

Business Economics for Engineers

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McGRAW-HILL Book Company (UK) Limited

London . New York . St Louis . San Francisco . Auckland
Bogotá . Guatemala . Hamburg . Johannesburg . Lisbon
Madrid . Mexico . Montreal . New Delhi . Panama . Paris
San Juan . São Paulo . Singapore . Sydney . Tokyo . Toronto

Published by
McGRAW-HILL Book Company (UK) Limited
MAIDENHEAD · BERKSHIRE · ENGLAND

British Library Cataloguing in Publication Data
Betts, R. J.

Business economics for engineers.

1. Business enterprises—Finance

I. Title

338.7

HF5550

79-41646

ISBN 0-07-084112-8

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12345 JWA 83210

Printed in Great Britain
by J. W. Arrowsmith Ltd., Bristol

Preface

The teaching of economics to students and professional people in fields other than economics itself, business studies, or accounting has usually been pigeon-holed as 'liberal studies'—interesting and broadening but not very relevant to the main subject of study.

This book is predicated on the view that a careful selection made from the large and heterogeneous field called 'economics', and presented with the proper perspective, can be much more than mere liberal studies for those such as engineers and applied scientists whose careers will be spent in a commercial environment. As the first chapter argues more fully, an ability to relate his work to the demands of that commercial environment is an essential component of the engineer's set of skills.

Needless to say, economics is not the only discipline capable of contributing to that ability, and no attempt has been made in this book to stay within the traditional academic demarcations. Where adjacent disciplines such as accounting or statistics can make a worthwhile contribution, they have been used, reflecting the approach developed over several years in teaching engineering and science students at Imperial College and in teaching postgraduate management science students, themselves largely of an engineering and science background.

Even so, no claim can be made to a treatment in great depth of any of the topics covered. Additional readings are, accordingly, provided at the end of each chapter.

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Introduction

A casual examination of any introductory textbook in the general field of economics will be enough to reveal that the field is wide and diverse in terms of both purpose and scope. Anyone who is looking for an introduction to the subject in all its aspects and for its own sake can select from an already wide range of basic texts, any of which will serve him well. A study of economics, however, is not only for those who have such a general interest but also for those who wish to select from the general field in the hope that they will thereby be helped in an understanding of particular kinds of problems. With this in mind, this chapter will set the remainder of the book in the context of its relationship to economics and other related disciplines, and will describe what the reader may reasonably expect to gain from it.

It is important for the newcomer to economics to appreciate that the greater part of the intellectual effort that has gone into it has not had as its prime purpose the development of the means of solving economic problems. Economics has been concerned primarily with understanding, specifically with understanding the processes concerned in the creation and distribution of material wealth. In this respect, the subject is more akin to physics or chemistry than to engineering or medicine. We can, indeed, take this comparison further.

The 'natural' sciences pursue their understanding of phenomena at different levels of aggregation, from sub-particle physics at one extreme to astronomy at the other. Yet these different fields of study are linked; greater understanding at one level is a means of greater understanding at another. In the same way, economics is studied on different levels of aggregation from the behaviour of individual consumers to the processes of international trade and finance. These different levels of aggregation are linked as they are in the natural sciences. However, just as scientists specialize within a continuous field of study, so most economists specialize, usually within one level of aggregation. Correspondingly, economics text books may specialize in one field of study.

Although economics has been concerned in the first instance mainly with understanding, greater understanding creates at least a greater potential for problem-solving and increasingly, in recent years, professional economists have addressed their knowledge to practical problems. These may be problems of the national economy, such as inflation, unemployment or the balance of payments; they may be industrial problems, such as the proper public policy towards the motorcar or shipbuilding industries; or problems in the field of public investment, such as the motorway building programme or the siting of a major airport development. They may also be concerned with the problems arising within individual companies.

Emerging from this discussion is a possible classification of areas of interest within economics. Along one dimension we may have a breakdown corresponding to levels of aggregation. One common distinction is between 'macroeconomics', which studies the behaviour of the national and the international economy, and 'microeconomics', which focuses on particular industries and markets and the companies and buyers of which they are composed.

Along another dimension we might distinguish between 'positive' and 'normative' economics. Positive economics is concerned with explaining economic phenomena, and normative with evaluating them. To put this crudely, positive economics asks how an economic system works, and normative economics asks how well it works and how it might be made to work better.

On such a simple two-way classification this book would be placed somewhere in the normative-microeconomics cell, but the classification is not in itself important.

Purpose and scope of the book

This book is not written for professional economists, not even for economists who are professionally concerned with management problems. Nor is it directed to anyone looking for an introduction to the general study of economics: its scope is much too narrow. It is addressed to those who wish, as an aspect of their training or their professional responsibilities, to have a better understanding of the economic aspects of business or of the economic facets of a

set of problems within business. The typical reader of this book may therefore be an engineer or applied scientist or a student in one of those fields. He may be a business studies or management science student looking for an introduction to some of his subjects before turning to more specialist sources.

A practising engineer, for example, is likely already to be aware of his need for some types of knowledge other than engineering as such and even to have a good understanding of what it is that he needs to know. On the other hand, an engineering or science student, whatever the emphasis that his teachers place on applied problems, may find it difficult to see how an understanding even of only some aspects of economics can be of help to him.

Economics may appear in many curricula as an aspect of 'liberal studies' where it is intended to be of general educational benefit rather than of directly vocational relevance. However, with a proper selection and proper perspective, a knowledge of economics in conjunction with related fields such as accounting, statistics and operational research is an essential part of the practising engineer's professional training. It is essential on two levels.

1. In a market economy, products are designed and produced not because the designer and producer find them intellectually or professionally satisfying but because those in authority in the producing organization judge that they will contribute to a set of objectives of which (at least in the non-government sector) profitability will be an important component.

The creative engineer or research scientist in industry must work with and through others—general managers, accountants, marketing executives, production specialists, shop-floor workers, etc. All these people have their own particular values, sectional interests, perspectives and terminology, but the demands of the commercial environment ultimately condition the role that they all play and how it must be played. The judgements that they make and the attitudes they adopt to what the engineer does or wishes to do will reflect that conditioning. The engineer must appreciate and share this sensitivity to the commercial dimensions of the company's activities if he is to contribute to the full the skills and talents that he has to offer. He must learn to apply the 'right' criteria, and to communicate, challenge and defend according to the right rules and in the right language, and the rules and language will be economic and financial rather than technical. This need arises as often because the engineer has too much potential

power as because he has too little, i.e., not only because he needs to make a case persuasively but because his command of technical detail may allow him to push through a project that is commercially unsound only because non-specialists are too overawed to challenge it until it is explained in terms they can relate to commercial principles.

2. There are some aspects of engineering activity that call directly for economic and financial analysis. These may have to do with the evaluation of development projects, with the selection of alternative technically feasible means of providing some production service, or with the costing of some activity.

It is inevitable that in a book such as this, the second of these two aspects is covered only briefly since each corresponds to a specialist field. Only the major problems and principles can be illustrated.

The first aspect hinges on the choice of perspective. The essential objective is an understanding of the commercial environment of engineering activities, and this is best achieved by a treatment of major areas such as the formulation of company objectives, product policy, demand analysis, costing, pricing and investment appraisal. The perspective is not that of someone whose responsibility it is to manage in these areas, but of someone who wishes to understand what goes on around him in a commercial organization so that he may relate it to his particular role.

Since the economic environment of the company itself conditions that within the company, we take that as our starting point in Chapter 2.

One final note is in order. Throughout this book, the engineer is referred to in the masculine gender. This is for economy only, and indicates no presumption that engineers are, or should be, exclusively males.

The firm and its environment

As the introduction to this book explains, the study of economics has traditionally followed a number of classifications, one of which reflects the level at which economic activities are aggregated.

The focus of this book is, of course, on the level of the firm and in particular on the decisions that have to be made in planning and controlling its operations. It would be quite mistaken, however, to suppose that any firm can be usefully studied in isolation from the larger system of which it is necessarily a part.

This larger system in its turn has two important dimensions, both of which must be considered because both affect profoundly those aspects of the firm that we are seeking to understand.

The first dimension involves the means whereby resources are supplied to the firm and its outputs are accepted by its buyers. The second dimension is the political, legal and social framework within which the activities of all firms are contained. As we will see, the two closely interact and, indeed, in some forms of political organization are almost indistinguishable. The next chapter will examine the institutional framework, while this chapter will be concerned with the first dimension—the firm's economic environment. In later parts of the book we will examine in more practical detail how the firm can manage its interaction with its environment. Here we are concerned with the general nature of those interactions and how they affect the decisions that the firm must make.

The problem of scarcity

If our task here is to understand how the firm relates to its economic environment, then we have to understand, to put it crudely, what the firm is for, i.e., what role the firm plays in the larger system of which it is in this context merely a sub-unit.

To understand this we have in turn to ask what function or

functions that larger system performs. This takes us on to a consideration of some of the fundamental problems of economics and in particular to what has been regarded traditionally as the central problem in the study of economics, i.e., an understanding of the mechanism whereby societies make choices about how they will use their economic resources.

This is a universal problem, because all societies face the problem of 'scarcity' in that they would all like to be able to consume more goods and services than their resources are able to supply. This problem may seem at first sight to be more pressing in some societies than in others; the goods available in aggregate to citizens of the USA might more than satisfy the immediately felt wants of tribesmen in New Guinea. But we must see wants in this context in relative and not absolute terms. The USA faces scarcity in its economic sense because its citizens cannot satisfy all their wants from available resources, however excessive those wants may seem to citizens of materially less well-endowed societies. More of good A will still require that less of goods B and C be consumed, and Americans, as in any society, must have some means of registering their decision that the extra of A is worth the sacrifice that it entails of some of goods B and C.

Every society develops mechanisms for making and enforcing these choices whatever the level of its economic development, and it would certainly appear that for a modern industrialized economy this mechanism will have to be a very complex and detailed one. This is not simply because the number of discernibly different products is so huge, but because so many of the things that are produced are not for the direct satisfaction of personal wants. It is relatively easy to see the want-satisfying role of a breakfast cereal or a pair of shoes or even of a trip to a seaside resort, and therefore easy to imagine the kind of mechanism whereby these 'final goods', as they are known, are called into being. It is less easy to see how those goods that we call 'intermediate goods' (i.e., those that are used to produce other goods), such as fork-lift trucks, sulphuric acid, or the services of management consultants, relate to the satisfaction of society's wants and how their production is regulated by society's choice-making mechanisms.

Nevertheless, as we shall see, goods and services of all types (at least in principle) owe their existence to society's choices about the use of its resources. Let us consider now how those choices are expressed. If we confine ourselves to the developed industrial world, then two main models for this choice-making process can

be recognized. We will consider first the essential features of these models, bearing in mind that our description will initially be considerably simplified and idealized. The reality we will consider later.

Centrally planned systems

In the USSR and countries of Eastern Europe, resources are allocated according to a centrally determined and directed plan. Here, an organ of the state draws up a budget for some future period which sets out in varying degrees of detail how much of the various goods and services will be produced and allocates a corresponding share of the required resources to the establishments that are to produce those goods and services.

One question that arises immediately concerns how the planners are to decide how much of each final good is to be produced. The answer to this arises on three levels. On one level, the planners must observe a set of politically determined priorities which may in turn reflect plans for the long-term development of the economy and society. Priority might be given, e.g., to the development of agriculture, steel or railways. On a second level, the planners may have to respond to pressure exercised through the political process itself. If the plan is unpopular then action may be taken through the ballot box, if the system allows, or more directly if it does not, as when popular unrest in Poland in the early 1970s obliged the authorities to rescind intended increases in the price of food.

On the third level, and on a more regular and systematic basis, the planners may take account of the shortages and surpluses that have arisen during the present planning period and make appropriate adjustments to intended output quantities for the next period. This does not mean, of course, that the pattern of production will eventually reach a stable optimum because the pattern of buyers' preferences, as in any society, will be constantly changing. What it means is that, within the limitations of what is practicable, the pattern of production can be made to respond to the expressed preferences (expressed through what they buy and decline to buy) of the population of buyers.

The market system

In the economies of Western Europe and North America, a different model prevails. This is based on what economists call 'the

market system'. Much more attention will be given here to the market system than to the centrally planned system both because it is more difficult to understand and because it is assumed in the remainder of the book that the market system provides the background to the problems we will be studying. It is worth noting at this stage that, in Britain, the nationalized industries are to be considered part of the market system. ICI and the National Coal Board both operate in markets, even though both they and their markets are widely different in character. Thus 'the market system', at least in this context, is not meant to be synonymous with private enterprise.

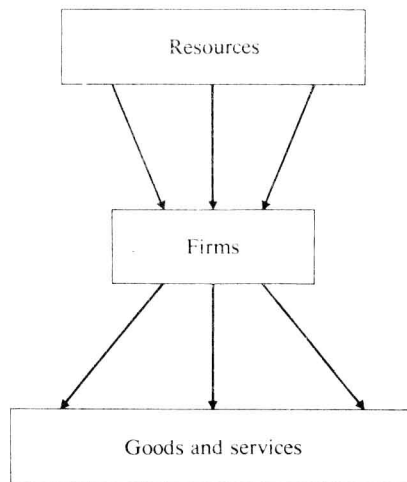


Fig. 2.1 The flow of resources in a market economy

In a market system, decisions as to what will be produced and what will be bought are decentralized, i.e., they are not subject to a conscious overall plan. The market is more in the nature of an automatically adaptive mechanism than a centrally controlled one.

Driven by the search for profit, and acting on signals in the form of price changes, firms channel society's resources into the set of goods and services that society collectively values most highly.

This process is depicted in simple form in Fig. 2.1. A more complex representation showing the corresponding decisions which the firm itself makes is shown later in Fig. 2.3.

Prices in the market system

How does this apparently beneficial process come about? Do firms

perform this role of intermediaries between resources and desired products as an act of public philanthropy?

On the contrary, the classic models of the market system presuppose that each of the participants acts entirely in his own interest. The worker tries to maximize the income he derives from his labour, the owner of the firm tries to maximize his profits, and the consumer—the buyer of final products—tries to maximize the satisfaction (or ‘utility’, to use the technical term) that he derives from the spending of his limited income. All these individual selfish strivings are not merely reconciled but combine to maximize the good of the whole, and the key mechanism in bringing this about is ‘the price system’. Let us see in brief outline then how the price system channels and directs these self-seeking energies at work in the market.

For any good of which the quantity offered for sale is currently less than the amount that buyers wish to buy at the going price, there will be a tendency for the price to rise. Conversely, the price will tend to fall of any good of which more is currently offered for sale than buyers wish to buy at the current price. If nothing else changes, the firms experiencing a price increase will find it profitable to increase their output level (i.e., the quantity they offer for sale) and those experiencing a price reduction will find it profitable to reduce the quantity they offer for sale. This is, of course, precisely what the community would wish them to do, because more resources will then flow into those goods of which the community wants more than is currently offered, and fewer resources will flow into the production of those goods of which the community wants less.

For this to happen, the firms that are to increase their output must assert their claims for more resources. This they do not by putting in a request to a central planner, but simply by buying more in the market for the resources that they need. If this causes a net increase in the quantity of those resources demanded by all firms together, which then causes the prices of those resources to rise (as is assumed to be the usual case), then those firms that are best able to pay the higher price will collect the resources. Moreover, those firms that are best able to pay the higher price will be those offering for sale products whose prices are themselves rising, and, as we have seen, those products will be precisely the ones for which the demand currently exceeds the quantity supplied.

Thus, in the competition for scarce resources, the market will

favour those firms whose products represent uses of those resources in ways that are most favoured by the final buyers. They will be able to outbid other firms for extra resources by offering higher wages for labour, higher prices for priority in the delivery of raw materials, higher interest rates for funds, and so on. This they can do because the community of final buyers is prepared to reimburse them through increased prices for the extra supplies of the products they are offering, but is not prepared to reimburse the other firms because, at the moment, they value extra supplies of their products less highly.

This model of the market, then, describes a system in which the community's resources are allocated to the production of the myriad distinguishable goods and services that a modern economy produces, not according to the directives of a central planner, but by a system of prices. These prices act as signals to the enormous number of resource controllers represented in this model by firms. These signals tell them which goods and services it will be profitable to produce more of and which less of. By this mechanism a pattern of required final goods is established. This pattern of final goods is then transposed by the firms into corresponding resource needs, and thus the demand pattern for final goods determines the demand pattern for intermediate goods of all kinds.

What we have described here—the market system—enshrines the principle of 'consumer sovereignty'.

The implications of consumer sovereignty for any firm operating in such a system are clear. In order to survive it must address itself always to the needs of the consumer, the final buyer, so disposing its resources as to be able to offer either desired final goods directly to the consumer, or intermediate goods to other firms in the chain of firms that seeks ultimately to meet the needs of the final consumer.

Efficiency

The model implies more than this, however. The task of the firm is not simply to convert resources into the 'right' set of goods in the 'right' quantities, but also to do so by the economically most efficient methods that technology can provide.

For any given good, the consumer will want to minimize the price he must pay so that he can maximize the total satisfaction he derives from his limited income. Similarly, the buyer of

intermediate goods, the firm, will wish to pay the lowest price it can, given the specification of the items it needs, so that it can minimize its production costs for the required output and thus maximize the profit it can retain from any given level of the income that it derives from what it sells. Furthermore, it must do this not merely by combining in the most efficient way the resources that it uses, but also by its choice of the types of resources to be used. There may be several kinds of raw materials, for example, that are technically capable of providing a certain finished product, but the customer may be totally indifferent to which was used because it makes no difference to what he wishes the product to do for him. Food grown on what would otherwise be prime residential land is likely to taste no better than food grown on remote but equally fertile land. A farmer who attempts to pass on the cost of his residential-quality land in his food prices is likely to be disappointed.

Thus we can see that the market directs custom to those producers who offer the most desired goods produced from the most appropriate resources in the most efficient way. To put this more crudely, firms have to make decisions about what, how much, with what, and how? The market rewards those firms that get the right answers and punishes those that do not.

Competition

The process we have described does not, of course, involve the firm only with its customers and the suppliers of its resources. It involves it also with other firms, in that the market system throws firms into 'competition' with each other. Firms strive to attract to their own products the limited expenditure of potential customers, and in so doing to distract custom from the products of other firms.

One effective way of doing this is to offer products at lower prices; but firms will not want to reduce prices to the point at which their profits, the purpose of all their actions, are actually reduced. Conversely, the firm cannot add to its profit without limit by raising its prices, because it will merely lose custom to other firms. In this way, the process of competition acts as a control on firms, preventing them from meeting their objectives merely by raising prices, and thus channels their energies towards the needs of the buyer. The market thus rewards any firm that is able to use resources more efficiently, thereby lowering its production costs and its prices by allowing that firm to gain custom at the expense of other