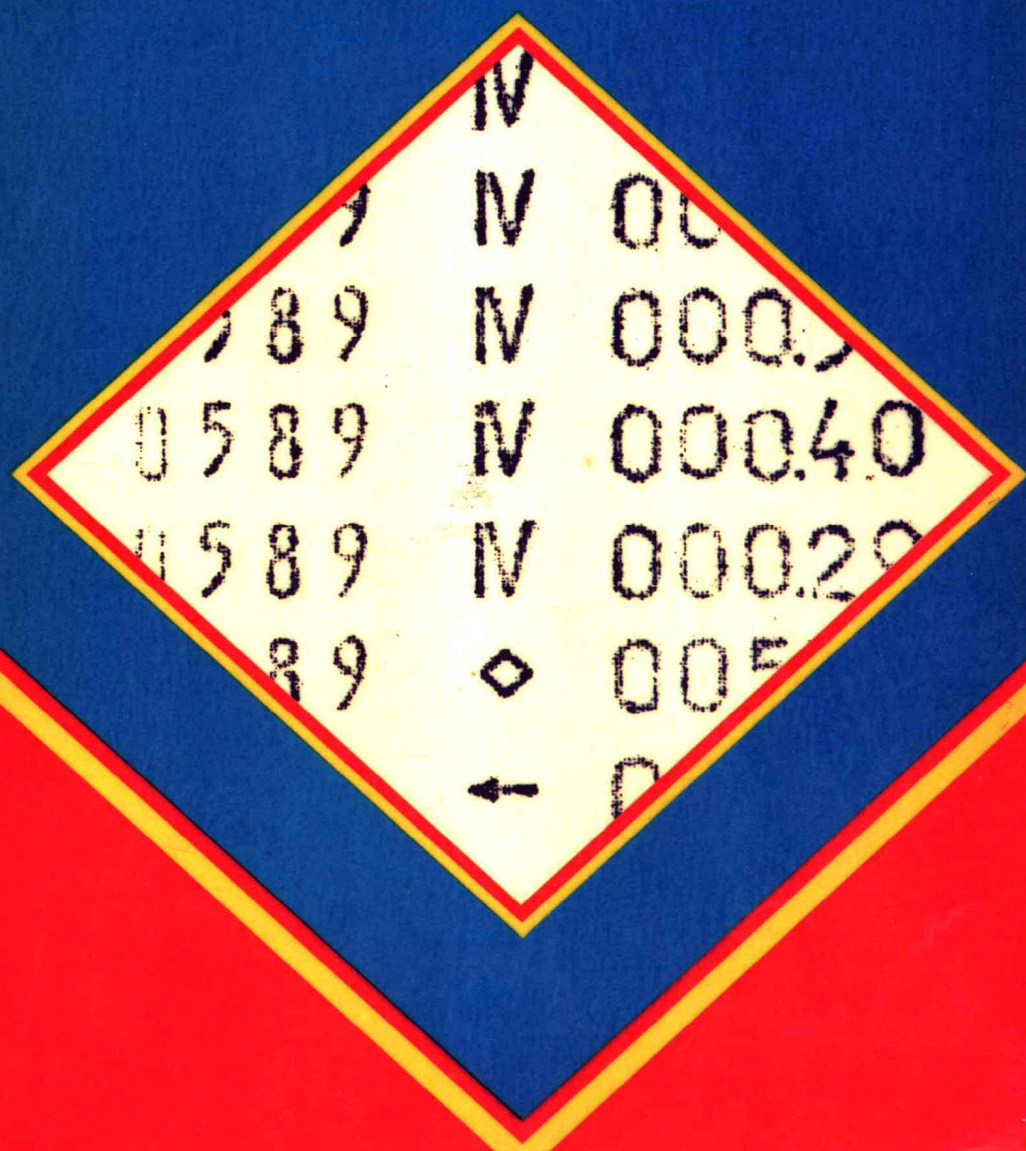


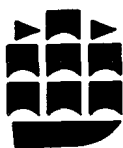
MICROECONOMICS

H Gravelle & R Rees



Microeconomics

Hugh Gravelle and Ray Rees



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Preface

This textbook in the theory of microeconomics has been written for three kinds of reader. First, for the student who has completed an *introductory course in economics* at about the first-year undergraduate level and who is now embarking upon a more specialized course in microeconomic theory. The core of this book is an exposition of the topics he will need to cover at the level appropriate for an economics specialist. In this exposition we have made liberal use of a fairly restricted set of mathematical methods. The following can therefore be thought of as prerequisites:

1. The idea of a set and set inclusion; union, intersection and partitions of sets.
2. The meaning of necessary and sufficient conditions and of \Rightarrow and \Leftrightarrow notations.
3. Vectors as arrays of numbers and their association with points in the appropriate coordinate space; addition, subtraction, and inner products of vectors; convex combinations of vectors.
4. Functions.
5. Limits of sequences and continuity of functions.
6. Differentiation of functions of $n \geq 1$ variables.
7. Unconstrained maximization and minimization of functions of $n \geq 1$ variables.

These topics are usually covered in introductory 'maths for economists' courses and several excellent textbooks exist which cover the material. No particular facility with these mathematical prerequisites is assumed. This is something which itself should develop as the reader works carefully through the book.

Because methods of constrained maximization are the foundation for most of microeconomics at this level, Chapter 2 should be worked through at some time. This chapter tries to give an elementary exposition of optimization theory which, though requiring no previous knowledge other than that contained in the prerequisites just described, will help the reader to a better understanding of the subsequent analysis. Where further

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mathematical ideas are required, such as those of mappings, fixed points and distance functions, they are covered in appendices to the chapters where they are applied.

On each major topic – the theories of the consumer and the firm, competitive and non-competitive markets, general equilibrium and welfare economics – there are chapters or sections of chapters which extend the basic material in a way we hope will be useful for the second kind of reader, the final year undergraduate economist. Here we have sought to provide expositions of such topics as the ‘characteristics’ approach to consumer theory, the theory of time allocation, search theory, non-profit maximizing theories of the firm, market failure and the second best, and the theory of choice under uncertainty. Our intention was to provide concise but reasonably comprehensive treatments of these topics, which could then be filled out by journal readings and applications to problems. This material has been used by us and our colleagues over the past few years on third-year courses in advanced economic theory, public sector economics, mathematical economics and the theory of business decisions. The more difficult of this material is indicated by an asterisk on the title of the chapter or section in which it is presented. The reader is advised to cover the unasterisked core material thoroughly before going on to the asterisked sections.

Finally, we hope this book will prove useful to the graduate student just embarking on a ‘taught master’s’ course, partly as a means of revision and partly as an introduction to some of the topics he will later cover with greater rigour and depth. It is mainly to this reader that the chapters on general equilibrium theory and exchange under uncertainty, as well as the later sections of several other chapters, are directed.

Broadly speaking, we hope that the student could take up this book when he has completed his studies at the introductory level and will find it a useful basis for his work in microeconomics throughout and possibly beyond his time as an undergraduate.

In writing this book we had two aims: to help the student to a good understanding of the nature and purpose of microeconomic theories and models and the way they all fit together; and to develop the basic tools and concepts of analysis with as much clarity and rigour as is possible at this level. We have tried to avoid what we regard as the two undesirable extremes: a treatment which emphasises tools and techniques without consideration of their underlying purpose and rationale; and a description of microeconomics which leaves the student without a firm grasp of methods of analysis with which he can then solve problems of application.

The exercises at the end of each section should be regarded as an integral part of the book. They are of two kinds: short sharp questions designed to test the reader’s understanding of specific points, often by asking him to explain the consequences of changing the assumptions (which has the further advantage of saving space in the text); and the ‘starred’ questions which might well form the subjects (as they have in our own teaching) of

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small-group tutorial sessions and written assignments. These latter questions are starred not only because they may be intrinsically more difficult but also because they will usually require a little effort from the student and some discussion with the teacher. Further reading may also often be necessary for which the references at the end of each chapter give a preliminary guide.

For reading and commenting on various parts of various drafts of this book and/or for helpful discussions of many points, we would like to thank Bernard Corry, Mike Danes, Eli Katz, Clive Southey, Francis Tapon, Alf Vanags and Bill Wells. Ian Walker read through the entire manuscript and made many helpful comments and suggestions. The errors and solecisms which remain are no fault of anyone but ourselves. David Pearce has been an exceptionally tolerant and helpful editor. Special thanks go to Norma Venn, who rescued us from a secretarial impasse and did a splendid job of typing the manuscript, and to Pat Watson, who re-typed large parts of the final draft. We are also grateful to several generations of graduate and undergraduate students at Queen Mary College, London, who helped us develop the material contained in this book, and who latterly have commented on several of the chapters.

H.S.E.G.

R.R.

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Chapter 1

The nature and scope of microeconomics

A. Concepts and methods

Microeconomics consists of a set of theories with one aim: to help us gain an understanding of the process by which scarce resources are allocated among alternative uses in a modern economy, and of the role of prices and markets in this process. In its purest form, it is therefore essentially a philosophical inquiry into the processes of resource allocation. However, with understanding usually comes the ability to predict and to control, and this has been the case in microeconomics. The concepts and relationships economists have developed in their attempt to understand the workings of the economy provide the basis for the design of policies by governments wishing to influence the outcome of this process, or alternatively for a critique of the actions governments might take. Through the development of 'operations research', 'management science' and 'business economics', concepts from microeconomics have been applied to assist rational decision-taking in business, suggesting that Nature does indeed imitate Art.

A good way of providing an introductory overview of microeconomics is to set out its basic elements.

1. *Goods and services or commodities*

These are the central objects of economic activity, since 'economic activity' consists of the production and exchange of commodities. We distinguish commodities from each other by one or more of three characteristics: their *physical* nature and attributes, which determine the way in which they meet the needs of consumers and producers; the *location* at which they are made available; and the *date* at which they are made available. For example, coal and crude oil are physically different commodities, as are the services of a hairdresser and those of an accountant (though in each case, the broad category of resource from which the commodities derive – 'land' in one case and 'labour' in the other – is the same). Equally important is the fact that crude oil in Dubai available

tomorrow is a different commodity from crude oil available tomorrow at a refinery in Western Europe; while coal in London today is a different commodity from coal in London this time next year. The basis of the distinction between commodities is that they cannot be regarded as perfect substitutes in production or consumption – a businessman who goes along to his accountant for advice on a tax problem would not be just as happy to be offered a haircut instead. In most of microeconomics we assume that there is a *finite* set of possible physical bundles of attributes, a finite set of possible locations – we do not regard geographical space as continuous, but rather divided up into small areas – and a finite set of dates. We do not regard calendar time as continuous, but rather divided up into equal discrete time intervals, and moreover not as extending indefinitely far into the future, but instead we assume some definite, though possibly very distant, time horizon. These assumptions ensure that there is a finite number of commodities to be taken into account in our theories. Alternatively, we could assume a *continuum* of commodities: given any one commodity, we could always define another which is as close as we like to the first in attributes, location and time. Moreover this commodity continuum need not be bounded – we could picture commodities as points on a line which stretches to infinity, since we could always define commodities available later in time. The methods of analysis required for an economy with such a commodity continuum differ sharply from those conventionally used in economics. Since the assumptions required to establish a finite set of commodities do not seem to do serious injustice to reality, while considerably simplifying the analysis, we gladly adopt them.

2. Prices

Associated with each commodity is a price, which may be expressed in one of two ways. First, we may choose one commodity in the economy as a *numeraire*, i.e. as the commodity in terms of which all prices are to be expressed. For example, suppose we choose gold. Then the price of each commodity is the number of units of gold which exchange for one unit of that commodity. The price of gold of course is 1. In general, we are free to choose *any* commodity as numeraire, so that prices could just as well be expressed in terms of the number of units of some kind of labour service which exchange for one unit of each other commodity. It might be argued that in reality different commodities may have different degrees of suitability for use in market transactions. Commodities which are not easily divisible, and which are bulky and subject to physical decay, will tend not to be used as a means of payment. However, it is important to note that a numeraire is not intended to represent a *means of exchange*, or ‘money’, in this sense. We are simply using it as a *unit of account*, or a *unit of measurement* for prices in the economy, and *nothing need be implied about the mechanism by which transactions actually take place*. Given the choice of numeraire, prices are effectively *commodity rates of exchange* – they express the rate at which the numeraire exchanges for each other commodity. They have the dimension

(units of the numeraire/units of the commodity). They are therefore not independent of the units in which we measure commodities. For example if we double the unit in which we measure each commodity *except* for the numeraire we would have to double prices (explain why).

The second way in which prices might be expressed does not involve a numeraire. Instead, we suppose there to be some unit of account which is not a quantity of some physical commodity, but an abstract unit used in making bookkeeping entries. If one unit of a commodity is sold, the account is credited with a certain number of units of account, while if the commodity is bought, the same number of units is debited from the account. The price of the commodity is then the number of units debited or credited per unit of the commodity. We find it useful to give this unit of account a name, and so we could call it the £ sterling, or the US \$, for example. If different accounts are kept in different units, then rates of exchange between units of account must be established before transfers from one account to another can be made. Clearly, there is no physical substance corresponding to the unit of account, say the £ sterling. A cheque made out for £ x is an instruction to credit one account and debit another, i.e. to transfer x units of account between accounts. Notes and coin have no intrinsic worth (until perhaps they cease to be used in exchange and acquire intrinsic worth – become commodities themselves – to numismatists), but are simply tokens representing numbers of units of account which are passed around directly and form part (usually a relatively small part) of the credit side of one's accounts.

The somewhat abstract way of expressing prices in terms of units of account therefore corresponds to the way prices are expressed in reality, and has come about because of the development of the modern banking system. There is, however, a straightforward correspondence between prices expressed in terms of units of account and prices expressed as commodity rates of exchange. Thus, suppose we have the set of prices expressed in £ sterling: $p_1, p_2 \dots p_n$. Then, by taking any one such price, say the n th, and forming the n ratios:

$$r_1 = p_1/p_n; \quad r_2 = p_2/p_n; \quad \dots \quad r_n = p_n/p_n = 1 \quad [\text{A.1}]$$

we can interpret each r_j , $j = 1, 2, \dots, n$, as the number of units of commodity n which will exchange for one unit of commodity j , i.e. as commodity rates of exchange with n as the numeraire. Each r_j will be in dimensions (units of good n /units of good j) as we can see from:

$$p_j/p_n = (\text{£/units of good } j \div \text{£/units of good } n) = (\text{units of good } n/\text{units of good } j), \quad j = 1, 2, \dots, n \quad [\text{A.2}]$$

Thus, each r_j in effect tells us the number of units of good n we could buy if we sold a unit of good j and spent the proceeds (p_j units of account) on good n .

3. Markets

The everyday notion of a market is as a specific place where certain types of commodities are bought and sold, for example a cattle market, or a fruit and vegetable market. The concept of a market in economics is, however, much more general than this: a market exists whenever two or more individuals are prepared to enter into an exchange transaction, regardless of time or place. Thus, if two poachers meet in the middle of a forest in the dead of night, one with a catch of salmon and the other with a bag of pheasants, and they decide to negotiate an exchange of fish for fowl, we would say that a market exists. The word 'market' denotes an exchange situation. The central problem in microeconomics is the analysis of how markets operate, since we view the process of resource allocation as a market process – a resource allocation is brought about by the workings of markets. For every commodity, therefore, a market does or will exist, and something which cannot be exchanged upon a market is not, from the point of view of microeconomics, a commodity.

It is important to distinguish between *forward* and *spot* markets. On a spot market, an agreement is made under which delivery of a commodity is completed within the current period; on a forward market, delivery will be made at some future period (some markets may do both, e.g. the market in leasehold accommodation, where what may be sold is a flow of housing services over a possibly very large number of years). We could envisage an economy in which at a given point in time there exists a market for every commodity, which means there is a complete system of spot and forward markets. In such an economy, contracts would be entered into for all future exchanges of commodities as well as for all current exchanges, and so market activity could cease entirely after the first period: the rest of time would be spent simply fulfilling the contracts already concluded. Real economies, of course, do not possess such complete market systems. In any one period, markets exist for delivery of commodities within the period, and some forward markets exist for future delivery, but only relatively few. Hence, at any one time only a relatively small subset of all commodities can be exchanged. We then get a sequence of market systems, one in each period, and exchange activity takes place continually.

This picture of the economy raises a number of interesting questions. How will the outcomes on markets at one period be influenced by expectations about the outcomes in later periods? What will be the relationship, if any, between spot prices of commodities with the same physical attributes but different dates of delivery (e.g. the price of crude oil now and its price this time next year)? Can income (which we can take here to be the proceeds of sales of commodities, including of course labour services) be transferred between time periods and, if so, how? What are the consequences of the fact that the future cannot be known with certainty?

The analysis of the full implications of the view of the economy as a time sequence of market systems is complex and still incomplete. One approach to it (that followed in this book) is to take it in three stages. We

first of all analyse an 'atemporal economy', which could be thought of as an economy existing for just a single time period. We then extend the analysis to an 'intertemporal economy' by considering an economy which will exist over more than one period, but make the assumption of *complete certainty* – all relevant facts about the future are fully known at each point in time. We then take the final step of relaxing this certainty assumption and allowing incomplete information about data relating to the future. It is the analysis of this last kind of economy which is not yet really complete. Interestingly, as long as we assume complete certainty, analysis of an intertemporal economy can be made formally identical to that of the atemporal economy, or, alternatively, identical to that of the kind of economy in which there is a complete system of spot and forward markets existing at any one time (see Ch. 15). At a more advanced level of analysis, it is usual to merge stages one and two, and analyse an economy which could be interpreted either atemporally or intertemporally. Indeed, on certain quite strong assumptions it is possible to do the same for the economy with uncertainty (see Ch. 20). However, in this book we shall take one stage at a time.

4. Economic agents

The basic units of analysis in microeconomics are the individual economic agents or decision-takers (hence the term *microeconomics*), who are usually classified either as *consumers* or *firms*. A consumer is regarded as an individual who may own initially certain stocks of commodities, his 'initial endowment' (counted as part of his wealth), and who has to choose an amount of each commodity (which may of course be zero) to consume. This amount, in conjunction with his initial endowment, will determine the quantity of each commodity he will want to buy or sell on the relevant market. An alternative and less general formulation is to ignore the selling side of the consumer's activities, and assume his initial endowment takes the form of 'income', expressed in units of account or in terms of some numeraire. We then analyse simply his consumption (equals purchasing) decision, assuming also that he holds zero stocks of all the goods he might want to consume. This somewhat restrictive view of the consumer's activities is useful as a way of developing certain tools of analysis, but clearly can only be provisional, if we also want to say anything about the supply of commodities such as labour services.

A firm is also usually regarded as an individual decision-taker, undertaking the production of commodities by combining inputs in technological processes. These inputs will usually themselves be commodities, some of which the firm may own as part of its initial endowment, and some of which it may buy on the relevant markets. In certain cases, however, important inputs may not be commodities, e.g. sunshine in the production of wine. The crux of the distinction between consumers and firms is the nature of their economic activity: consumers buy and sell commodities in order to consume; firms buy inputs and produce commodities in order to sell.

Of course, in reality the counterparts of these theoretical abstractions are more complex. 'Consumer units' are usually groups of two or more people comprising a 'household' and decisions on purchases and sales may well be group decisions. Microeconomics might find itself accused of taking an old-fashioned (even sexist!) view of the world in assuming a single directing intelligence (the head of the household?) as the consumer. The point is of course that we are not trying to model in any detail the organization of a household. Provided that the household acts in its decision-taking in a way which corresponds reasonably closely to certain principles of rationality and consistency, it is *enough for the purposes of our theory* to regard it as a single abstract decision-taker, 'the consumer'. If the organization of the household were shown to be such as to lead to significant departures from these principles of rationality and consistency, and to make our theories seriously misleading when used to explain and predict consumption decisions then we would have to reconstruct our theory of the consumer to take account of this.

In the case of the firm, the empirical counterpart of the theoretical entity may be thought even less like a single individual. Although many owner-controlled or *entrepreneurial* firms exist, economic activity is dominated by large corporations, with complex structures of organization and decision-taking. We can apply the same argument as before: it is a simplifying theoretical abstraction to ignore the organisational characteristics of firms for the purpose of our analysis of the general resource allocation process, which is defensible as long as the explanations and predictions we make about the decisions of firms in this process are not shown to be false by the evidence of firms' behaviour. Much more so than in the case of the household, however, there is a great deal of argument and a little evidence to suggest that certain aspects of the organizational structure of firms *do* lead them to behave differently from the predictions of the theory of the firm as a single decision-taker. Accordingly, we devote a good deal of space in Chapters 6 and 13 below to examine theories which take some account of the organisational characteristics of modern corporations.

The classification of the set of economic agents into consumers and firms reflects the basic distinction between the activities of production and consumption. However, we can quite easily choose a less rigid separation between types of economic agents. For example, if the decision-taker controlling the firm is a person, the *entrepreneur*, then he is necessarily a consumer as well as a producer. We could then construct a theory which has the producer taking consumption decisions as well as production decisions. This leads to a view of an economy as consisting basically of consumers, at least some (and possibly all) of whom have access to production possibilities—they possess the knowledge, skills and initial endowment of commodities (including probably 'capital goods') which enable them to produce as well as exchange. Such an economy is quite amenable to analysis by the methods developed for the economy in which we preserve the distinction between consumers and producers and indeed, if we make the