18

Competitive General Equilibrium

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Concepts and techniques

Adam Smith's invisible hand and competitive general equilibrium theory
(Own price) excess demand curve
Existence of competitive general equilibrium: system of equations, Walras' Law, numeraire good
Determination of prices: outcome versus process approach
Tatonnement (groping), the auctioneer, the Walrasian rule for price adjustment and false trading
Instability of an equilibrium and multiple equilibria (Giffen goods)
Edgeworth box diagrams
Marginal rate of substitution (MRS)
Marginal rate of transformation (MRT), marginal cost and opportunity cost
Production possibility frontier (PPF)
Edgeworth's recontracting process, decentralization and false trading
Pareto efficiency: First and Second Welfare theorems
Production and consumption externalities
Non-convexities
Economic welfare policy: efficiency versus distribution, the theory of the second best

Links

- Competitive general equilibrium theory represents the synthesis of the neoclassical school of thought in its purest form. It embodies all the characteristics of the neoclassical approach. Reflecting the assumptions of methodological individualism and rationality, consumers' preferences and firms' technologies are the exogenous variables which determine the outcome at the level of the economic system through the maximization of consumers' utility and firms' profits. The use of equilibrium modelling and the emphasis on prices are also core assumptions of the neoclassical approach.
- Competitive general equilibrium theory brings together various building blocks that you have met earlier in the book. The theory itself was outlined in Chapter 1, which introduced competitive equilibrium analysis and also examined the concept of Pareto efficiency. Chapter 2 and Chapter 8 illustrated the neoclassical theory of consumption (including technical aspects such as utility functions, indifference maps and the marginal rate of substitution) and production (including technical aspects such as the production function and isoquant maps). Chapter 5 and Chapter 12 examined the role of the labour market, the key factor of production in the economy.

- The discussion of the welfare effects of a decentralized market economy also builds on the discussion of welfare carried out in Chapter 4, which examined in depth the concepts of utility and Pareto efficiency.
- Some assumptions that are necessary for the competitive general equilibrium theory to work have been examined in previous chapters. Chapter 2 introduces the important case of Giffen goods and upward sloping demand curves, while Chapter 15 analyses the problems that commodities with public good qualities such as information pose to the theory.

1 Introduction

One of the most significant aspects of economic change in the last decades of the twentieth century has been the resurgence of economic liberalism – the belief that decentralized markets promote economic prosperity more effectively than state planning or intervention. This has contributed to the break-up of the Soviet bloc in eastern Europe and also to the many changes seen in mixed economies, such as the UK, where the economic frontiers of the state have been pushed back in a number of ways. These policies have included various combinations of liberalization, deregulation and privatization. In the UK, for example, organizational changes have been introduced within the public sector in an attempt to replicate the market and introduce more commercial practices. Some aspects of such 'social markets' will be discussed in the following chapter. At the same time as these organizational changes have taken place, the traditional legal protections which supported trade union activities have been taken away in order to make the labour market closer to the ideal 'flexible' market which responds to market forces.

These changes are the result of a complex interweaving of many factors, but economic arguments have played their part. In the UK, the apparent failure of Keynesianism in the 1970s to deliver non-inflationary growth contributed to the increasing disenchantment with state intervention in the economy, and provided a new platform for anti-Keynesianism to play an influential role in the shift towards economic liberalism. These liberal economic arguments grew out of a long-running debate about the merits of a decentralized market economy as opposed to state planning, and about the virtues of competition. Neoclassical economics has contributed to this debate.

Chapter 1 sketched in a preliminary way the important result that a competitive general equilibrium is a Pareto-efficient outcome. This result has been used by many economists to argue for the merits of a decentralized market economy and explains why neoclassical economics is generally assumed to represent a free market orientation. On the other hand, the model of the competitive economy that underpins this result is a highly abstract one which is based on very restrictive assumptions. Many economists have questioned whether it does, in practice, provide such a strong case for decentralized market economies. In this chapter we shall investigate this issue. We shall look more deeply into the model of competitive general equilibrium and its links with Pareto efficiency. In the course of this, we shall also find that the model of competitive general equilibrium does not give us any simple or straightforward advice on the extent to which decentralized economic policies should be pursued, and that its actual role in economic debates in the past illustrates the equivocal nature of the policy conclusions that can be drawn from it.

How a decentralized, unplanned competitive market can produce orderly outcomes is a question that has fascinated economists since at least the eighteenth century. As you learnt in Chapter 1, the idea that the unintended consequence of individuals behaving with only their own interests in mind may be an outcome that is orderly – even beneficial – for society as a whole, has been encapsulated by the idea of the 'invisible hand'. The paradoxical nature of the idea that economic outcomes which are unplanned at an economy-wide level may be better than planned ones seems to fly in the face of common sense. The invisible hand becomes even more extraordinary when this beneficial outcome is seen as the result of the pursuit of self-interest on the part of individual economic agents. Somehow the invisible hand transforms private self-interest into overall economic well-being.

HOW MANY ECONOMISTS DOES IT TAKE TO CHANGE A LIGHTBULB?

– NONE, THE INVISIBLE HAND DOES ALL THE WORK!

This apparent paradox has led economists to ask two different sorts of questions. The first question concerns the operation of the invisible hand: just how does a competitive market function? How are prices set in a competitive market, and how is equilibrium restored after a disturbance? The second question concerns the allegedly beneficial outcome of a competitive market: how is it that competitive outcomes promote overall economic well-being? What is meant by 'well-being' and are there different gainers and losers in competitive markets?

These questions are explored in the following sections which together build on and extend the model of the competitive market you first met in Chapter 1. In Section 2 we shall examine the competitive general equilibrium model first put forward by Léon Walras to explain how a decentralized system of markets can cohere without any overall plan. In Section 3 we shall consider how equilibrium prices are determined in this model. In Section 4 we shall look at a different version of this model, drawing upon neoclassical analysis of consumer and firm behaviour. Section 5 considers what is meant by beneficial outcomes. It looks at the normative or welfare properties of competitive equilibrium outcomes, and the policy conclusions that might be drawn from this.

In addition to addressing the issue of competitive markets, we shall also be reviewing and pulling together different aspects of the neoclassical model that you have met in various parts of the course. We shall be building on the preliminary groundwork of Chapter 1 and linking together the neoclassical analysis of consumer behaviour and household labour supply from Chapters 2 and 5 with the neoclassical theory of the firm and labour demand from Chapters 10 and 12. We shall pull together these different parts of the neoclassical theory so that you can see how they all fit together to form a coherent model of the interrelated way in which markets work. In this way I hope to show you something of the overall theoretical power of the model of competitive equilibrium, while also discussing some of the unresolved issues concerning it that continue to trouble economists.

2 The Walrasian model

2.1 Introduction

When the BSE crisis hit the British beef industry in 1996, in the wake of scientific evidence that beef might not be safe to eat, the price of beef plummeted as consumers lost confidence in beef and cut down their consumption of it. The fall in prices hit retailers, the beef products industry and beef farmers. As their incomes fell, all those involved in the various stages of producing and retailing beef had less money to spend on purchases. Beef farmers in particular were badly hit as it was suddenly not worth taking their animals to market, yet it was costly to keep them until prices increased. The fall in farmers' incomes in turn affected the value of farming land. Many consumers turned to substitute products and increased their demand for other meat, poultry and fish, while others increased their purchases of vegetarian substitutes such as vegeburgers and vegesausages. The increased public awareness of, or misinformation about, farming practices led to an increased demand for organic produce, while food manufacturers who used beef derivatives started looking around for non-beef substitutes. The original crisis in the beef market thus had a number of ramifications throughout other markets.

Some of these effects may have been short-lived, but the BSE crisis was a highly dramatic example of the sorts of changes that are happening all the time in the economy. Fashions come and go, new products are invented as old ones die out and new sources of raw materials are discovered. The economy is like a kaleidoscope of shifting demand and supply, ever restless and changing as shifts in one market have repercussions in many other markets far removed from it. Faced with these intricate interconnections between markets, economists want to explain whether and how order is possible in this kaleidoscope of activity. They want to see whether people operating atomistically as consumers or producers are part of a wider co-ordination of economic activities in which all choices can be realized. Can this complex interplay of different markets cohere as a consistent intermeshing of individual choices, or is the kaleidoscope simply a picture of chaos? Does this kaleidoscope need a visible guiding hand, in the shape of some other kind of institution, to co-ordinate economic activities, or is the invisible hand working efficiently?

2.2 Competitive general equilibrium

The competitive general equilibrium model was first outlined by Léon Walras (1834–1910), who was born in France but became professor of economics at Lausanne in Switzerland where he was a pioneer of the mathematical approach to economics. Walras' interest in economics was part of a methodological desire to apply the methods of the physical sciences to economic theory that resulted from a broad concern with social and political issues. He took a keen interest in social justice and proposed the nationalization of land and natural monopolies. He described himself as a 'scientific socialist' (Walker, 1987).

As we saw in Chapter 1, the Walrasian competitive general equilibrium model is based on the individual choices of economic agents in response to given market prices and the exogenous variables of preferences, resource endowments and technology. The kaleidoscope of economic activity is held fixed for a moment to see whether, given the exogenous variables, the sum of the choices of all individual agents are consistent, so that consumers' plans to purchase coincide with producers' plans to supply. This requires equilibrium in every market, so finding out whether individual choices are consistent implies that we have to find whether there exists a set of equilibrium prices at which demand and supply are in balance everywhere.

Walras' work laid the foundations for an analysis of competitive general equilibrium and his insights have since been developed in advanced mathematical models. We can get some of the flavour of this model by using partial equilibrium analysis of one market in which the prices of other goods are held constant. Figure 18.1(a) shows a demand and supply diagram like the ones you met in Chapter 1, where the prices of all other goods are held constant. Remember that the demand curve derives from utility-maximizing behaviour by households, and the supply curve derives from profit-maximizing behaviour by firms. At the equilibrium price, P_E, quantity demanded equals quantity supplied, Q_E. If price is below the equilibrium price, say at P_a, then the quantity demanded, Q_a^D is greater than the quantity supplied, Q_a^S. If the price is above the equilibrium price at P_b, the quantity demanded, Q_b^D, is less than the quantity supplied, Q_b^S.

As we wish to focus on the determination of the equilibrium price, it is helpful to represent this in terms of an (own-price) excess demand curve which shows the difference between the quantity demanded and the quantity supplied of a good at each level of its own price, again on the assumption that all other prices are held constant. This is shown in Figure 18.1(b). The vertical axis shows price and the horizontal axis shows excess demand which is positive when demand is greater than supply and negative when supply is greater than demand. At the equilibrium price P_E, excess demand is zero because demand and supply are equal; this is the point at which the excess demand curve intersects the price axis. At prices below P_E there is a positive excess demand; this is shown for P_a where the excess demand is Z_a which is equal to the distance

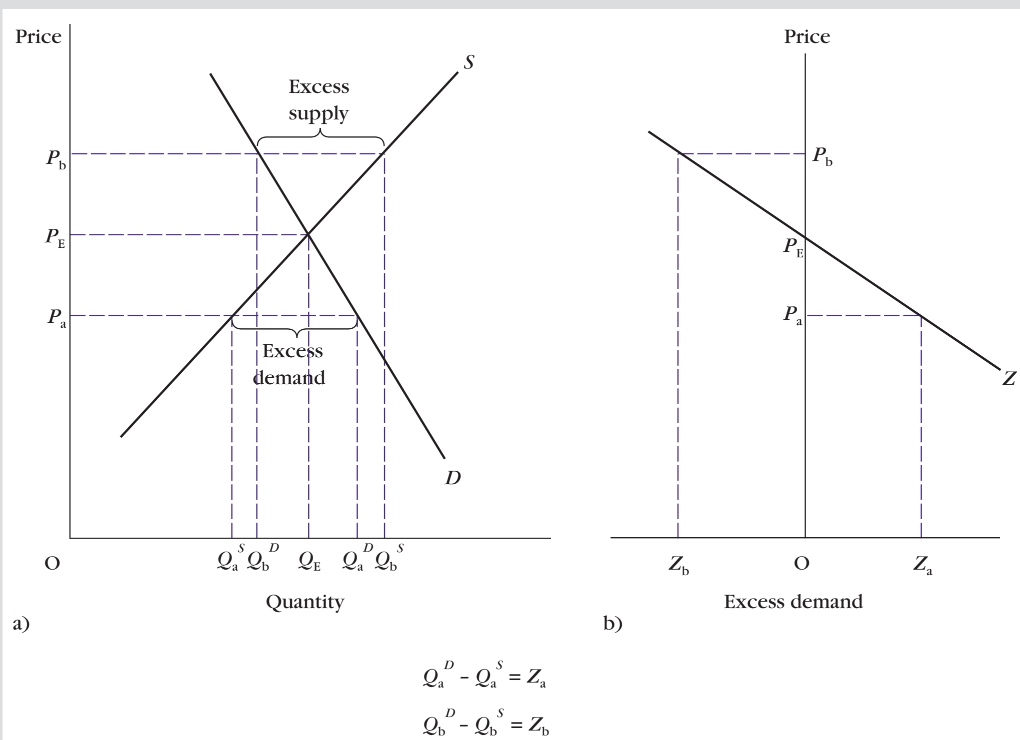
$Q_a^D - Q_a^S$ in Figure 18.1(a). At prices above P_E there is a negative excess demand since demand is less than supply. This is shown for the price P_b by Z_b which is equal to $Q_b^D - Q_b^S$ in Figure 18.1(b).

Figure 18.1 shows just one market with its (own-price) excess demand curve. The exogenous variables here are the prices of all other goods as well as preferences, resource endowments and technology. If any of these changed there would be a shift of the excess demand curve. In a general equilibrium model, however, we are looking at all markets simultaneously and so the excess demand for any good is dependent on all prices, not just on its own price. For example, the excess demand for vegeburgers is dependent not only on the price of vegeburgers, but also on all other prices.

One task for general equilibrium theory is to establish the conditions for the existence of a competitive equilibrium. This requires finding out whether a set of equilibrium prices exists for all markets simultaneously, bearing in mind all the ramifications implied in the notion that all the excess demands depend on all the prices. Certainly, some of these ramifications might turn out to be very small, but finding the total effect of all these interdependencies requires that none is overlooked. Establishing the existence of an equilibrium for the model as a whole involves finding a set of prices where all excess demands are simultaneously equal to zero.

As it is not possible in two dimensions to draw excess demand as a function of many prices, general equilibrium analysis cannot be represented in diagrams in the way that partial equilibrium analysis can. For a mathematical formulation of the problem of the existence of competitive equilibrium, you might like to read the technical box that follows.

Figure 18.1 Demand, supply and excess demand in a single market



The existence of competitive equilibrium

The competitive general equilibrium model is composed of n goods and services. The ith good has an excess demand function:

$$Z_i = Q_i^D - Q_i^S$$

where $i = 1, 2, \dots, n$

As explained in Chapter 1, the variables which are held constant for this model – the exogenous variables – are the initial endowments of resources owned by households, the preferences of households and the available technology. The variables that are to be determined by the equations of the model – the endogenous variables – are the equilibrium prices.

There is no money in this model, and demand and supply levels depend only on relative prices. An equilibrium set of prices is, therefore, a set of relative prices. If we choose any good, say the nth good, as a *numeraire good* or unit of account in which the prices of all other goods are expressed, then its price $P_n = 1$. This means that the prices of all other goods, $P_1, \dots, P_{n-1}$ are just their prices relative to the price of the nth good, because:

$$P_i = \frac{P_i}{1} = \frac{P_i}{P_n}$$

Numeraire good

The numeraire good is the good in terms of which all prices in the model are expressed. All prices are therefore relative prices.

Since P_n is always 1, there are just $n - 1$ relative prices to be found.

How do we write the excess demand function for the ith good? We know that the excess demand for the ith good is a function of all the exogenous and endogenous variables. As it is a general equilibrium – and not a partial equilibrium – model, we must recognize that every excess demand Z_i will depend not only on its own relative price, but on all other relative prices as well. The excess demand for the ith good can, therefore, be written as:

$$Z_i = f_i(U, R, T, P_1, P_2, \dots, P_{n-1})$$

U = preferences

R = initial endowments

T = technology

where the excess demand, Z_i for the ith good, is a function of preferences, initial endowments, technology and all $n - 1$ relative prices.

The plans of all economic agents are consistent when all excess demands are zero, that is, all goods and services offered for sale have a purchaser and all potential purchasers are able to find the goods and services they want to buy. To establish whether an equilibrium exists, we therefore need to find the set of prices at which all the excess demands are equal to zero. As it happens, we only need to do this for the excess demands for $n - 1$ goods. This is because each agent spends all their available income (there is no saving) but no more than their income (there is no borrowing either), whether or not the system is in equilibrium. For each individual agent, the total amount planned to be spent on purchasing goods and services equals the total amount expected in income from supplying goods and services. If this holds for each agent, then it must hold for all agents taken together, so that the value (in terms of the numeraire) of the sum of all excess demands must equal zero. This implies that the following expression must always hold, not just for equilibrium prices:

$$P_1Z_1 + P_2Z_2 + \dots + P_{n-1}Z_{n-1} + Z_n = 0$$

where $P_n = 1$ because n is the numeraire good. This property of excess demand functions is known as *Walras' Law*.

Walras' Law

Walras' Law states that the value of the sum of all excess demands must equal zero whether or not the system is in equilibrium.

As a result of Walras' Law, if the n–1 excess demands $Z_1 \dots Z_{n-1}$ are zero, then the nth excess demand, Z_n, must also equal zero. This can be seen more clearly by reformulating Walras' Law as follows:

$$P_1Z_1 + P_2Z_2 + \dots + P_{n-1}Z_{n-1} = -Z_n$$

This implies that we need only find a set of prices such that $n - 1$ excess demands are equal to zero. In other words, in a system where there are n goods, an overall equilibrium exists when $Z_i = 0$ for all $i = 1, 2, \ldots, n - 1$. This implies a system of $n - 1$ equations:

$$Z_1 = f_1(U, R, T, P_1, P_2, \ldots, P_{n-1}) = 0$$

$$Z_2 = f_2(U, R, T, P_1, P_2, \ldots, P_{n-1}) = 0$$

$$\ldots$$

$$\ldots$$

$$Z_{n-1} = f_{n-1}(U, R, T, P_1, P_2, \ldots, P_{n-1}) = 0$$

We have here a model in $n - 1$ equations and $n - 1$ unknown prices. Mathematically, finding the equilibrium prices amounts to solving these equations simultaneously. If these equations can be solved, then equilibrium exists.

Walras' approach to competitive general equilibrium has fundamentally influenced the way that economists now think about it. Mathematical refinements of Walras' insights have deepened economists' understanding of the conditions required for the existence of a competitive general equilibrium, but there is one issue which remains something of a conundrum – and that is the process by which prices are determined. This is the subject of the following section.

3 The determination of prices

3.1 Introduction

When economists talk about the determination of prices, this has (at least) two distinct meanings, although in practice it is hard to keep them apart. One meaning applies to equilibrium models such as the one in the technical box above where equilibrium prices are determined by a system of equations; here 'determined' implies a logical outcome. The other meaning concerns the process by which prices are determined in actual markets; 'determined' now refers to a real process of change through time. The value of any formal model lies in the insights that it provides into real economic situations, but the model may sometimes be a rather 'idealized' version of real events. A conundrum that has puzzled economists is how the determination of equilibrium prices in the mathematical model relates to the process of price determination in real markets. This conundrum is the subject of this section.

3.2 The Walrasian auctioneer

Because the Walrasian model is an equilibrium model, it does not consider what happens if the system is out of equilibrium. This raises a question as to how equilibrium prices are actually arrived at in real situations where markets are out of equilibrium. This question is made more complicated by the competitive assumption that all agents are price takers, that is, agents accept the going equilibrium prices and make their plans subject to these prices. In the formal model this is straightforward as the equilibrium prices are simply the solution to the system of equations. In the real world, however, this introduces a problem. If all agents are price takers, how do prices ever actually get changed in real markets?

Walras himself tried to show how actual competitive markets could arrive at the equilibrium prices by a process of trial and error, by what he called 'groping' or 'tâtonnement' in his original French. Walras suggested that a competitive market process of price adjustment could be imagined as an auction or a place where prices are openly announced by brokers or criers, and where agents make provisional bids to buy or sell goods on the basis of these prices (Walras, 1954, pp.83–4). This process goes through a number of different rounds; prices are called out and agents make their bids, and then, without any trades taking place, another set of prices is called out and further bids are made, and so on, until a set of prices has been reached at which all the excess demands are equal to zero. Thus agents are able to keep revising their plans with each new price called out until excess demands are eliminated. Only when offers to buy equal offers to sell will trade actually take place at the announced prices. One crucial aspect of this process of groping or tâtonnement is that trades do not take place at disequilibrium prices. It is thus a highly stylized account of price adjustment and it is hard to think of any real world counterpart. Walras recognized that this ideal version of a competitive market was not the norm, but he felt that many markets, such as stock exchanges and trading markets, approximated closely to it. He also argued that it was an acceptable scientific procedure to start off with a theoretical ideal and then work from that, because this was the method used in physics (p.84).

Walrasian rule for price adjustment

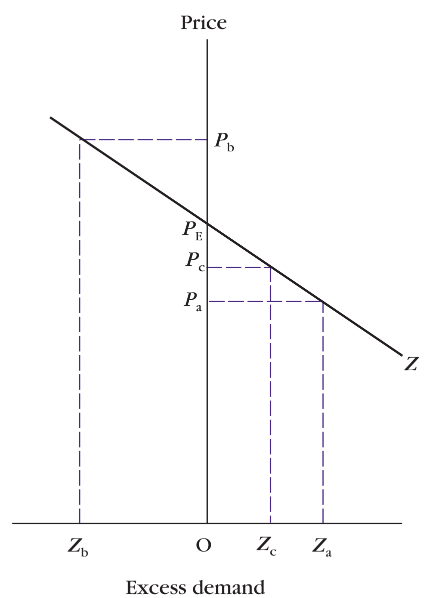
The Walrasian rule for price adjustment is that price should be raised if there is positive excess demand and reduced if there is negative excess demand.

Later economists have tried to make sense of the process of tâtonnement as an account of how prices adjust in competitive markets, by adopting the idea of a central 'auctioneer' who calls out prices and who works out, from the bids provided by all agents, the excess demands at each set of prices called out. The *Walrasian rule for price adjustment*, which the auctioneer implements and which competitive markets operationalize, is that price should be increased if there is positive excess demand at that price, and reduced if there is negative excess demand. This process of price adjustment continues until all excess demands have been eliminated. This notion of a central auctioneer following the Walrasian rule for price adjustment is really a 'fiction', it is not supposed that competitive markets work in this way but it tries to catch the essence of how anonymous markets seem to work. This auctioneer is sometimes referred to as the Walrasian auctioneer.

The Walrasian rule for price adjustment can be illustrated using Figure 18.2, but remember that the auctioneer is not meant to have the information given by the excess demand curve, only the bids to buy and sell at the prices that are called out.

If P_a were called out, the auctioneer would discover that there was positive excess demand at that price equal to Z_a. Following the rule, the auctioneer would then increase the price, maybe to something like P_b. When P_b is called out, the auctioneer discovers that excess demand would now be negative at Z_b which implies that the price change was too great. Now the price needs to be reduced again, but as P_a was too low, the next price should be higher than that. Perhaps now P_c is called out but there would still be excess demand of Z_c, so the price needs to be increased, and

Figure 18.2 Tâtonnement: following the Walrasian rule for price adjustment in a partial equilibrium setting



Exercise 18.1

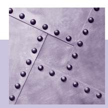
Try to imagine yourself as the Walrasian auctioneer in a very simple situation – say a single market – just to get a flavour of what is involved. Remember that you are not meant to know what the excess demand curve looks like. Look at the steps below and describe how they follow the Walrasian rule for price adjustment.

1 If a price of 120 were called out, the excess demand would be –100.
2 If a price of 70 were called out, the excess demand would be 50.
3 If a price of 100 were called out, the excess demand would be –40.
4 If a price of 90 were called out, the excess demand would be –10.
5 If a price of 80 were called out, the excess demand would be 20, etc.

What might the next step be?
Where might the equilibrium price lie?

so on. Eventually after groping about in the dark we see that the price should eventually converge on the equilibrium price of P_E.

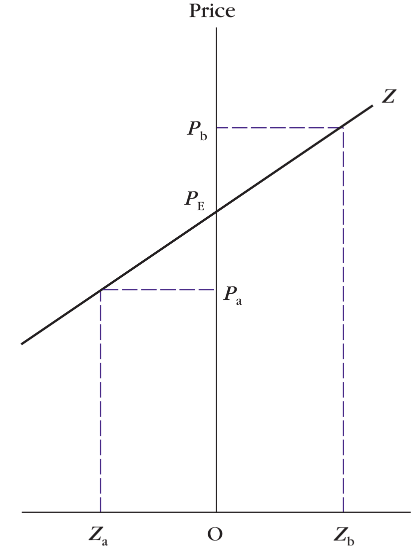
By examining the properties of excess demand functions such as that illustrated in Figure 18.2, economists have developed mathematical models of the process of Walrasian price adjustment. They have discovered that if an excess demand curve is negatively sloped throughout its range, then the Walrasian rule for price adjustment will result in convergence on a single equilibrium price. If an excess demand curve does not have this shape, the Walrasian rule may not converge on an equilibrium price and/or there may also be more than one equilibrium outcome.



Instability and multiple equilibria

If an excess demand curve is positively sloped throughout its range, the Walrasian rule for price adjustment is unable to converge on the equilibrium price. This is illustrated in Figure 18.3.

Figure 18.3 Unstable equilibrium: an upward-sloping excess demand curve



In Figure 18.3 the equilibrium price is P_E but the Walrasian rule for price adjustment would not converge on this price if it started from any other price. If P_a were called out, there would be negative excess demand of Z_a. According to the Walrasian rule, a negative excess demand requires a reduction in price, but if a price below P_a is called out, this would result in an even larger negative excess demand. This in turn would prompt the auctioneer to call out an even lower price, and so the price would diverge further and further away from the equilibrium price. Similarly, if P_b were called out, there would be positive excess demand of Z_b.

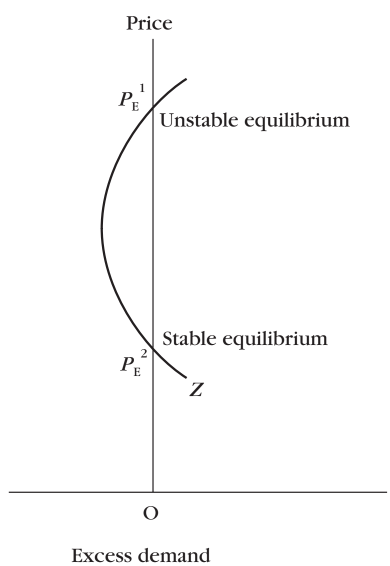
According to the Walrasian rule, a positive excess demand requires an increase in price, but if a price above P_b is called out, this would result in an even larger positive excess demand. This would prompt the auctioneer to call out an even higher price, and so again the price would diverge further away from the equilibrium price. Thus, although an equilibrium price exists at P_E, this is an unstable equilibrium because any movement away from it would result in further movements away from it. By contrast, the equilibrium in Figure 18.2 is stable because any movement away from it results in convergence back on the equilibrium.

If an excess demand curve has a positively sloped section as well as a negatively sloped section, then instability can be combined with more than one equilibrium. This is illustrated in Figure 18.4.

In Figure 18.4 the excess demand curve is negatively sloped at low prices and positively sloped at high prices. There are two equilibrium prices, P_E^1 and P_E^2. An unstable equilibrium price is shown at P_E^1, whereas P_E^2 is a stable one. You can see this by starting from any price below P_E^1 and showing that the Walrasian rule results in convergence on P_E^2. Starting from a price greater than P_E^1 does not lead to a convergence on P_E^1 but results in greater and greater price increases with greater and greater levels of positive excess demand. Figure 18.4 therefore illustrates both an unstable equilibrium, at P_E^1, and multiple equilibria, at P_E^1 and P_E^2, one of which, P_E^2, is stable and one of which, P_E^1, is unstable.

How might excess demand curves have upward-sloping sections? They are caused by the presence of strong income effects which outweigh the substitution effects of a price change, and so

Figure 18.4 Instability and multiple equilibria



produce demand or supply curves which have the 'wrong' slope for some prices. Chapter 2, Section 3.2, discussed Giffen goods for which demand increases as their price rises, and in Chapter 5, Figure 5.5 showed how the presence of strong income effects in the labour market produces a backward bending supply curve of labour. Either of these cases could result in the excess demand curve shown in Figure 18.4.

Exercise 18.2

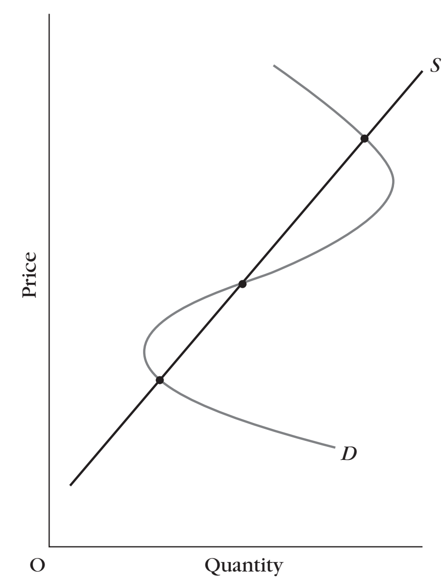
Figure 18.5 shows the market demand and supply curves for a good that is a Giffen good at some prices. Derive the excess demand curve for this good. Identify the stable and unstable equilibrium prices for this good. (See Chapter 2, Section 3.2, for the derivation of this diagram.)

I have argued that a competitive process of price adjustment may be thought of in terms of the fiction of the auctioneer, but the auctioneer is really some way from being a good image of the invisible hand. The auctioneer represents a centralization of the process of price adjustment that accords little with the notion of decentralization that is implicit in the invisible hand. In addition, tâtonnement implies that no trades take place until the equilibrium price has been announced by the auctioneer. This, too, is hardly a realistic picture of a decentralized market where equilibrium prices, arising from the give and take of everyday market transactions, emerge gradually out of disequilibrium prices (Hahn, 1987).

3.3 Competitive markets

One of the very few real world instances of tâtonnement is the fixing of the price of gold in London. This occurs at twice daily meetings which are chaired by a representative of N.M.Rothschild & Sons Ltd, and are attended by dealers who are in telephone contact with their dealing rooms who, in turn, keep in touch with customers. At these meetings, the chairman functions as the Walrasian auctioneer by announcing an opening price and then receives bids at that price from the dealers in consultation with their dealing rooms. If the buying and selling bids do not 'balance' the chairman

Figure 18.5 Market demand and supply curves for a Giffen good



announces another price and a second round of bids are made. This process continues until a balance is achieved and then the chairman announces that the price is 'fixed'. This 'fixed' price then provides a published benchmark price for gold.

The London Gold Fixing

The fixings are meetings held twice daily at 10.30 and 15.00 hours in the City of London to establish the market price for gold. These meetings provide market users with the opportunity of buying and selling at a single quoted price.

Each member of the fixing sends a representative to the fix meeting who maintains telephone contact throughout the meeting with his dealing room. The chairman of the fixing, traditionally the representative of N.M. Rothschild & Sons Limited, announces an opening price which is reported back to the dealing rooms. They in turn relay this price to their customers, and, on the basis of orders received, instruct their representative to declare as a buyer or seller. Provided both buying and selling interests are declared, members are then asked to state the number of bars in which they wish to trade. If at the opening price there is either no buying or no selling, or if the size for the buying and selling does not balance, the same procedure is followed again at higher or lower prices until a balance is achieved. At this moment the chairman announces that the price is 'fixed' … The fixing will last as long as is necessary to establish a price which satisfies both buyers and sellers. In general this will be about 10–20 minutes, but in exceptional circumstances may take more than an hour.

A feature of the London fixing is that customers may be kept advised of price changes throughout a fixing meeting, and may alter their instructions at any time until the price is fixed. To ensure that a member can communicate such an alteration, his representative has a small flag on his desk which he raises and, as long as any flag is raised, the Chairman may not declare the price fixed.

The fixing provides a published benchmark price, which is widely used as a pricing medium.

Source: Rothschild pamphlet

The example of fixing the gold price is instructive as it shows the institutional requirements for a tâtonnement process to work in practice; the fixing involves a small group of dealers and their customers within a highly specialized market setting. It is hard to imagine this process working in large markets that involve many buyers and sellers, let alone working across all markets simultaneously in a general equilibrium framework. The gold fixing also shows that any particular institutional setup requires its own resourcing and does not come free; a number of individuals have to give up time in order to attend the gold fixing meetings twice each day. This reminds us that, in practical situations, markets are not simply disembodied forces that cost nothing, but represent particular institutional settings that require their own resources in order to function. Financial markets are a good example of this. These markets are often seen as good approximations of competitive markets, but they are not costless. For example, the size of salaries in major financial centres is legendary – quite apart from the champagne lunches! – and a striking reminder of the resource costs of even highly competitive market institutions.

The gold fixing is also a highly centralized way of determining equilibrium prices, again illustrating the conundrum that the process of tâtonnement seems to require a centralized rather than a decentralized method of fixing prices. This is also illustrated by the argument, originally made in the 1930s, that tâtonnement could be used to carry out a form of socialist central planning! It was suggested by Oskar Lange and Abba Lerner that a central planning board could act like a Walrasian auctioneer in setting the prices of capital goods and state-owned resources and so bypass the need for an actual market in finding equilibrium prices. Against this Hayek argued that the informational assumptions of such planning overlook the way in which information is produced as part of the market process, and that it is precisely the ability of markets to economise on information that enables them to function more efficiently than any plan, making it impractical to try to imitate the Walrasian process of tâtonnement (Vaughn, 1980, summarizes the socialist calculation debate.)

Thus, in trying to operationalize the notion of tâtonnement, some economists saw the Walrasian system as a blueprint for socialist planning rather than decentralized markets. And in arguing against socialist planning, Hayek also argued against Walrasian economics as a theoretical system. A root problem, recognized by neoclassical economists, is that competitive analysis assumes that all agents are price takers, but this leaves unresolved the issue of how prices are changed when the system is out of equilibrium.

Although this problem remains unresolved at a theoretical level, at the practical level of real markets it is clear that the direction in which many prices change does conform to the Walrasian rule for price adjustment, in that positive excess demand leads to a rise in price and negative excess demand leads to a fall in price.

Reflection

As an illustration of this, think about a local market where you do your shopping. Can you think of cases where the goods with a negative excess demand are sold off cheaply at the end of the day? Alternatively, house and flat prices in your area might be a good example of competitive prices. To what extent does the local estate agent perform the role of the Walrasian auctioneer?

In spite of these theoretical difficulties, experiments in economics have also confirmed many times over that there is a rapid convergence on the equilibrium price in various kinds of competitive markets. In particular, there is one trading structure in which the competitive equilibrium price is attained especially fast in experimental situations, and that is the 'oral double auction' (Hey, 1991, p.198). The oral double auction has been described in the following manner:

> *'This envisages the market participants to be either physically present in the same location or telephonically linked so that they can all communicate with each other. There is an auctioneer who administers the auction process but who otherwise takes a passive role. The active role is taken by the agents themselves, who are free to call out bids (offers to buy) or asks (offers to sell) depending upon whether they are potential buyers or potential sellers … The process of calling out, and accepting, bids or asks continues until no new bids or asks are forthcoming and trade has ceased.'*
>
> (Hey, 1991, p.185)

With oral double auctions, market clearing is a dynamic disequilibrium process in that deals are finalized at going prices rather than waiting until an equilibrium price has been discovered as in the case of the Walrasian auctioneer. And unlike the case of the Walrasian auctioneer, it is a form of competition that is commonly found in real markets, for example the London International Financial Futures Exchange (LIFFE).

Thus, in spite of the theoretical difficulties which have perplexed theoretically-minded economists, for practical purposes many economists accept the usefulness of the insights of the Walrasian model in explaining some real markets. In spite of its strict assumption of price taking and no trading at disequilibrium prices, the Walrasian auctioneer model is regarded as a benchmark illustration of the convergence of competitive markets on the equilibrium price.

4 Some more models of general equilibrium

4.1 Introduction

We have seen that the question of the existence of general equilibrium comes down to the question whether there is a set of prices at which all excess demands are zero. This is a very complicated question for many goods, but if the idea of a competitive economy is simplified to just two goods and two consumers, it is possible to use Edgeworth box diagrams to represent a competitive general equilibrium and to show that, under certain conditions, equilibrium prices do exist. These diagrams are named after Francis Edgeworth who, like Walras, was one of the founders of general equilibrium analysis. Edgeworth (1845–1926) was born in Ireland and eventually became a professor at Oxford. He was a classicist and linguist, but he also pioneered a mathematical approach to economic analysis, as well as publishing work in ethics and in statistics (Newman, 1978).

In this section I shall use the Edgeworth box diagram first to represent a general equilibrium in a competitive exchange economy in which there is consumption but no production, and then I shall add production to present a general equilibrium of exchange, consumption and production.

4.2 General equilibrium of exchange and consumption

Chapter 2 showed how the behaviour of individual consumers explains the shape of the demand curve. Each consumer's preferences may be represented using an indifference map.

A single indifference curve is shown in Figure 18.6, which is based on Figure 2.6 in Chapter 2. It is assumed that indifference curves are convex to the origin. If the budget constraint is shown by the line BC, then the consumer maximizes utility by consuming the bundle where the budget line is tangent to an indifference curve. This occurs at point A.

The horizontal axis measures the units of good *G*, and the vertical axis measures the units of good *F*. At point A, the marginal rate of substitution of good *G* for good *F*, $MRS_{G,F}$, is equal to the relative price of *G* in terms of *F*, $\frac{P_G}{P_F}$, that is:

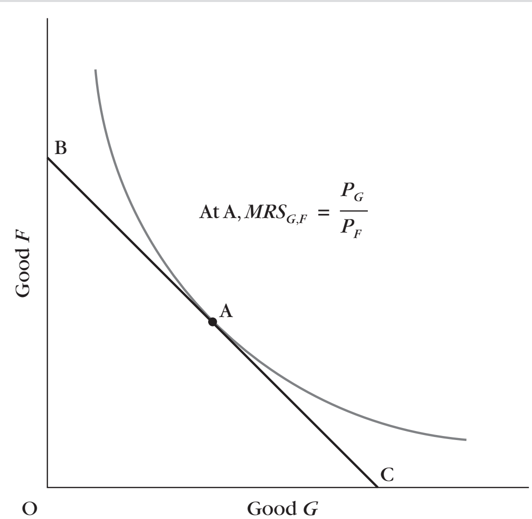
$$MRS_{G,F} = \frac{P_G}{P_F}$$

In other words, the rate at which a consumer would give up *F* for *G* and still remain on the same indifference curve is equal to the price of *G* in terms of *F*.

We can use this principle of utility maximization to develop a simple general equilibrium model of exchange and consumption in a competitive economy comprising two individuals and two goods. This model may seem very restrictive, but we shall see that the results generalize to many consumers and many goods. This simple economy can be illustrated using the Edgeworth box diagram in Figure 18.7. There is no production in this economy, but each individual receives a bundle of goods as an initial endowment. The economy's initial endowment of two goods is just the sum of the individuals' initial endowments. Let us say this sum is 50 kilos of figs (good *F*) and 60 kilos of grapes (good *G*); this gives the dimensions of the box shown in Figure 18.7. Figs are measured vertically and grapes are measured horizontally on the sides of the box diagram. By reading the axes from the bottom left hand corner for one agent and from the top right hand corner for the other agent, any point in the box can be understood as representing two bundles of goods, one for each agent, such that the two bundles together equal the economy's initial endowment. Such a point is shown as point A in Figure 18.7.

Reading Figure 18.7 from the bottom left-hand corner with the origin at O_x one agent, Xerxes, has 40 kilos of figs and 10 kilos of grapes at point A.

Figure 18.6 Utility maximization



Reading the figure from the top right-hand corner with the origin at O_y the other agent, Yvonne, has 10 kilos of figs and 50 kilos of grapes at point A. (If you find this hard to follow, try turning the page upside down to see Yvonne's quantities. Note that Xerxes' axes are in black and Yvonne's are coloured). The sum of the two bundles of goods comprise the total endowment of the economy. Moving to any other point within the box keeps the same total endowment of the two goods but distributes them differently between the two consumers, Xerxes and Yvonne.

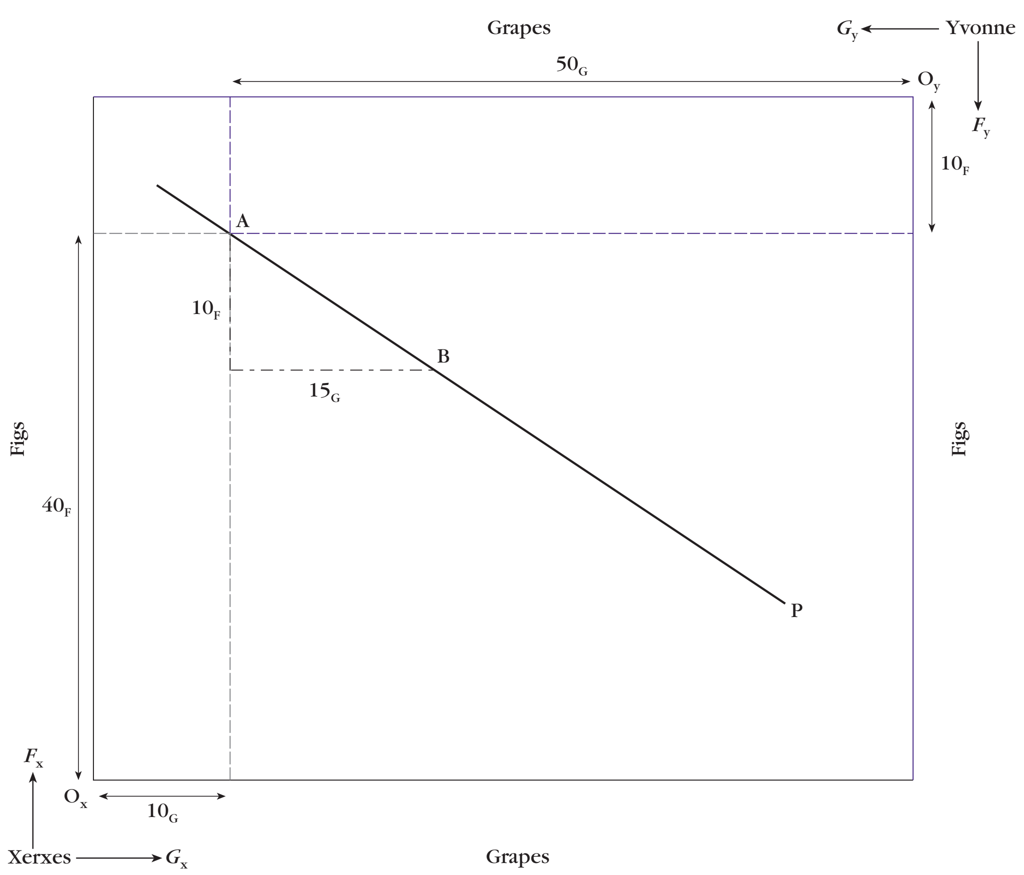
In this exchange economy, the only way for individuals to increase their utility is by exchanging some of their goods with each other. Exchange enables the two individuals to consume different combinations of the commodities that are available in this economy. We can represent the bundles that can be reached by exchange at a particular relative price by drawing a price line in Figure 18.7.

For example, all the bundles on the price line, P, in Figure 18.7 can be reached by exchange from A at the relative price:

$$\frac{P_G}{P_F} = \frac{2}{3}$$

That is, the price of grapes in terms of figs is $\frac{2}{3}$. This implies that, trading along the price line from A to B, 10 kilos of figs would be exchanged for 15 kilo

Figure 18.7 An Edgeworth box diagram showing an initial allocation of two goods between two consumers, and a price line



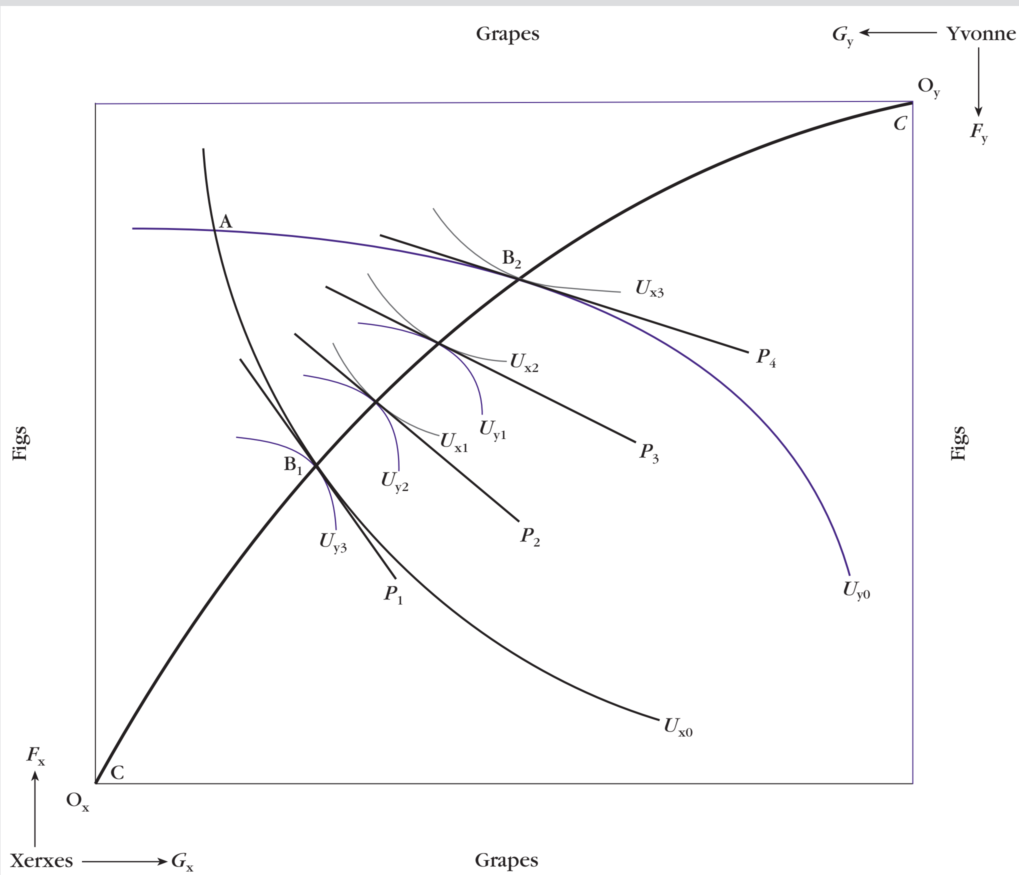
of grapes. Xerxes' consumption bundle at B would contain 15 kilos more of grapes and 10 kilos less of figs than at A; Yvonne's consumption bundle at B would contain 15 kilos less of grapes and 10 kilos more of figs.

The question for general equilibrium analysis is whether, given the agents' preferences, there exists a relative price between the two goods such that, if the individuals were to trade with each other at this price, excess demand for both goods would be zero. (Note: since there are only two goods, there is only one relative price and, by Walras' Law, if there is zero excess demand for one good there must be zero excess demand for the other good too.)

In order to examine the exchange that Xerxes and Yvonne will choose, we need to show their indifference maps in the Edgeworth box diagram. This is shown in Figure 18.8 where the indifference maps are represented by just four indifference curves for each consumer.

The Edgeworth box diagram in Figure 18.8 shows the indifference maps of both individuals, but Yvonne's is turned upside down because her consumption is measured in the opposite direction to Xerxes'. Xerxes' indifference map extends from the bottom left-hand corner up and to the right with the origin at O_x and is shown in black. His indifference curves are labelled U_{x0}, U_{x1}, U_{x2} and U_{x3}. Yvonne's indifference map has been flipped over so that it reads from the top right-hand corner down to the left with the origin at O_y and is coloured. Again you may find turning the page upside down helps

Figure 18.8 Simultaneous utility maximization



you to see this. Yvonne's indifference curves are labelled U_{y0}, U_{y1}, U_{y2} and U_{y3}. The initial endowment, A, is at the intersection of the indifference curves U_{x0} and U_{y0}.

Looking at the two indifference maps in Figure 18.8, we can see that there are a number of points of common tangency between the two sets of indifference curves. These points represent positions of simultaneous utility maximization by Xerxes and Yvonne, subject to different common prices which are shown by the different price lines, P_1, P_2, P_3 and P_4. For example, with the price line P_2, Xerxes is maximizing utility on indifference curve U_{x1}, and Yvonne is maximizing utility on indifference curve U_{y2}. When all the points of common tangency of all the indifference curves have been joined up, they form a line, *CC*, which is known as the *contract curve*. Note that, as utility maximization for any consumer implies that the MRS equals the ratio of prices, simultaneous utility maximization for both consumers, subject to a common price ratio, implies that Xerxes' MRS is equal to Yvonne's MRS.

Contract curve

The contract curve shows all the points of tangency between the indifference curves of two consumers. These are the points at which simultaneous utility maximization is possible for the two consumers, subject to different prices.

We have seen that simultaneous utility maximization is possible only at points on the contract curve. Given the initial allocation at A, however, not all points on this contract curve represent an improvement for both Xerxes and Yvonne, since there are some points on the contract curve that represent a worse outcome than at A. Xerxes would not want to trade to a point on the contract curve below and to the left of B_1 as this would put him on a lower indifference curve than U_{x0}. Similarly, Yvonne would not want to trade to a point on the contract curve above and to the right of B_2 as this would put her on a lower indifference curve than at U_{y0}. With an initial endowment at A, only points which lie on the portion of the contract curve between points B_1 and B_2 are preferred to A by both Xerxes and Yvonne. This portion of the contract curve, which lies between the two indifference curves corresponding to the initial allocation, is known as the *core*.

The core

The core of a two-person exchange economy is that portion of the contract curve that is preferred by both consumers to the initial endowment.

Starting with an initial allocation at A, the equilibrium outcome must lie within the core, but where within the core? Any point within the core qualifies as such a competitive equilibrium outcome if, at some given price ratio, both consumers would choose to trade to that point from the initial allocation at A. In terms of the Edgeworth box shown in Figure 18.9, such a point must be one at which a price line *P* drawn to it from A, is tangent to both consumers' indifference curves. Such a point is shown at E in Figure 18.9. In moving from A to E, Xerxes and Yvonne are trading figs and grapes at the price ratio given by the price line, with Xerxes exchanging figs for grapes and Yvonne exchanging grapes for figs.

At E, the amounts demanded and supplied by Xerxes and Yvonne are equal, given the price line, *P*, and so excess demands are zero. At A, if faced with the price line *P*, both Xerxes and Yvonne would trade along it until they reached their highest indifference curve at point E, where each would be maximizing utility. Xerxes would be on his highest indifference curve, U_{xE}, and Yvonne would be on her highest indifference curve, U_{yE}, given the price line *P*. At the equilibrium point E, Xerxes consumes 35 kilos of figs and 25 kilos of grapes, and Yvonne consumes 15 kilos of figs and 35 kilos of grapes. Comparing this consumption with the initial allocation at A, we find that Xerxes has traded 5 kilos of figs for 15 kilos of grapes, and Yvonne has traded 15 kilos of grapes for 5 kilos of figs. Xerxes is now consuming more grapes and fewer figs, and Yvonne is consuming more figs and fewer grapes, but note that Xerxes' offer to sell figs equals Yvonne's offer to buy figs (5 kilos), and Xerxes' offer to buy grapes equals Yvonne's offer to sell grapes (15 kilos). Thus demand equals supply. These trades imply that the price of grapes in terms of figs is:

$$\frac{P_G}{P_F} = \frac{1}{3}$$

Note that at equilibrium both consumers' MRS, as expressed by the slopes of their indifference curves, are equal to relative prices, that is:

$$MRS_{G,F} = \frac{P_G}{P_F} = \frac{1}{3}$$

Exercise 18.3

Consider an economy in which there are two consumers, Brenda and Colin, and two goods. At the initial allocation, Brenda has 30 kilos of figs and 20 kilos of grapes and Colin has 20 kilos of figs and 40 kilos of grapes (Note: in this example the total endowment for the economy is still 50 kilos of figs and 60 kilos of grapes). Brenda and Colin trade until an equilibrium is reached at which Brenda's consumption bundle is 25 kilos of figs and 35 kilos of grapes.

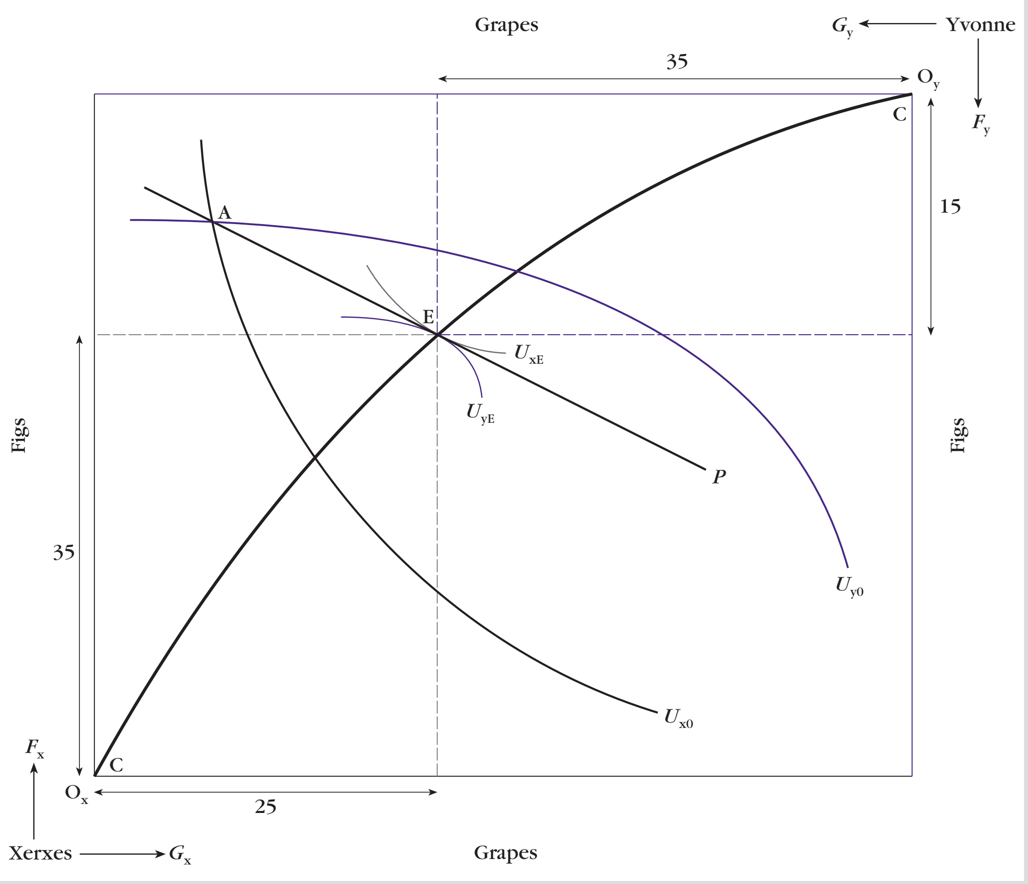
1 What is Colin's equilibrium consumption bundle?
2 What trades have to take place to reach this equilibrium from the initial allocation?
3 What must the price ratio, $\frac{P_G}{P_F}$, be?
4 Draw an Edgeworth box diagram to represent this.

Disequilibrium and multiple equilibria

Disequilibrium

To check whether you understand why Xerxes' and Yvonne's MRS must be equal to the relative price at equilibrium, try thinking through a

Figure 18.9 A competitive equilibrium



different situation where it does not hold, where their indifference curves are not tangent to the price line and so there is disequilibrium. This possibility is illustrated in Figure 18.10 where the price line cuts the contract curve at point H which is in the core but where the price line is not tangent to an indifference curve of either Xerxes or Yvonne at this point.

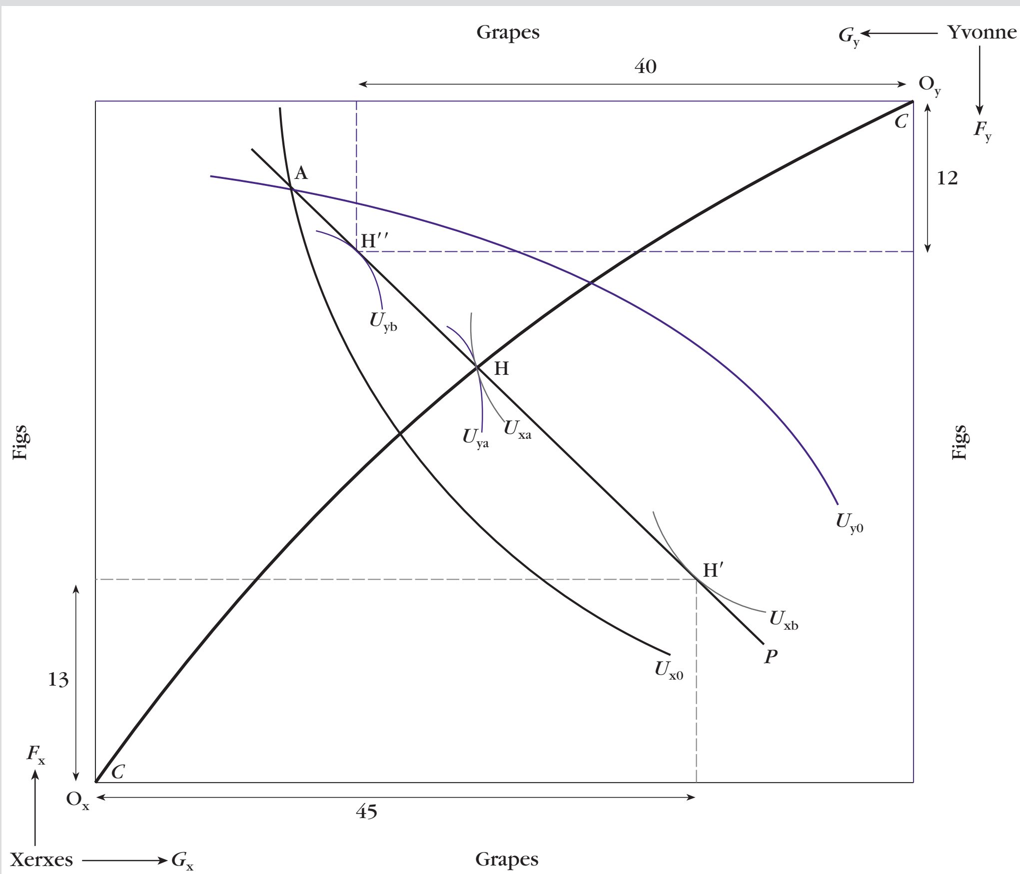
In Figure 18.10, at point H, the price line, *P*, is not tangent to either Xerxes' indifference curve U_{xa} or Yvonne's indifference curve U_{ya}. You can see this because both indifference curves cross *P*. This implies that at H both Xerxes and Yvonne would prefer to move to a higher indifference curve. Xerxes would prefer to move to H′ on indifference curve U_{xb} and Yvonne would prefer to move to point H′′ on indifference curve U_{yb}, but this is not possible because to get from H to H′, Xerxes wants to exchange figs to get more grapes but, unfortunately, Yvonne wants to do the same to get to H″. The amounts offered in exchange by Xerxes are not consistent with the amounts offered by Yvonne, and so there is disequilibrium.

Question

Why are the consumption bundles at H′ and H′′ inconsistent?

At H′ Xerxes wishes to consume 13 kilos of figs and 45 kilos of grapes, but at H′′ Yvonne

Figure 18.10 Disequilibrium



wishes to consume 12 kilos of figs and 40 kilos of grapes. If Xerxes wishes to consume 13 kilos of figs and Yvonne wishes to consume 12 kilos, their total consumption would be 25 kilos. This is less than the total initial endowment of 50 kilos of figs. Similarly, if Xerxes wishes to consume 45 kilos of grapes and Yvonne wishes to consume 40 kilos, this is more than the total initial endowment of 60 kilos of grapes. Given the initial allocation at A where Xerxes has 43 kilos of figs and 15 kilos of grapes, and Yvonne has 7 kilos of figs and 45 kilos of grapes, the amounts offered in exchange are inconsistent and so demand and supply are not equal.

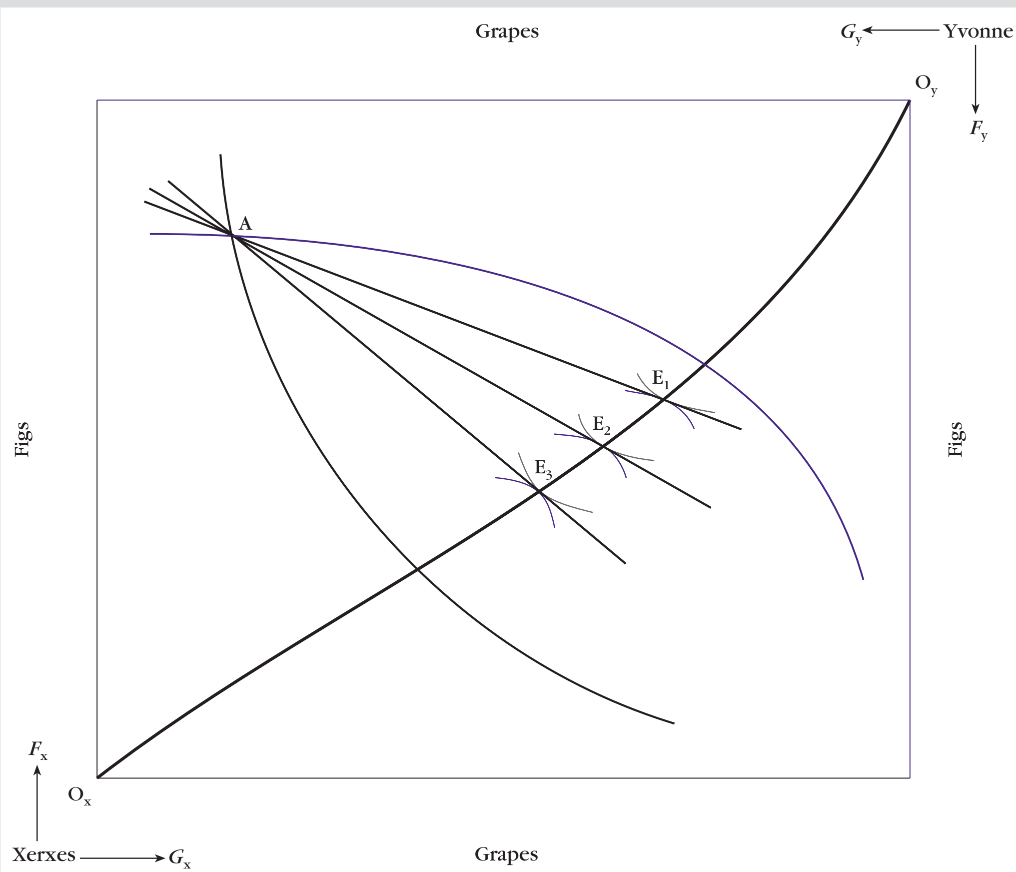
Xerxes wishes to trade 30 kilos of figs for 30 kilos of grapes whereas Yvonne wishes to trade 15 kilos of grapes for 5 kilos of figs. At this relative price of $\frac{P_G}{P_F} = 1$ there is a positive excess demand for grapes of 25 kilos and a negative excess demand for figs of 25 kilos.

So the relative price shown by the price line *P* cannot be an equilibrium price. If there is positive excess demand for grapes and negative excess demand for figs, the Walrasian rule for price adjustment says that the price of grapes should be raised relative to that of figs.

Exercise 18.4

Should the price line pivot around A in a clockwise or anti-clockwise direction in order to get to an equilibrium from A?

Figure 18.11 Multiple equilibria



Multiple equilibria

There can be more than one equilibrium point and this can be represented using an Edgeworth box diagram. Multiple equilibria occur when it is possible to draw more than one price line through the initial allocation at A which is tangent to a pair of indifference curves in the core. This possibility is shown in Figure 18.11.

Excess demands are zero at each of the equilibria marked as E_1, E_2 and E_3. Note that at each equilibrium, both consumers' MRS are equal to the relative price:

$$\text{MRS}_{G,F} = \frac{P_G}{P_F}$$

but the relative price and corresponding MRS are different for each equilibrium.

Exercise 18.5

On Figure 18.11, is the price of grapes relative to figs higher at E_1 or E_3? What does this imply about the $\text{MRS}_{G,F}$ at these two equilibria?

We saw an example of a competitive equilibrium at E in Figure 18.9, but it is important to remember that the equilibrium reached at E depends on the initial endowment of resources between Xerxes and Yvonne as shown at point A. Different initial allocations of resources would result in a different equilibrium. This is shown in Figure 18.12 (overleaf) where the initial endowment at point A′ is more unequal than it was at A in Figure 18.9, as Yvonne has more figs and more grapes than she had at A (and also more at A′ than Xerxes has). The resulting equilibrium at E′ enables her to consume more of both goods than she could at E (and also more at E′ than Xerxes can).

The indifference maps for Yvonne and Xerxes are the same in Figure 18.12 as in Figure 18.9, and the total endowment of 50 kilos of figs and 60 kilos of grapes is also unchanged. The only difference lies in the distribution of this endowment between Yvonne and Xerxes at A′. Yvonne now has 42 kilos of figs and 50 kilos of grapes, and Xerxes now has only 8 kilos of figs and 10 kilos of grapes. With a relative price of $\frac{4}{5}$, the equilibrium is shown at E′. At this point Yvonne consumes 38 kilos of figs and 55 kilos of grapes and Xerxes consumes 12 kilos of figs and 5 kilos of grapes. Thus we see in this case how a different initial endowment results in a different equilibrium.

This section has presented a very simple model of an exchange economy with only two consumers, two goods and no production. In spite of this, the results using the Edgeworth box diagram illustrate an example of a competitive equilibrium, based on utility maximization by price-taking consumers. The features of a competitive equilibrium which it illustrates hold even when there are many consumers and many goods.

- All excess demands are zero: at equilibrium, Xerxes' offers to buy and sell grapes and figs exactly match Yvonne's offers to sell and buy grapes and figs.
- Until equilibrium is reached, trade between agents can allow all agents to increase their utility, i.e. trade is a positive-sum game: both Xerxes and Yvonne increase their utility by trading with one another. This holds even when the original distribution between the consumers is very unequal.
- The equilibrium outcome depends on the distribution of the initial endowment between the two consumers: the competitive equilibrium at E depends on the initial allocation at A, and a different endowment of goods between Xerxes and Yvonne results in a different equilibrium with different prices and different equilibrium consumption bundles for each of them.

In this section I have focused on a pure exchange economy where there is consumption but no production. In the next section I will look at the production side of an economy, so that in Section 4.4 I can combine the two to give a general equilibrium of exchange, consumption and production.

4.3 *Equilibrium in production*

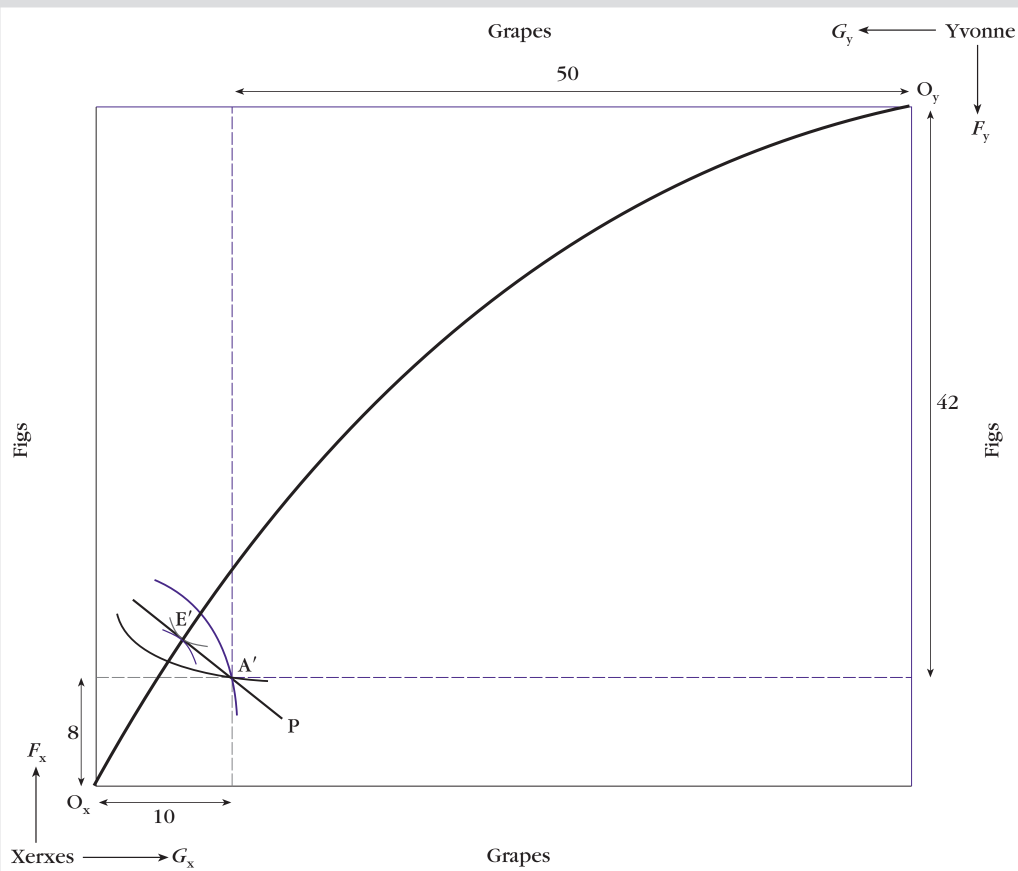
To represent the production side of the economy on a diagram, we keep to a simple model of two final goods, but, as with the two-person exchange model, the results generalize to many commodities. Our aim is to find out the amounts of the two goods produced and the price at which they are sold. The first step involves considering all possible combinations of quantities of the two goods that could be produced given existing technology and different techniques of production. The production possibility frontier (PPF), which you met in Chapter 6, shows all the maximum combinations of two goods that are feasible given existing technology. Figure 18.13 shows a production possibility frontier in which kilos of grapes are measured on the horizontal axis and kilos of figs are measured on the vertical axis.

Given the existing technology, every point on the production possibility frontier shows the maximum possible output of one good, given the output level of the other good. For example, point B on the PPF shows that if the quantity of grapes produced is G_B, the maximum amount of figs that it is possible to produce is F_B.

The slope of the PPF, $\frac{\Delta F}{\Delta G}$, is negative and its magnitude shows the rate at which figs have to be sacrificed (or foregone) in order to produce one more unit of grapes. We have met this idea before too: it is a version of the notion of opportunity cost that you met in Chapter 6 and is called the *marginal rate of transformation* (MRT) as it measures the rate at which one good can be 'transformed' into another by reducing the output of one and increasing the output of the other, assuming that all resources are fully employed:

$$\text{MRT}_{G,F} = -\frac{\Delta F}{\Delta G}$$

Figure 18.12 A general equilibrium where Yvonne is rich and Xerxes is poor



The marginal rate of transformation (MRT)

The marginal rate of transformation of good *G* for good *F* measures the rate at which the output of *F* has to be reduced to obtain an additional unit of *G*. It is given by the magnitude of the slope of the production possibility frontier $MRT_{G,F} = -\dfrac{\Delta F}{\Delta G}$

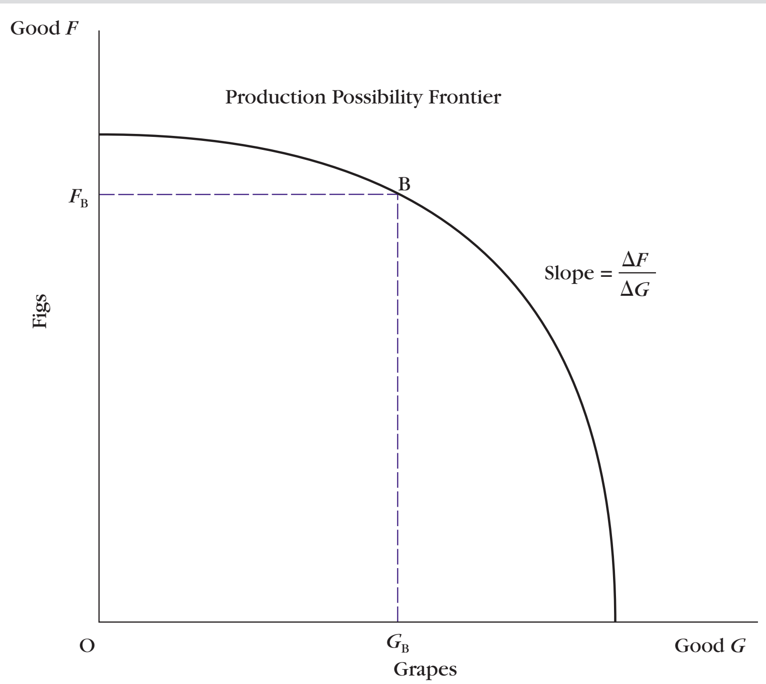
An important feature of the PPF is that its slope is different at each point. The slope of the PPF at any point can be found by measuring the slope of a line which is tangent to it at that point.

On Figure 18.14 compare the slope at point B with that at B′ which is further to the right along the PPF. At point B′, the tangent is shown by the line T′ and is steeper than the tangent T at B. This shows that the slope of the PPF becomes more steeply negative along its length from left to right; that is, the MRT of good *G* for good *F* increases as more of good *G* and less of good *F* is produced. The MRT of a good increases as more of it is produced because the opportunity cost of producing it increases as more resources are transferred into its production.

We can see that the MRT between two goods measures the rate at which production of one has to be reduced in order to increase production of the other by one unit, and that this is equivalent to the notion of opportunity cost. We can put this in terms of their relative marginal costs (*MC*). The marginal cost of a good is the cost of the last unit produced (*Changing Economies*, Chapter 4, Section 4). In a many-good economy, we think of this as measured in terms of money. In our two-good model, cost can only be measured relative to the other good. So the marginal cost of producing one extra unit of good *G*, is simply the amount of good *F* it costs to produce that unit of good *G*, that is, the opportunity cost of that last unit of *G* in terms of *F*. But this is just the marginal rate of transformation of good *G* for good *F*. In other words:

$$MC_G = MRT_{G,F}$$

Figure 18.13 The production possibility frontier for figs and grapes



If there were more goods we would have to talk in terms of ratios of marginal costs, and the marginal cost of one good in terms of another would be equal to the ratio of their marginal costs. So in general:

$$\mathrm{MRT}_{G,F} = \frac{MC_G}{MC_F}$$

However, if we are measuring costs in terms of good F, then $MC_F = 1$. For example, if the marginal cost of grapes is twice that of figs, this means that one more kilo of grapes costs two units of figs. In this case also, the $\mathrm{MRT}_{G,F} = 2$, because two kilos of figs have to be given up in order to have one more kilo of grapes.

In a competitive economy, however, profit maximization implies that firms produce at that level at which marginal costs are equal to output prices (Chapter 10 and *Changing Economies*, Chapter 7, Section 4). This means that in equilibrium, the ratio of the marginal costs of the two goods will be equal to their relative price, that is:

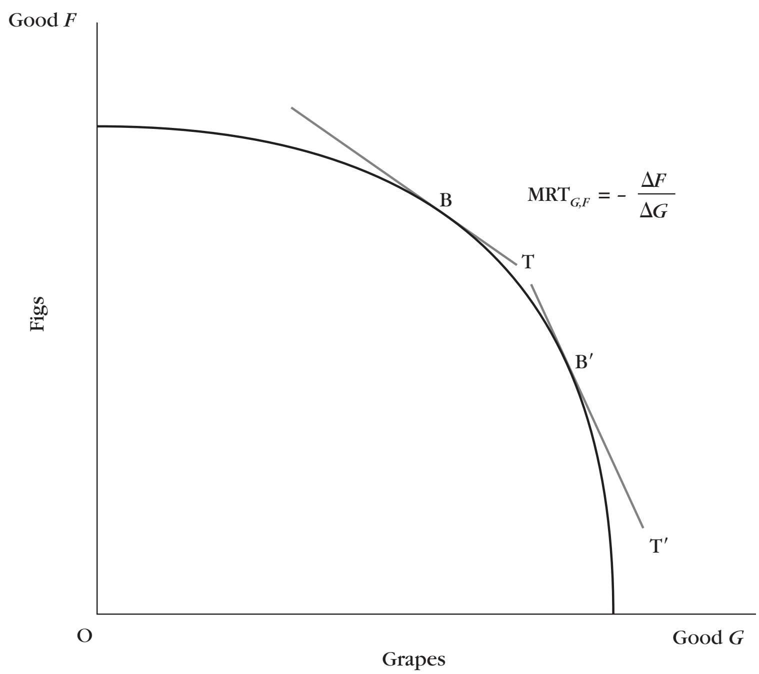
$$\frac{MC_G}{MC_F} = \frac{P_G}{P_F}$$

This implies that the marginal rate of transformation between the two goods is equal to their relative price in a competitive economy, that is:

$$\mathrm{MRT}_{G,F} = \frac{P_G}{P_F}$$

This is an important result because it shows that profit maximizing under competitive conditions results in the relative output price being equal to the magnitude of the slope of the production possibility frontier. This can be illustrated by adding a price line to the production possibility frontier as shown in Figure 18.15. If the relative price of grapes in terms of figs is shown by the price line, P, the

Figure 18.14 The MRT equals the magnitude of the slope of the PPF



profit maximizing output mix under competitive conditions will be at the point E. This is the point at which the price line is tangent to the production possibility curve, making the magnitude of its slope, $MRT_{G,F}$, equal to the price ratio, $\frac{P_G}{P_F}$.

We have now derived a production possibility frontier for the economy which shows that, under competitive conditions, the economy's MRT between the two goods is equal to their relative price. We are now ready to expand our model of the exchange economy to include production so that we can find out whether there exists a relative price that will support a general equilibrium of exchange and production simultaneously. This is the subject of the next section.

4.4 *General equilibrium with production*

We are now ready to examine a simultaneous equilibrium for exchange and production. In this economy, both figs and grapes can be produced. Our task is to find the equilibrium relative price and the output mix of figs and grapes, together with the amounts consumed by Xerxes and Yvonne.

We know that consumer optimization under price taking results in the marginal rate of substitution of grapes for figs being equal to the ratio of prices for both consumers:

$$MRS_{G,F} = \frac{P_G}{P_F}$$

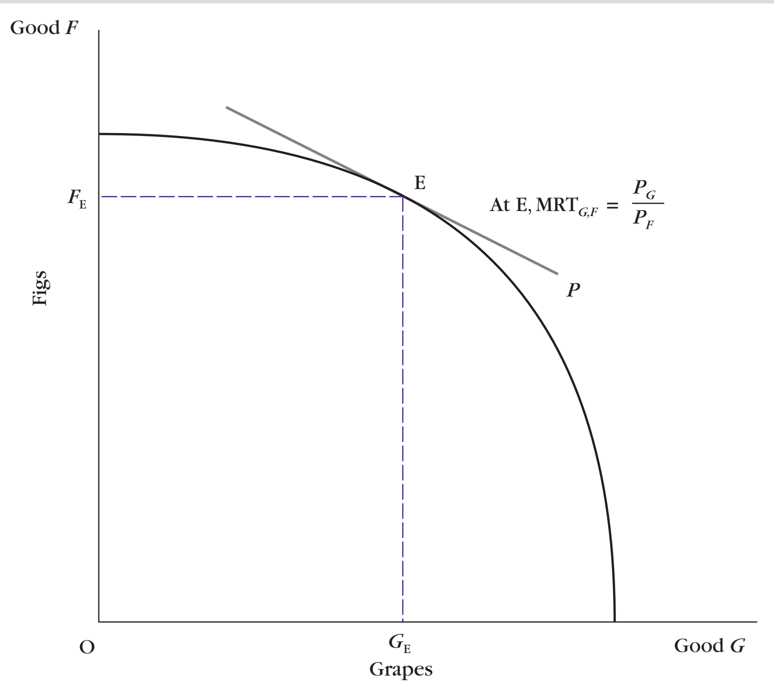
We have also seen that profit maximization under price taking results in the marginal rate of transformation of grapes for figs being equal to the ratio of prices:

$$MRT_{G,F} = \frac{P_G}{P_F}$$

This implies that, in equilibrium in a competitive economy, the marginal rate of substitution must be equal to the marginal rate of transformation, that is:

$$MRS_{G,F} = \frac{P_G}{P_F} = MRT_{G,F}$$

Figure 18.15 Competitive output



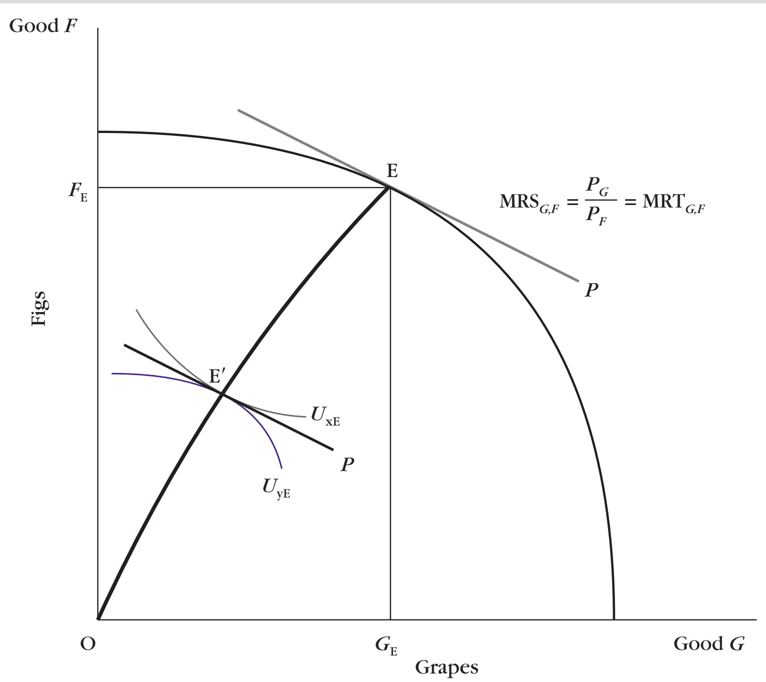
This can be illustrated by combining the box diagram of exchange and consumption with the production possibility frontier diagram. This is shown in Figure 18.16.

The production possibility frontier shows the competitive profit-maximizing output mix, E, where F_E of figs and G_E of grapes are produced, subject to the price line P. These amounts of figs and grapes then provide the dimensions for an Edgeworth box with the competitive utility-maximizing consumption bundles of figs and grapes at E′, subject to the price line P. This is a competitive equilibrium because excess demands for figs and grapes are zero at E′, given the price line P. Note that the MRS for each consumer equals the MRT because both equal the relative price. This implies that the MRS and MRT lines are parallel because they have the same slope, that is:

$$\mathrm{MRS}_{G,F} = \frac{P_G}{P_F} = \mathrm{MRT}_{G,F}$$

A complete general equilibrium model also needs to include an analysis of Xerxes' and Yvonne's endowment of the factors of production which are used to produce the final output, and whose sale gives them the income required to buy their respective consumption bundles at E′. Thus the competitive equilibrium in Figure 18.16 depends crucially on the initial endowment of factors of production between Xerxes and Yvonne, although this is not shown on the diagram. With a different distribution of the initial endowment, the relative incomes of Xerxes and Yvonne would be different and so we would expect the output mix and consumption bundles to be different as well. For example, if Yvonne received a greater initial endowment she would be able to consume a larger bundle than before, that is, she would be able to consume more of both figs and grapes. Thus, the output mix at E and the consumption bundles at E′ in Figure 18.16 represent just one possible competitive equilibrium. In general, we would expect there to be as many different equilibrium output mixes and consumption bundles as there are different initial endowments of factors of production, assuming that each initial endowment leads to a

Figure 18.16 Competitive equilibrium in exchange, consumption and production



unique equilibrium. Multiple equilibria would, of course, make this more complicated.

Exercise 18.6

If the equilibrium price of grapes in terms of figs were higher than shown in Figure 18.16, what would this imply about the equilibrium output mix of figs and grapes, and the consumers' MRS?

4.5 Conclusion: prices again

This section has examined the existence of competitive general equilibrium in two-person, two-good models which can be illustrated using Edgeworth box diagrams. As with the Walrasian model, we have found that the existence of equilibrium is dependent on there being a relative price that will yield zero excess demands. Note, however, that the issue of how the equilibrium price is actually set is still unresolved. The two agents are price takers, but the process by which the equilibrium price might have been discovered by actual agents falls outside the model.

Edgeworth was aware of this issue and, like Walras, he proposed a way around it. His solution was to think of price setting in terms of a series of contracts made directly between agents which can be renegotiated right up until the moment when the equilibrium outcome is reached. This process of 'recontracting', as Edgeworth called it, ensures that contracts that do not result in the equilibrium outcome are not adhered to, that is, that there is no 'false trading'. It is the equivalent of Walras' idea that no actual trades take place until the process of tâtonnement has finished and the equilibrium prices have been called out. If there are two agents negotiating a price, then the final equilibrium can be anywhere in the core. As we have seen, the core is the part of the contract curve that is preferred by both agents to the original endowment, but the actual point reached within the core depends on the negotiations between the two agents. Edgeworth showed mathematically that the equilibrium outcome negotiated by agents will converge on the competitive outcome of a Walrasian model as the number of agents becomes very large. In this large numbers case, the core of the contract curve shrinks to a single point representing the competitive outcome. (This cannot be illustrated using a box diagram for the same reason that excess demand curves in a general equilibrium setting can not be illustrated diagramatically: a two-dimensional surface is incapable of representing the multi-good, multi-person case.) The process of recontracting thus attempts to solve the problem of how the equilibrium outcome is actually discovered in real markets without a Walrasian auctioneer. Recontracting means that contracts are made directly between maximizing agents, but to explain how the equilibrium is arrived at we still need to rely on the device that no false trades are concluded. It therefore does not solve the theoretical conundrum of how equilibrium prices in real world markets can be determined as the outcome of ordinary trading relations where 'false', that is disequilibrium, trades are the norm.

5 COMPETITIVE EQUILIBRIUM AND WELFARE ECONOMICS

5.1 Introduction

In the Introduction to this chapter we saw how arguments for economic liberalism have been linked with the neoclassical analysis of competitive markets. In this section we come to consider the argument that a competitive equilibrium promotes economic well-being, by which I mean Pareto efficiency. This was presented intuitively in Chapter 1, but we will now trace this argument more rigorously. (See Chapter 4 for a discussion of different notions of well-being.)

5.2 Efficiency and competitive equilibrium

The notion that a competitive equilibrium promotes economic well-being is based on the argument that a competitive equilibrium is Pareto efficient, in that it is impossible to improve any agent's situation without making someone else worse off. We can examine this argument by looking back at Figure 18.16 which showed how, in the general equilibrium of exchange and production, the same price line P is tangent to both the economy's production possibility frontier at E and the consumers' indifference curves at E′. This means that the relative price represented by P is equal to both the economy's MRT and consumers' MRS at these points, and therefore that:

$$\text{MRT} = \text{MRS}$$

This implies that the opportunity cost of grapes in terms of figs in production is equal to consumers' preference for grapes relative to figs. To demonstrate that this competitive equilibrium is Pareto efficient, we now need to show that it is impossible to reallocate production or consumption to make either Xerxes or Yvonne better off without making the other worse off. We do this by showing that MRT = MRS is also the condition for Pareto efficiency.

First consider whether in Figure 18.16 there is any other consumption bundle on the contract curve that is more preferred than E′ by either Xerxes or Yvonne, which does not make the other worse off. Any other consumption bundle on the contract curve will be more preferred than E′ by either Xerxes or Yvonne, but less preferred by the other. Points to the right of E′ on the contract curve would be more preferred by Xerxes as lying on a higher indifference curve than U_{xE}, but less preferred by Yvonne as lying on an indifference curve below U_{yE}. Similarly, points to the left of E′ would be more preferred by Yvonne but less preferred by Xerxes. Thus, all points on the contract curve are Pareto efficient in an exchange economy. This may be contrasted with all those consumption bundles that are off the contract curve and which are not Pareto efficient because moving from them to some point on the contract curve would increase utility for one agent (without reducing it for the other) or for both agents. For example, looking back to Figure 18.9, a point such as A is less preferred by both Xerxes and Yvonne to any point in the core. Another way of saying this, as we have seen, is that it is only on the contract curve that both consumers are maximizing utility, given their preferences and the relative price ratio, and where they have the same MRS of one good for the other.

All points on the contract curve are Pareto efficient in an exchange economy, but in a production and exchange economy, only point E′ is a Pareto-efficient consumption bundle when output is at E. This is because consumers' MRS at E′ equals the MRT at E. If the rate which consumers would give up units of F for an additional unit of G equals the rate at which the output of F has to be reduced to obtain an additional unit of G, then it is impossible to reallocate production or consumption to make either Xerxes or Yvonne better off without making the other worse off. Consider the case where the MRT of good G for good F is greater than the MRS of good G for good F. In this case, the amount of F given up to produce the last unit of G is greater than the amount of F which a consumer would give up for that unit of G and still remain on the same indifference curve. This implies that reducing the output of G by one unit would increase the output of F by an amount that would place one or both consumers on a higher indifference curve. Changing the output mix by reducing G by one unit and increasing F would, therefore, be a Pareto improvement. Similarly if the MRT of good G for good F were smaller than the MRS of good G for good F, then increasing the output of G would put consumers on a higher indifference curve and so would also be a Pareto improvement. It is only when the MRS = MRT for every pair of goods and for every consumer, that it is impossible to reallocate production or consumption in such a way as to make any consumer better off without making some other consumer worse off. The equality between MRS and MRT for all goods and all consumers is, therefore, the condition for Pareto efficiency.

The reason a competitive equilibrium is Pareto efficient is that, in the absence of externalities, the Pareto condition MRS = MRT always holds. Firms set marginal costs equal to prices and this implies that the economy's MRT equals relative prices; consumers adjust their consumption so that their MRS equals relative prices. The outcome is that MRS = MRT. This result, that, in the absence of externalities, a competitive equilibrium is Pareto efficient, is known as the *First Welfare Theorem*.

First Welfare Theorem

The First Welfare Theorem states that, in the absence of externalities, any competitive equilibrium is Pareto efficient.

There are two points to notice about the First Welfare Theorem. The first is that it is silent about the issue of distribution. When we considered the exchange economy above, we saw that a competitive equilibrium depends on the initial endowment, and so there is a different equilibrium for each initial endowment. This is also true when we include production – there will be many competitive equilibria depending on the initial endowments of productive resources. Each of these equilibria is Pareto efficient but the final allocation of consumption is different in each. The second point is that the First Welfare Theorem contains a proviso that there are no externalities. Externalities occur where private costs/benefits differ from social costs/benefits (*Changing Economies*, Chapter 10, Section 3.1). If there are externalities, then firms and consumers are setting their private costs and benefits equal to prices, and this means that competitive prices will not reflect social costs and benefits. If there are externalities, this means that competitive prices fail to equate the true social MRT with the true social MRS, and so the competitive outcome is not Pareto efficient.

Externalities mean that a competitive equilibrium is not Pareto efficient

Production externalities

In the case of pollution from a factory, for example, the social costs of production exceed the firm's private costs as the latter do not take into account the effects of the pollution on the environment or on people's health. Competitive firms will carry on producing until the private marginal cost equals the market price. If the marginal social cost exceeds the marginal private cost, this means that the social cost at the margin exceeds the market price, and so the true social MRT exceeds consumers' MRS in a competitive equilibrium. This implies that consumers are not paying the full cost of the activity and that there is more than a Pareto-efficient quantity of the polluting activity being produced.

Consumption externalities

In the case of contagious diseases, for example, other people benefit from a person's inoculation against the diseases in addition to the immediate consumer of the inoculation, and so the marginal social benefit is greater than the marginal private benefit. In this case, the true social MRS is greater than the MRT in a competitive equilibrium, and so the quantity consumed is smaller than the Pareto-efficient quantity.

We have seen that the First Welfare Theorem shows that any competitive equilibrium is Pareto efficient, under certain conditions. Is the converse also true, that any Pareto-efficient allocation can be achieved as a competitive equilibrium? The answer to this question is complicated by the problem of nonconvexity. So far in this chapter I have assumed that the production possibility frontier bows outwards and that consumers have convex indifference curves, so I have avoided the problems posed by nonconvexities (see Chapters 2 and 8). The presence of nonconvexities means that a competitive equilibrium may not exist. I will trace through the implications of this for the case of nonconvexity in production, that is, in increasing returns to scale.

A technology is nonconvex if there are increasing returns to scale. These increasing returns to scale are associated with imperfectly competitive firms, not competitive firms (Chapter 8; *Changing Economies*, Chapters 6 and 7). This is because, under increasing returns to scale, large firms may out-compete small firms until the number of firms becomes so small that other strategic considerations will start to apply (see Chapter 11). The presence of increasing returns therefore means that a competitive equilibrium may not exist. For this reason, it is not the case that every Pareto-efficient allocation is also a competitive equilibrium because the competitive equilibrium might not exist. Pareto efficiency is possible even in the presence of increasing returns, but the increasing returns may prevent that outcome from being a competitive equilibrium. This brings us to the *Second Welfare Theorem* which states that, if there are no nonconvexities, every Pareto-efficient allocation can be achieved as a competitive equilibrium.

Second Welfare Theorem

The Second Welfare Theorem states that, in the absence of nonconvexities, every Pareto-efficient allocation can be achieved as a competitive equilibrium.

The Second Welfare Theorem shows that, if there are no nonconvexities, any Pareto-efficient allocation can be achieved by competitive markets from some initial allocation of resources. Note the importance of the initial endowment again. We have seen that every Pareto-efficient competitive outcome is based on an initial endowment of resources distributed among the economic agents. The converse is that any Pareto-efficient outcome is feasible as a competitive outcome but the initial distribution has to be the appropriate one. This result is significant as it shows that, theoretically, the issues of efficiency and distribution are separate. Competitive prices secure an efficient outcome (in the absence of externalities and nonconvexities) from any initial endowment, but an appropriate initial endowment is needed to secure any particular distributional outcome. Thus, the competitive market itself can be said to be distributionally neutral. The policy implication is that issues of efficiency and distribution are better kept separate. Policies to promote competition can be used to secure efficiency, unhindered by distributional considerations, because these can be looked after by adjusting people's initial endowments – preferably by lump sum taxes or benefits that do not distort relative prices or choices at the margin.

How does this result affect the case we considered in Section 4.2 for the exchange economy where Yvonne is rich and Xerxes poor, as was illustrated by the initial endowment A′ in Figure 18.12? If it were decided that Xerxes should have a larger consumption bundle than that shown at E′ what would be the best policy?

Question

Look again at Figure 18.12. If you were to introduce a policy to increase Xerxes' final consumption bundle so that he could consume more of both figs and grapes than at E′, how might you do it?

The implication of the Second Welfare Theorem is that distributional issues should be resolved by changing the initial endowments, and not by changing the competitive pricing mechanism. The solution would be to change the initial endowment at A′, by giving Xerxes more and Yvonne less, and then letting the market mechanism work to produce an equilibrium price at which both Xerxes and Yvonne maximize their utility by trading until their MRS equals that price.

This separation between efficiency and distribution is clear-cut in theory, but it is not so easy to make in practice as we shall see in the following section. The policy implications of the two welfare theorems are considered in the next section.

5.3 Welfare policies

We have seen that, at a theoretical level, there is a strong link between competitive outcomes and Pareto efficiency. This has been used to suggest that a decentralized economy with competitive markets and an absence of government intervention is the one that works most efficiently. According to this argument, government intervention in the form of taxes, subsidies, regulations and the direct provision of services, distorts the role of prices in allocating resources and so introduces inefficiencies into a market economy. The policy issues are, however, more complicated than this would suggest.

Improving efficiency

If the world we live in corresponded to the assumptions required for the two welfare theorems, there would be little need for government economic policy. As, however, the assumptions do not, in general, hold in the real world, it has been argued that the welfare theorems provide a rationale for certain types of government intervention to improve efficiency.

It is clear that many externalities exist in real economies. The problem with externalities is that market prices do not reflect the true social costs or benefits of an economic activity because economic agents set their private MRS or marginal costs to market prices. By doing this they leave out of account the additional external social implications of their actions. One policy response is to introduce a tax or subsidy which reflects the additional social costs or benefits of the economic activity. In this way, it is argued, the market price (including the tax/subsidy) will convey the true social cost/benefit of the activity. This is the economic rationale behind the calls for polluting activities to be taxed, for example. Such taxes are known as 'green taxes'. If the tax reflects the amount of pollution caused, then polluters have an incentive to find ways of reducing the polluting side-effects of their economic activity. This should result in levels of pollution that are Pareto efficient in that the social costs of the products of a polluting activity are made equal to the private costs faced by producers, and the prices consumers pay for the products also reflect these costs (*Changing Economies*, Chapter 10, Sections 3 and 5).

As we have seen, the notion of 'competition' in competitive general equilibrium theory is a highly specific notion that is hard to operationalize given the requirement that all agents are price takers. In many real world markets, it is clear that firms do have a degree of control over prices. Thus, in many real markets, the kind of competition that is relevant may be a far cry from the one needed by the Walrasian model and may be closer to the disequilibrium process emphasized by evolutionary economists (see Chapter 16) or strategic behaviour in oligopoly markets (see Chapter 11). Policies to encourage competition may, therefore, be encouraging not so much Walrasian price taking but other market forms in which prices diverge from marginal costs, especially in markets where there are significant returns to scale.

Furthermore, competitive models of markets tend to see 'market forces' in abstraction from the institutional settings within which these markets actually operate. We had a glimpse of this in the example of the London Gold Fixing in which the benchmark price of gold emerges not from the interplay of impersonal market forces, but as a result of twice daily meetings of a group of dealers with a chairman who acts as a Walrasian auctioneer. This example reminds us that, unlike the model of price-taking competition, information is not a free good. In the real world without a Walrasian auctioneer, both transaction costs and information costs may be considerable.

Thus, in terms of practical policies, the choice is not whether to make markets work so that agents take prices as given, but whether markets can be made to work more competitively in a broad and pragmatic way. This, however, may not bear a close relation to the Walrasian model taken strictly, especially in a world of imperfect competition and increasing returns.

Second-best policies

The policy problems we have considered derive from the fact that a real economy does not meet the strict conditions required for the welfare theorems. This suggests that we live in a 'second-best' world. What should be the guidelines for policy in a second-best world? It has been argued by some economists that the satisfaction of some marginal conditions for Pareto efficiency in the presence of the continued failure of others, will not necessarily improve consumer well-being. For example, if an economy is composed of many monopolists and prices, in general, are greater than marginal costs, then forcing one monopolist to price at marginal cost but leaving the others free to price as they wish may introduce a greater distortion between the prices of different goods. In these circumstances, the best policy – although it is a *second-best policy* – is to try to ensure that distortions across the economy are kept in balance as much as possible.

The Theory of the Second Best

The Theory of the Second Best states that the satisfaction of some marginal conditions for Pareto efficiency in the presence of the failure of others will not necessarily improve consumer well-being. In cases where the first-best policy is not possible, the second-best policy is to have uniform distortions across the economy, rather than eliminating distortions in only some sectors.

As the real world is a second-best world, this implies that the best policy would involve trying to balance out the various distortions in the marginal conditions for competition and Pareto efficiency. Transport policy offers an example of the difficulties involved. In a price-taking Pareto-efficient world, different methods of transport would compete equally and all market prices would reflect true social costs. The actual mix of bikes, trains, cars, buses and planes would, therefore, reflect consumer preferences in the face of true social costs. But how should transport policy be arranged when some forms of transport have received more subsidies than others? The problem is exacerbated by the problem of defining and measuring social costs. Proponents of rail transport, for example, argue that road users are subsidized by the enormous public expenditure on roads and motorways. In a second-best world where, despite vehicle and petrol taxes, it is politically infeasible to argue that road users should pay the full cost of their road use, rail supporters argue that railways should be subsidized to create more of a 'level playing field' across transport services. The argument that railways should be subsidized to counteract the inadequacy of green taxes on road pollution is an example of a second-best argument. (Cyclists can argue that cycling is the most under-subsidized of all forms of transport, especially in view of the absence of pollution from cycling.)

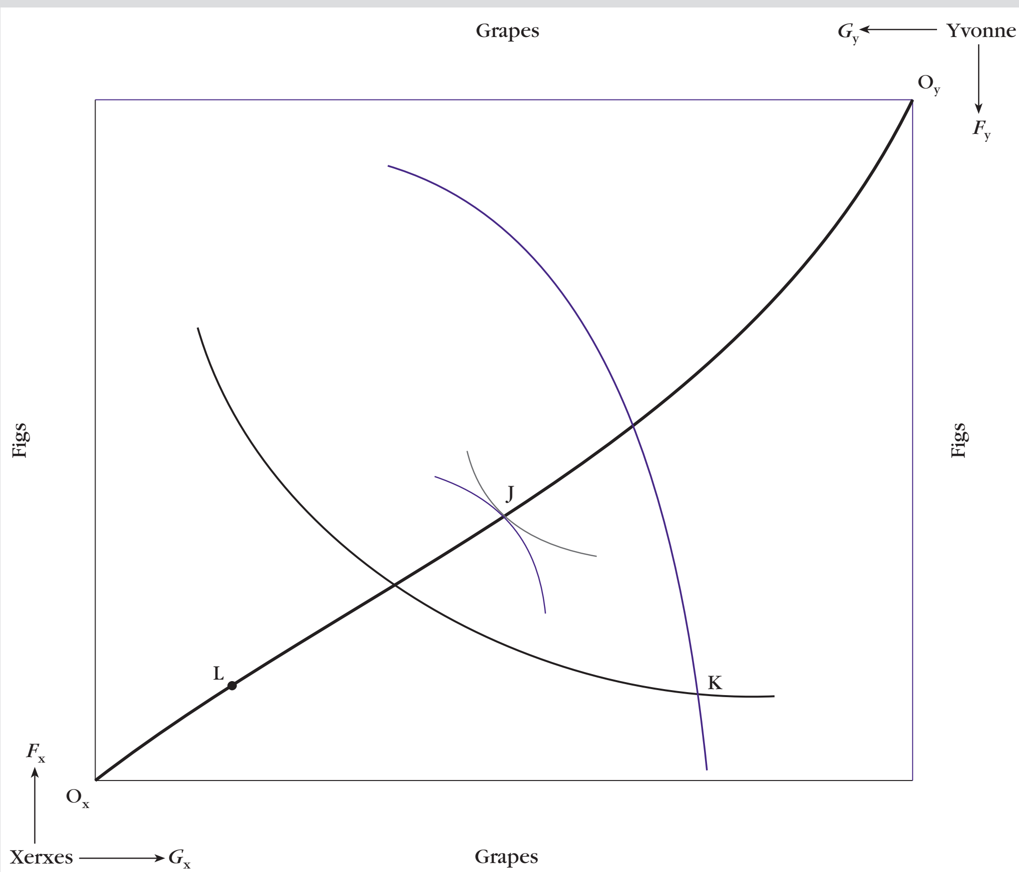
This approach to a partial improvement in the marginal conditions, however, requires considerable knowledge, skill and a disinterested public spirit on the part of the government. The question of knowledge and skill brings us back to the paradox raised earlier, where the Walrasian tâtonnement seems a far cry from the notion of the invisible hand in a decentralized market economy. We are back to the notion of a more active central agency which uses the Walrasian model as a planning tool to make markets work more effectively than they can unaided. It also brings us to the issue of the 'economics of politics', and whether governments are able to operate – like the auctioneer does – as disinterested players who stand outside the game, uncontaminated either by their own interest in being re-elected or by the special interest groups (such as road and rail users) which lobby the government in support of their own interests (*Changing Economies*, Chapter 10, Section 4).

Distributional policies

The Pareto criterion states that there is a welfare improvement only if someone is made better off (in that person's estimation) without making someone else worse off (in that other person's estimation). This implies that the Pareto criterion is not always relevant when choices have to be made on distributional grounds. For example, the Pareto criterion cannot help in making choices between different initial endowments. Nor can it provide a way of choosing between different Pareto-efficient points on the contract curve, although it may sometimes be helpful in choosing between points off the contract curve compared to a point on the contract curve. This is illustrated in Figure 18.17.

The consumption bundle at J is Pareto efficient and is preferred by both customers to the bundle at K, since both are on a higher indifference curve at J. But what if we want to compare K with L, a very unequal distribution, similar to the distribution we

Figure 18.17 Efficiency and distributional objectives



saw in Figure 18.12? L is Pareto efficient because it lies on the contract curve, but it is an unequal distribution compared with K which is not Pareto efficient. Yvonne would prefer to be at L than at K, whereas Xerxes would prefer to be at K than at L. If a society has mechanisms for making collective economic choices, then it might prefer a point such as K to one such as L on distributional grounds, thus choosing to trade-off efficiency for a distributional objective of, say, a more equal society.

Efficiency and distribution

A feature of the Second Welfare Theorem is that it separates efficiency and distributional issues, although, as we have seen, a society may choose to trade efficiency for the sake of distributional objectives. In practical issues of welfare policies, however, it is not easy to keep them separate. The reason for this is that prices perform two functions simultaneously:

- they allocate resources between alternative uses
- they influence agents' budget constraints.

This distinction is sometimes expressed in terms of the allocative and distributional function of prices. Welfare policies that affect prices will therefore have both allocative and distributional implications.

As an example of this connection between the allocative and distributional implications of welfare policies, consider again the case of transport policy. Any transport tax/subsidy, as we have seen, will affect the choices made at the margin by consumers and producers. In this respect it is an allocative policy, but it also has distributional effects because it increases the real incomes of those who use the subsidized service at the expense of those who pay taxes. Or consider health policy. Changes in the prices charged for medical services will have both allocative and distributional effects: demand will fall for a service whose price is increased, and users of this service will experience a fall in their real income, either by having to pay more for it or by failing to benefit from the medical service if they can no longer afford to purchase it.

5.4 Conclusion

This section has examined the First and Second Welfare Theorems which summarize the close connection between competitive equilibrium and Pareto efficiency. In spite of these theoretical results, we have found that there are some welfare arguments for government intervention in the presence of externalities. In addition, in a second-best world there are arguments for government policy to balance out the various distortions in the marginal conditions for Pareto efficiency and so try to make markets work more efficiently than they can unaided. On the other hand, these welfare arguments raise difficult issues about the knowledge and skill available to governments. We also saw that the separation between efficiency and distribution implied by the Pareto criterion is not always possible in practice and that once distributional objectives are taken into account, an efficient outcome may not always be the most desirable one.

6 Conclusion

This chapter has analysed two different versions of the model of competitive general equilibrium, and has examined the argument that competitive outcomes are Pareto efficient. The chapter has shown that, although the notion of competition as an 'invisible hand' has an intuitive appeal, economic models that analyse the way competition works are complex and highly abstract. These models are useful in showing precisely the assumptions that are required for competition to function, but their significance for contentious policy debates is double-edged. The models have been used both to argue for decentralized policies of non-intervention, as well as for more interventionist policies ranging from socialist central planning in the 1930s to social-democratic tax/subsidy policies that have resurfaced in recent years in connection with 'green' issues, but which have a longer history in connection with welfare policies of income redistribution and the provision of health and education services. The moral, if there is one, is that economic models, by themselves, rarely provide definitive answers to social and political questions, although they are sometimes claimed to do so in public debates.

Answers to exercises

Exercise 18.1

After the first price of 120, excess demand is negative so the price is reduced to 70. However, a price of 70 leads to positive excess demand, so the price is

Figure 18.18 Excess demand as revealed by a Walrasian process of price adjustment

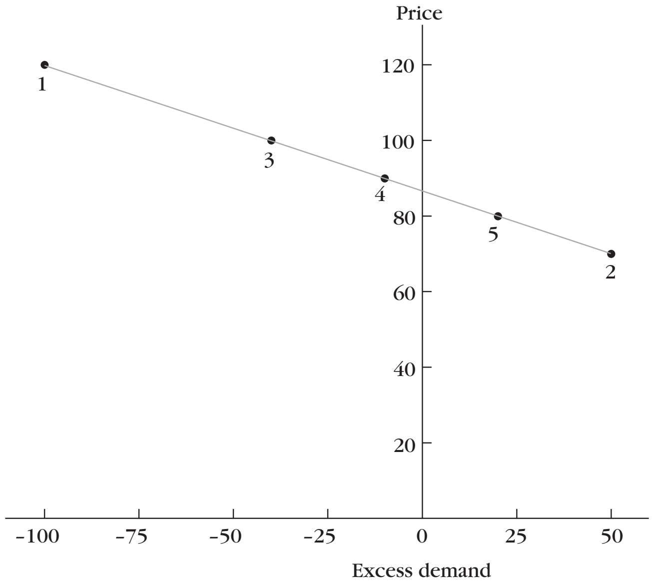
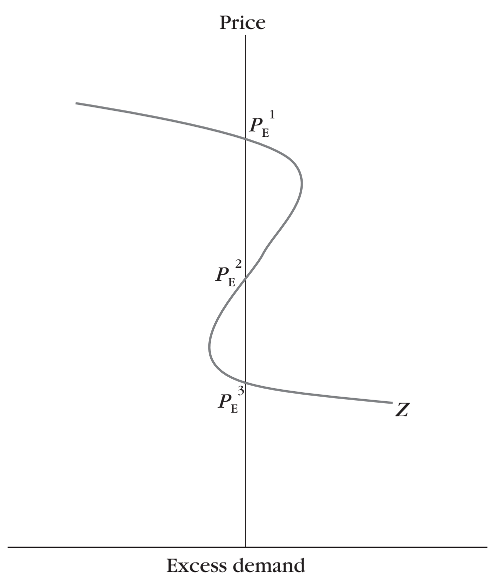


Figure 18.19 The excess demand curve for a Giffen good



raised, though not as high as before, to 100. This still leads to negative excess demand, so the price is reduced to 90. This still leads to negative excess demand, so the price is cut again to 80. Now excess demand is positive, so the price needs to rise to 85 (say). From the information given so far we can plot some points on an excess demand function, as in Figure 18.18.

From Figure 18.18 it can be seen that the equilibrium price should lie between 80 and 90.

Exercise 18.2

Figure 18.19 shows the excess demand curve for this good. There are three equilibrium prices: P_E^1 and P_E^3 are stable and P_E^2 is unstable.

Exercise 18.3

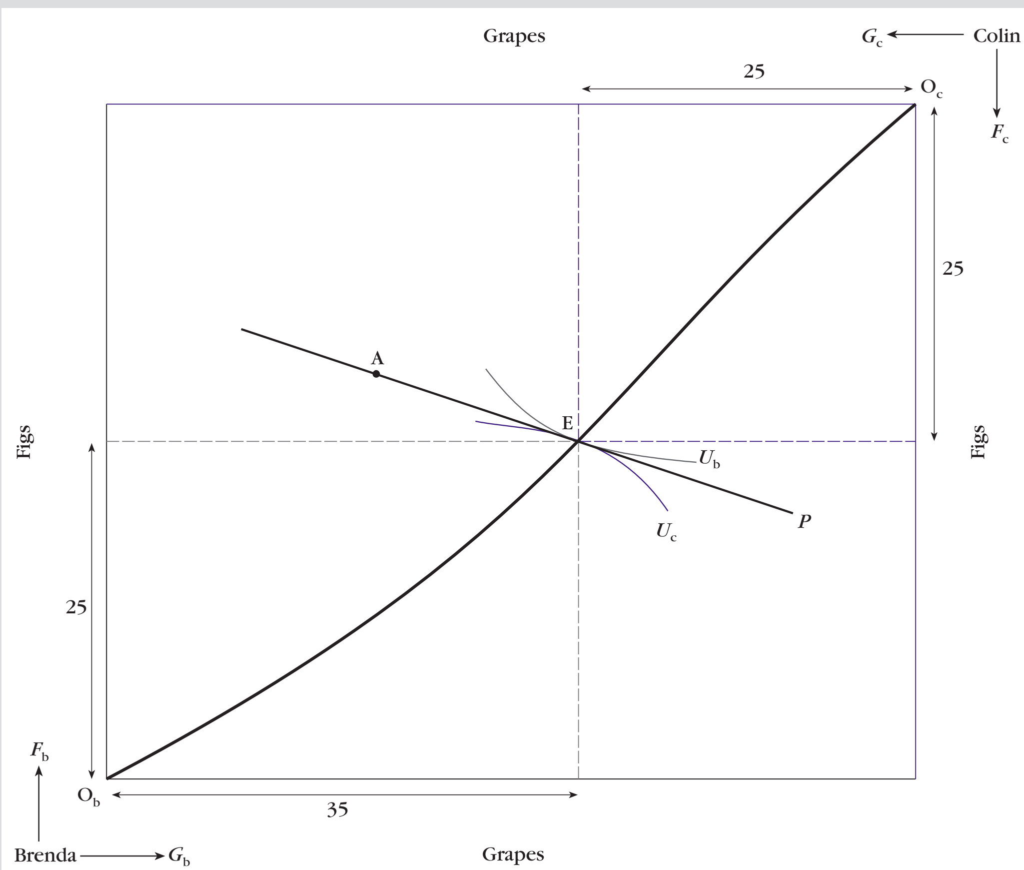
The initial allocation is shown at point A.

1 Colin's equilibrium consumption bundle is 25 kilos of figs and 25 kilos of grapes.
2 Brenda trades 5 kilos of figs for 15 kilos of grapes and Colin trades 15 kilos of grapes for 5 kilos of figs.
3 The price ratio $\frac{P_G}{P_F} = \frac{1}{3}$
4 The Edgeworth box diagram is shown in Figure 18.20.

Exercise 18.4

If the price of grapes rises relative to that of figs, more figs are traded for each kilo of grapes and the price line pivots in a clockwise direction.

Figure 18.20 A different competitive equilibrium



Exercise 18.5

At E_3 more figs are traded for each kilo of grapes than at E_1. This means that the price of grapes relative to figs is higher at E_3 than at E_1, so $MRS_{G,F}$ is greater at E_3 than E_1.

Exercise 18.6

If the equilibrium price of grapes in terms of figs is higher than shown in Figure 18.16, this implies that the equilibrium output mix is at a point on the PPF which is further to the right since the price line is tangent to a steeper portion of the PPF. This output mix contains fewer figs and more grapes. In this situation, grapes are a more highly valued commodity in relation to figs, and so the consumers' MRS of grapes for figs is also higher.