal domains that is relevant, the behaviour of people either individually or in organised groups, in producing and delivering products and services that are valued (*production*), and the behaviour of people as consumers (*consumption)*. It is particularly relevant in a wool marketing course to note that the ultimate objective of economic activity is consumption. There is just no point in even the most technically efficient production of one tonne never-rust stainless steel nails if nobody wants them.

Many people view economics as a highly theoretical and "academic" discipline that is not linked to the real world. Students worried about the pedigree of economics for the real world might note three things. First, many of the world's very best business brains invest their own time in undertaking MBA degrees. Second, people spend tens of thousands of dollars – in terms of income foregone, fees and other costs, to get their MBAs. Third, the rules they are taught for pricing Jumbo jets, cars, fizzy drinks and hamburgers, etc are all derived from the economics outlined here, even if the rules are expressed in somewhat different ways.

The fact is economics rests on two key foundation stones that exist quite independently of any economic theories. These are the existing production technology developed by agricultural scientists, woolgrowers and others, and consumers' preferences, as expressed by consumers' choices in the real marketplace.

Economics bridges the gap between these foundation stones in presenting a logical framework for analysing:

- How, in a world of scarcity, producers and consumers make choices designed to maximise their wellbeing;
- The interactions between the producers (supply) and consumers (demand) sides of the market; and
- The economic efficiency of resource allocation resulting from the free operation of the market and of the impacts of any government intervention designed to improve or alter market outcomes.

Students with some background in economics will remember that a fundamental conclusion of economics is that, provided society is prepared to accept the initial distribution of income, the interactions of consumers and producers in free competitive markets will result in an efficient allocation of society's scarce resources. The competitive market is said to be efficient in an economic sense because it satisfies the maximum feasible level of consumers' wants at least cost. It does this by allocating final goods and services to those consumers who value them most, ensuring that the goods and services are provided at least cost which means that all production inputs, including labour, are paid the value of their contribution at the margin so that production decisions reflect the true economic opportunity costs of resources to society.

The necessary conditions for a competitive market are reasonably well approximated in agricultural markets where for the most part aggregate production outcomes are the result of decisions by individual producers whose output typically constitutes a very small part of the market total. It is useful to briefly review this and some of the other characteristics of agricultural industries, and particularly of wool, that can affect agricultural marketing before turning to the cornerstones of market analysis, producer and consumer behaviour.

13.2 Characteristics of agriculture

The characteristics of farms and farm production differentiate agriculture from many other types of production activities. Those characteristics of farming have implications for the marketing of agricultural products. The distinctions can be summarised under four headings.

Resource specificity

Farming, certainly broadacre farming, is a land based and land-intensive activity and is location specific. Yes, wheat and wool can be produced in many places, farmers can change their enterprise focus and can move from Victoria to Queensland to carry on a business of farming. But it is not possible to “pick up” any one farm and move it to a more favourable location when circumstances change. And because agriculture is land-intensive, the scale and labour requirements of farming in advanced countries mean that production occurs some distance from markets.

The land based and biological nature of farming also mean that compared to non-farm activities, it can be difficult both to expand the business by increasing farm area or livestock numbers and to shift between enterprises. For instance, a large shed in a town can be used for many production activities but it is not sensible to convert steep country into prime cropping land.

The family basis of many farm operations also works to impede adjustment of farm businesses to changing circumstances. A family operation has more restricted access to capital than corporations and the lifestyle and “self-employed” aspects of farming can cause people to hang on in a failing business longer than otherwise.

Assembly and quality

The agricultural sector is typically made up of many relatively small owner-operated farms that are widely dispersed. Consequently weather conditions alone can cause both within season and between season variations in the quality of production. Differences in the abilities of farm operators are another source of quality variation. These factors lead to a requirement to assemble and grade output from different farms so the product can be sold in “marketable quantities” to buyers in “distant” markets.

Aside from the quality differences already mentioned, many farms produce similar products that are difficult if not impossible to differentiate in the minds of buyers. So Joe Bloggs has little chance of a price premium for his 20 micron merino fleece wool over wool of identical quality and presentation produced by his neighbour and sold at the same time and place.

Storage

In addition to the within season and between season variations in the levels of production due to weather, much of farm production comes in lumpy units such as the annual harvest of winter cereals or the annually shorn wool clip. These factors lead to a need to store products that are often perishable for relatively long periods between harvests.

In contrast, factory production processes can be maintained throughout the year, are not subject to the vagaries of the weather and can be more easily tuned to the changing level of sales of the product.

Competitive structure

The production of individual farms or farmers is generally small relative to the aggregate industry output. But if farmers are all responding to a set of incentives and so all expand or reduce output simultaneously, then their collective action will have an appreciable impact on the market. The relatively small scale of individual farms also means that individual producers will not be able to recoup the costs of advertising or R&D expenditures they might want to undertake.

Whilst the types of distinctions just listed need to be recognised, they should not be blown out of proportion. There are many forms of family based businesses operating outside farming that share some of agriculture's characteristics. For example, non-farm family businesses probably face similar capital constraints to those that operate in agriculture. And, for example, even if corner grocers are not subject to droughts and floods, they can be ruined just as effectively if a new supermarket with good parking decides to locate nearby. And, finally, just how different is the personal adjustment challenge for a 55 year old farmer forced out of agriculture from that of a 55 year old middle manager made redundant?

13.3 Wool's characteristics

Wool is a long-established natural fibre that meets both "basic" and "discretionary" needs of human beings. This means many people know wool's positive (warmth, fire safety, etc) as well as its negative (prickle) attributes. The importance of the fashion element of demand, especially in richer countries, is that fashion goods have in-built obsolescence, needing to be replaced whenever fashion swings far enough. The fashion element of wool demand makes wool demand relatively income responsive amongst agricultural commodities. Wool's "natural/green" tag and the fact of the fashion element of wool demand probably make wool more promotable than other commodities, but also make the wool market more the captive of the economic climate.

As with other broadacre commodities, wool production is a land based activity. But, being a livestock activity, the lag between a decision to expand production and the realisation of the decision is longer than for annual crops. This characteristic of wool can become very important in the incidence of the benefits and costs of government policies on woolgrowers.

Wool is a minor commodity on the world stage accounting for probably no more than three per cent of total fibre production. Since man-made fibres account for over half of all fibre output, an increase of perhaps five per cent in man-made fibre production could completely replace wool. That five per cent is probably well within the capacity of existing plants. So ultimately the world can easily do without wool, wool is a fibre of choice, not a necessity. Nevertheless, wool remains an important commodity for Australia and Australia is a big fish in the world wool pond. Australia accounts for some 25 per cent of world wool production and about half of total world wool exports. In fact Australia holds an even more significant position in the market than these aggregate figures suggest because wool is an heterogeneous commodity, as shown in Figure 13.3.

Figure 13.3 Wool Production: Major Exporters.
Sources: Wool International (1997); Connolly (1990).

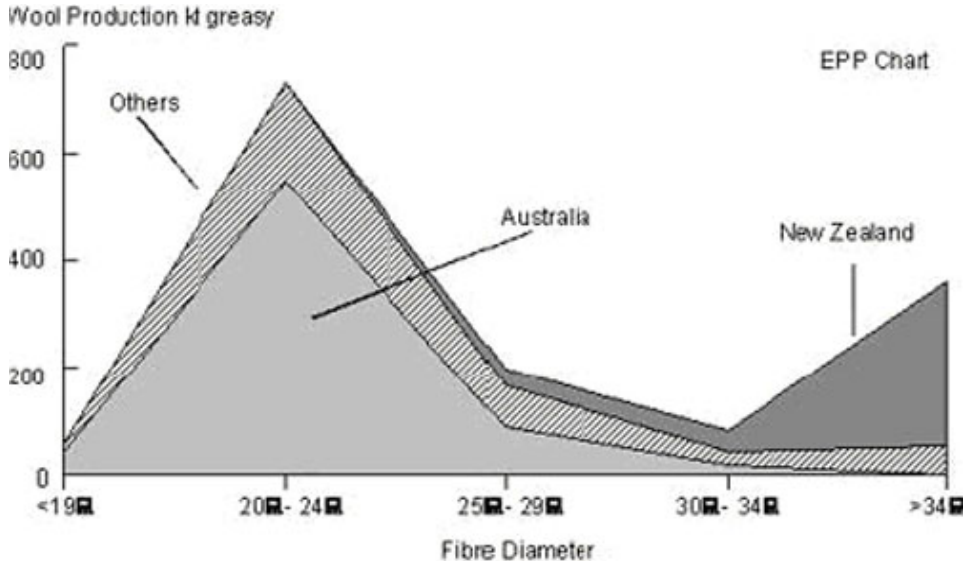


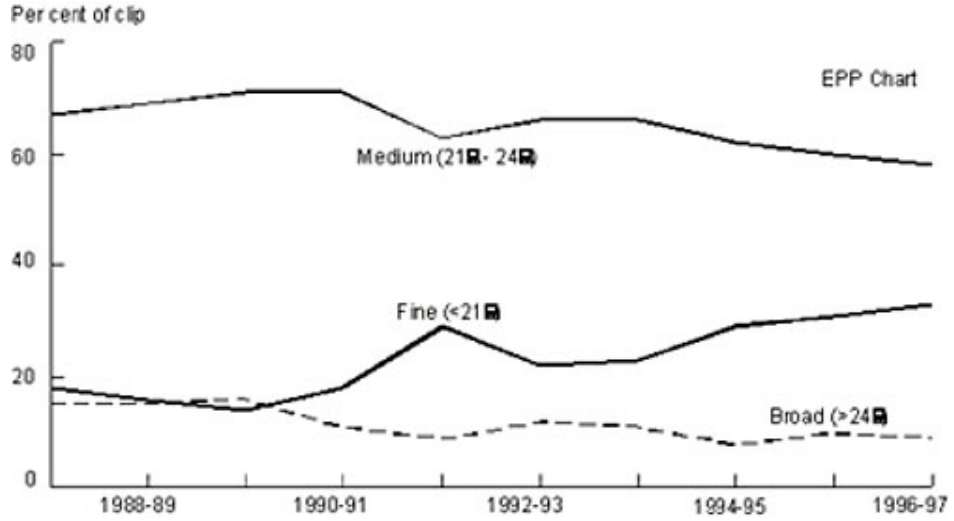
Figure 13.3 shows wool production by the major exporting countries (the "Others" are South Africa, Argentina and Uruguay) which account for nearly half of total world production and for nearly 75% of world raw wool exports. In Australia's case, wool exports in raw and semi-processed form make up 95% or more of the average clip. Note the demarcation shown in Figure 13.3 between the quality profiles of the major exporters. Australia dominates the finer apparel segments of the market giving Australia, but not individual growers – some market leverage. What this leverage means today is that if unduly low market prices make wool unprofitable in Australia, the consequent production adjustments by woolgrowers will tend to cause prices to move upwards. But, as demonstrated with the collapse of the Reserve price Scheme, it also gives Australia the capacity to wreak havoc in the market with poorly considered policies.

Figure 13.3 is based essentially on data for 1982-83, but it is unlikely that revisions to the data would alter the essential points substantially.

While Australia remains a big fish in the world wool pond, the importance of wool in Australia has declined dramatically since the heady days of 1950-51 (Heady 1952, see Table 13.1). The changing position of wool reflects the phenomenally favourable starting point of 1950-51 as well as changes in wool production, down over 40% since 1990-91, relatively poor wool prices and, of course, more favourable trends for other farm sectors.

The declines in the relative importance of wool are not necessarily a cause for policy concern because they also reflect the maturation and diversification of the Australian economy. Moreover, half of all broadacre farms still run sheep and wool as a primary income source for roughly 11,000 farm properties. Unfortunately, ABARE survey data suggest sheep specialist properties have been a lagging sector of Australian broadacre agriculture. Since the collapse of the Reserve Price Scheme in 1991, sheep specialists have racked up business losses averaging $245,000 per farm. And although the wool stockpile has now finally disappeared, sheep specialist properties appear to be less profitable than other broadacre farm types. Large wool growing properties – those running more than 3000 sheep – have earned returns on par with broadacre generally, but there are relatively few such properties.

Figure 13.4 Changing Clip Composition.
Sources: Wool International (1997); Connolly (1990).



The very low wool prices following the collapse of the Reserve Price Scheme in 1991 have aggravated the decline in the industry's relative importance. Woolgrowers have responded to the unfavourable levels of wool prices since 1991 by cutting production and turning to other enterprises where possible. Growers have also responded by shifting towards producing finer wools, which fetch higher prices, as shown in Figure 13.4. The relatively sudden jump in the share of fine wools in the clip in 1991-92 is probably due to the dry conditions during the season and the appreciable price premium for the finer wools over 1987-88 to 1990-91.

Table 13.1 Wool's Changing Position in the Australian Economy. Source: Table prepared by K. Stott, The Woolmark Company from data supplied by ABS, AWEX and ABARE.

	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2005-06
Wool Industry							
Sheep Numbers (million)	109	147	172	134	163	119	101
Wool Production (kt greasy)	507	737	890	701	1066	652	508
Shorn wool (kt greasy)	467	667	800	638	990	602	461
Average Nominal Price (A$/kg clean)	4.49	1.63	1.10	4.08	6.31	6.82	6.78
Real Price A$/kg (2004/05 values)	79.00	17.64	9.21	12.44	9.10	7.85	6.78
Domestic Economy (A$ million)							
Gross Domestic Product	7,078	15,028	35,111	145,642	397,883	707,140	922,386
Gross Farm Production Value	1,924	2,745	3,539	11,540	21,214	34,359	37,900
Livestock products	1,259	1,674	2,063	6,229	12,069	15,772	17,723
Wool	1,237	637	518	1,633	4,093	2,541	1,970
Crop products	665	1,072	1,476	5,311	9,145	18,587	20,176
Wheat	250	391	404	1,684	1,989	5,130	5,727
Australian Exports (A$ million)							
All Merchandise Exports	1,974	1,884	4,244	18,718	52,155	115,794	154,383
Farm Exports	1,780	1,400	2,103	8,179	13,111	32,653	30,531
Wool & sheepskins	1,308	712	594	1,920	2,887	3,897	2,544
Wheat	216	309	434	1,577	1,643	4,197	3,296
Wool's Share (%)							
GDP	17.6	4.2	1.5	1.1	1.0	0.4	0.2
Value of Rural Production	64.3	23.2	14.6	14.2	19.3	7.4	5.2
Merchandise Exports	66.3	37.8	14.0	10.3	5.5	3.4	1.6
Farm Exports	73.5	50.9	28.2	23.5	22.0	11.9	8.3

13.4 Producer/production analysis

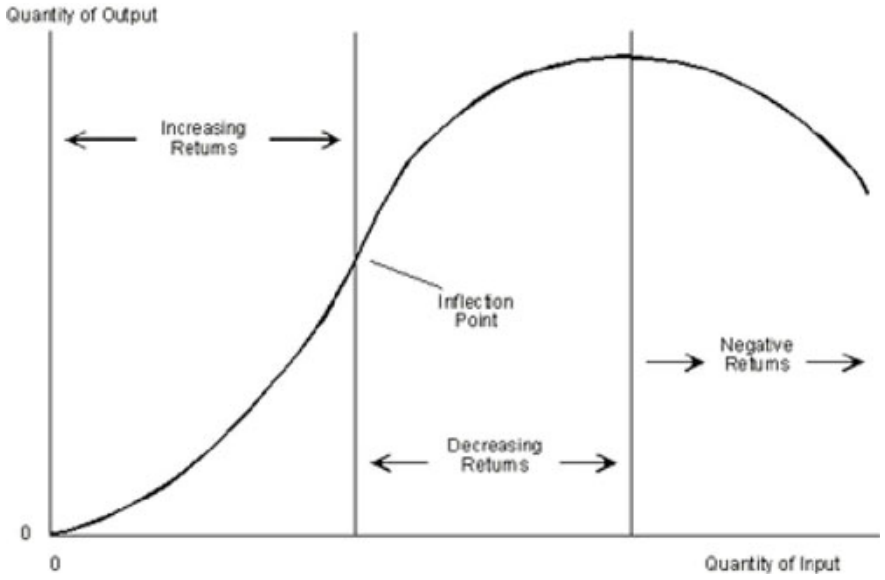
Producer or production analysis is concerned with the production activities of people and firms. Producer analysis has two foundations. The first, already noted, is the state of production technology as summarised by the firm's production function at any given time. Whilst economists might have coined the term, the production function is ultimately the result of “hard” science and technology. The second foundation stone of producer analysis is a set of propositions about producers and their behaviour. These propositions are that firms or producers are well informed, are rational, seek to maximise their profits subject to the available technology, and produce only a small part of total market supply.

The production function

A firm’s production function fully describes the nature of the technology available to the firm and shows the relationship between the quantities of inputs used per unit of time and the resultant total production.

Figure 13.5 shows a typical or classical production function where, for the sake of simplicity, only a single input is required to produce the final product. Notice that at first the addition of extra inputs causes production to grow at an increasing rate. After a point, adding more inputs causes output to grow at a diminishing rate. Eventually output peaks and then declines if even more inputs are added.

Figure 13.5 Classical production function.
Source: Haszler, Economic Policy Perspectives, (2006).



This changing relationship between additional input use and output is measured by the Marginal Product of the input, a critical concept in determining a firm’s costs and output. **Marginal Product** (MP) is the extra or incremental output obtained from the last incremental unit of input used. It is measured by the slope of the production function. So if Q is output, I is inputs and MP_I is the marginal product of I, then:

If $Q = f(I)$, $MP_I = dQ/dI$

As indicated above, marginal product increases up to a point, **the inflection point**, and then falls and eventually becomes negative beyond the point of maximum total output given by the highest point on the production function.

This relationship between marginal products and input usage gives rise to the **Law of Diminishing Marginal Returns** which states that if additional units of any one input are added to a production process, with all other inputs held constant, eventually additional usage of the input will cause total production to fall. Table 13.2 below provides some hypothetical examples of the law of Diminishing Marginal Returns. The crop example just illustrates the well-known phenomenon of too much fertiliser "burning" a crop.

Table 13.2 Hypothetical Examples of Total and Marginal Product Relationships. Source: Haszler, Economic Policy Perspectives, (2006).

Crop Yield from Fertiliser			Wool Production per Hectare		
Units of Fertiliser	**Total Crop Yield**	**Marginal Yield**	**Sheep/ha**	**Total Wool Yield/ha**	**Marginal Wool Yield/ha**
1	10	-	2.5	11.4	-
2	19	9	5.0	22.6	11.2
3	26	7	7.5	33.2	10.6
4	29	3	10.0	42.4	8.2
5	30	1	12.5	49.6	7.2
6	29	-1	15.0	55.2	5.6
7	27	-2	17.5	55.1	- 0.1

The zones of increasing, decreasing and negative returns in Figure 13.5 have considerable significance in terms of managing real-life businesses (as indicated below).

- **Zone of increasing returns**: It does not pay competitive firms to operate in this zone, provided it is profitable to produce in the first place. The reason is that the marginal product of the input is increasing, so profitability also increases progressively through this range. The only reason an informed firm might produce in this zone would be if the firm was absolutely starved of the cash needed to buy additional inputs.
- **Zone of decreasing returns**: Producing somewhere in this zone will maximise the firm's profits.
- **Zone of negative returns**: It is economically irrational, and just plain wasteful, to produce in this zone. Any output level in this area can be produced with fewer inputs at an "earlier" point on the production function. So why would any informed, rational and profit maximising firm or producer want to spend more than necessary on inputs?

The foregoing discussion of the various zones of the production function provides the clue to the point that classical functions as shown in Figure 13.5 would generally be based on experimental data. Given enough time, etc we would expect commercial firms to end up operating in the zone of decreasing returns.

Note that a firm's production function is not necessarily fixed except in the short-term. Successful R&D that increased the efficiency of a plant's fertiliser uptake and utilisation would lift the "output/fertiliser" function so that, at every initial fertiliser application, production was greater than before. A change in technology that better matched the rate of release of the fertiliser with the plant's needs would have the same general effect.

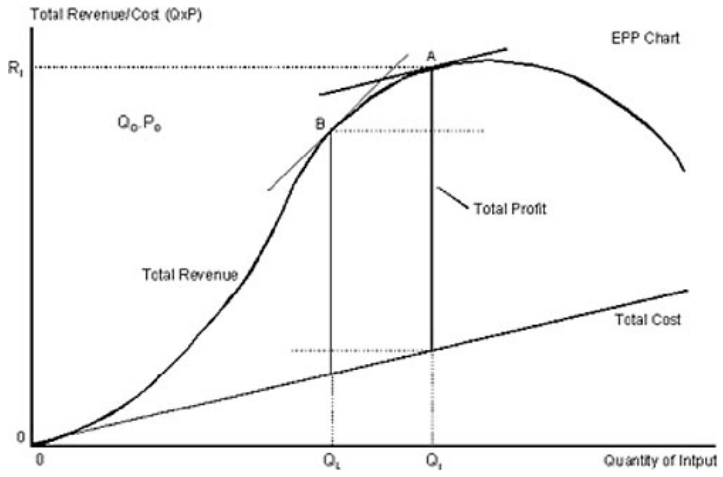
By contrast, if fertiliser quality deteriorated – so less was produced for any given quantity of fertiliser – the production function for the inferior fertiliser would sit lower and perhaps to the right of the original function.

13.5 Total revenue function

The physical production function can be manipulated to determine the firm's optimal levels of input usage and production. This is demonstrated in Figure 13.6 in which the scale on the horizontal input axis is the same as in Figure 13. 5. Note, however, the vertical axis is now measured in dollars on a scale based on multiplying the original output quantities Q_O by the output price P_O.

The total revenue curve in Figure 13.6 looks surprisingly like the original production function. And so it should because total revenue at each input usage is derived simply as the original Q_O times P_O.

Figure 13.6 Total Revenue and Total Costs Functions.
Source: Haszler, Economic Policy Perspectives, (2006).



The total revenue curve (TR) gives rise to a concept analogous the marginal product on the physical production function, namely the value of the marginal product (MP). The **value of the marginal product** (VMP) is the value of the product of the last unit of input applied and measures the marginal or incremental revenue (MR) obtainable for each additional unit of input applied. So, given the subscripts O and I indicate output and input respectively, P is price and the other symbols are as already indicated, then:

$VMP_I = MP_I \cdot Po = MR_I$
It follows from the Law of Diminishing Marginal (physical) Returns that VMP must also eventually fall.

In Figure 13.6 the total cost (TC) line shows the costs of the inputs used to generate the revenues given by the total revenue curve. In the case of the total cost curve, the **marginal cost** of inputs is the cost of the last unit of input used. So if fertiliser inputs are measured in 250 kg units and fertiliser costs $120 per tonne, the marginal cost of inputs is $30.

Because the firm is too small for its requirements to affect input prices, input prices are constant and so:

$TC_I = Q_I \cdot P_I$
which means in this case that TC_I is a straight line passing through the origin with slope P_I.

The line tangent to the total revenue curve at point A is parallel to the total cost curve and so has the same slope, that is P_I. It is obvious by inspection that in this single input case the distance between total revenue and total costs, or profit, is greatest at the input usage of Q_I consistent with point A. That is, the profit maximising level of input usage is at Q_I .

What if a firm not subject to capital constraints was operating with a lower level of inputs, Q_L? It is clear by inspection that the increase in total costs incurred by moving to Q_I would be more than compensated by the related increase in total revenue.

Therefore, the state of the firm's production technology at the time in question and market prices for the output and the input, both beyond the small competitive firm's control – uniquely determine the optimal or maximum profit position for the firm, as using Q_I inputs to produce Q_O output in the example shown.
The conclusions based on Figure 13.6 point to a fundamental rule, namely that competitive firms should operate, use inputs in this case, up to the point where the incremental benefits (marginal revenue/returns or MR) just equal the incremental increase in costs (marginal cost or MC). Prior to that level of activity or input usage, the firm will not receive its maximum "activity benefits bang" for its "activity costs buck". In this case, marginal cost is the input price P_I which is constant at all levels of input usage as the firm is, by definition, too small to affect the market. And marginal revenue is the value of the marginal product VMP_I which varies as MP_I varies at every level of input usage, with the output price Po again constant at any given time.

Some reflection and just a little imagination in defining benefits and costs should show that, wherever people have choices, the MR = MC rule of economics is in fact a universal optimisation rule.

An increase in output prices would "lift" the total revenue curve and increase the optimum levels of input usage and output. A drop in market prices for the output would work in the reverse direction. A drop in input prices would reduce the slope of the total cost curve. This would make it profitable to increase input usage to expand output and profit. In effect, the slope of the total cost curve would decline with the result that the tangency of a line parallel with the total revenue curve would occur to the right of point A. But even if input costs fell to zero, it would not pay to use inputs beyond the point of maximum output and revenue.

13.6 Input usage and output generalised

Provided individual producers or firms have access to sufficient capital to maximise profits, they should apply variable inputs up to the point where, holding all other inputs constant, the value of the marginal product (VMP) of the input equals its own price:

$VMP_I = MP_I \,.\, P_O = P_I$

This point is demonstrated by the data in Table 13.3. For each of three different hypothetical crops, the table provides the type of data that would underpin Figure 13.6. The input information and yield data define the production function for each crop, and the costs and returns data are given in the succeeding columns. The task is to determine the optimal, profit maximising, levels of fertiliser use and production for each of the three crops. The constraint here is that fertiliser applications can only be adjusted in increments of 100 kg/ha.

The optimal levels of fertiliser application to each of the three crops are shown in bold text in the table. It is important to note that these are the optimal levels under the operational constraint that fertiliser can only be applied in increments of 100 kg/ha. Take Crop 1. Here, when fertiliser is applied at 700 kg/ha, the VMP at $34.50 is much closer to the input price per 100 kg of $35.00 than when fertiliser use is 600 kg/ha. But it is still not worth using more than 600 kg/ha because the next 100 kg fertiliser above 600 kg/ha actually reduces profit.

So even if the farmer had unlimited cash, it would not pay to spend more than $525 to use more than 1,500 kg of fertiliser (600+300+600). Anything more than that reduces profits and so is just wasteful.

Without the increment constraint of 100 kg/ha, The true point of maximum profit with respect to fertiliser use in the case of all three hypothetical crops would be somewhat higher than the 600 kg/ha, 300 kg/ha and 600 kg/ha levels shown and would occur at fertiliser application rates between the indicated rate and the one above it. If the 100 kg/ha incremental application constraint did not apply, so that fertiliser inputs were perfectly divisible down to increments of 1 kg/ha or even less, the profit maxima would indeed occur where $VMP_I = P_I$.

Even if capital is scarce the value of the marginal product still provides a basis for allocating inputs as shown in Table 13.4.

With restricted funds, the input should be allocated to where it yields the greatest benefit. The best application can be visualised as a sequential application of each 100 kg increment of fertiliser in descending order of the value of the value of the marginal product of fertiliser with respect to each of the three crops.

If the farmer can only afford to spend, say, $350 on fertiliser to buy 1,000 kg, then 400 kg would be applied to Crop 1, 300 kg to Crop 2 and 400 kg to Crop 3. Compared to the unrestricted capital case, this is a sub-optimal level of fertiliser use but, given the financial constraint, it maximises the *net* return from using the fertiliser.

Table 13.3 Equalising at the Margin: Three Crops.
Source: Haszler, Economic Policy Perspectives, (2006).

Production Function			Costs		Returns		Profit
Fertiliser Input	**Yield**	**Marginal Product**	**Total Cost**	**Marginal Cost**	**Gross Return**	**Value of Marginal Product**	
kg/ha	**kg/ka**	**kg/ka**	**$**	**$**	**$**	**$**	**$**
			@ $0.35/kg		Crop 1 @ $0.30/kg		
0	900	-	0	-	270.0	-	270.0
100	1300	400	35	35	390.0	120.0	355.0
200	1640	340	70	35	492.0	102.0	422.0
300	1925	285	105	35	577.5	85.5	472.5
400	2160	235	140	35	648.0	70.5	508.5
500	2350	190	175	35	705.0	57.0	530.0
600	**2500**	**150**	**210**	**35**	**750.0**	**45.0**	**540.0**
700	2615	115	245	35	784.5	34.5	539.5
800	2700	85	280	35	810.0	25.5	530.0
					Crop 2 @ $0.25/kg		
0	1000	-	0	-	250.0	-	250.0
100	1330	330	35	35	332.5	82.5	297.5
200	1580	250	70	35	395.0	62.5	325.0
300	**1755**	**175**	**105**	**35**	**438.8**	**43.8**	**333.8**
400	1870	115	140	35	467.5	28.8	327.5
500	1930	60	175	35	482.5	15.0	307.5
600	1970	40	210	35	492.5	10.0	282.5
700	1980	10	245	35	495.0	2.5	250.0
800	1950	- 30	280	35	487.5	- 7.5	207.5
					Crop 3 @ $0.10/kg		
0	2000	-	0	-	200.0	-	200.0
100	3000	1000	35	35	300.0	100.0	265.0
200	3800	800	70	35	380.0	80.0	310.0
300	4500	700	105	35	450.0	70.0	345.0
400	5100	600	140	35	510.0	60.0	370.0
500	5580	480	175	35	558.0	48.0	383.0
600	**5950**	**370**	**210**	**35**	**595.0**	**37.0**	**385.0**
700	6210	260	245	35	621.0	26.0	370.0
800	6360	1150	280	35	636.0	15.0	356.0

Table 13.4 Best Fertiliser Allocation to Three Crops.
Source: Haszler, Economic Policy Perspectives, (2006).

Fertiliser		Return from Successive 100 kg units of Fertiliser			Cumulative Gross Return	Cumulative Profit
Cumulative Quantity	Cumulative Cost	Crop 1	Crop 2	Crop 3		
kg	$	$	$	$	$	$
0	0	270.0	250.0	200.0	720	720
100	35	120.0			840	805
200	70	102.0			942	872
300	105			100.0	1042	937
400	140	85.5			1128	988
500	175		82.5		1210	1035
600	210			80.0	1290	1080
700	245	70.5			1361	1116
800	280			70.0	1431	1151
900	315		62.5		1493	1178
1000	**350**			60.0	**1553**	**1203**
1100	385	57.0			1610	1225
1200	420	45.0			1658	1238
1300	455			48.0	1703	1248
1400	490		43.8		1747	1257
1500	525			37.0	1784	1259
1500	**525**	**750.0**	**438.8**	**595.0**	**1784**	**1259**
1600	560	34.5		26.0	1818	1258
1700	595		28.8		1847	1252
1800	630				1873	1243
1900	665	25.5			1899	1234
2000	700		15		1914	1214
2000	**700**	**810**	**482.5**	**621.0**	**1914**	**1214**

13.7 Cost concepts and the firm's cost curves

The analysis up to now has relied on identifying optimal levels of input use that then define the optimal output. However, it is useful in market analysis to link the firm's marginal costs directly to its marginal or incremental costs **per unit of production**. That link follows from a more detailed consideration of the firm's cost relationships.

Competitive firms such as most family farms around the world take input and output prices as given so their output decisions are determined by their cost curves which, as before, depend on their production function and its marginal product characteristics.

Measuring the **economic cost** of an activity means measuring its **opportunity cost**, that is the costs of what is given up, or sacrificed for the chosen activity. Time off from study just before final university exams might result in fail results for one or more subjects leading to a need to repeat the whole year. In that case the economic cost of the time off would be all the costs involved in repeating the subject plus the costs of the student's lifetime stream of graduate income being deferred one year. A heavy penalty indeed. On the other hand, the time off might provide a much-needed rest, which then results in the student scoring better than otherwise in all the following exams. In that case the cost is in fact a benefit. Or put otherwise, the cost arises from *not* taking the time off.

Explicit costs are costs for resources, including services, purchased to produce the firm's output. Explicit costs impose direct financial costs on the firm and include rates, phone, insurance, wages, the costs of other purchased inputs, and taxes.

Implicit costs are the costs implicitly incurred for resources that are not actually paid for but are still used in production by the firm. Such costs include the opportunity cost of the firm's management (in owner operator firms) or the interest cost on using the capital of the firm's owners in the business.

Imagine that a successful barrister or specialist surgeon decides to make a switch to full-time farming for its alleged "lifestyle" advantages. The economic cost of the barrister's or surgeon's farm's management is the income he or she could earn in his or her profession, *not* what a hired farm manager is paid. Where the farm family's capital is used on the farm, the cost of that capital is not the bank interest rate or the rate that other farms are earning in agriculture, useful benchmarks though these *might* be, but the best rate the capital could earn in any activity, of course taking account of levels of risk, etc.

Total fixed costs (TFC*),* are sum[s] which the firm is committed to pay to factors of production [land, labour, capital] no matter what it [the firm] does and no matter how its actions turn out. Since [these] unavoidable costs are not affected by the firm's actions and will have to be met no matter what the firm does [their] magnitude cannot affect the firm's actions. (Friedman 1965).

So fixed costs, also called overhead or sunk costs, are the costs of the firm's unchangeable, unavoidable or fixed factors of production, or inputs that do not and cannot, in the period under review, vary with the level of output. They include rates on buildings owned by the firm, capital costs of the firm's fixed buildings and machinery, or even the firm's wage bill for current employees, etc.
Total variable costs (TVC*)* are costs that *do vary* in response to the firm's decisions about its level of output, include materials and energy costs and costs of other inputs that go directly into the production process.

There is an important distinction between "fixed costs" and costs incurred on account of "fixed factors of production" which might include land, buildings etc. For example the rates on and capital costs of farmland and buildings will constitute fixed costs over a given period of time if there is no alternative use possible of those assets over that period other than on the farm. But what if the farmer could rent out his land, buildings and machinery to a neighbour? In that case, in economic – as opposed to accounting – terms those land, building and machinery costs become variable costs to the home farm operations. Equally, labour costs can be fixed costs in an economic sense if farm labour has been hired under, say, an annual wage contract. But labour costs for casually employed fruit pickers will be variable costs.

This discussion points to the fact that all costs must be defined with respect to the contractual obligations associated with them and with respect to a particular time period or length of run. It is conventional to define:

- the ***short-run*** as a period during which at least some of the firm's costs are fixed;
- the ***long-run*** as a period over which all costs are variable or avoidable because the firm can decide to shut down or choose between different production systems.

There is no single definition of just what length of time constitutes the short-run and the long-run. In farming, a single crop cycle from planting to harvest would qualify as the short-run. But what if the winter cereal crop fails and is replaced by plantings for a summer crop? In woolgrowing the period between successive shearings is clearly the short-run, because even starving sheep grow wool.

Total costs (TC = TFC + TVC) are all the costs incurred by the firm in producing a given level of output, including implicit as well as explicit costs.

Average costs (AC) for any given level of output are simply the total cost measures divided by quantity (Q):

AC = TC/Q but since
TC = TFC + TVC
AC = TC/Q = TFC/Q + TVC/Q
AC = AFC + AVC

which gives us definitions for **average fixed cost** (AFC) and **average variable cost** (AVC) .

Marginal costs are defined analogously to marginal product. That is, the marginal cost at any given level of output is the additional cost incurred in producing the last unit of output. Marginal cost is the derivative of the total cost function with respect to output and, recall the definition of fixed costs, is determined by variable cost:

MC = dTC/dQ = dVC/dQ

Figure 13.7 The Firm's Costs.
Source: Haszler, Economic Policy Perspectives, (2006).

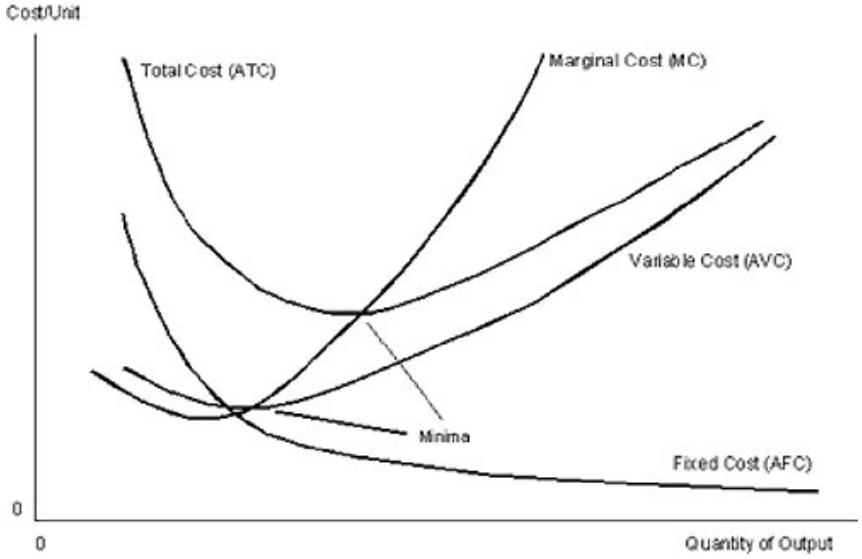


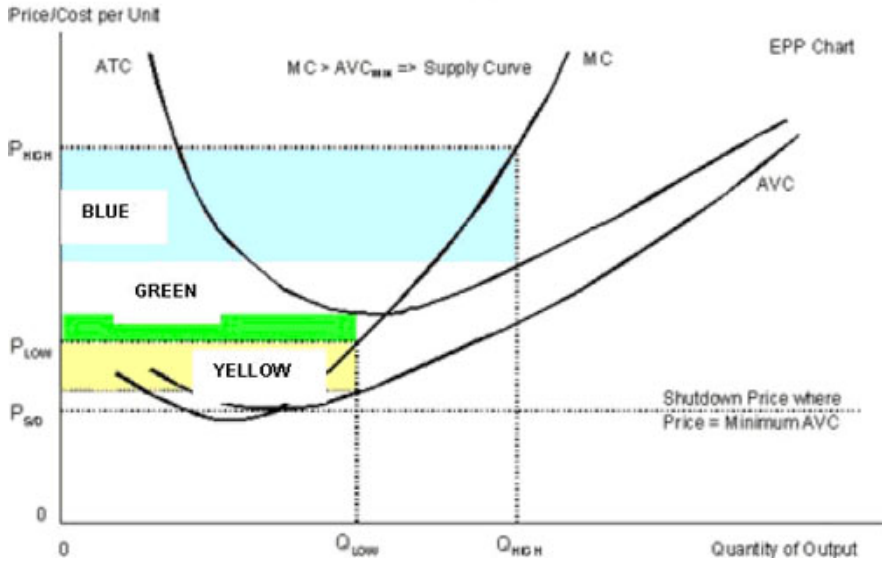
Figure 13.7 shows typical average cost curves for a typical competitive firm. Notice that since fixed costs are fixed, average fixed cost declines as output increases. Average variable cost and marginal cost decline at first as output expands from low levels, but then both rise after a point. In fact for firms operating in competitive markets, marginal cost *falls* when the marginal product of the variable factor *rises* and marginal cost *rises* when the marginal product of the variable factor *falls*. The marginal cost curve always cuts the average total cost and average variable cost curves at their minima.

Table 13.5 Hypothetical Cost Relationships: Chair Producing Firm. Adapted from: Waud, et al. (1992).

Number of Labourers L No.	Chairs Produced per Week Q No.	Total Fixed Cost TFC $	Total Variable Cost TVC $	Total Cost TC $	Gross Return GR $	Total Profit $	Change in Total Cost $
			TVC = wage x L	TC = TFC + TVC	Price = $40/chair	Profit = GR - TC	
0	0	50	0	50	0	-50	50
1	1	50	50	100	40	-60	50
2	3	50	100	150	120	-30	50
3	6	50	150	200	240	40	50
4	10	50	200	250	400	150	50
5	13	50	250	300	520	220	50
6	15	50	300	350	600	250	50
7	16.5	50	350	400	660	260	50
8	17.5	50	400	450	700	250	50
9	18	50	450	500	720	220	50
10	18.3	50	500	550	730	180	50
		Average Fixed Cost AFC $/chair	Average Variable Cost AVC $/chair	Average Cost AC $/chair	Average Return AR $/chair	Average Profit $/chair	Marginal Cost MC $/chair
					MC = Δ in TC/Δ in Q		
0	0						
1	1	50.0	50.0	100.0	40	-60.0	50.0
2	3	16.7	33.3	50.0	40	-10.0	25.0
3	6	8.3	25.0	33.3	40	6.7	16.7
4	10	5.0	20.0	25.0	40	15.0	12.5
5	13	3.9	19.2	23.1	40	16.9	16.7
6	15	3.3	20.0	23.3	40	16.7	25.0
7	16.5	3.0	21.2	24.2	40	15.8	33.3
8	17.5	2.9	22.9	25.7	40	14.3	50.0
9	18	2.8	25.0	27.8	40	12.2	100.0
10	18.3	2.7	27.4	30.1	40	9.9	200.0

Table 13.5 provides a numerical illustration of the relationships between the firm's costs. You should make sure that, based on the input and output data and TFC and TVC data provided, you are able to reproduce the other numbers in the table.

Figure 13.8 Shutdown and Supply Curve.
Source: Haszler, Economic Policy Perspectives, (2006).



As with the earlier production function analysis based on Table 13.3, these precise conclusions are somewhat masked by the fact that the labour inputs are not perfectly divisible into tenths and smaller fractions of a week so that the exactly precise profit maxima are not revealed by the increments shown.

However, the precise optima are indicated in Figure 13.8, which shows a firm with given productivity and costs operating under different market prices. Let's begin with the favourable situation when market price is at P_{HIGH}. At that price it pays the firm to produce Q_{HIGH}. If the firm produces more, its marginal cost on each extra unit of output exceeds the market price leading to a loss on all output above Q_{HIGH}. Producing less will not maximise profits shown by the large shaded rectangle. Notice that at P_{HIGH}, Q_{HIGH}. The firm is making an economic or supernormal profit indicated by the blue rectangle.

But what if prices fall to P_{LOW}? The firm should produce Q_{LOW}. The firm makes a loss at Q_{LOW} but the firm earns a margin above average variable cost on all units of Q_{LOW} shown by the yellow shaded area. This reduces the extent of the firm's total loss by the extent of the small green shaded area. If the firm chose to shut down when price was at P_{LOW}, it's loss would equal the sum of the two smaller (green and yellow) shaded areas.

But if prices fell as low as $P_{S/D}$, the firm no longer has any margin above variable costs so it does not even pay to turn on the lights! So the shutdown rule is:

shutdown if P < minimum AVC

Clearly it is also unprofitable to operate at prices less than minimum variable cost. So a profit maximising informed competitive form would work under the following operational rules:

In the short-run:

P = MC < AVC < ATC	Making losses, don't even turn on the lights
P = MC = min AVC	"Shutdown" point, shutdown, cannot reduce losses by operating
P = MC > AVC < ATC	Stay in business, even expand to minimise losses/maximise profits
P = MC > AVC > ATC	Earning economic profits, definitely stay in business to maximise profits

In the later case the firm is said to be making an **economic profit**, it is earning more than required to keep its resources in that activity. In a competitive industry this will provide the incentive for new firms to enter the industry and “compete away” the economic profit.

In the long-run:

- P = MC = minimum ATC Equilibrium, no "economic profit", no entry

It is not possible to sustain economic profits in a competitive industry in the long run because the existence of economic profits will cause new firms to enter the activity, increasing the market supply, which will reduce prices thereby bidding away the short-run economic profit.

In industries subject to variable output prices, like most agricultural industries, it is possible for firms to earn economic profits from time to time without necessarily causing any significant entry of new firms. Informed potential entrants would know that “next year” could bring on a drought or a collapse in market prices due to a bumper harvest somewhere. So they and existing firms would probably work on an “expected” level of profit that smooths out the highs and lows in the market. The fact that so many farms do indeed hang on in tough times rather than selling up provides some real world evidence of the cost and production principles outlined here.

The ultimate conclusion from this analysis of the typical firm’s production function, costs and market prices is the important result that a competitive firm maximises profits by producing where its marginal costs (MC) equal the market price (P), because for a competitive firm the market price is fixed and represents its marginal revenue (MR). So the competitive firm’s profit maximising production rule is to produce where:

$MC_O = MR_O = P_O$

This “marginal bang” for the “marginal buck” rule is the output equivalent of the input usage rule developed earlier. The MC = MR = P rule also generates the important result that the competitive firm's marginal cost curve above minimum average variable cost is its **supply curve** which is the schedule of quantities that the competitive firm will produce at different levels of prices.

13.8 Consumer/consumption analysis

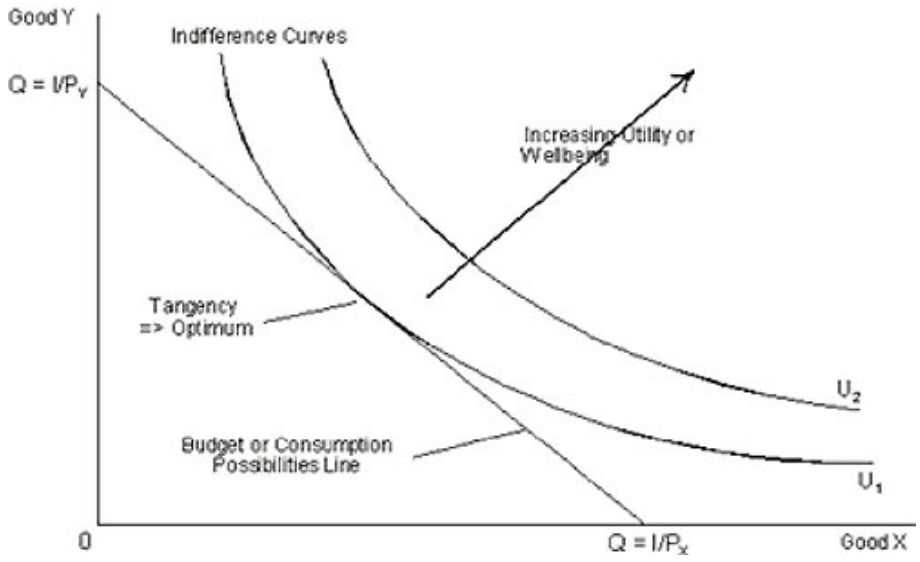
Consumer or consumption analysis is concerned with the consumption activities of people and is ultimately based on insights into and analysis of observed consumer behaviour. We can understand quite readily that having more money, means we can have more of things generally, that we can afford some things which when we were poorer we could not, that price really "matters" for some people and some purchases and not always for other people and other purchases. For example, for most people price matters when buying a car, but not when buying salt. We can also understand that richer people can choose to give more to charity, buy fancier cars and live in larger houses, or all of these together.

There is a remarkable similarity between the propositions about consumer behaviour and those regarding producers and firms.

Just as the technology available to a firm at any one time is the cornerstone of producer analysis, just so the consumer’s set of preferences as revealed in the market is the cornerstone of consumer analysis. As with producer analysis, consumer theory has a second foundation stone in the form of a set of propositions about consumers and their behaviour. These are that consumers are well informed and rational, seek to maximise their “utility” or wellbeing subject to their current incomes, individually have no market power so they accept prices as given, and are non-satiated, that is “want more”.

There are two points of detail to note about these propositions. First, the “want more” proposition is essentially another way of saying that at any one time the world’s resources are scarce relative to consumers’ wants. To help judge the “reasonableness” of this proposition, students should note three things. First, that poor people want more is news to nobody. Second, it is not necessary for everyone to want more of everything. Third, even the richest people find ways to spend their money and, for the most part, are careful not to lose their wealth.

Figure 13.9 The Consumer’s Preferences.
Source: Haszler, Economic Policy Perspectives, (2006).



The other point of detail is that rationality means that consumers are both able to determine their preferences and that they do so in a logical (transitive) way. That means that faced with sets of consumption bundles A, B and C:

if A > B and B > C, then A > C
that is given the first two orderings of preferences, the consumer will also prefer bundle A over bundle C.

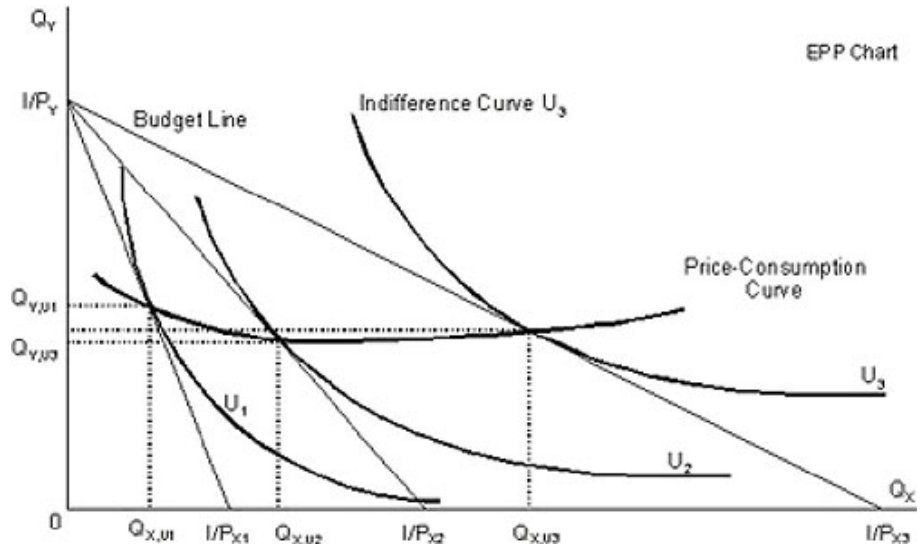
The analysis of consumer behaviour then begins with the consumers preferences as shown in Figure 13.9. The figure deals with the simple case of only two goods X and Y and shows two indifference curves U_1 and U_2. These **Indifference curve** represent combinations of goods X and Y that provide equal levels of satisfaction or wellbeing to the consumer. That is consumers are indifferent to where along the curve they end up and the curve shows how units of X are substituted for Y and *vice versa*.
The curve U_2 represents higher levels of consumption of both X and Y than does U_1. Because consumers “want more” the consumer’s satisfaction is higher everywhere on U_2 than on U_1. And because consumers are unsatiated, levels of satisfaction or wellbeing increase in the direction of the arrow. In principle there are an unlimited number of indifference curves massed up next to each other but rationality means that indifference curves are “well behaved” in the sense they do not cross.

The indifference curve also shows a consumer’s **willingness to buy,** or consume, bundles of X and Y. Any bundle on a single curve is as good as any other, but any bundle on a “higher” curve is better than any bundle on a “lower” curve.

The consumer’s **ability to consume** is determined by the consumer’s income or budget constraint, which is represented by the budget line. The **budget line** shows the combinations of goods X and Y that can be purchased with the consumer’s income. If a consumer spends all of his/her income on Y, the maximum quantity of Y that can be bought is given by income divided by the price of Y, that is where $Q_Y = I/P_Y$). Similarly the maximum quantity of X that can be purchased from any level of income is I/P_X.

Obviously, income changes cause parallel shifts in the line – the higher the income, the further up and to the right will be the budget line. And changes in prices of X and Y cause radial shifts in the budget line – so if the price of X falls while the price of Y says unchanged, the budget line will swing out to cut the Good X axis further to the right.

Figure 13.10 Preferences and Prices.
Source: Haszler, Economic Policy Perspectives, (2006).



The consumer's optimum position is where the highest possible indifference curve is tangent to the budget line. This is the optimum position as it represents the point of maximum possible consumption and, so, maximum possible satisfaction or wellbeing for the consumer. At the point of tangency the consumer's **willingness to buy** (indifference curve) combinations of X and Y just equals the consumer's **ability to purchase** (budget line) those goods.

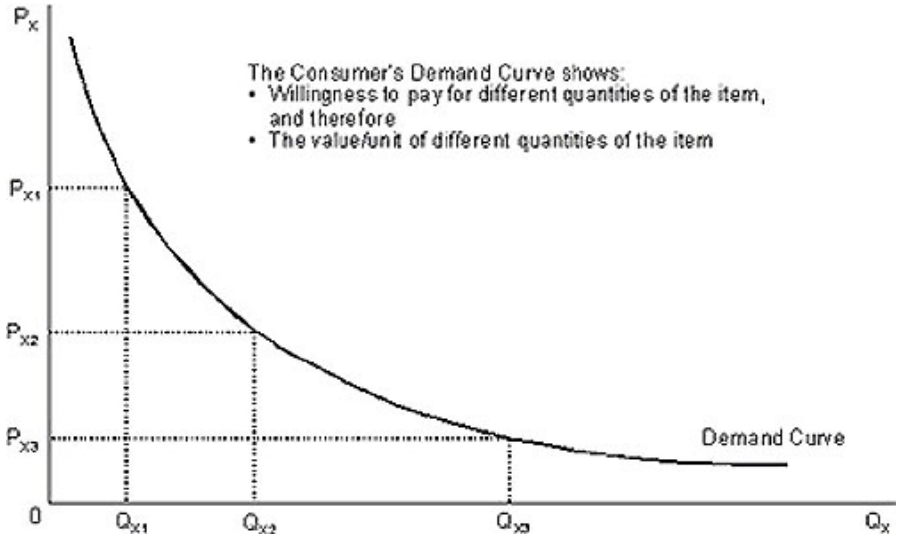
Because consumers "want more" they choose levels and combinations of consumption sets consistent with the highest possible indifference curve. But note that the indifference curve is shown as curvilinear in the figure because of the **Law of Diminishing Marginal Utility of Consumption**. On any one indifference curve, the marginal value of each additional unit of consumption of a product diminishes as consumption of that product increases. Or, put another way, the consumption of each additional unit of the product is valued less than the one immediately before.

As noted before, changes in market prices cause "swings" in the budget line. Figure 13.10 shows such swings due to changes in the price of X. As the price of X increases from P_{X1} to P_{X2}, the budget lines swings out leading to new points of tangency with progressively higher indifference curves from U_1 to U_3. And each point of tangency coincides with a different combination of X and Y from $Q_{Y,U1}$ - $Q_{X,U1}$ out to $Q_{Y,U3}$ - $Q_{X,U3}$. As the latter combination is on a higher indifference curve it is preferred to the first one.

All the points of tangency between the budget lines and indifference curves in the figure can be joined to generate the **price-consumption curve**. The information embodied in the price-consumption curve can be used to generate the consumer's demand curve shown in Figure 13.11.

For the given level of income, each point on a price-consumption curve represents four consistent data items: (1) consumption of X; (2) price of X; (3) consumption of Y; and (4) price of Y. The combinations of the quantity of X and the price of X generate the consumer's **demand curve** which represents the **schedule** showing the relationship between purchases of a good and its price.
Note that the X axis in this and the preceding figure are on the same scale and that the price and quantity combinations P_{X1} - Q_{X1} to P_{X3} - Q_{X3} shown in the figure are the same as in the previous figure.

Figure 13.11 The Demand Curve.
Source: Haszler, Economic Policy Perspectives, (2006).



Given that consumers are rational in making their purchasing decisions, demand curves also show the consumer's willingness to pay for an item and, therefore, the value that consumers place on purchasing or using different levels of a given product or service.

The demand curve falls from left to right in the figure (negative relationship) because all commodities have substitutes and consumers are assumed to be non-satiated. So as the price of a commodity falls people will consume more of it by either switching to it from a substitute or because they are prepared to consume more within the same budget.

Students should note that price consumption curves can also be used to derive three other functional relationships, namely:

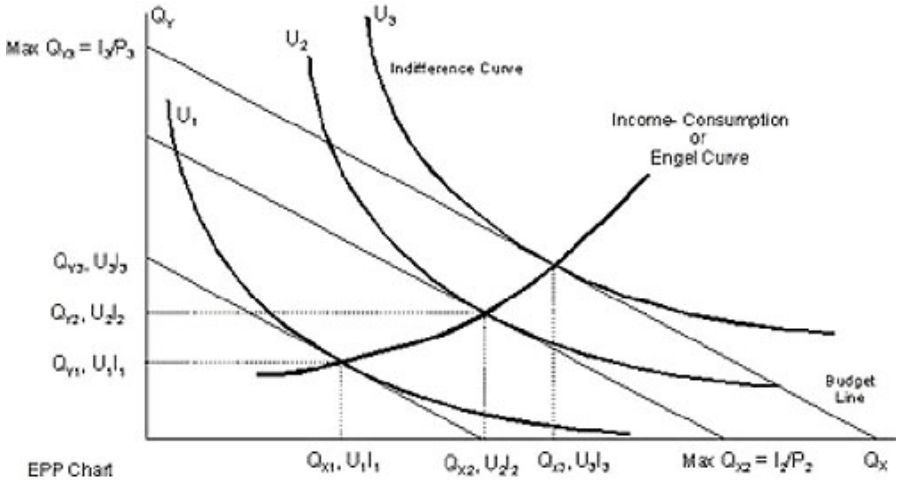
- The demand curve for Y
- A curve describing the relationship between consumption of X and the price of Y; and
- A curve describing the relationship between consumption of Y and the price of X.

Some reflection should also lead to the conclusion that if the exercises of Figure 13.9 and Figure 13.10 were repeated under a higher (lower) level of the consumer's income, the resultant demand curve would sit to the right (left) of the one drawn.

The effects of changes in income alone on consumption, that is without any price changes, can be understood by reference to Figure 13.12. In this figure increases in income are shown by the outward parallel shifts in the budget line. Again there are different points of tangency between the successively higher budget lines and indifference curves.

The line joining the points of tangency between indifference curves and the budget line as income grows is called the **income-consumption curve**. Where the relationship refers to food consumption, the income-consumption curve can also be called an **Engel curve** after the German statistician who first observed that as consumer income increases, the proportion spent on food decreases.

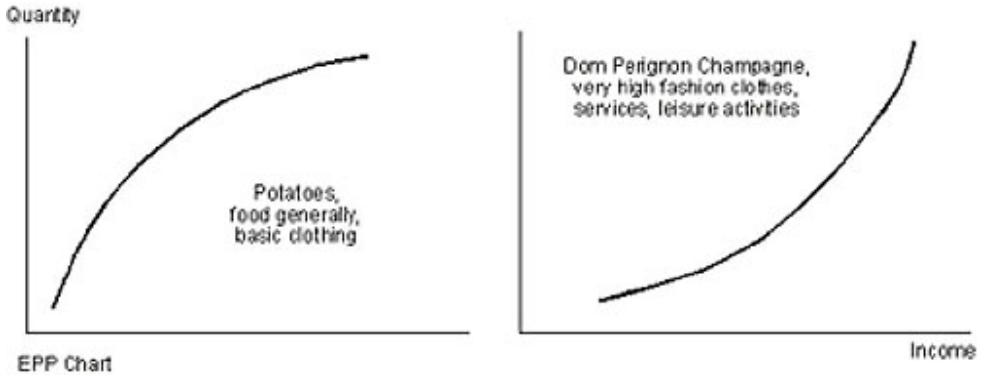
Figure 13.12 Income and Consumption.
Source: Haszler, Economic Policy Perspectives, (2006).



As shown in Figure 13.12, consumption of most goods and services increases as incomes grow because consumers "want more", even if not more of everything, then at least more of some things.

However, the income-consumption relationship varies according to the type of product as seen in Figure 13.13.

Figure 13.13 Some Engel Curves.
Source: Haszler, Economic Policy Perspectives, (2006).

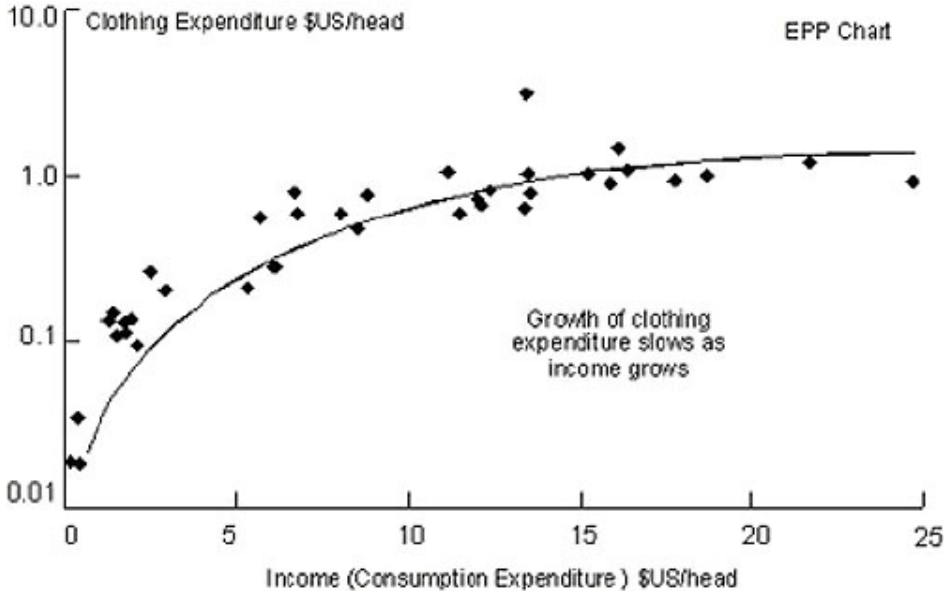


For more basic goods, consumption will eventually approach a maximum as shown for potatoes, food and basic clothing above. For such goods market growth ultimately depends on population growth. For other goods such as luxuries, travel and entertainment, consumption continues to grow as income rises.

Note there is a difference between the quantity-income and expenditure-income relationship. Even where quantity growth tapers off after a point, expenditure on the commodity may continue to expand if value adding services, providing convenience, variety, fashion, are added to the basic product.

The income-consumption relationship for wool is an important issue in understanding longer-term market prospects for wool. Consider first, Figure 13.14 which shows the relationship between income (or consumption expenditure) per head and expenditure on clothing and footwear for 37 countries. Clearly, the income based demand trends for clothing and footwear are likely to be more favourable than for basic foods such as potatoes. But, ultimately expenditure on clothing and footwear, the category for apparel wools, slows as income grows. So even with value adding, eventually population growth becomes the principal demand driver.

Figure 13.14 Income and Clothing and Footwear Expenditure.
Source: IWS (1997/98).

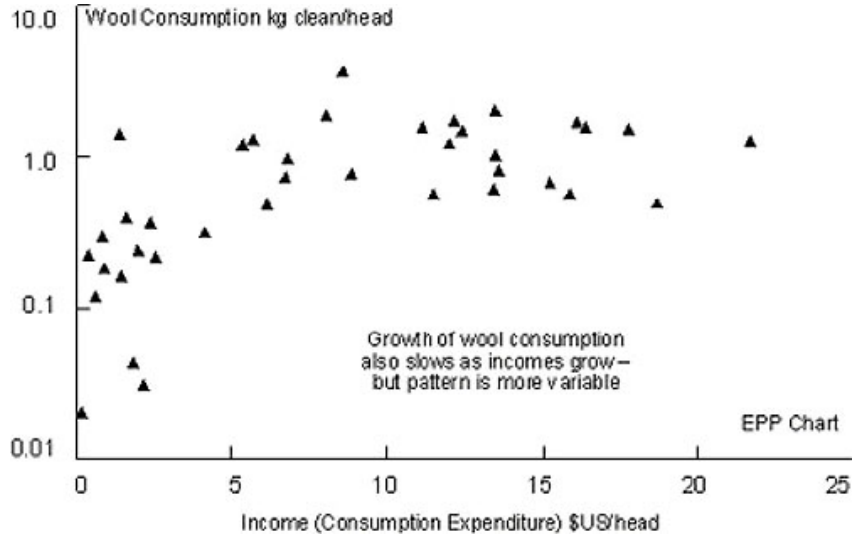


Wool consumption follows the same pattern as expenditure on clothing and footwear, but wool's pattern is more variable (see Figure 13.15). The tendency for the growth of clothing expenditure per head and wool consumption per head to fall as incomes rise means that wool's share of total consumer expenditure falls as incomes rise.

Clearly these circumstances are less favourable for wool than otherwise. However, spending on "fashion", as opposed to "basic", clothing rises with income growth. This latter trend sustains a higher level of aggregate wool demand than if richer people just bought basic clothes.

Ultimately, the issue for woolgrowers is not what happens to wool's *share* of consumer spending but whether at ruling levels of production and prices wool production is profitable on a sustainable basis.

Figure 13.15 Income and Wool Consumption.
Source: IWS (1997/1998).



13.9 Market demand and supply analysis

Consumers and producers interact in markets to satisfy their consumption wants and profit plans. A **market** is defined as a place, organisation or procedure that allows buyers and sellers of a commodity to communicate for the purpose of engaging in trade or exchange.

There are markets for both goods and services and they have a variety of functions:

- Physical-transport, storage, processing, etc;
- Exchange-buying/selling, assembly, breaking down into retail lots;
- Facilitating-providing information, financing, risk bearing.

The market interactions of producers and consumers can be summarised in terms of market demand and supply curves. **Market supply and demand curves** are obtained very simply by adding quantities demanded and supplied at each price by all the market participants as illustrated in Figure 13.16. Here, Tom, Dick and Harry each consume some product and their aggregate market demand curve is that shown for the TDH market. The figure is drawn to scale, so inspection will show that the quantities at each price on the TDH market demand curve are just the (horizontal) sums of the quantities demanded by Tom, Dick and Harry at each price.

Aggregate market supply curves are also obtained by adding the supply curves of individual firms along the horizontal or quantity axis. Recall that the firm's supply curve is its marginal cost curve where MC > AVC_{MIN}

In the analysis that follows the market demand and supply curves are shown as linear functions. Students should note very carefully that this practice here and in many other economics texts is adopted purely as a matter of convenience. In fact, the "true" market curves are unlikely to be linear for two reasons. First, the laws of diminishing marginal product and diminishing marginal utility both imply that the individual functions are non-linear. Second, even if the individual functions were really linear, the aggregate functions will not be linear unless the slopes of each individual consumer's and producer's functions are identical. Otherwise, the aggregate functions will be kinked as shown in Figure 13.16. It should be obvious with a moment's reflection that the aggregate function will have as many kinks as there are different slopes for the individual consumer or producer functions. With many producers and consumers, the aggregate demand and supply curves are likely to approximate reasonably smooth functions.

This detail on aggregation and the slope of market demand and supply functions may appear rather academic. However, it can have some considerable significance in policy analysis.

Figure 13.16 Aggregating Individual Demand Curves.
Source: Haszler, Economic Policy Perspectives, (2006).

Supply and demand jointly determine prices. The wishes of buyers and sellers are communicated to each other through the "invisible hand" of market prices and variations in market prices reconcile demand with supply.

A market equilibrium is said to exist when, at some ruling market price, market demand equals market supply so there is no excess demand or supply and the market is said to be cleared.

That is consumers get all they want at the price and producers sell all they want to sell. In equilibrium the forces operating on the market or economy over some given period are balanced so that there is no tendency for change in the absence of new "shocks" or disturbances to the system. However, because the economic system is subject to frequent shocks, as shown in the earlier graph of long-term wool prices, it is sometimes more realistic to think of economic equilibrium as *a tendency* rather than some fixed immutable *state* for all time.

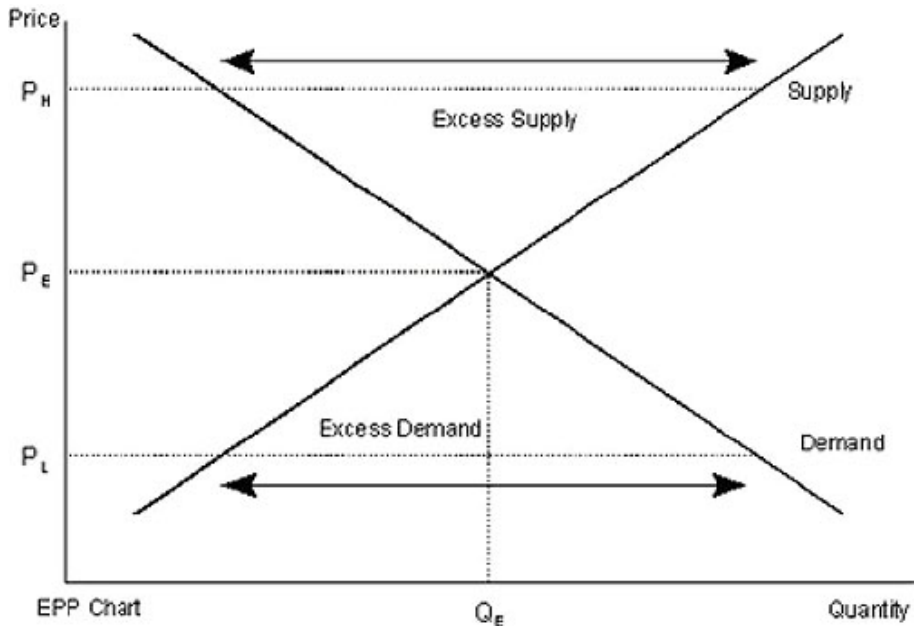
In Figure 13.17 the market starts off either with excess demand or excess supply. If demand exceeds supply (perhaps the Government has restricted output for some reason) consumers will begin to bid up the price in order to get access to the restricted volume.

If supply exceeds demand (for example too many cars are produced during a recession), retailers will begin to discount prices to attract customers in order to clear their unwanted stocks. In either case, prices move towards the equilibrium price, which will equate demand with supply. At the intersection of the demand and supply curves in the figure, demand equals supply and prices will remain at P_E unless some new shocks to the system shift demand or supply.

All the necessary conditions for a competitive market equilibrium are rarely met, even in agriculture. But where the conditions are met or closely approximated then, given the existing levels and distribution of income and the available technology, a competitive market equilibrium, generated by the interactions of many individually small consumers and producers, provides the maximum level of output, produced at least cost and distributed to the consumers who value it most. That result makes the market equilibrium position an important benchmark in policy analysis for wool, grains, steel, housing and even doctor's fees.

The discussion of supply and demand so far has proceeded largely in a two dimensional setting. But it has been indicated here and there that the two dimensional figures are all drawn subject to the *ceteris paribus* or other things constant assumption. It is important to recognise that assumption in market analysis. And for that purpose, it is useful to think of market supply and demand as functions of the following kinds:

Figure 13.17 Market Equilibrium.
Source: Haszler, Economic Policy Perspectives, (2006).



$\mathbf{QS_i = f_i\ (P_i}$ / P_j, Input prices, Technology, Weather, etc .....)
Market Supply
$\mathbf{QD_i = f_i\ (P_i}$ / P_j, Income, Tastes, Age, Gender, Advertising, etc.....)
Market Demand

where QS_i and QD_i are the quantities of product i produced and consumed, P_i is its price, P_j is the price of substitutes or complements for i and the other factors are as spelled out.

The **supply curve** is the *schedule* showing the *relationship* between QS_i and P_i and it shows how the supply of a product will change as its price changes. Similarly, the *relationship* between QD_i and P_i is known as the **demand schedule** or curve and shows how consumption of a product will change as its price changes.

The other variables in the equations are known as supply and demand *shifters*. Their role can perhaps be better appreciated by reference to the formula for a straight line, namely Q = a + bP where a is the intercept of the function on the horizontal axis and b is the slope. Rewriting the two equations in that form gives:

$\mathbf{QS_i =}$ (P_j, Input prices, Technology, Weather, etc .....) + b$\mathbf{P_i}$
Market Supply
$\mathbf{QD_i =}$ (P_j, Income, Tastes, Age, Gender, Advertising, etc.....) + b$\mathbf{P_i}$
Market Demand

In terms of the two-dimensional representations of demand and supply, therefore, changes in the variables shown in brackets change the intercepts of the functions and therefore move or shift the supply and demand curves in their entirety along the horizontal quantity axis.

This means that the quantity supplied or demanded of a product can be altered in two fundamentally different ways:

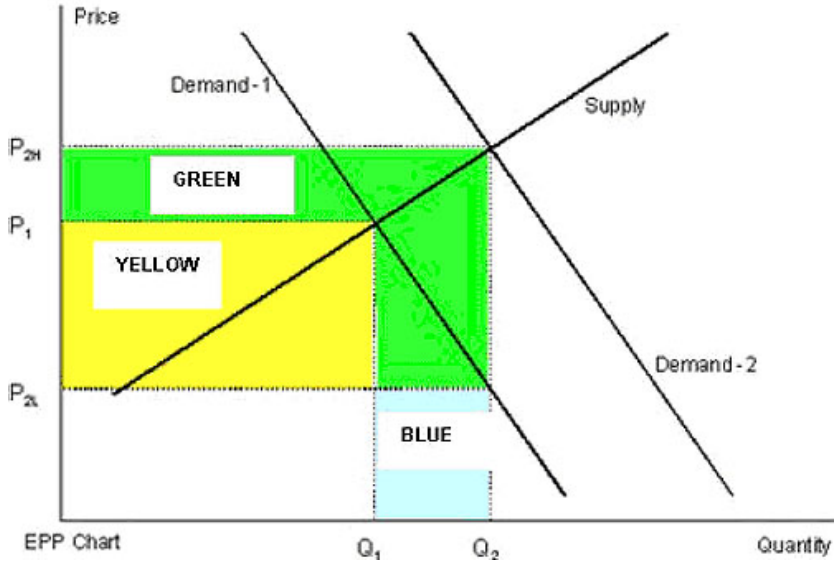
- Changes in the **product's own price**: these changes cause movements **along the curves** with the now familiar result that, other things constant, the higher the price of a product, service or resource, the larger the quantity supplied of it, and the less consumed of it and *vice versa*;
- Changes in the variables making up the **composite intercept** term: these changes cause movements or shifts **of the whole curves** resulting in a change in quantity demanded or supplied at every price.

Economists have good reasons for emphasising the difference between movements along supply and demand curves and movements of the curves. The reason is indicated by Figure 13.18.

Imagine you are a producer of something or other and your accountant has told you that is essential you increase your firm's sales revenue. You could "buy sales" as shown in the figure by dropping price from P_1 to P_{2L}. Sales will certainly increase here, to Q_2.

But do you really want that result? No! Your sales revenue would drop from $P_1.Q_1$ to P_{2L} .Q_2., which is a net reduction equal to a loss of revenue given by the large yellow shaded area and a smaller gain equal to the small blue shaded area. Not a good result in itself and certainly not if you account for the costs of producing the extra output.

Figure 13.18 Buying Sales.
Source: Haszler, Economic Policy Perspectives, (2006).



But what if you had access to free advertising that could bring in new customers so that demand shifted out to Demand-2 also generating sales of Q_2? Do you really want that result? Definitely yes! Now price increases to P_{2H} and your sales revenue is P_{2H}. Q_2, which is an increase on your original revenue equal to the sum of the green and blue shaded areas. As it happens this rise more than covers your extra production costs and you are now net ahead.

It is arguable that the strategy of disposing of the Reserve Price Scheme's stocks after the collapse of the Scheme in 1991 was basically a strategy of "buying sales". There is no evidence that the relatively large sales of growers' first-hand wool plus stockpile wool at low prices generated any shift in demand at all.

Figure 13.19 summarises the impacts of some of the common supply and demand shifters. Consider the following types of changes on the supply side.

- Changes in the **price of substitutes** in production: if the price of wheat rises while the price of barley stays the same, to continue maximising their profits farmers will swap between the two crops thereby increasing wheat production and reducing barley production;
- Changes in the **price of complements in production** or of **joint products**: an increase in the price of wool will eventually lead to an expansion of mutton production after the flock reaches some desired level and growers revert to normal culling for age.
- Changes in prices of **inputs/resources or factors of production**: increases in input prices reduce the profitability of the base product so, for example, an increase in wages may reduce production of clothing;
- Changes in **technology/productivity**: new technologies or production processes may favour some products over others, for instance transistors put crystal sets out of the market and more recently CDs have replaced LPs.

There are many ways that shocks can disturb a market equilibrium as shown by the panels in Figure 13.20. In the top right figure the increase in demand is greater than the increase in supply. Perhaps a new wave of immigrants has boosted housing demand but the housing industry's capacity to respond fully is initially restricted by the time needed to organise land subdivisions, design houses, train builders, etc. Anyway, the different demand and supply shifts shown in that panel increase prices for houses, at least for a while.

Figure 13.19 Principal Function Shifters.
Source: Haszler, Economic Policy Perspectives, (2006).

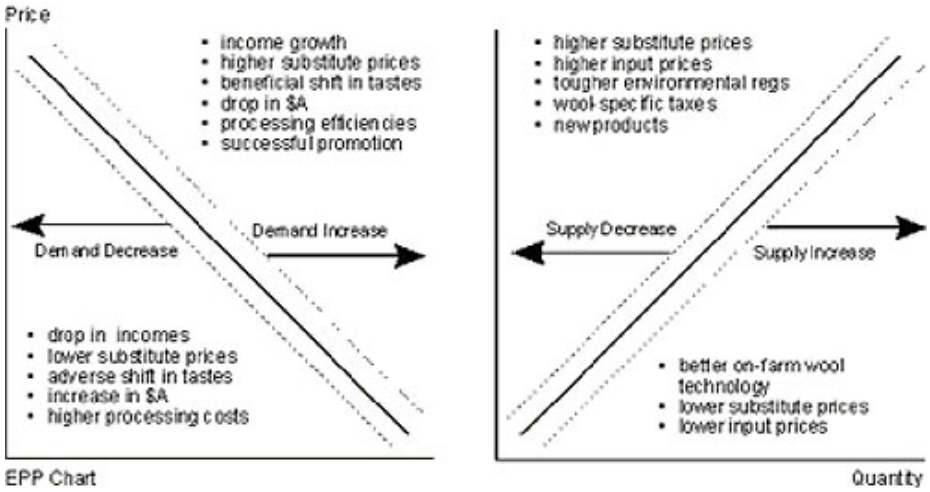
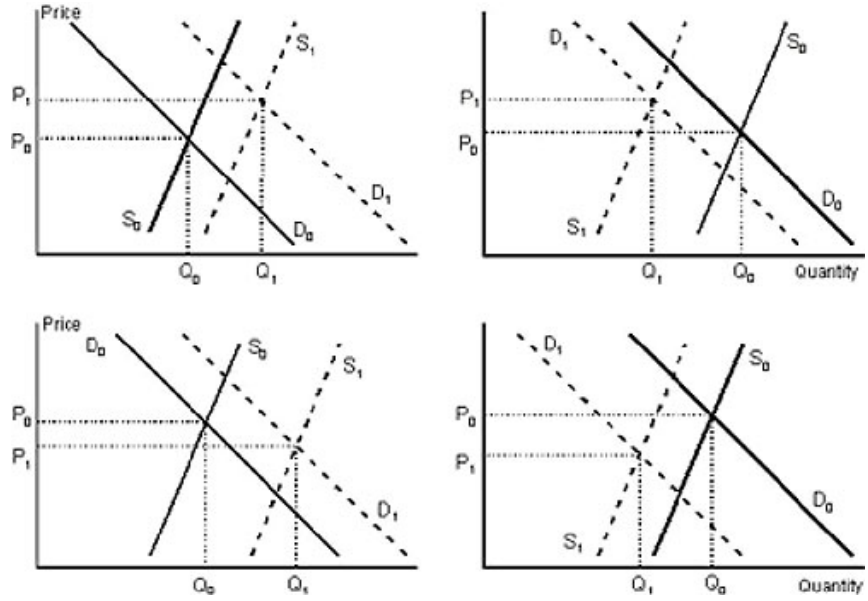


Figure 13.20 Supply and Demand Shifts.
Source: Haszler, Economic Policy Perspectives, (2006).



The four panels in Figure 13.20 demonstrate the following results concerning shifts of demand and/or supply:

- increase in demand > increase in supply-price rises
- decrease in demand > decrease in supply-price falls
- increase in demand < increase in supply-price falls
- decrease in demand < decrease in supply-price rises

13.10 Responsiveness or elasticity

Economists often use elasticities to characterise individual and market demand and supply functions such as the demand functions shown in Figure 13.20. The term **elasticity** is just technical economics jargon for **responsiveness**. In economics the responsiveness of interest is that of some dependent (LHS) variable, quantity demanded or supplied, with respect to some explanatory (RHS) variable, such as price or income. In particular, elasticity is measured as the proportional (or percentage) change in one variable due to a proportional (or percentage) change in another.

For a function such as Q = f (P), where quantity is the dependent (LHS) variable and price is the explanatory (RHS) variable, elasticity is defined as:

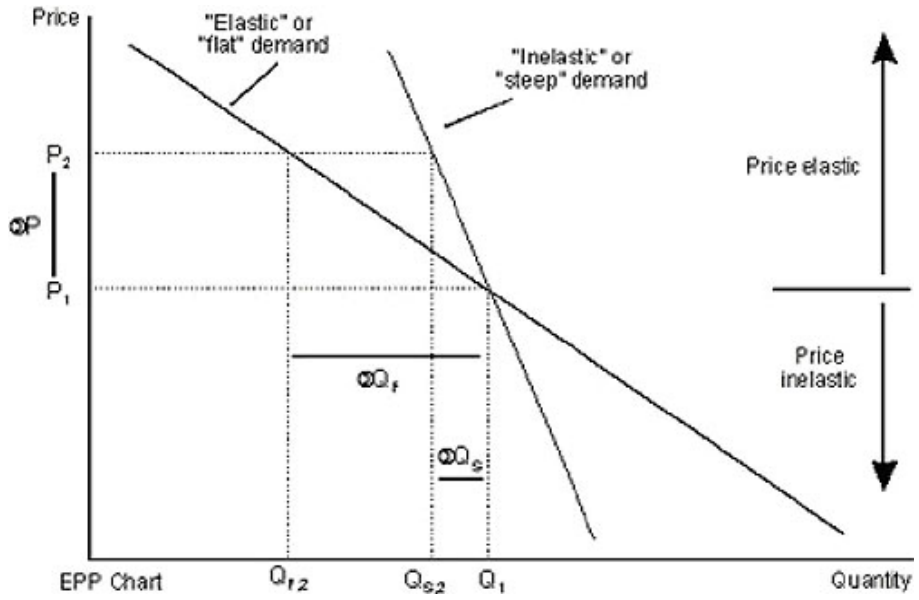
$E = \Delta Q/Q \div \Delta P/P = \Delta Q/\Delta P \times P/Q$

Elasticity is a fundamental concept in both theoretical and applied economics and is obviously related to the slope of a function as they both refer to “responsiveness”.

Elasticities are measured as ratios of ratios and therefore are “unit-less”. That makes them easily transferable and comparable between commodities, countries, over time and between problems That transferability explains the popular use of elasticities by economists as a general descriptor.

By contrast, slopes must be defined with respect to the units of measurement used to derive the slope coefficient and so are not very easily transferable. Nevertheless, the slopes of supply and demand curves can be the more important issue in policy analysis.

Figure 13.21 Elasticity Equals Responsiveness.
Source: Haszler, Economic Policy Perspectives, (2006).



Demand (and supply) curves are often categorised as elastic or inelastic in a relative sense based on their slopes. Saying a curve is inelastic means that quantity shows a relatively low degree of responsiveness to changes in price and *vice versa*.

Figure 13.21 provides an intuitive method for determining the relative magnitudes of elasticities on two functions. What happens to quantity when price changes by the same Δ P? Clearly $\Delta Q_S < \Delta Q_F$ so the steeper function is generally the more “inelastic”.

Elasticities can be measured or specified in two ways.

- **Point Elasticity** – measured at a point
  $E = dQ/Q \div dP/P = dQ/dP \times P/Q$
- **Arc or Midpoint Elasticity** – measured over a range
  $E = (Q_2 - Q_1)/(Q_2 + Q_1)/2 \div (P_2 - P_1)/(P_2 + P_1)/2$, so
  $E = (Q_2 - Q_1)/(Q_2 + Q_1) \div (P_2 - P_1)/(P_2 + P_1)$

For arc elasticities the main issue is to be consistent in identifying the P,Q set that is to be labelled 1. For both point and arc elasticities it is important to watch the signs.

The terms $\Delta Q/\Delta P$ represents the gradients or slopes of the various functions which, in these cases, are shown with the dependent variable on the horizontal axis. That is, the figures show the functions as X = f(Y) and not as Y = f(X).

For straight lines of the general form Y = a + bX, as shown in the figure, the definition of elasticity can, therefore, be simplified as follows:

$E = \Delta Q/\Delta P \times P/Q = bP/Q$, since $\Delta Q/\Delta P$ = slope = Rise/Run = b

For demand curves, an increase in prices (rise) means a decrease in quantity (run) so the slope coefficient b is negative and so is the own-price elasticity. For supply curves, an increase in prices (rise) means an increase in quantity (run) so b is positive and so is the own-price elasticity.

Table 13.6 shows the mathematical expressions for the slopes and elasticities for some functional forms that are commonly used in economics. In the context of the discussion in this Lecture, students might find it convenient to interpret Y as quantity Q and X as price P. Students should note the "symmetry" between the linear and logarithmic functions. Linear functions have constant slopes but elasticities that vary everywhere along the curve. Logarithmic, often called double-log, functions have constant elasticities but slopes that vary everywhere along the curve.

As an exercise, students should try to prove that b is the elasticity of the logarithmic function. In doing so it is helpful to note that the double-log function is also written as $Y = a X^b$. The only other thing needed for the proof is the general formula for elasticity given above.

The definition of elasticity as E = bP/Q for linear functions indicates that elasticities vary with P and Q and so vary all along linear functions and need to be expressed with respect to a particular point on the demand (or supply) curves. In fact there is a very specific pattern of elasticities along a linear demand function as follows:

- E > |1.0 | for quantities less than the midpoint of the data range;
- E = |1.0 | at the midpoint of the data range;
- E < |1.0 | for quantities above the midpoint of the data range.

These relationships hold true for the elastic or flat function in the figure around Q_1, which is the midpoint of its data range. But for the inelastic or steep function the potential data range includes quantities to the left of the function drawn. That means that even though the two functions intersect at P_1,Q_1, nevertheless Q_1 is not the midpoint for the flat function which is likely show inelastic demand over the entire range drawn.

Table 13.6 Alternative Functional Forms: Their Slopes and Elasticities.
Source: Goreux (1960).

Function		Function Slope	Elasticity Coefficient
1. Linear	Y = a + b X	b	b X/Y
2. Logarithmic	log Y = a + b log X	b Y/X	b
3. Semi-logarithmic*	Y = a + b log X	b/X	b/Y
4. Log-inverse*	Log Y = a - b/X	b Y/X_2	b/X
5. Log-log-inverse*	log Y = a - b/X - c log X	$(Y (b - c X))/X_2$	(b - c X)/X
6. Inverse	Y = a - b/X	b/X_2	b/(X Y)

* These formulae refer to Neperian or natural logarithms and a correction factor is required if logs to base 10 are used. So the elasticity coefficients for the functions become 0.4343 b/Y for (3), 2.3026 b/X for (4) and - c + 2.3026 b/X for (5).

13.11 Types of elasticities

It is possible to define an elasticity with respect to any of the variables identified in the generic market supply QS_i and market demand QD_i equations shown following Figure 13.17 or indeed any other variables that may also affect demand and supply. However, the more commonly cited supply and demand elasticities are:

- **Own-price elasticity** $\Delta Q_i / Q_i \div \Delta P_i / P_i$

The own-price elasticity measures the proportionate or percentage change in quantity of good Q_i in response to the proportionate or percentage change in its own price P_i. The own-price elasticity is sometimes referred to in shorthand simply as the "demand elasticity" or the "supply elasticity".

Own-price elasticities of supply are positive and own-price elasticities of demand are negative and refer to movements **along** the supply and demand curves.

As noted already, for linear functions the own-price elasticity is given by $E_{ii} = b\ P_i./ Q_i$. The subscript ii with E simply indicates that we are referring the elasticity of the quantity i with respect to its own price P_i.

- **Cross-price elasticity** $\Delta Q_i / Q_i \div \Delta P_k / P_k$

The cross-price elasticity measures the proportionate or percentage change in quantity of good Q_i in response to the proportionate or percentage change in the price of some other commodity or product P_k– not its own price P_i. The term "cross-elasticity" is used as a shorthand form of cross-price elasticity.

Cross-price elasticities can take either positive or negative values depending on the circumstances. For a demand curve a positive cross elasticity indicates that the goods are substitutes such as tea and coffee. So if we are concerned with tea demand, a positive cross elasticity for coffee just indicates that an increase in the price of coffee will stimulate consumers to drink more tea.

Recalling the earlier indifference curve analysis, the increase in the price of coffee will shift the budget line back along the coffee axis, leading to a tangency with a different indifference curve and a changed mix of tea and coffee consumption. All of these changes are needed to maximise the consumer's wellbeing under the new circumstances. In pursuing their self-interests, consumers engage in this sort of substitution without any need for outside direction or prompting.

Table 13.7 Some Australian Own-Price and Income Elasticities.
Source: Pers. Comm.. R. Dumsday. Adapted from Dixon et al. (1992)

Product Group	Own-Price Elasticity	Income Elasticity
Books and Newspapers	- 0.21	0.38
Rail Transport	- 0.21	0.39
Soft Drinks	- 0.22	0.39
Confectionery	- 0.22	0.39
Beer	- 0.40	0.72
Motor Vehicles	- 0.58	1.08
Wine and Spirits	- 0.60	1.08
Health Services	- 0.68	1.20
Electronic Equipment	- 0.74	1.33
Communications	- 0.76	1.37
Restaurants	- 0.84	1.51
Air Transport	- 1.01	1.84

By contrast a negative demand cross elasticity indicates that the goods are complementary in consumption, that is consumed together like milk and breakfast cereal. So a drop in the price of cereals will result in increased consumption of cereals and also some increase in milk consumption.

In the case of supply curves, a positive cross-price elasticity indicates the two products are complementary in production, like sheepmeat and wool. So in the case of wool supply, an increase in the price of sheepmeat increases the profitability of the whole sheep enterprise and so will result in some increase in wool production as well as an increase in sheepmeat output. Obviously a negative cross elasticity in supply meant the two products are substitutes in production, like wheat and barley in parts of Australia. In considering the supply of wheat, an increase in the price of barley makes wheat relatively less profitable so profit maximising firms reduce their wheat plantings when barley prices rise, of course provided everything else remains constant!

For linear functions the cross-price elasticity is given by $E_{ik} = b\ P_k / Q_i$. The subscript ik with E indicates that we are referring the elasticity of the quantity i with respect to the price of k this time, not i.

- **Income elasticity of demand** $\Delta Q_i / Q_i \div \Delta I / I$

The income elasticity of demand measures the proportionate or percentage change in the quantity of good Q_i demanded or consumed in response to the proportionate or percentage change in consumer's incomes, where I is income.

The income elasticity is positive for normal goods. Again recall the earlier indifference curve analysis. An increase in income causes an outward parallel shift in the budget line so that in maximising their wellbeing consumers are able to increase consumption of both products, in the simple two product case, without any need to substitute as when prices change.

In the case of inferior goods, income elasticities are negative instead of positive. The point is that the particular good is valued so little that an increase in income allows consumers to substitute more valued and more expensive goods in their purchases.

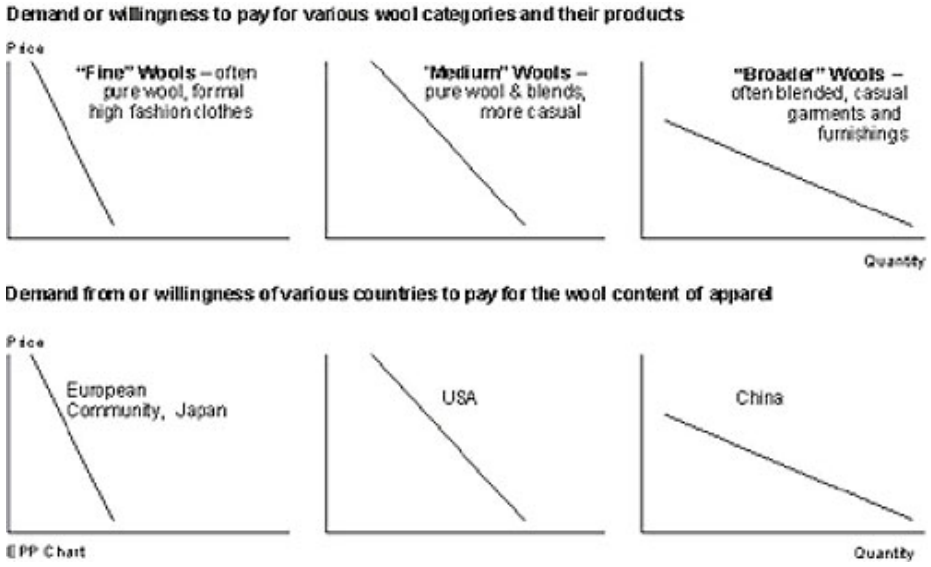
There are not many obvious examples of inferior goods. But in higher income countries soup bones, cheaper/fattier processed meats, such as Devon sausage, and perhaps some of the cheaper clothing brands can be inferior goods.

There is some evidence that in Australia the income elasticity of demand for mutton is negative these days. As their incomes have increased over past decades, it seems Australians are choosing to buy higher priced cuts of meat like lamb instead of mutton – that is when butchers give them the choice, which is not often these days.

Figure 13.22 splits the aggregate wool market into a variety of segments based on the own-price elasticity of demand in those segments Just as all wools are not the same, there are differences in:

- the demand for **different qualities** of wool related to their differing processing characteristics, the products that can be made from them and the preferences of the consumers buying the products;
- the demand from **different countries** related again to the preferences and income levels of the consumers in those countries.

Figure 13.22 Characterisations of Wool Demands. Adapted from: Beare and Meshios (1990); Connolly (1992); Stoeckel, Borrell and Quirke (1990).



- **Expenditure income and quality elasticities**

So far demand has been defined in terms of quantities purchased. It is also possible to define demand in terms of consumer expenditures on a product, where expenditure is defined intuitively as $S = P_i Q_i$, where S is "spend" or expenditure and the income elasticity of expenditure ES is:

$ES_i = \Delta S_i / S_i \div \Delta I / I = \Delta S_i / \Delta I \times I/S_i$

The expenditure elasticity can be broken down into the quantity elasticity and a "quality elasticity" that measures how much consumers are prepared to pay for a class of goods, such as CD Walkmen as their incomes rise:

$ES_i = E_{il} + EV_{il}$

where ES_i is the income elasticity of expenditure just defined, EQ_{il} is the quantity income elasticity of demand defined earlier and EV_{il} is the income elasticity of quality (V for value), quality elasticity for short. The quality elasticity is an important concept for a commodity like wool where, typically, the value added in processing etc is large relative to the value of the raw wool in the final product. However, it is important to note that the above split into quantity and quality components is based on the assumption that prices indicate quality, so that a more expensive stereo set is necessarily a "better" stereo.

Price levels often do "signal" quality. But, remember there is always someone around prepared to rip-off uninformed consumers by selling them expensive junk.

13.12 Revenue and the own-price elasticity of demand

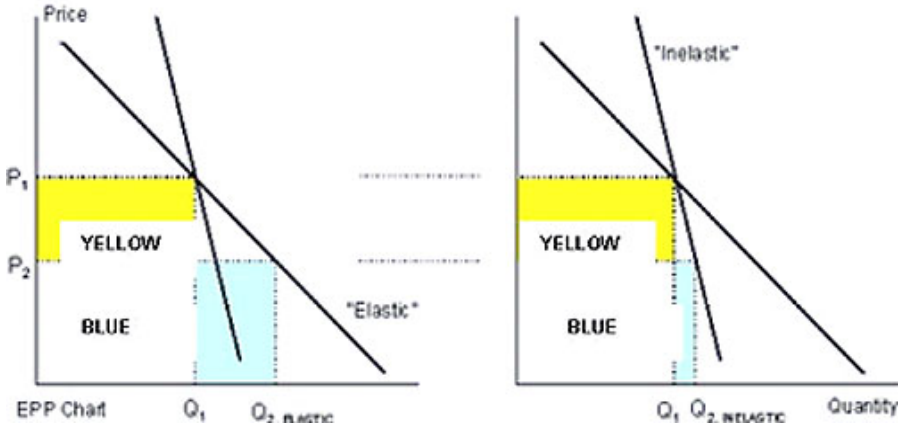
This discussion of elasticities is provided, not for its theoretical value, but because it has a practical application. Where firms do have a choice over their pricing decisions, the own-price elasticity of demand helps determine the firm's optimal pricing and sales strategies.

The importance of elasticity in the firm's pricing and sales decisions is illustrated in Figure13.23. If demand is relatively "elastic" (working with the left panel), dropping prices as shown will cause a change in sales revenue equal to the revenue gained (blue shaded area) minus the revenue lost (yellow shaded area). And if demand is relatively "inelastic (working with the right panel), dropping prices as shown will again cause a change in sales revenue equal to the revenue gained (yellow shaded area) minus the revenue lost (blue shaded area).

Clearly there is no advantage in dropping prices to improve sales revenue when demand is inelastic BUT, if the firm has the choice there is an advantage in raising prices. Provided the firm has the choice, it is not profitable to operate in the inelastic portion of the demand curve, and in that portion of the curve raising prices will increase revenue – because $|+\Delta P| > |-\Delta Q|$.

Note that these comments do not provide a prescription for running price stabilisation schemes!

Figure 13.23 Elasticity and Revenue.
Source: Haszler, Economic Policy Perspectives, (2006).



13.13 Determinants of elasticities

Ultimately, consumers' preferences and the production technology determine demand and supply elasticities. So elasticities are likely to differ for different groups of consumers and producers and need to be determined for each group or individual of interest. Nevertheless the production and consumption attributes or circumstances of goods and services can indicate the relative orders of magnitude for their elasticities.

The determinants of supply elasticities include the following factors.

- **Other enterprises**: The more substitutes in production there are for some commodity, the higher will be its own-price elasticity of supply. Consider the case where a farmer can produce only one commodity, say wool. After some time the farmer will get to a position where he or she is producing the maximum quantity as efficiently as possible. A drop in wool prices that is perceived to be "permanent" is likely to lead to some cut in output. But the supply response to an increase in prices will be zero!

- **Size of operation**: It is easier to expand a small(er) operation so the supply elasticities are likely to be larger for small operations. Contrast the aggregate wool supply with the aggregate supply of eggs in Australia and the possible responses to a doubling of wool and egg prices. Any substantial expansion of the wool clip would require significantly more land, which will need to be bid away from other activities. But an egg producing operation needs little land so it can be set up almost anywhere, without much disturbance to existing activities.

For their part, the determinants of demand elasticities include the following factors.

- **Substitute goods and services**: The more close substitutes there are for something the greater the chance for consumers to "cherry-pick" the relatively cheaper items as they seek to maximise their wellbeing. And that means that greater the number of substitutes, the higher the (absolute) own-price elasticity.
- **Essentials**: This point follows from the previous one. An essential item has few – if any – substitutes, so its price elasticity will be low in absolute terms. The consumer simply has little or no choice and must pay "any" price to get the essential item.
- **Budget shares**: Price elasticities for items that make up a small part of the consumer's total expenditure are generally low. A consumer who spends, say, $3.50 per year on shoelaces will not be much affected even if the price doubles. But what about the effect of an increase in house rent if rent makes up 50 per cent of the consumer's budget. Obviously price elasticities are likely to be especially low for essential items that comprise a small share of the budget, like salt.
- **Income**: Income elasticities are generally relatively low for essentials and higher for luxuries. Obviously essentials have a "first call" on a consumer's income so that after a point increases in income may lead to very little if any additional consumption of essentials.

Note that the "essentials" and "budget shares" on the demand side have their counterparts in the "other enterprises" and "size of operation" factors on the supply side.

Table 13.8 Estimates off Some US Food Demand Elasticities: Retail Level.
Source: George and King (1971).

Product Demanded	Elasticity with Respect to						
	BF	LM	BU	MG	AF	NF	Income
Beef – BF	- 0.64	0.05	..	..	- 0.39	0.10	0.29
Lamb Mutton – LM	0.59	- 2.63	..	..	- 0.77	0.20	0.57
Butter – BU	..	..	- 0.65	0.16	- 0.43	0.11	0.32
Margarine – MG	..	..	0.42	- 0.85	0.00	0.00	0.00
All Food – AF	- 0.04	- 0.01	- 0.01	..	- 0.24	0.06	0.18
Non Food – NF	- 0.02	..	..	..	- 0.23	-1.02	1.24

Note: .. denotes less than 0.005 in absolute terms. These elasticities were obtained by direct estimation subject to the imposition of theoretical constraints such as the homogeneity condition which is illustrated by the fact the unrounded sum of the AF, NF and income elasticities = 0.

13.14 Length of run

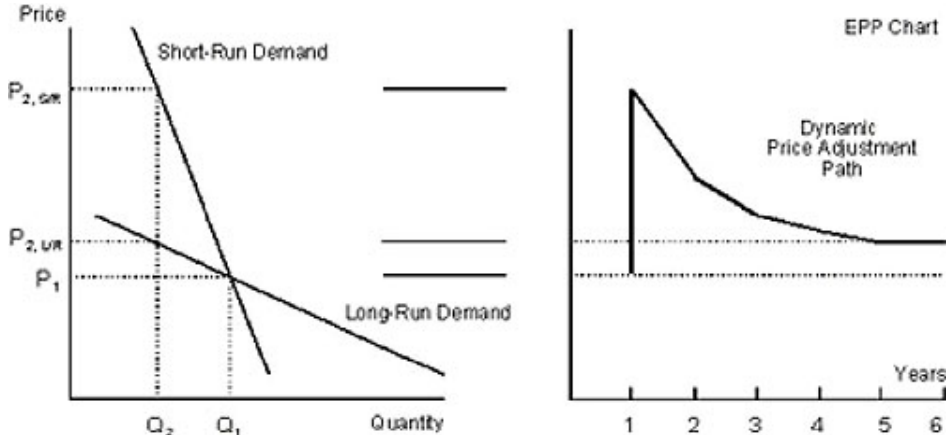
The degrees of response of demand, supply and prices to various economic stimuli depend in part on the period of time over which the responses are measured. Obviously the related elasticities also vary with the time period under consideration. Consequently, economists commonly distinguish between the short-term, the medium-term and the long-term.

- In the **short-term** only very limited responses to changing economic conditions are possible because at least something remains fixed. Consumers' tastes might remain constant and firms do not have time to install new equipment, buy more land, organise an extra shift, etc. So the immediate response to some stimulus will be less than the response over a longer period.

- The response in the **medium-term** is greater than in the short-term because at least some of the firm's fixed factors of production become variable because, for instance, wage contracts and rental agreements may expire. On the demand side, consumers have, perhaps, had some time to identify and evaluate substitute goods or reduce their wardrobe stocks to justify buying new clothing.
- In the **long-term** firms have no fixed costs and established consumer tastes can change so demand and supply are much more responsive to varying economic stimuli.

The distinctions refer to the degree of response that is feasible and not to any particular length of time. So short and long-run mean different lengths of time in different industries. In agriculture, the short-term might vary from 6-8 weeks for vegetable crops, to 4-5 months for broiler production, perhaps one year for annual crops, to 2-3 years for sheep or cattle enterprises and 8-10 years for tree crops. In the case of the annual wheat crop, for example, farmers can only plant one crop of wheat per year, so supply is fixed for a year once the crop is planted.

Figure 13.24 Short and Long-Term Impacts.
Source: Haszler, Economic Policy Perspectives, (2006).



The relationship between short and long-run demand curves is illustrated in Figure 13.24. A similar relationship exists on the supply side.

Imagine that the figure shows demand schedules for wheat and a drought reduces the crop from last year's Q_1 to this year's Q_2. In the short-term of one year, wheat supply would be shown as a vertical line at Q_1 and Q_2 respectively. Note that this means the short-run supply elasticity for wheat is exactly zero. Now what happens in the market?

Given that consumers' preferences are also fixed in the short-run, the only thing that can change to re-balance supply and demand is price, that is price changes must accommodate *all* the impact of the supply shift so the drought-induced reduction in wheat production causes a relatively sharp spike in wheat prices. So the supply shift interacts with the short-run demand curve and wheat prices increase from P_1 to $P_{2,S/R}$.

But the impact of the single supply shock is spread between quantity and price over the medium to long-run – periods in which consumers' can decide to learn about substitute products and farmers are able to change their plantings and crop rotations in response to the changes in wheat prices. If there are no further shocks to the system and consumers have time to respond fully to the change in wheat supply and prices the market will reach a new equilibrium at a price of $_{2,L/R}$.

That is the medium and long-run-run supply and demand curves are much "flatter" than in the short-run and supply and demand shocks of the same size as before produce a much smaller price change in the long-run than in the short-term.

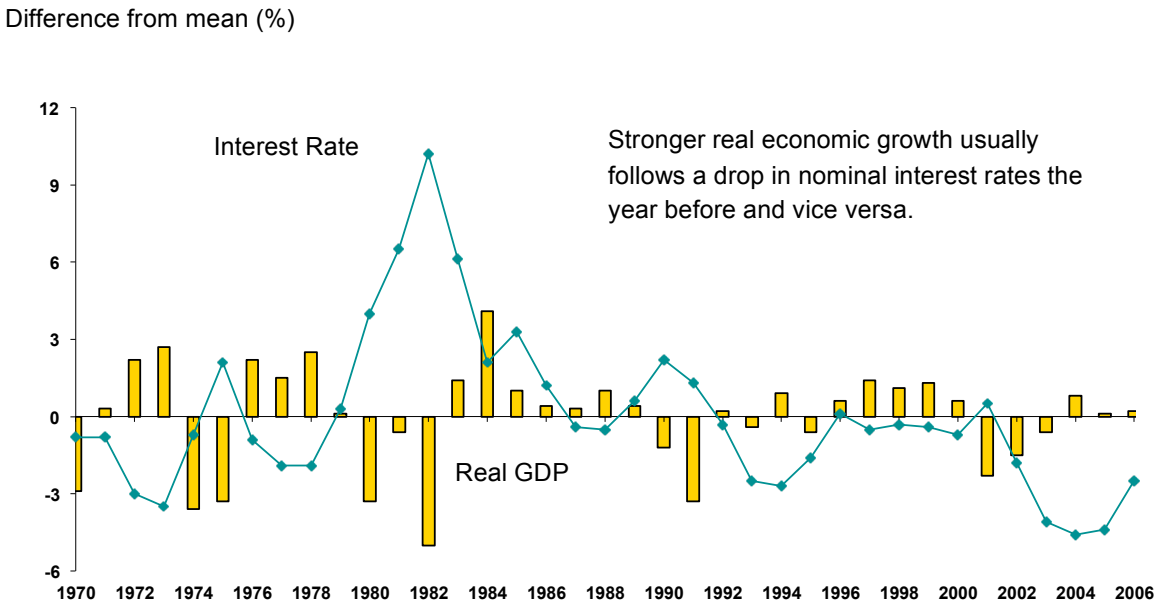
As noted already, there is a particular reason for maintaining the distinction between the short and long-term in the case of wool. As clothing and footwear are durable items, consumers do not necessarily have to replace these every day. So a drop in clothing prices may generate little immediate change in purchases as people deplete their wardrobe stocks first. But that constraint will disappear in the long-run so the ultimate response to a sustained drop in prices should exceed the immediate response.

Of course the distinction between the short-and long term can be somewhat academic. The economic system is subject to continual shocks so we never see the long run because, as John Maynard Keynes said, “In the long-run we are all dead.” His sentiments are reflected in the fact that much of the debate about government policies is concerned with carving-up the short-term benefits and off-loading onto others the short-run costs of policy decisions.

13.15 Significance of macroeconomic and external shifters

The preceding material provides all the analytical material needed to evaluate the relative significance of the principal macroeconomic and external factors that affect the wool market. As a prelude, it is instructive to refer back to Figure
13.1 that provided a general overview of the world system within which the Australian wool industry operates. Figure 13.25 and Figure 13.26 illustrate some of the linkages more directly.

Figure 13.25 US Interest Rates and GDP. Source: Figures prepared by K. Stott, The Woolmark Company, from data supplied from US Census Bureau.



Note: Data refer to growth in US GDP in the current year and prime lending rate the year before.

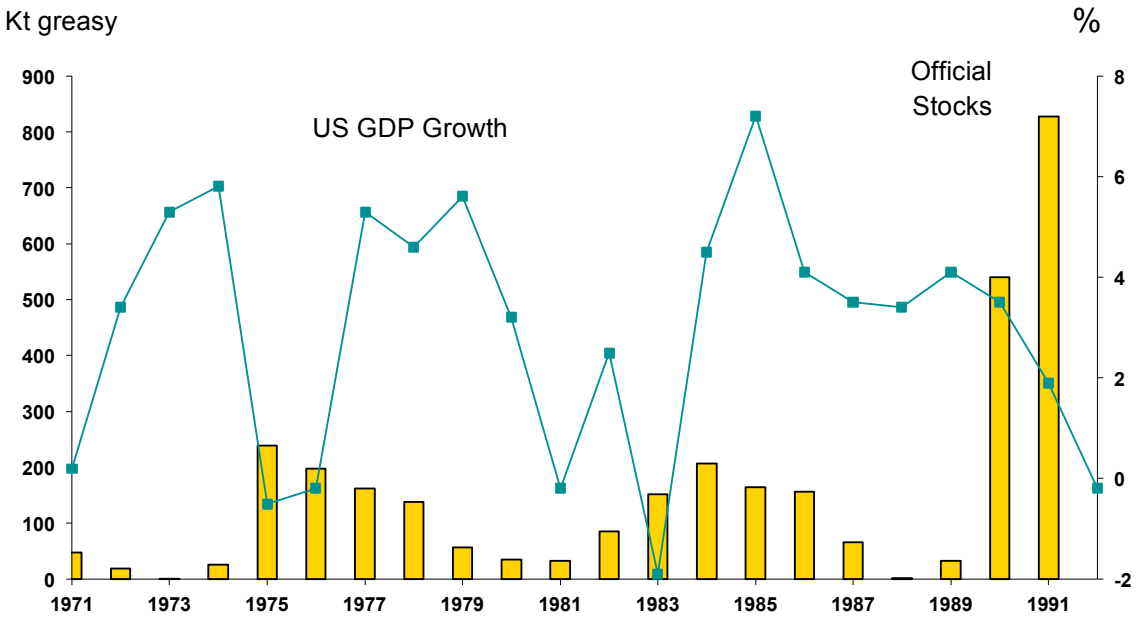
The US economy is one of the main “engines” of world economic growth because it is so large in an absolute sense and because income per head in the United States is high. So the US economy has many ‘rich” consumers who buy products from all around the world and in so doing add to economic growth elsewhere. Figure 13.25 is presented here to illustrate one relationship between two key macro variables relevant to wool.

Figure 13.26 is designed to help demonstrate the central importance of changes in consumer incomes to the wool market. Naturally the full story is more complicated than shown in the figure. The levels of and changes in the former Australian Wool Corporation's stocks were also influenced, amongst other things, by:

- The levels of the minimum reserve price that were set under the scheme;
- The direct effect of interest rates in Australia and elsewhere in determining the value on the $A;
- Changes in wool production in Australia and competitor trading countries; and
- Differences between actual and anticipated market developments.

Nevertheless, a logical inference from the figure is that for much of the period over which the Reserve Price Scheme for wool operated, the RPS was stabilising wool prices, through its stock purchases and sales, counter-cyclically against the world business cycle, as indicated by the variations in the growth of real US GDP.

Figure 13.26 Income and Wool Market Impacts: Official Stocks. Source: Figures prepared by K. Stott, The Woolmark Company, from data supplied from US Census Bureau.



Note: Data refer to ending official stocks in the year shown and the growth of US GDP the year before.

The final element needed to complete the market analysis jigsaw is the information on Australian wool elasticities provided in Table 13.9. The estimates provided in the table rely on a variety of studies carried out up to 50 years ago and on data spanning back by up to 70 years. Clearly, the empirical research confirms the theoretically based analysis, namely that long-run elasticities are greater in absolute terms than short-run elasticities. The key point is that the raw wool market is inelastic in the short-run but, as the theoretical analysis indicates, is more elastic in the long-run. In fact, wool demand appears to be just "elastic" in the technical sense in the long-run.

Note that large unexpected changes in prices can lead to much greater substitution in the short-run than indicated by the accepted cross-price elasticities of demand and supply which are "average" measures reflecting the more usual variations in relative prices. This is one reason why, in the context of stabilisation schemes, it can be so very risky to follow price spikes up with substantial increases in intervention prices, as the Australian wool industry learned so dramatically with the former Reserve Price Scheme for wool.

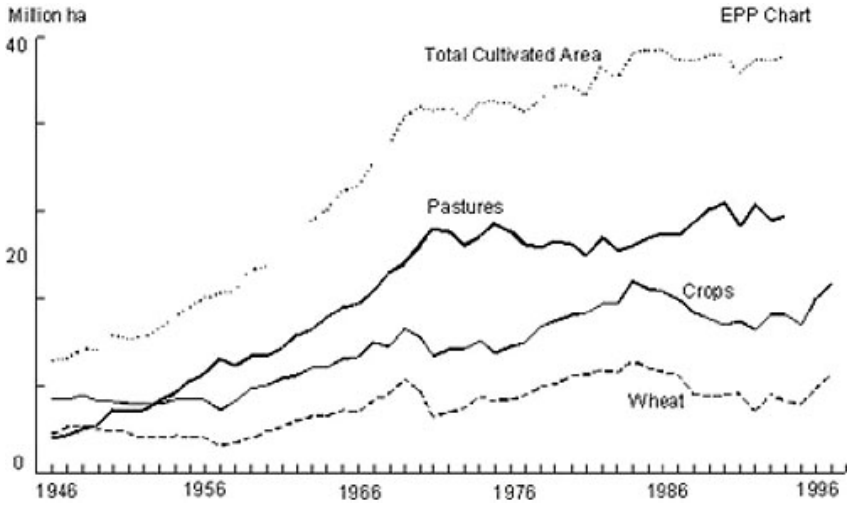
Students should note that in the case of wool supply, sheepmeat, cattle, and grains are all shown as being substitutes in production. The relevant cross-price elasticities are based on relatively more recent estimates as data for earlier periods suggested these products and wool were complements in production.

Figure 13.27 supports the notion of a fundamental change in the way that changes in prices of other commodities shift the wool supply function. Up till the late 1960s land utilisation for livestock (pastures) and crops expanded roughly together – due partly to the gradual opening up of new land which was in turn supported by the progressive spread of the ley rotation system throughout the mixed broadacre farming regions.

Table 13.9 Plausible Australian Wool Elasticities. Source: Haszler (2003).

	Short-Run	Long-Run
Australian Raw Wool Demand		
Wool price	-0.35	-1.05
Cotton/synthetics price	0.10	0.30
Income per head	0.40	1.20
Wool promotion	0.05	0.15
Australian Raw Wool Supply		
Wool price	0.05	0.80
Price of sheepmeat	-0.01	-0.18
Price of beef & veal	....	-0.17
Price of beef	-0.01	-0.18

Figure 13.27 Land Utilisation in Australia. Source: Haszler (2003).



In the late 1960s the wheat crop reached a then record level and because of excess wheat stocks in major exporting countries, the Australian Government imposed delivery quotas, effectively a restraint on production, on wheat, then by very far the major broadacre crop. The delivery quotas seem to have forced farmers to investigate new types and combinations of farm activities.

At that point what appears to have been a broadly complementary relationship between crop and livestock production seems to have been replaced by a more competitive relationship. That is the cross-price elasticities of supply between wool and many other broadacre enterprises seem to have switched to being negative.

13.16 Flow of (linear) simulation

Economic simulation is a technique for assembling and harnessing information needed to analyse government policies, to study the characteristics of markets and to assess and forecast market developments. Simulation is a very commonly used analytical method in economics. It is an appropriate tool where the analyst does not have access to an appropriate and formally estimated econometric model but does have information on the necessary elasticities and other parameters.

The key steps in a simulation analysis are:

- Choose the base market price, quantity and other values to represent equilibrium values relevant to the issue under consideration;
- Choose model parameters, usually the elasticities, judged applicable to those base values;
- Infer or derive the market demand and supply functions that pass through the base price/quantity equilibrium, by using the chosen base values and parameters;
- Introduce "shocks" or policies and solve for new equilibria;
- Evaluate the new equilibria and make judgements.

Some students may find the following material rather mathematical. Those who do should persevere because nothing more than a little algebra and simple arithmetic is required.

The simulation exercise is based on the following general form of the linear market model:

Total world demand for Australian wool $Q_D = a + b\ P_W + c\ P_S\ R + d\ I\ R$
Australian wool supply to the world $Q_S = g + h\ P_W + j\ P_L + k\ P_B + m\ P_G$

It is absolutely critical to note these are general forms of the equations and that the operational or actual signs of the coefficients will be determined by the signs of the elasticities.

For the demand function, Q_D is the quantity of raw wool demanded, P_W is the auction price of wool in \$A, P_S is an index of the price of substitute fibres in \$US and I is an index of world income in \$US. Since the exchange rate R is measured as \$A/\$US, $P_S.R$ is the price of substitute fibres in \$A and I.R is world income in \$A. The market demand and supply functions must obviously be specified in the same currency units as the supply function. On the mixed grounds of relevance and convenience, real US GDP is used as the index of world income while the US price of synthetics for cotton blending is used as the price indicator for substitute fibres.

For supply, Q_S is raw wool production, P_W is the wool auction price, P_L and P_B are the saleyard prices of lamb and cattle and P_G is the grain price indicated by the unit gross value of wheat production, all in \$A.

The elasticities for the model are as indicated in Table 13.9 and the base values are as shown in Table 13.10. Note that the simulation model does not distinguish between domestic and foreign demand for Australian wool. This reflects the fact that 95 per cent or even more of the Australian wool clip is usually exported in either raw or semi-processed form.

Given that E refers generally to both elasticities of demand and supply, the formula for elasticity can be used to find the slope coefficients for each of the variables in the demand and supply functions as follows:

$E = \Delta Q/Q \div \Delta P/P = \Delta Q/\Delta P \times P/Q = b\ P/Q,$
so in the case of the own price elasticity $b = E_{WW}\ Q_W/P_W$

The latter formula applies to every coefficient other than the intercept terms a and g in the demand and supply curves, with the proviso that P is replaced as appropriate by the relevant variable. So, for example:

$d = E_{WI}\ Q_W\ /(I\ R)$ and $k = E_{WL}\ Q_W/P_L$

Table 13.10 Base market Values for Simulation Model.
Source: Haszler, Economic Policy Perspectives, (2006).

Demand Function			Supply Function		
Wool Quantity	kt greasy	787	Wool Quantity	kt greasy	787
Wool Price	cA/kg greasy	537	Wool Price	cA/kg greasy	537
Price of Synthetics	cUS/kg	72	Price of Lamb	cA/kg	43
Income	$US billion	6082	Price of Beef Cattle	cA/kg	121
Exchange Rate	$A/$US	1.172	Price of Grain	$A/tonne	121

The intercept terms can be found by substituting back into the original equations and taking the difference, as shown below for the demand curve:

$Q_D = a + b\,P_W + c\,P_S\,R + d\,I\,R$, so

$a = Q_D - (+ b\,P_W + c\,P_S\,R + d\,I\,R) = Q_D - (b\,P_W) - (c\,P_S\,R) - (d\,I\,R)$

and so given the signs of the elasticities, the sign on P_W changes so the expression ultimately becomes:

$a = Q_D + b\,P_W - c\,P_S\,R - d\,I\,R$

Remember the watch-point, watch the signs!

Students should use the information in Table 13.9 and Table 13.10 to derive the full demand and supply equations. The correct answers (as shown in the spreadsheet which is part of the Activity for this topic – Found on the CDRom under Topic Folders>Topic 13>Activities>Topic 13 (HaszlerFirmCosts.xls)) are:

$Q_D = 669.3 - 0.513P_W + 0.933P_S\,R + 0.044\,I\,R$
total world demand for Australian wool

$Q_S = 767.7 + 0.073P_W - 0.185P_L - 0.032P_B - 0.065P_G$
Australian wool supply to the world

And in terms of the standard own-price/own-quantity functions shown in the diagrams, the equations are:

$Q_D = (669.3 + 0.933P_S\,R + 0.044\,I\,R) - 0.513P_W$
and at the mean values
$Q_D = 1063.0 - 0.513P_W$
$Q_S = (767.7 - 0.185P_L - 0.032P_B - 0.065P_G) + 0.073P_W$
and at the mean values
$Q_S = 748.0 + 0.073P_W$

In a system such as this, equilibrium price is found by setting $Q_D = Q_S$ as follows:

$1063.0 - 0.513P_W = 748.0 + 0.073P_W$, so
$(0.073 + 0.513)P_W = 1063.0 - 748.0$ so, $P_W = 537.5$

Allowing for rounding, 537.5 is close enough to the actual auction value of 537.3c/kg, so the calculations are correct. Students should solve for Q_D and Q_S to make sure the two quantities are indeed the same at PW = 537.3.

Where the values of the explanatory variables change from their base values, the new equilibrium is obtained by solving first for P_W and then solving for Q_S and Q_D. Don't be lazy, solve for both as a check to make sure you have not made any arithmetical errors.

For the particular simulation system being used here, because $Q_S = Q_D$ in equilibrium, the equation for solving for price is:

$669.3 - 0.513P_W + 0.933P_S R + 0.044 I R = 767.7 + 0.073P_W - 0.185P_L - 0.032P_B - 0.065P_G$

so

$-0.513P_W - 0.073P_W = 767.7 - 0.185P_L - 0.032P_B - 0.065P_G - 669.3 - 0.933P_S R - 0.044 I R$

so

$-0.586P_W = 98.4 - 0.185P_L - 0.032P_B - 0.065P_G - 0.933P_S R - 0.044 I R$

so

$P_W = -(98.4 - 0.185P_L - 0.032P_B - 0.065P_G - 0.933P_S R - 0.044 I R)/0.586 = 537.4$ cA/kg

Calculating the individual impacts of changes in each of the explanatory variables is then a simple matter of substituting into the equation for PW above. To compute the individual impacts of each of the six explanatory variables (don't forget the exchange rate) it is necessary to carry out nine separate sets of calculations.

Fortunately the spreadsheet supplied on the CD and WebCT in Activities, Topic 13 takes care of the tedium of doing these calculations (Topic Folders>Topic 13>Activities>Topic 13 (HaszlerFirmCosts.xls).

Analysis using the spreadsheet should demonstrate one of the main conclusions you should take from this topic. That conclusion is that under normal circumstances, **demand side variations account for most of the volatility in the wool market**. This is because of both the absolute magnitudes of the demand side elasticities and because of the inherent variability of the demand side factors, especially the exchange rate.

Table 13.11 Some Plausible Wool-Relevant Supply Elasticities for Australia. Note:: .. denotes less than 0.005 in absolute terms. Sources: Haszler (2003); Connolly (1992); Fisher and Wall (1990).

Change in Supply of	Change in Price of			
	Wool	**Sheep-meat**	**Beef & Veal**	**Wheat**
	Short-Term (1 year) Elasticities			
Wool	**0.05**	-0.01	..	-0.01
Sheep-meat	-0.02	**0.23**	-0.03	0.04
Beef and Veal	-0.01	-0.05	**0.11**	-0.01
Wheat	-0.14	0.12	..	**0.32**
	Long-Term Elasticities			
Wool	**0.80**	-0.18	-0.07	-0.18
Sheep-meat	-0.05	**0.65**	-0.08	0.12
Beef and Veal	-0.15	-1.38	**2.90**	-0.28
Wheat	-0.24	0.21	..	**0.55**

Readings

The following readings are available on CD

1. Ashton, D. Brittle, S. and Sheales, T., 2000, *Demand for Wool in a Changing World,* Australian Bureau of Agricultural Resources and Economics.
2. Australian Bureau of Agricultural Resources and Economics (ABARE), 2001, *Outlook 2001*, *Proc. of the National Outlook Conference,* Sections:
    a. Economic Overview,
    b. Regional Australia,
    c. The Future of Farming: Vol 1,
    d. Fibres and Textiles.
3. Australian Bureau of Agricultural Resources and Economics (ABARE), 2003, *Outlook 2003*, *Proc. of the National Outlook Conference,* Sections:
    a. Economic Overview,
    b. Fibres
4. Australian Bureau of Agricultural Resources and Economics (ABARE), 2003, Australian Farm Surveys Report: 2002 and other editions, Australian Bureau of Agricultural Resources and Economics, Canberra.
5. Pearce, D., Vincent, D. and McKibbin, W. 1993, *Macroeconomic Policy and Woolgrowers*, Centre for International Economics, Canberra.
6. Stoeckel, A., Borrell, B. and Quirke, D. 1990*, Wool Into the 21st Century: Implications for Marketing and Profitability*, Centre for International Economics, Canberra.

Activities

Available on WebCT

Multi-Choice Questions

Submit answers via WebCT

Useful Web Links

Available on WebCT

Assignment Questions

Choose ONE question from ONE of the topics as your assignment. Short answer questions appear on WebCT. Submit your answer via WebCT

Summary

Summary Slides are available on CD

This topic has traversed a substantial area within the field of introductory microeconomics. The reason for covering some of the material presented is to ensure that you understand the logical basis for the propositions that are more directly and immediately relevant to a wool marketing course. Ultimately, the topic provides the basis for the following five key insights relevant to the economics of wool marketing.

First, two of the fundamental building blocks of economics and market analysis come from outside economics itself. These foundations stones are the technology available to firms at any given time, as represented in the firm's production function, and the consumer's preferences, as represented by the consumer's indifference curves. Economics links these foundations with propositions about the behaviour of individual producers and consumers to develop individual supply and demand curves. Those curves measure the firm's production costs and the value of consumption to consumers.

Second, economics then adds a formal and analytical method for understanding the interactions of consumers and producers in markets. That model relies on market demand and supply curves, which also measure costs and value, obtained by horizontally summing over individual consumers and firms.

Third, the foregoing analysis, coupled still with the behavioural propositions about informed, rational, unsatiated and maximising consumers and firms, yields a very general optimising rule. The rule is that consumers and producers should operate where the incremental return or gain (MR) from an additional unit of consumption, input application or production just equals its incremental cost (MC). And in competitive markets producers maximise their profits and consumers maximise their wellbeing where:

MC = MR = Market Price

Fourth, elasticity, or responsiveness, is a fundamental concept having relevance to pricing decisions of firms and to the magnitude of the various external shocks that regularly affect the wool market.

Finally, market supply and demand analysis can be used to understand, monitor and to help anticipate developments in the wool market. A key finding of the simulation exercise is that demand side factors such as income growth and exchange rate fluctuations explain much of the short-term variation in the wool market.

As noted at the beginning of this Topic, failure to analytically evaluate the market's gyrations can make the difference between business failure and success.

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Glossary of terms

The definitions of standard terms in microeconomics are probably common property these days. However, it is professionally polite to note that the following owes much to Samuelson and Nordhaus (1989).

Equilibrium (Consumer)	The position in which the consumer is maximising his or her wellbeing, that is, the consumer has chosen the bundle of goods and services which given the consumer's preferences, income and market prices best satisfies the consumer's wants
Equilibrium (Producer/Firm)	The position or level of output at which the firm maximizes its profits subject to any constraints such as the state of technology; for competitive firms, equilibrium is where marginal cost equals marginal revenue equals market price
Firm	An entity that hires or buys factors of production and organises them to produce and sell goods and services
Fixed Cost	A cost that is independent of the level of output and, therefore, has no effect on the short-run production decisions of competitive firms
Fixed Input(s)	Those inputs whose quantity used cannot be varied in the short-run
Income	The flow of earnings received by an individual.
Income Elasticity of Demand	The percentage change in the quantity of a product demanded in response to a percentage change in consumer incomes
Indifference Curve	A line showing all the possible combinations of the products among which a consumer is indifferent because each combination on the line gives the consumer an equal level of satisfaction or wellbeing
Inferior Good	a good whose consumption declines as income rises
Law of Diminishing Marginal Utility	The law that states that as more and more of any one commodity is consumed, the incremental value or utility of each additional unit declines
Law of Diminishing Returns	The law of production stating that, when all other inputs are held constant, the incremental output from successive units of the variable input will eventually decline; that is that the marginal product of the variable input declines after a point
Law of Supply and Demand	The analytical result that under perfect competition market price will move to a level at which the quantity that consumers wish to buy just equals the quantity that firms wish to produce, so that there is no excess demand or supply

Long Run	A period or length of time over which all the factors of production become variable and the firm can choose its optimum level of production and technology
Marginal Cost	The change in total cost resulting from a unit change in output. Because fixed costs are fixed in the short-run, marginal cost also equals the change in variable costs due to an additional unit of output
Marginal Product	The change in total product or output resulting from a unit change in the use of a variable input while all other inputs are held constant
Marginal Revenue	The change in total revenue resulting from a one unit change in the quantity sold
Market	Any arrangement that facilitates buying and selling (trading) of goods, services, factors of production or future commitment
Opportunity Cost	The best alternative foregone
Price Elasticity of Demand	A measure of the degree to which quantity of a good demanded by buyers responds to a change in its own price. Measured as the percentage change in quantity purchased divided by the percentage in price that caused the quantity change
Price Elasticity of Supply	An analogous measure to the price elasticity of demand.
Production Function	The relationship that describes how maximum levels of output change in response to changing levels of inputs. The production function is determined by the technology available to the firm
Profit	In economics defined as the difference between total sales revenue and the full opportunity cost of all the resources involved in producing the goods. In accountancy, profit is the difference between total revenue and costs “property” chargeable against the goods sold. The distinction between economic and accounting profit lies in the difference in the valuation of costs
Short run	The period in which at least some of the firm’s factors of production are fixed
Substitutes	Two goods which “compete” with each other as do tea and coffee or gloves and mittens. There are complements in supply as well as demand
Shutdown Point (Price)	The point where the market price is just sufficient to cover average variable costs. So the firm’s losses per period just equal its fixed costs and there is no point in operating

Supply Schedule (Curve)	A schedule or curve showing the quantity of a good that an individual firm (individual supply curve) or firms in aggregate (market supply curve) would produce at each price, holding other things constant
Total Cost	The sum of all the costs of all the inputs used in production
Total Revenue	The total revenue received from sales of a product, which equals quantity times price
Variable Cost	A cost that varies with the quantity of output
Value of the Marginal Product	The change in total revenue due to using an extra unit of a variable factor