5 The Theory of Consumer Choice

In previous chapters we have learned to use demand curves to represent consumer behaviour. The properties of these demand curves may usefully be summarized by own price, cross price, and income elasticities of demand. In this chapter we go behind these measures of demand by building a model of consumer behaviour. The model of consumer choice explains how buyers reconcile what they would like to do, as described by their tastes or preferences, and what the market will allow them to do, as described by their incomes and the prices of different goods. The model allows us to predict how consumers will respond to changes in market conditions. It helps to make sense of the price and income elasticities examined in Chapter 4.

5-1 THE THEORY OF CONSUMER CHOICE

The model has four elements which describe both the consumer and the market environment:

1 The given income that the consumer can spend
2 The prices at which goods can be bought
3 The consumer's tastes, which rank different combinations or bundles of goods according to the satisfaction they yield the consumer
4 The behavioural assumption that consumers do the best they can for themselves. Of the possible consumption bundles that can be purchased out of a given income, the consumer picks the bundle that maximizes his or her own satisfaction.

Each of these elements in the model requires detailed discussion.

The Budget Constraint

Together, elements (1) and (2) define the consumer's budget constraint.

> The *budget constraint* describes the different bundles that the consumer can afford.

Which bundles are feasible, or can be afforded, depends on two factors: the consumer's income and the prices of different goods.

Consider a student with a weekly budget (income, allowance, or grant) of £50 which can be spent on meals or films.[1] Each meal costs £5 and each film £10. What combination of meals and films can the student afford to buy? Completely going without films, the student can spend £50 on 10 meals at £5 each. Completely going without meals, the student can buy 5 cinema tickets at £10 each. Between these two extremes lies a range of combinations of meals and films that together cost exactly £50. These combinations are called the budget constraint.

[1] When there are more than two goods, we can think of 'films' as standing for 'all goods other than meals'.

Thus, the budget constraint shows the *maximum* affordable quantity of one good given the quantity of the other good that is being purchased.[2] Table 5-1 shows the budget constraint for the student in our example. Each row of the table shows an affordable consumption bundle. For example, row 4 shows that 6 meals (costing £30) and 2 films (costing £20) use up all available income. Other rows are calculated in the same way.

Table 5-1 shows the *trade-off* the student must make between meals and films. Higher quantities of meals require lower quantities of films. For a given income, the budget constraint shows how much of one good must be sacrificed to obtain larger quantities of the other good. It is because there is a trade-off that the student must make a *choice between* meals and films.

The Budget Line

It is useful to depict the budget constraint of Table 5-1 as a *budget line*. Plotting the data of Table 5-1, the budget line in Figure 5-1 again shows the maximum combinations of meals and films that the student can purchase out of available income.

The position and shape of the budget line are determined by its end points A and F, which have a simple economic interpretation. Point A shows the maximum quantity of films (5) that the budget will purchase if the student goes without meals: £50 buys at most 5 tickets at £10 each. Point F shows that £50 buys at most 10 meals at £5 each if the student goes without films. The budget line joins up points A and F. Intermediate points on the line such as B and C show more balanced purchases of meals and films.

The budget line is a convenient way to examine the trade-off between meals and films. The slope of the budget line indicates how many meals must be sacrificed to get another film. Moving from point F to point E reduces the quantity of meals from 10 to 8 but increases the quantity of films from 0 to 1. This trade-off between meals and films is constant along the budget line. Giving up two meals at £5 each always provides the extra £10 to buy an additional cinema ticket.

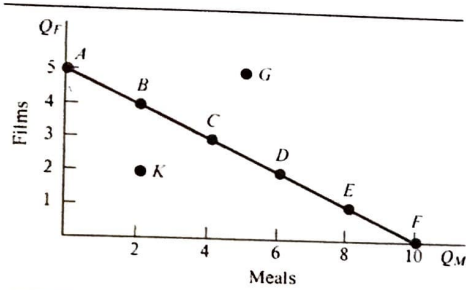
We now see the crucial role of prices. It is because film tickets cost twice as much as meals that two meals must be sacrificed to purchase another film ticket. If films cost three times as much as meals it would be necessary to sacrifice three meals to pay for one extra film. *The slope of the budget line depends only on the ratio of the prices of the two goods.* The slope of a line is the change in the vertical distance divided by the corresponding change in the horizontal distance. In Figure 5-1 the slope of the budget line is $-\frac{1}{2}$. A

[2] We assume that all income is spent on goods. There is no saving. We defer analysis of the important choice between spending and saving until Chapter 20.

TABLE 5-1
ALTERNATIVE AFFORDABLE CONSUMPTION BASKETS

QUANTITY OF MEALS (Q_M)	SPENDING ON MEALS (£5 × Q_M)	QUANTITY OF FILMS (Q_F)	SPENDING ON FILMS (£10 × Q_F)
0	0	5	50
2	10	4	40
4	20	3	30
6	30	2	20
8	40	1	10
10	50	0	0

FIGURE 5-1 THE BUDGET LINE. The budget line shows the maximum combinations of goods that the consumer can afford, given income and the prevailing prices. Points such as *B* and *C*, on the budget line *AF*, use up the entire consumer budget. Points such as *G*, above the budget line, are unaffordable. Points such as *K*, inside the budget line, would allow additional consumption of at least one good.



positive change of 1 film must be divided by the corresponding negative change of −2 meals.

This example illustrates the general rule

$$\text{Slope of the budget line} = -P_H/P_V \qquad (1)$$

where P_H is the price of the good whose quantity is measured on the horizontal axis and P_V is the price of the good whose quantity is measured on the vertical axis. In our example, the price of meals P_H is £5 and the price of films P_V is £10. Formula (1) confirms that the slope of the budget line is $-\frac{1}{2}$ and the minus sign reminds us that there is a trade-off. We have to *give up* one good to get more of the other good.

Thus, the two end-points of the budget line (here, *A* and *F*) show how much of each good the budget will buy if the other good is not purchased at all. The slope of the budget line joining these end-points, depends only on the *relative* prices of the two goods.

Any point above the budget line (such as *G* in Figure 5-1) is unaffordable. The budget line shows the maximum quantity of one good that can be afforded, given the quantity purchased of the other good and given the budget available for spending. Given an income of £50, the point *G* is out of reach since it requires £25 to buy 5 meals and £50 to buy 5 cinema tickets. Points such as *K*, which lie inside the budget line, leave some income unspent. The point *K* requires £10 for meals and £20 for films leaving £20 unspent. The student could use this £20 to buy 4 extra meals (moving from *K* to *D* without sacrificing films) or to buy 2 extra film tickets (moving from *K* to *B* without sacrificing meals). Only on the budget line is there a trade-off where the student must choose *between* films and meals.

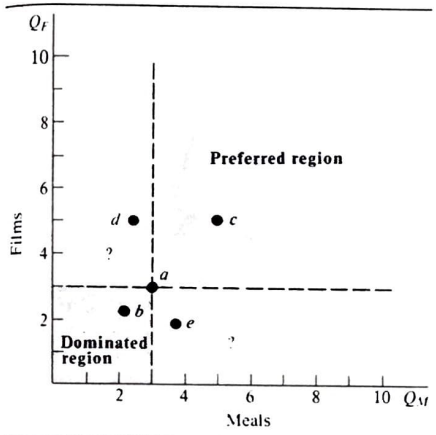
Tastes

The budget line summarizes the market environment (income and prices) of the consumer. We now consider the consumer's *tastes*. We make three assumptions that seem rather plausible. First, we assume the consumer can rank alternative bundles of goods according to the satisfaction or *utility* they provide. Utility is the satisfaction or happiness a consumer derives from a particular bundle of goods. It is unnecessary for the consumer to quantify this utility, for example to decide that one bundle yields twice as much utility as another bundle. We only require that the consumer can decide that one bundle is better than, worse than, or exactly as good as another. We assume that this ranking of possible bundles is internally consistent: if bundle *A* is preferred to bundle *B* and bundle *B* is preferred to bundle *C*, then bundle *A* had better be preferred to bundle *C*.

Second, we assume that *the consumer prefers more to less*. If bundle *B* offers more films but the same number of meals as bundle *K* we assume that bundle *B* is preferred. How do we handle things like pollution, which are not goods but 'bads'? Other things equal, consumers do not prefer more pollution to less. Economists get round this problem by redefining commodities so that the assumption will be satisfied. For example we can analyse tastes for clean river water rather than for polluted river water. More clean water is better, other things equal.

Figure 5-2 examines the implications of these assumptions about tastes. Each point in the figure shows a particular consumption bundle, a quantity

FIGURE 5-2 CONSUMER RANKING OF ALTERNATIVE CONSUMPTION BUNDLES. The consumer evaluates alternative consumption bundles, which are identified by points *a*, *b*, *c*, *d*, and *e*. With respect to point *a*, any point to the north-east is preferred and any point to the south-west is dominated by *a*. Points such as *d* or *e* in the other two regions may or may not be preferred to *a*, depending on the consumer's tastes.



of meals and a corresponding quantity of films. For the moment we ignore whether or not these bundles are affordable. We are interested only in tastes themselves. We begin at the bundle shown by the point *a*. Through this point we draw a horizontal line and a vertical line. Since more is preferred to less, any point such as *c* to the north-east of *a* is preferred to *a*. Point *c* offers more of *both* goods than *a*. Conversely, points to the south-west of *a* offer less of both goods than *a*. Point *a* is preferred to points such as *b*.

Without knowing the consumer's exact tastes we cannot be sure how points in the other two regions (north-west and south-east) will compare with *a*. At points such as *d* or *e* the consumer has more of one good but less of the other good than at *a*. Someone who really likes food might prefer *e* to *a*, but an avid film buff would prefer *d* to *a*. Others might be indifferent between *d*, *a*, and *e*, ranking them equal in terms of the utility they provide.

We now introduce the concept of the marginal rate of substitution of meals for films.

> The *marginal rate of substitution* of meals for films is the quantity of films the consumer must sacrifice to increase the quantity of meals by one unit *without changing total utility*.

Since consumers prefer more to less, an additional meal tends to increase utility. To hold utility constant, when one meal is added the consumer must simultaneously sacrifice some quantity of the other good (films). The marginal rate of susbstitution tells us how many films the consumer could exchange for an additional meal without changing total utility. The marginal rate of substitution must be a negative number: it is the ratio of a negative change in the quantity of films to the positive change in the quantity of meals when utility remains unaltered.

Suppose the student begins with a bundle comprising 5 films and no meals. Having already seen 4 films that week, the student probably does not enjoy the fifth film very much. With no meals, the student is *very* hungry. The utility of this bundle is low: being so hungry, the student cannot really enjoy the films anyway. To obtain the same amount of utility the student could give up a lot of films in exchange for a little food. The marginal rate of substitution is a large negative number and we say that it is high.

Suppose instead that the student is consuming a large number of meals but seeing few films. To obtain the same amount of utility, the student will be reluctant to sacrifice much cinema attendance to gain yet another meal. The marginal rate of substitution is a small negative number and we say that it is low. When the ratio of films to meals is already high the marginal rate of substitution of meals for films is high. It makes sense to sacrifice abundant films for scarce meals. Conversely, when the ratio of films to meals is already low the marginal rate of substitution of meals for films is low. It does not make sense to sacrifice scarce films for yet more meals.

Economists believe that this common-sense reasoning about tastes or preferences is very

robust. It will hold in a wide range of circumstances. Indeed, it is sufficiently plausible that it can become a general principle, the third assumption we need to make about consumer tastes. It is called the assumption of a diminishing marginal rate of substitution.

> Consumer tastes exhibit a *diminishing marginal rate of substitution* when, to hold utility constant, diminishing quantities of one good must be sacrificed to obtain successive equal increases in the quantity of the other good.

For example, our student might be indifferent between, that is, be equally happy with, bundle $X = (6$ films, 0 meals), bundle $Y = (3$ films, 1 meal), and bundle $Z = (2$ films, 2 meals). Beginning from bundle X, a move to Y sacrifices 3 films for 1 meal, but a further move from Y to Z sacrifices only 1 film for 1 extra meal. Such tastes satisfy the assumption of a diminishing marginal rate of substitution.

These three assumptions – that consumers prefer more to less, can rank alternative bundles according to the utility provided, and have tastes satisfying a diminishing marginal rate of substitution – are all we shall require. It is now convenient to show how tastes can be represented as *indifference curves*.

Representing Tastes as Indifference Curves

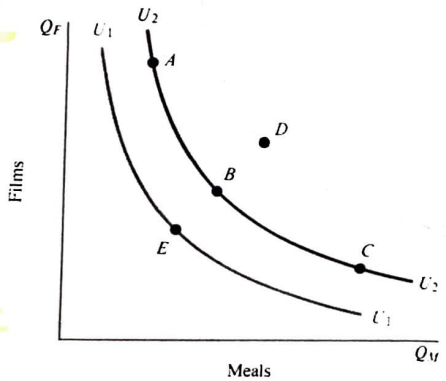
If we join up all the many points the student likes equally, we obtain an indifference curve.

> An *indifference curve* shows all the consumption bundles which yield the same utility to the consumer.

Figure 5-3 shows three indifference curves labelled U_1U_1, U_2U_2, and U_3U_3.

Every point on U_2U_2 yields the same utility. Point C offers a lot of meals and few films, point B offers a more balanced quantity of meals and films, and point A offers many films but few meals. Because the consumer prefers more to less, *indifference curves must slope downwards*. Since more meals tend to increase utility, some films must simultaneously be sacrificed to hold utility constant.

FIGURE 5-3 REPRESENTING CONSUMER TASTES BY INDIFFERENCE CURVES. Along each indifference curve, such as U_2U_2, consumer utility is constant. Since more if preferred to less, any point on a higher indifference curve, such as U_3U_3, is preferred to any point on a lower indifference curve. Indifference curves must slope downwards. Otherwise the consumer would have more of both goods and would be better off. Diminishing marginal rates of substitution imply that each indifference curve becomes flatter as we move along it to the right.



The slope of each indifference curve gets steadily flatter as we move to the right. This follows immediately from the assumption of a diminishing marginal rate of substitution. At point A, where films are relatively abundant compared with meals, the consumer will sacrifice a lot of films to gain a little more food. At the point B, where films are less abundant relative to meals, the consumer will sacrifice a smaller quantity of films to gain the same additional quantity of meals. And at the point C the student now has so many meals that hardly any films will be sacrificed for additional meals. In fact, we now recognize that the marginal rate of substitution of meals for films is simply the slope of the indifference curve at the point from which we begin. These two properties of a single indifference curve – its

downward slope and its steady flattening as we move to the right – follow directly from the assumptions that consumers prefer more to less and that their tastes satisfy the assumption of diminishing marginal rates of substitution.

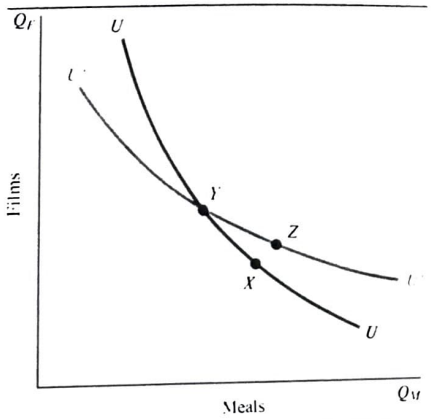
Now consider the point D, which lies on a different indifference curve U_3U_3. Point D offers more of both goods than point B. Since consumers prefer more to less, utility at D must be higher than utility at B. By definition, all points on U_3U_3 yield the same utility. The difference between U_2U_2 and U_3U_3 is that every point on U_3U_3 yields more utility than every point on U_2U_2. Conversely, point E must yield less utility than point B since it offers less of both goods. Every point on U_1U_1 yields less utility than every point on U_2U_2.

Although in Figure 5-3 we have drawn only three indifference curves, we can imagine drawing in other indifference curves as well. As we move on to higher indifference curves we move to bundles that will be preferred. Higher indifference curves are better because the consumer prefers more to less.

You may be wondering if it is a coincidence that we have not drawn any indifference curves that cross each other. It is not: our assumptions guarantee that indifference curves cannot cross. Figure 5-4 shows why. Suppose the indifference curves UU and $U'U'$ were to intersect. Since X and Y lie on the same indifference curve UU, the consumer is indifferent between these points. But Y and Z both lie on the indifference curve $U'U'$. Hence the consumer is indifferent between Y and Z. Together these imply that the consumer is indifferent between X and Z. But this is impossible, since the consumer gets more of both goods at Z than at X. Hence intersecting indifference curves would violate our assumption that consumers prefer more to less. Our assumptions about consumer tastes rule out intersecting indifference curves.

We can now represent the tastes of any particular consumer by drawing the complete family or *map* of indifferent curves. Figure 5-5 shows the indifference map for two consumers with different tastes. In each case, moves to a higher indifference curve imply an increase in utility. In Figure 5-5(a) we show the indifference map for a glutton who is always prepared to give up a lot of films to gain a little extra food. Figure 5-5(b) shows the indifference map for a weight-watching film buff, who will give up large quantities of food to increase the quantity of films by even a small amount. Both indifference maps are valid in the sense that they satisfy our three basic assumptions about consumer tastes. Our theory is sufficiently general to cope with either of these extreme kinds of preferences as well as with more typical preferences which lie somewhere in between these two cases.

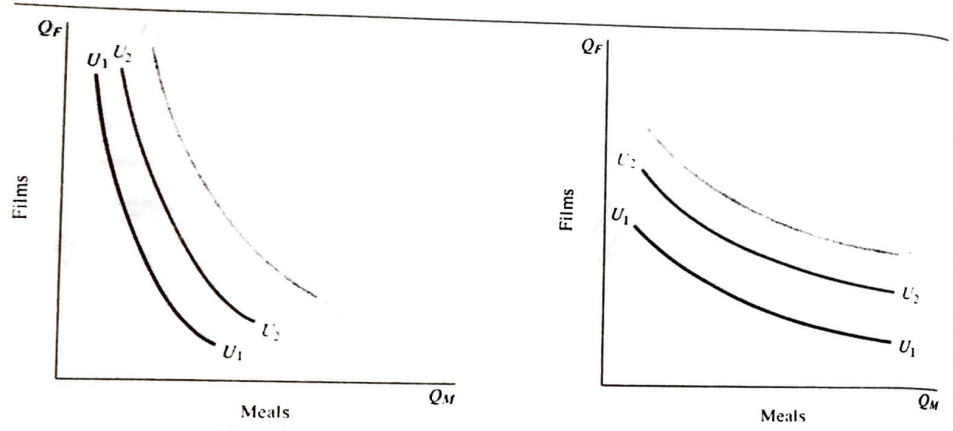
FIGURE 5-4 INDIFFERENCE CURVES CANNOT INTERSECT. If indifference curves intersected, the consumer would be indifferent between X and Y, which both lie on the indifference curve UU, and between Y and Z, which both lie on the indifference curve $U'U'$. Hence the consumer would be indifferent between X and Z. Since Z offers more of both goods than X, this violates the assumption that consumers prefer more to less. Hence indifference curves cannot intersect.



Utility Maximization and Consumer Choice

The budget line describes the affordable bundles given the consumer's market environment (the budget for spending and the price of different

FIGURE 5-5 REPRESENTING DIFFERENCES IN TASTES. To hold utility constant along a particular indifference curve, a glutton will give up a large quantity of films for extra meals but a weight-watching film buff will give up very few films for the same increase in meals.



goods). The indifference map shows the tastes of the consumer. To complete the model, we add the behavioural assumption that *the consumer chooses the affordable bundle that maximizes his or her utility.*

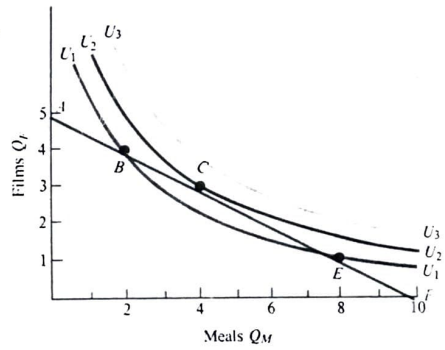
The consumer cannot afford points that lie above the budget line and will never choose points that lie below the budget line. If the consumer begins at a point below the budget line, some income is unspent and it is possible to purchase more of one good without sacrificing any of the other good. Spending all the available budget and thereby moving on to the budget line must increase utility since the consumer prefers more to less.

Thus we know the consumer will select a point on the budget line. To determine which point on the budget line maximizes utility we need to think about the consumer's tastes. We expect our glutton to pick a point with more meals and less films than the point our film buff will select. We begin by showing in general how to use indifference curves to determine the bundle the consumer will choose. Then we confirm that our model of consumer choice can capture the different behaviour of the glutton and the film buff.

Figure 5-6 again shows the budget line AF for the student who has £50 to spend on films at £10 each and meals at £5 each. The indifference curves U_1U_1, U_2U_2, and U_3U_3 are part of the complete indifference map describing the student's tastes. The student prefers any point on U_3U_3 to any point on U_2U_2, which in turn is preferred to any point on U_1U_1.

Since U_3U_3 lies everywhere above the budget line AF, all points on U_3U_3 are unattainable, however much the student would like to obtain this amount of utility. Suppose the student considers the attainable point B on the indifference curve U_1U_1. This will certainly be preferred to the point A, which must lie on a lower indifference curve (since indifference curves cannot intersect, the indifference curve through A must lie everywhere below the indifference curve U_1U_1). Similarly, the point F must lie on a lower indifference

FIGURE 5-6 CONSUMER CHOICE IN ACTION. Points above the budget line AF are unaffordable. The consumer cannot reach the indifference curve U_3U_3. Points such as B and E are affordable but only allow the consumer to reach the indifference curve U_1U_1. The consumer will choose the point C to reach the highest possible indifference curve U_2U_2. At the chosen point C, the indifference curve and the budget line just touch and their slopes are equal.



curve than the point E and the student prefers E to F.

However, the student will chose neither the point B nor the point E. By moving to the point C he or she can reach a higher indifference curve and obtain more utility, so C is the point that the student will choose. Any other affordable point on the budget line will place the student on a lower indifference curve, and any indifference curve above U_2U_2 lies entirely above the budget line AF and involves bundles that are unaffordable given the budget constraint. The assumption that consumers choose the bundle that maximizes their utility given the affordable possibilities described by the budget line thus has the following simple implication: *the chosen bundle will be the point at which an indifference curve just touches the budget line.* Mathematicians would say that the budget line is *a tangent* to the indifference curve U_2U_2 at the point C. The budget line does not ever cross any higher indifference curve, such as U_3U_3 and crosses twice every lower indifference curve, such as U_1U_1. Point C describes the point of maximum utility given the budget constraint.

It is helpful to reach the same conclusion by a slightly different chain of reasoning. Consider again point B in Figure 5-6. The slope of the budget line indicates the trade-off between affordable quantities of films and meals that the market environment will allow. When films cost £10 and meals £5, two meals can be traded for one film. The slope of the indifference curve at B (the marginal rate of substitution of meals for films) shows how the consumer would trade meals for films to preserve a constant level of utility. Beginning at B, it makes no sense to move leftwards along the budget line. The extra affordable quantity of films gained by sacrificing a meal is less than the marginal rate of substitution, the extra quantity of films needed to maintain utility when a meal is sacrificed. At the point B the budget line is flatter than the indifference curve. Moves to the left would take the student on to a lower indifference curve because the market trade-off is less than the required utility trade-off. Similarly, beginning at the point E it cannot make sense to move to the right along the budget line. The market trade-off of meals for films is less than the utility trade-off required to hold utility constant. Moves from E to the right must reduce utility and take the consumer on to a lower indifference curve.

However, it makes sense to consider a move from B to the right. The market trade-off of affordable meals for films exceeds the utility trade-off required to maintain constant utility.

The student is able to move on to a higher indifference curve and increase utility. Similarly, it makes sense to consider a move from E to the left. Again the market trade-off, this time increasing the quantity of affordable films in exchange for less meals, more than compensates for the utility trade-off, the slope of the indifference curve, required to maintain utility at a constant level. Moves from E leftwards along the budget line must increase utility and allow the student to reach a higher indifference curve.

In fact, we can make a general principle out of these examples. Wherever the budget line *crosses* an indifference curve, so that the affordable market trade-off (the slope of the budget line) differs from the marginal rate of substitution (the slope of the indifference curve, which shows the utility trade-off between the two goods to preserve total utility), a move along the budget line in one direction will increase utility since the market trade-off is better than the utility trade-off required to maintain constant utility; but a move along the budget line in the opposite direction will decrease utility since the market trade-off is worse than the utility trade-off required to maintain constant utility.

Viewed in these terms, *the point C, which maximizes utility, is the point at which the slope of the budget line and the slope of the indifference curve coincide.* At all other points on the budget line the slope of the indifference curve through such points differs from the slope of the budget line: a move in one or other direction will increase utility. Only at point C are there no feasible or affordable moves along the budget line that increase utility. The student will choose point C since it maximizes utility.

Whichever line of reasoning we adopt, we reach the same conclusion: point C offers the highest affordable utility. It is precisely because it is the point at which the indifference curve just touches the budget line that the slopes of the indifference curve and the budget line coincide, ruling out a feasible move that would increase utility.

To check that our model of consumer choice makes sense, we consider what it implies for the observable behaviour of our glutton and film buff whose tastes between meals and films differ. Recall that in Figure 5-5 we represented the indifference curves of the glutton as steep and the indifference curves of the film buff as flat. To maintain a constant level of utility along a particular indifference curve, the glutton will always sacrifice a lot of films for more food but the film buff will hardly sacrifice any films for a lot more food.

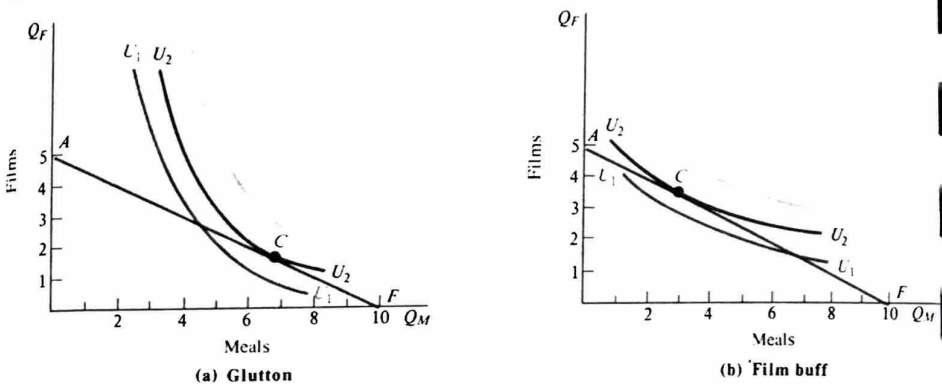
In Figure 5-7 we give these two students the same budget line. They have the same income and face the same prices for food and films. Only their tastes differ. Figure 5-7(a) shows that the chosen point C for the glutton occurs at a combination of a lot of meals but few films. Figure 5-7(b) confirms that the film buff will choose a point C with many more films but much less food. The theory of consumer choice based on individual utility maximization successfully translates differences in tastes into differences in revealed or observable demands for the two goods.

Both students have a diminishing marginal rate of substitution of meals for food. Each indifference curve becomes flatter as we move to the right. The theory of consumer choice implies that each student will choose a point C at which their marginal rate of substitution equals the slope of the budget line, which depends only on the relative price of films and meals. Because the glutton has a strong preference for food (steep indifference curves), the chosen point must lie far to the right to give the indifference curve a long time to flatten out. Because the film buff has flat indifference curves, the chosen point must lie well to the left before indifference curves can become flatter than the budget line.

5-2 ADJUSTMENT TO INCOME CHANGES

In the previous chapter we introduced the concept of the income elasticity of demand to describe, other things equal, the response of quantity demanded to changes in consumer incomes. Now we can use our model of consumer choice to analyse this response in greater detail.

FIGURE 5-7 THE EFFECT OF TASTES ON CONSUMER CHOICE. Both students face the same budget line AF and choose the point C, maximizing utility where the indifference curve is tangent to the budget line. The glutton has steep indifference curves and must consume a lot of meals before the diminishing marginal rate of substitution flattens the indifference curve sufficiently. The film buff has flat indifference curves and the point of tangency occurs much further to the left. Thus the glutton chooses more meals but fewer films than the film buff.



For given tastes and prices, Figure 5-8 shows the adjustment to a change in income. As in previous figures, we begin by assuming the student has an income of £50, faces the budget line AF, and chooses the point C at which utility is maximized. Now suppose the student's income rises from £50 to £80. Prices of meals and films remain unchanged at £5 and £10 respectively. With higher income the student can afford to buy more of one or both of the goods. The budget line shifts outwards from AF to $A'F'$. To find the exact position of this new line we have to calculate the purchasing power of the new income in terms of the two goods. Again we calculate the end points at which all income is spent on a single good. The point A' shows that at most £80 buys 8 films at £10 each. The point F' shows that £80 buys at most 16 meals at £5 each. Joining these points yields the new budget line $A'F'$. Since the slope of a budget line depends only on the relative prices of the two goods, which remain unchanged, the new budget line $A'F'$ is parallel to the old budget line AF.

Which point on $A'F'$ will the student choose? Our model of consumer choice implies that the student will choose the point C' at which the new budget line is tangent to the highest attainable indifference curve. However, the position of this point C' depends on the map of indifference curves that describe the student's tastes.

The empirical evidence examined in the previous chapters suggests that for most consumers food is a normal good but a necessity whereas entertainment is a luxury good. Figure 5-8 shows the case in which the student's tastes have these properties. A rise in income from £50 to £80 leads the student to move from the point C (2 films, 6 meals) to the point C' (4 films, 8 meals). Thus, a 60 per cent rise in income induces a 100 per cent increase in the quantity of films demanded, confirming that films are a luxury good with income elasticity in excess of unity. Similarly, the

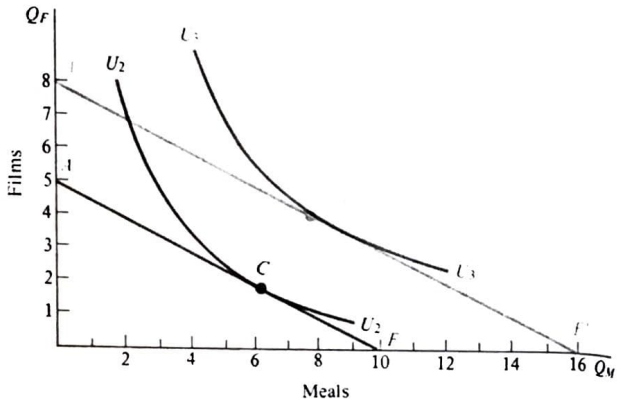


FIGURE 5-8 THE EFFECT OF AN INCREASE IN CONSUMER INCOME. An increase in consumer income from £50 to £80 induces a parallel shift in the budget line from *AF* to *A'F'*. The new end points *A'* and *F'* reflect the increase in puchasing power if only one good is purchased. The slope remains unaltered since prices have not changed. At the higher income the consumer chooses *C'*. Since both goods are normal, higher income raises the quantity of each good demanded but the percentage increase in film quantity is larger since its income elasticity is higher.

60 per cent rise in income induces a 33 per cent increase in the quantity of meals demanded. Thus, the income elasticity of demand for food is (0.33/0.6) = 0.55, confirming that food is a normal good (income elasticity greater than zero) but a necessity (income elasticity less than unity).

In contrast, Figure 5-9 illustrates the case in which the student's tastes make food an inferior good, for which the quantity demanded declines as income rises. At the point C′ on the budget line *A′F′* fewer meals are demanded than at the point C on the budget line *AF*, corresponding to the lower income.

The effects of a fall in income are, of course, exactly the opposite. The budget line shifts inwards but remains parallel to the original budget line. When both goods are normal, lower consumer income reduces the quantity demanded for both goods. If one good is inferior the quantity demanded will actually rise as income falls. Notice both goods cannot be inferior: when income falls but prices remain unchanged it cannot be feasible for the consumer to consume more of both goods.

Income Expansion Paths

Thus far we have considered the response of demand to a particular change in income, other things equal. We might wish to know the response of demand to income over all possible variations in income. To study this we can trace out the *income expansion path*. The income expansion path shows how the chosen bundle of goods varies with consumer income levels.

Figure 5-10 illustrates the indifference map describing the tastes of a particular consumer. Other things equal, different incomes correspond to different budget lines. By drawing a sequence of parallel budget lines, one for each possible income level, we can trace out the points that the consumer would choose to attain the highest possible indifference curve at each income level. For example, at the low income level represented by the budget line A_1F_1 the consumer chooses C_1, but at the high budget income represented by the budget line A_4F_4 the consumer chooses C_4. Joining up all these points we obtain the income expansion path describing changes in quantity demanded as income is varied.

5-3 ADJUSTMENT TO PRICE CHANGES

Having studied the effects of changing tastes and changing income on quantity demanded, we now isolate the effect of a price change. Relying on common sense, in Chapter 4 we argued that an

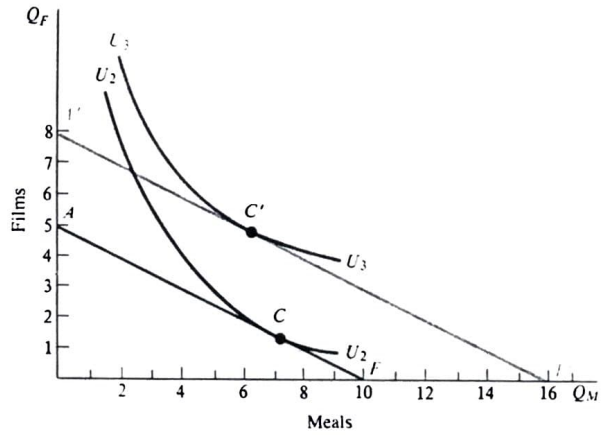


FIGURE 5-9 AN INCREASE IN INCOME REDUCES DEMAND FOR THE INFERIOR GOOD. Again, income is increased from £50 to £80 and there is a parallel shift in the budget line from *AF* to *A'F'*. If meals were an inferior good, the quantity demanded would fall as income rose. The consumer then moves from *C* to *C'* when income rises.

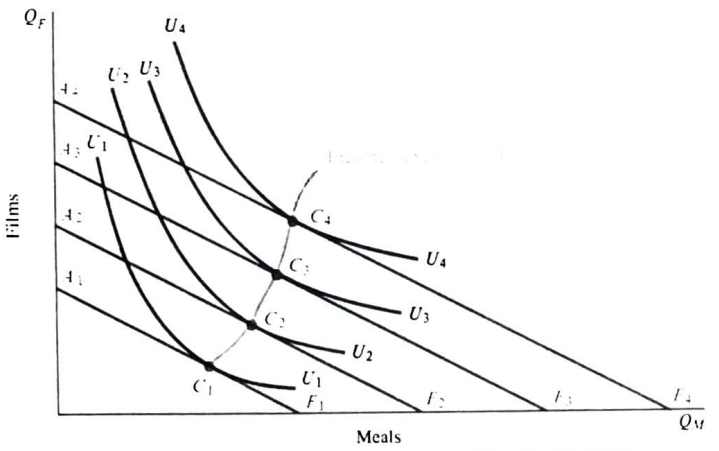


FIGURE 5-10 THE INCOME EXPANSION PATH. Successive increases in income lead to parallel outward shifts in the budget line. By drawing in the complete map of indifference curves we can trace out the points the consumer will choose. Joining these points, we obtain the income expansion path.

increase in the price of a good will reduce the quantity demanded, other things equal. The own price elasticity of demand measures this response, and will be larger the easier it is to substitute towards goods whose prices have not risen.

We also introduced the cross-elasticity of demand to measure the response of the quantity demanded of one good to a change in the price of another good. An increase in the price of good *j* tends to increase the quantity demanded of good *i* when the two goods are substitutes but tends to reduce the quantity demanded of good *i* when the two goods are complements. The empirical evidence in favour of all these propositions was presented in Tables 4-3 and 4-8.

Are these propositions invariably true, or did the evidence we examined just happen to confirm our common-sense reasoning? To answer this question we now offer a more formal analysis based on the model of consumer choice we have now developed.

Price Changes and the Budget Line

In Figure 5-11 we draw the budget line *AF* for a consumer with an income of £50 facing prices of £10 and £5 for films and meals respectively. Now suppose that meal prices increase to £10. Since the price of films remains unaltered, £50 still buys 10 films when all income is spent on films. The point *A* must lie on the new budget line as well as the old budget line. But when all income is spent on meals, £50 buys only 5 meals at £10 each instead of the 10 meals it used to buy at £5 each. Thus the other extreme point on the budget line shifts from *F* to *F'* when meal prices double. As usual, we join up these end-points to obtain the new budget line *AF'*. Thus the effect of an increase in meal prices is to *rotate* the budget line inwards around the point *A*, at which no meals are bought and meal prices are irrelevant.

Except at the point *A* itself, at the higher meal prices, the consumer can now afford fewer meals for any given number of films purchased, or fewer films for any given number of meals. For example, buying 3 films at £10 each, the consumer is forced to reduce purchases of meals from 4 to 2. Making the same point in a different way, the new budget line *AF'* lies inside the old budget line *AF*. The consumption bundles lying between *AF'* and *AF* are no longer affordable at the higher price of meals. In particular, the chosen point on the old budget line is no longer affordable unless it happened to be the extreme point *A*. This analysis shows how a price increase makes the consumer worse off by reducing consumption opportunities out of a fixed money income. The consumer's standard of living will fall.

To check that you understand how price changes affect the budget line, try drawing diagrams to illustrate the effect on the budget line of: (1) a reduction in the price of meals (*hint*: Figure 5-11 can be used. How?); (2) an increase in the price of films (*hint*: around which point does the budget line rotate?).

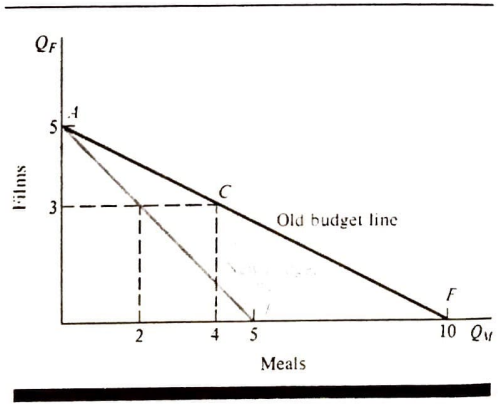


FIGURE 5-11 THE EFFECT OF AN INCREASE IN MEAL PRICES ON THE BUDGET LINE. The consumer begins at the point *C* on the budget line *AF*. Doubling meal prices halves the amount that can be spent on meals when no films are bought. The point *F* shifts to *F'*. The budget line rotates around the point *A* at which no meals are bought. Along the new budget line the consumer can no longer afford the original consumption bundle *C*. Consumption of one or both commodities must be reduced.

Substitution and Income Effects

Our model of consumer choice is based on the interaction of affordable opportunities represented by the budget line, and tastes represented by indifference curves. To analyse the effect of price changes on the actual quantity of goods demanded, we must now study how rotations of the budget line affect the highest indifference curve that the consumer can reach.

We have seen that an increase in the price of meals has two distinct effects on the budget line in Figure 5-11. First, the budget line becomes steeper, reflecting the increase in the relative price of meals. To obtain an additional meal a larger quantity of films must now be sacrificed. Second, in general the budget line *AF'* lies inside the original budget line *AF*. The purchasing power of a given money income has been reduced by the price increase. Economists therefore break up the effect of a price increase into these two distinct effects, one corresponding to the change in the relative prices of the two goods, the other corresponding to the reduction in the purchasing power of the given money income.

> The *substitution effect* of a price change is the adjustment of demand to the relative price change alone. The *income effect* of a price change is the adjustment of demand to the change in real income alone.

In Figure 5-12 we show how substitution and income effects may be used to organize the way we think about the response of demand quantities to an increase in the price of meals. At the original prices the consumer faces the budget line *AF* and chooses the point *C* to reach the highest possible indifference curve U_2U_2. At the higher meal price the budget line rotates to *AF'* and the consumer chooses the point *E* to reach U_1U_1, the highest indifference curve now possible. In this example, the doubling of meal prices reduces the quantity of meals demanded and the quantity of films demanded.

The Substitution Effect To isolate the effect of relative prices alone, imagine drawing the *hypothetical* budget line *HH*, parallel to *AF'* but tangent to the original indifference curve U_2U_2. Because *HH* is a parallel to the new budget line *AF'*, its slope reflects the new relative prices of

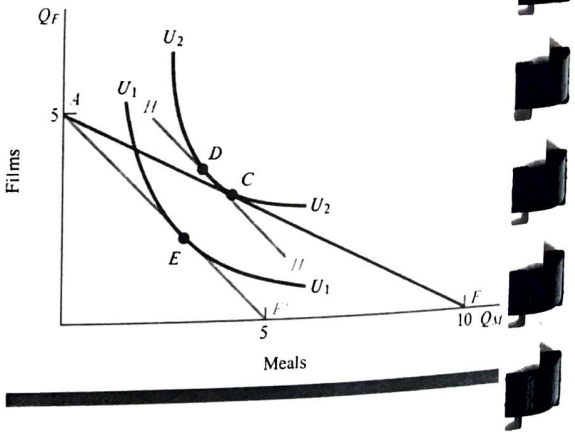


FIGURE 5-12 INCOME AND SUBSTITUTION EFFECTS OF AN INCREASE IN MEAL PRICES. Higher meal prices rotate the budget line from *AF* to *AF'*. The consumer moves from the point *C* to the point *E*. This move can be decomposed into a pure substitution effect, from *C* to *D*, the response to relative price changes at the old standard of living, plus a pure income effect, from *D* to *E*, the response to a fall in real income at constant relative prices. The substitution effect must reduce the quantity of meals demanded. The income effect also reduces the quantity of meals demanded provided meals are a normal good. Under these circumstances, price increases reduce the quantity demanded and demand curves slope downwards.

films and meals after the price of meals has risen. Because HH is tangent to the old indifference curve U_2U_2, it allows the consumer to attain the original level of utility and standard of living that, by definition, is constant along U_2U_2.

If confronted with the hypothetical budget line HH the consumer would choose the point D. The move from C to D captures the pure substitution effect, the adjustment of demand to relative prices when income is adjusted to maintain the old standard of living in the face of the new higher prices. *The substitution effect of an increase in the price of meals unambiguously reduces the quantity of meals demanded.* This result is perfectly general.[3] As meals become relatively more expensive, the consumer has an incentive to switch towards films, which have become relatively cheaper.

The Income Effect To isolate the effect of the reduction in real income, holding relative prices constant, consider now the parallel shift in the budget line from the hypothetical position HH to the actual new position AF'. The consumer moves from the point D to the point E. From Chapter 4 we know that, when both goods are normal goods, a reduction in real income will reduce the quantity demanded of both goods. Thus in Figure 5-12 we show the point E lying to the south-west of the point D.

The Net Effect of a Price Increase on the Quantity Demanded Although our model of consumer choice implies that the consumer moves directly from the original point C to the new point E, we can interpret this as a pure substitution effect from C to the hypothetical point D plus a pure income effect from the point D to the point E. Provided the good whose price has risen is a normal good, we can now prove that demand curves slope downwards as we asserted in Chapter 4.

The substitution effect from C to D necessarily reduces the quantity of meals demanded. When the price of meals rises, the budget line becomes steeper and we must move along U_2U_2 to the left to find the point at which it is tangent to HH. Similarly, the income effect must further reduce the quantity of meals demanded provided meals are a normal good. The point E must lie to the left of the point D.

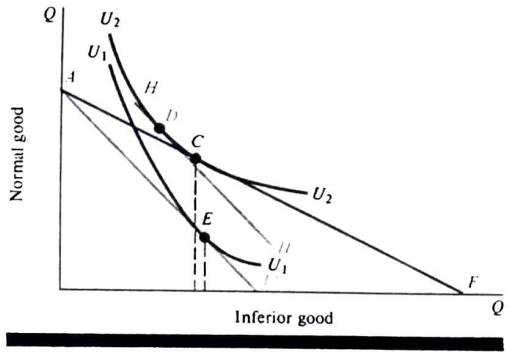
Inferior Goods Although the substitution effect is guaranteed to reduce the quantity of meals demanded when the price of meals increases, the income effect will go in the opposite direction when we examine a good that is inferior. Then reductions in real income increase the quantity demanded. We can even imagine a perverse case in which this effect is so strong that price rises actually increase the quantity of that good demanded. Demand curves then slope *upwards*! This possibility is illustrated in Figure 5-13. An increase in the price of the inferior good rotates the budget line from AF to AF'. The substitution effect, from C to D, tends to reduce the quantity of the inferior good demanded, but this is outweighed by the income effect, from D to E. Since the point E lies to the right of the point C, the net effect of the increase in price of the inferior good has been to increase the quantity demanded. Economists refer to such goods as 'Giffen goods', after a nineteenth century economist who claimed that increases in the price of bread increased the quantity of bread demanded by the poor.

Even though a good is an inferior good it need not be a Giffen good. It requires a very strong income effect – here an increase in demand in response to real income reductions – to offset the substitution effect, which must be negative. When goods are inferior, theoretical reasoning alone cannot establish which effect will dominate. We have to look at the empirical evidence. After many decades of empirical research, economists are convinced that the possibility of Giffen goods is largely a theoretical *curiosum*. In practice, goods are rarely sufficiently inferior that the income effect can reverse the substitution effect.

Thus, as an empirical judgement, economists have concluded that for inferior goods, the substitution effect outweighs the income effect and demand curves will slope downwards as price is increased. For the much more common case in which goods are normal, having a positive income elasticity of demand, the income and substitution effects both act to reduce the quantity demanded, as in Figure 5-12. The proposition that demand curves slope downwards can then be established by theoretical reasoning alone.

[3] With only two goods, substitution away from meals must imply substitution towards films. However, when there are more than two goods, we cannot be sure that the substitution effect will tend to increase the quantity demanded for all other goods. We discuss this shortly under the heading 'Complements and Substitutes'.

FIGURE 5-13 A PRICE INCREASE INCREASES THE QUANTITY OF A GIFFEN GOOD DEMANDED. The price increase rotates the budget line from AF to AF'. The substitution effect, from C to D, reduces the quantity of the inferior good demanded. Since the good is inferior, the income effect, from D to E, increases the quantity of the inferior good demanded. For a Giffen good, the income effect dominates and E lies to the right of C. In practice, the income effect for inferior goods is less strong and the point E, although to the right of D, usually lies to the left of C so that the quantity demanded falls as the price of the inferior good rises.



Cross Price Elasticities of Demand

Having used our model of consumer choice to investigate the response of quantity demanded to changes in the own price of a good, we now use the model to investigate the effect of an increase in the price of one good on the quantity of another good demanded. In Chapter 4 we suggested that cross price elasticities might be negative or positive, and we now illustrate these two possibilities, highlighting the different roles played by substitution and income effects.

Figure 5-14 illustrates the case where the cross price elasticity is negative. A rise in the price of meals leads to a reduction in the quantity of films demanded. Figure 5-14 has three properties. First, in purely utility terms, the two goods are poor substitutes. Indifference curves are very curved. Moving away from balanced combinations of the two goods requires very large additional quantities of one good to compensate for small losses of the other good if a constant level of utility is to be preserved. When the price of meals is increased, the substitution effect towards films is very small. Moving leftwards along U_2U_2, we quickly attain the slope required to match the new relative prices of the two goods. The substitution effect from C to D adds little to the quantity of films demanded.

Secondly, films have a high income elasticity of demand. They are a luxury good. Hence the income effect, the move from D to E in response to the parallel downward shift in the budget line from HH to AF', leads to a large reduction in the quantity of films demanded.

Finally, the point C lies well to the right on the original budget line AF. Meal expenditure takes up a large part of consumer budgets. Hence changes in meal prices lead to large changes in the purchasing power of consumer income. Not only is the quantity of films demanded very responsive to given changes in consumer real income, but in addition a given increase in meal prices has a large effect on consumer real income because meals are a large part of consumer budgets.

These last two effects lead to a large income

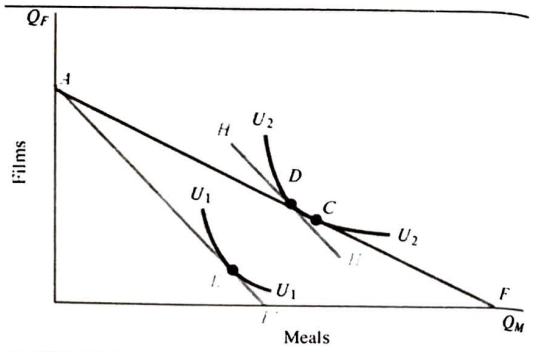


FIGURE 5-14 A NEGATIVE CROSS PRICE ELASTICITY OF DEMAND. An increase in the price of meals rotates the budget line from *AF* to *AF'*. The substitution effect from *C* to *D* is small. Indifference curves have large curvature since the two goods are poor substitutes in utility terms. The income effect from *D* to *E* implies a large reduction in films for two reasons. First, the reduction in real income is larger the further to the right the initial point *C*. Second, films are a luxury good whose quantity demanded is sensitive to changes in real income. Thus the income effect outweighs the substitution effect. *E* lies below *C*.

effect, which reduces the quantity of films demanded. Because the substitution effect in favour of films is small, the net effect is a reduction in the quantity of films demanded. Figure 5-14 illustrates the case in which an increase in meal prices reduces the quantity of films demanded. The cross price elasticity of demand is negative.

Figure 5-15 illustrates the opposite case, in which the cross price elasticity is positive. We now suppose the consumer is choosing between bread and other food and examine the effect of an increase in the price of bread. First, in purely utility terms there are quite good substitutes for bread, for example potatoes. To preserve a given level of utility consumers do not require large additional amounts of one good to depart from balanced combinations of the two goods. Indifference curves have much less curvature than in Figure 5-14.

Second, other food has a relatively low income elasticity of demand. To the extent that higher bread prices reduce real consumer income, this has a relatively small income effect acting to reduce the quantity of other food demanded. Third, since bread forms a relatively small share in consumer budgets, the increase in bread prices

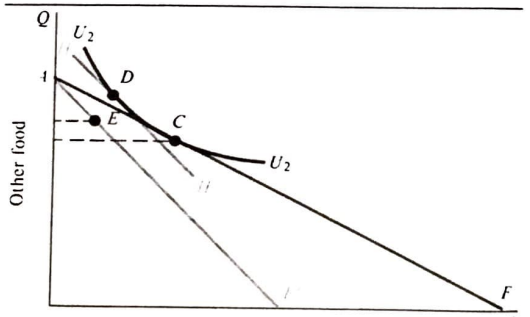


FIGURE 5-15 A POSITIVE CROSS PRICE ELASTICITY OF DEMAND. An increase in the price of bread rotates the budget line from *AF* to *AF'*. The substitution effect from *C* to *D* is large. Indifference curves have little curvature since the two goods are good substitutes in utility terms. The income effect from *D* to *E* is relatively small because the income elasticity of demand for other food is low and because the reduction in real income is small since bread forms a small share of the consumer budget. The substitution effect outweighs the income effect. *E* lies above *C*.

has a relatively small effect in reducing consumer purchasing power. Comparing Figures 5-14 and 5-15, the parallel shift from *HH* to *AF'* is much smaller in the latter.

These last two effects mean that there is only a small income effect acting to reduce the quantity of other food demanded. In contrast, the substitution effect in favour of other food is large. Hence a rise in bread prices increases the quantity of other food demanded. The cross price elasticity is positive. This positive effect would be even stronger if 'other food' were an inferior good. The income effect would then act to increase the quantity of other food demanded, thereby reinforcing the substitution effects in this direction.

Summary of the Effects of a Price Change on Quantity Demanded

In Table 5-2 we summarize the implications of our model of consumer choice for the demand response to a price change.

5-4 FROM THE INDIVIDUAL DEMAND CURVE TO THE MARKET DEMAND CURVE

The demand curve for a good shows the response of quantity demanded to changes in the own price of the good, holding constant consumer tastes, income, and the price of other goods. Only in the extreme case in which the good is so inferior that the income effect outweighs the substitution effect will an increase in own price increase the quantity demanded. We have argued that few goods are inferior and even fewer are very inferior. Thus we have now established the foundations for the proposition that individual demand curves slope downwards. For the rest of this book we assume that this proposition is correct. We consider now what this implies for the market demand curve.

The market demand curve is the sum of the demand curves of all individuals in that market. It is obtained by asking, at each price, how much each person demands. By adding the quantities demanded by all consumers at each price we obtain the total quantity demanded at each price, the market demand curve. Since, as price is reduced, each person increases the quantity demanded, the total quantity demanded must also increase as price falls. The market demand curve also slopes downwards.

We sometimes say that the market demand curve is the *horizontal addition of individual demand curves*. With prices on the vertical axis, we must add together individual quantities demanded at the same price. Figure 5-16 illustrates this idea for two consumers.

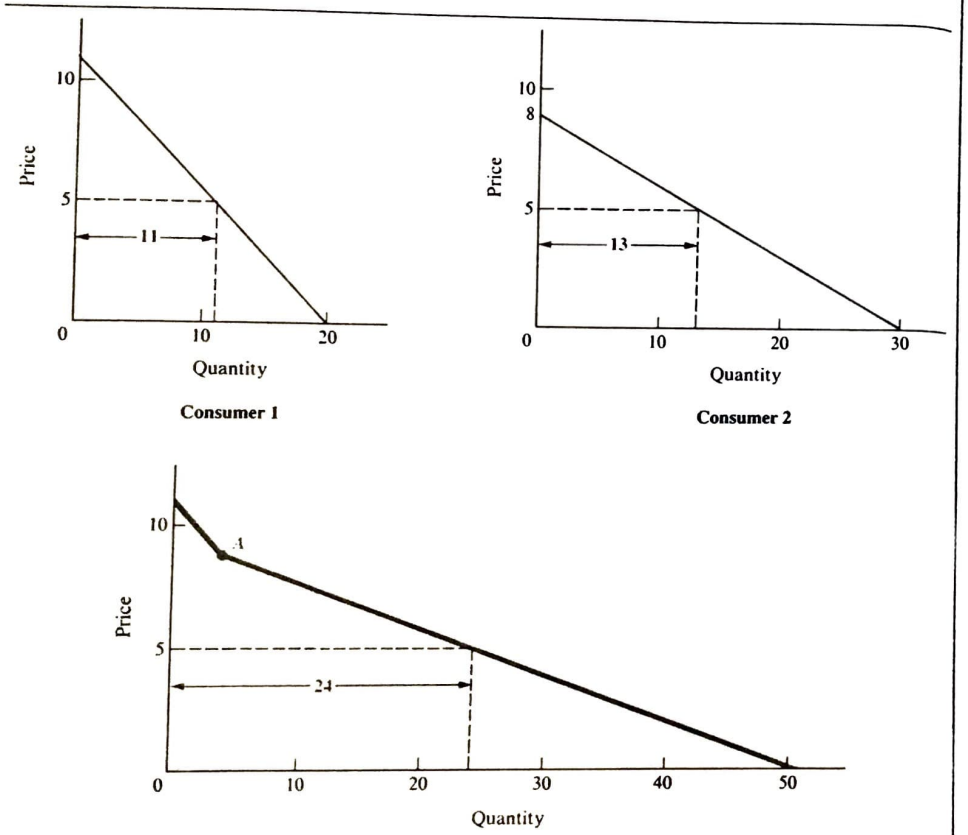
5-5 COMPLEMENTS AND SUBSTITUTES

We have now given many illustrations of how income and substitution effects may be used to understand the consequences of a price change. Whatever the direction of the income effect, when there are only two goods the substitution effect is always unambiguous. The pure relative price effect

TABLE 5-2
THE EFFECT OF AN INCREASE IN THE PRICE OF GOOD I ON THE QUANTITY DEMANDED OF GOODS I AND J

GOOD	TYPE	SUBSTITUTION EFFECT	INCOME EFFECT	TOTAL EFFECT
I	Normal	Negative	Negative	Negative
	Inferior	Negative	Positive	Ambiguous but usually negative
J	Normal	Positive	Negative	Ambiguous
	Inferior	Positive	Positive	Positive

FIGURE 5-16 INDIVIDUAL DEMAND CURVES AND THE MARKET DEMAND CURVE. The market demand curve is the horizontal sum of individual demand curves. For example, if the price is £5, the quantity demanded by consumer 1 is 11 units, and the quantity demanded by consumer 2 is 13 units. The total quantity demanded in the market at £5 is thus 24 units, as shown on the market demand curve. The market demand curve is kinked at point *A*, the price at which consumer 2 first comes into the market. At higher prices, the quantity demanded by consumer 2 is zero and the entire market demand curve comes from consumer 1.



leads the consumer to substitute away from the good whose relative price has risen towards the good whose relative price has fallen. In this sense, abstracting from income effects, goods are necessarily substitutes for one another in a two-good world.

When there are more than two goods we must recognize the possibility that some goods are consumed jointly – pipes and pipe tobacco, bread and cheese, electric cookers and electricity. We therefore have to recognize the possibility of *complementarity*.

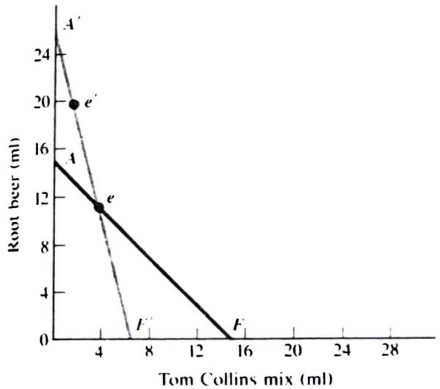
When there are many goods it is still possible to prove that there will be a substitution effect *away* from the good whose relative price has risen. However, it is not necessarily true that there is a substitution *towards* all other goods. Consumers will tend to substitute *away* from goods consumed jointly with the good whose price has risen.

Suppose the price of pipes rises. What will happen to the demand for pipe tobacco? (We ignore the income effect since expenditure on

BOX 5-1

SUBSTITUTION: EVEN RATS DO IT

The diagram shows the substitution effect in action. In an experiment, a consumer was offered a choice between a Tom Collins cocktail mix and root beer. Initially, facing the budget line *AF* with equal prices for the two drinks, the consumer chose the point *e*. Then the relative price of Tom Collins was increased fourfold but the consumer's income was adjusted, so that the new budget line *A'F'* went through the point *e* originally chosen. Although still possible to consume *e*, the consumer chose the point *e'*, substituting root beer for Tom Collins in response to the lower relative price of root beer.



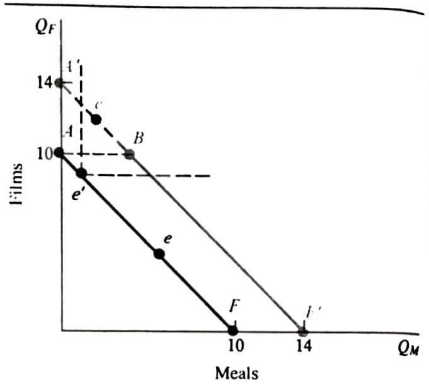
The consumer who illustrated the substitution effect so well was a white male albino rat. The budget line was the number of times he was required to push on two levers to get the two kinds of drink. Each push gave the rat some quantity of one drink but the quantity per push changed with the price of the drink. The experiment is reported in a paper by Professor John Kagel and others, 'Experimental Studies of Consumer Demand Behaviour Using Laboratory Animals' (*Economic Inquiry*, March 1975).

The authors report one other fascinating finding. When large changes were made in relative prices, there were 'severe disruptions' in the rat's consumer choice behaviour. Many humans feel the same way.

pipes is a tiny fraction of household budgets, so real incomes are only slightly reduced. Real income reduction will of course reduce the demand for all normal goods.) Since pipes and pipe tobacco are used jointly, we expect the demand for pipe tobacco will fall along with the quantity of pipes demanded. The demand curve for pipe tobacco shifts to the left in response to the increase in pipe prices.

The possibility of complementarity, the notion that certain goods are jointly consumed, arises quite frequently and represents a potentially important part of the adjustment of demand to price changes. Whenever goods are complements, an increase in the price of one good will reduce the demand for the complement both through the substitution effect (substituting away from the higher priced activity) and of course through the income effect (provided goods are normal). In problem 7 at the end of the chapter (page 111) this reasoning about complements and substitutes is used to discuss the effect of higher petrol prices on the demand by Londoners for weekend trips to the country.

FIGURE 5-17 TRANSFERS IN CASH AND IN KIND. A food transfer in kind may leave the consumer less satisfied than a cash transfer of the same value. A consumer beginning at e' might wish to spend less than the full in-kind allowance on food, moving to a point such as c. The budget line $A'BF'$ is available under a cash transfer. The in-kind transfer restricts the budget line to ABF', ruling out points $A'B$.



5-6 TRANSFERS IN CASH AND IN KIND: WHICH DOES THE CONSUMER PREFER?

A transfer is a payment, usually by the government, for which no corresponding service is provided by the recipient. Social security payments are an example. Wages are not transfers because the recipient is providing labour services in exchange for wages.

Although some transfers are in cash, some are *in kind*. For example, the poor may be given food stamps entitling them to buy food, but only food. The stamps cannot be spent on films or petrol. In this section we use the model of consumer choice to ask whether an in-kind transfer payment is preferred by the consumer to a cash transfer payment of equivalent monetary value.

The consumer has £100 to spend on food or films, each costing £10 per unit. Figure 5-17 shows the budget line AF. Now suppose in addition the government issues the consumer with food stamps worth four food units. How is the budget line affected? For any point on the old budget line AF the consumer can now have an additional four units of food by using the food stamps. Moving horizontally to the right a distance of four food units we obtain the new budget line BF'. To remind ourselves that food stamps cannot be used for buying films, we can think of the new budget line as ABF', reminding ourselves that the consumer can still consume at most 10 films.

Suppose the consumer had originally chosen point e on the old budget line AF. Since both goods are normal, the parallel shift in the budget line to ABF' – effectively, an increase in real income – will lead the consumer to choose a point to the north-east of e. This is precisely the point the consumer would have chosen had the transfer been in cash. When food costs £10 per unit, the cash-equivalent of four food units is £40, shifting the budget line to $A'F'$. Thus, if the consumer begins at e it makes no difference whether the transfer is in cash or in kind.

Suppose, however, that the consumer had begun at point e'. With a cash payment, the consumer might have wished to move to point c on the budget line $A'F'$. The transfer in kind, by restricting the consumer to the budget line ABF', prevents the consumer reaching the preferred point c. Perhaps instead the consumer moves to the point B, which can be reached. The point B must yield the consumer less utility than point c: when the consumer was given a cash payment and could choose either, c was preferred to B.

To check that you understand this, try drawing the indifference curve tangent to $A'F'$ at point c in Figure 5-17. Hence, since indifference curves cannot cross, show that the indifference curve through B must be a lower indifference curve yielding less utility to the consumer.

Cash transfers allow consumers to spend the extra income in any way that they desire. Transfers in kind may limit the consumer's option. Where they do, the increase in consumer utility will be less than under a cash transfer of the same monetary value.

Yet transfers in kind are politically popular. The electorate wants to know that money raised in taxation is being wisely spent. Some who favour transfers in kind will argue that the poor really do not know how to spend their money wisely and may spend cash transfers on 'undesirable' goods such as alcohol or entertainment rather than on 'desirable' goods such as food or housing.

You will recognize that one group says that people can best choose for themselves how to spend their money whereas the other group says that people may not act in their own best interests. This issue is not merely one of economics but also of philosophy, involving wider questions such as liberty and paternalism. In so far as people are capable of judging their own self-interest, the thrust of purely economic analysis is clear: people will be better off, or at least no worse off, if they are given transfers in cash rather than in kind.

SUMMARY

1 The theory of demand is based on the assumption that the consumer, given the budget constraint, seeks to reach the maximum possible level of utility.

2 The budget line shows the maximum affordable quantity of one good for each given quantity of the other good. The position of the budget line is determined by income and prices alone. Its slope reflects only relative prices.

3 Because the consumer prefers more to less, he or she will always select a point on the budget line. The consumer has a problem of choice. Along the budget line, more of one good can be obtained only by sacrificing some of the other good.

4 Consumer tastes can be represented by a map of non-intersecting indifference curves. Along each indifference curve, utility is constant. Higher indifference curves are preferred to lower indifference curves. Since the consumer prefers more to less, indifference curves must slope downwards. To preserve a given level of utility, increases in the quantity of one good must be offset by reductions in the quantity of the other good.

5 Indifference curves reflect the principle of a diminishing marginal rate of substitution. Their slope becomes flatter as we move along them to the right.