Managerial Economics

A game theoretic approach

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The beauty of a book on managerial economics is that it can be used as a way of introducing business and management students to economic concepts as well as providing economics students with a clear grasp of how to use the skills they will need in the world of business.

The concepts of strategy, the underlying motivations of all the agents involved in a particular economic situation, and the interdependence of actions taken by agents are the primary focus of this text, unlike many previous books in the area which have covered strategy and motivation very briefly.

Topics considered include:

- product differentiation and advertising
- price discrimination
- hiring and training workers
- labor–management relations
- international trade

A host of key learning features are employed to add color to the text such as case studies, examples, and exercises. Some of the many specific cases considered include a discussion of how to choose a mobile phone plan, advertising competition in the US beer industry, competition between Internet Service Providers, and incentives in PGA golf tournaments.

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Preface

Business is a game – the greatest game in the world if you know how to play it.

Thomas J. Watson, founder of IBM

This book represents a completely new approach to managerial economics by focusing on two of the major recent advances in economics: game theory and imperfect competition. Game theory is used to highlight the role of strategy in business decisions. Imperfect competition theory is used to explain how strategies interact in modern industries.

- Brings together two of the major recent developments in microeconomics: game theory and imperfect competition.
- Emphasis on strategic interaction between firms and on strategies for managers.
- Key points illustrated throughout the text with the use of business cases.
- Examples bring theory closer to the real world.
- End-of-chapter exercises test grasp of the theory.

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A great many undergraduate and graduate students at Wilfrid Laurier University were exposed to the material in this text at varying levels of sophistication over the years. We're sure that much was learned by all involved, and that this is a better text for the many comments which were received from these students.

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Chapter 1

Introduction

On August 27, 2001, Northwest Airlines, the fourth largest US carrier, announced it was reducing fares on domestic and international flights by as much as 25 percent. For example, the price of a round-trip ticket from Detroit to Paris fell from $679 to $512. Not only were fares reduced, but the normal 21-day advance purchase requirement for the cheap fares was cut to 14 days and tickets purchased over the web were eligible for an additional 5 percent discount. This was obviously a boon to travelers. But imagine what the situation was like at Northwest's main rivals: American Airlines, United Airlines, and Delta Air Lines. The cut in fares was significant and Northwest had advertised that it was going to last for at least four months. The other airlines had to react quickly or risk losing business to Northwest.[1] Given the slim profit margins enjoyed by airlines in 2001, it's probably not overstating the case too much to say that a quick and sensible reaction to Northwest's fare-cutting was vital to the profitability of the other airlines.

Moreover, imagine the situation at Northwest when someone first came up with the idea of a fare cut. One of their main concerns would have been: how are the other airlines going to react? Because Northwest's managers are well aware that the other airlines are operating on the brink of profitability, they must have expected that American, United, and Delta were going to react to the fare reductions offered by Northwest. Thus, when deciding to cut fares, Northwest's managers also must have taken into consideration how rival airlines would react.

There is nothing particularly special about this example. It merely serves to illustrate a central theme of this book: planning ahead and anticipating how rivals might react – in other words *strategy* – is a vital component of business. Anyone who plays a sport or takes part in a competition intuitively knows strategy is important. Business is no different. How firms react to things their rivals do is a critical part of decision-making within any firm.

A more common-place example takes place in almost every major city on every continent several times a year: gasoline price wars. If you drive a car, you will be especially aware of the price of gasoline and you will have noticed how the price fluctuates from one week to the next. For example, in Sydney, Australia, the price of petrol may vary by up to 20 percent in any given month. It is unlikely that the underlying cost of drilling, transporting, refining, and distributing the product varies by anything like as much as 20 percent a month. The price changes are much more likely to be the result of competition between firms for market share.

But the same underlying forces are at work here as in the air fares example. Each time a firm decides to cut (or raise) its price, it has to take into account how its competitors are going to react. In other words, firms have to take into account how their competitors are going to react to their decisions, and, as a result, firms have to come up with ways of dealing with their competitors' reaction. Put another way: strategy is vital to firms in a competitive business environment.

Both examples presented so far have been about the strategic aspects of pricing. But strategic issues are not confined to decisions about prices. Advertising is used heavily in some industries, especially beer and detergent retailing. We shall see that advertising plays a strategic role in positioning a firm's product relative to rival products. Investment, too, has a strategic element. Toyota Canada recently completed construction on a C$500 million expansion to its Cambridge, Ontario, factory where the Corolla model is produced. This signals to Toyota's competitors that the firm is committed to producing more Canadian-built cars in the foreseeable future, which has implications for pricing and production levels for any firm that produces a product to rival the Toyota Corolla. Mergers and acquisitions have a strategic element as well, as do research and development. All these strategic issues are discussed in various chapters of this book.

1.1 The use of game theory

Any student of economics knows about the demand and supply model. This simple yet remarkably powerful set of tools describes how markets made up of participants acting purely in their own self interest determine overall prices and production levels. On the demand side of the market, *consumers* make decisions about how to allocate a fixed set of resources to consume goods and services to make themselves as well off as possible. On the supply side of the market, *firms* produce goods and services. Firms are assumed to minimize costs and maximize profits, given the structure of competition. The simplest markets describe firms with no market power (*perfect competition*) or one firm with complete market power (*monopoly*).

But very few firms fit this description of the supply side of the market. It is certainly not the case that Northwest Airlines or United Airlines, Shell or BP, or Toyota or General Motors operate in a market where they have either no market power or complete market power. If we want to describe how decisions made by managers to maximize profits or minimize costs in any of these companies are made, we need to expand our demand and supply model to allow us to consider the strategic effect that decisions made by managers have on the market. The missing element from the simple demand and supply model is the fact that what a manager in one firm does will affect the behavior of other managers in the same market. All managers know this. Managers at Northwest know that managers at United and other airlines will respond to their pricing strategy, and an important part of their job is understanding how United will respond to their pricing strategy.

We have argued that strategy is at the center of important business decisions. Now you might think that there are probably as many strategies as there are business situations. This, after all, is the implicit view of case study analysis employed by many business schools. A case study is deliberately anecdotal: cases tell a story, and every story is different. Since every story is different, it might seem very difficult to come up with any

general system of analyzing business situations.

But this is precisely what we will attempt to accomplish through the use of *game theory*, the mathematical science of conflict and cooperation. We will show that many business situations can be deconstructed to a few basic conditions that can be systematically analyzed. We will also see how it is possible to break down strategy into component parts and analyze the role played by each part. Thus, through game theory we will develop a general approach to understanding what strategy is and how choices of strategy effect the outcome of certain situations. Theoretical analysis is all very well in the classroom, but it will never completely take the place of experience. That is why each chapter in the book contains several cases to illustrate and expand on the theoretical material and to tie it in to the real world.

1.2 Traditional managerial economics

What is so special about our approach to managerial economics? The answer is simple: the focus on strategy. Traditionally, managerial economics has simply been treated as intermediate microeconomics adapted for business students. This approach does not take into account a major development in economics that has taken place in the last 20 years: the use of game theory.

Ignoring game theory in economics is a bit like analyzing a successful professional sports team and focusing on the physical fitness of the athletes. Certainly, physical fitness is an important element of success in sport. But in the modern era where each team has the ability to ensure all its players are at the peak of their physical condition, physical fitness surely is not the key to the difference between winning and losing. Successful teams are those that have the best strategies, whether it be a strategy for getting players, a strategy for trading players, or strategy (tactics) employed during the game. Sir Alex Ferguson of Manchester United and Fabio Capello of AS Roma don't command the highest salaries because they know how to get their soccer players into shape. They are well paid because their strategies for success have been shown to work.

1.3 Overview of the book

This book is divided into three parts: basic theory, applications of game theory to interactions *between* firms, and applications of game theory to interactions *within* the firm. The first part, comprising Chapters 1–4, covers the basic economic tools of the firm. The second part, comprising Chapters 5–12, introduces game theory, which is our basic tool for analyzing strategic behavior, and applications of the tools to strategic interaction between firms. The third part of the book, comprising Chapters 13–16, analyzes strategic interaction within a firm.

In Chapter 2, we step back from the manager's role at the firm and examine the question of why firms exist in the first place. Obviously, if we have no idea why firms exist it will be difficult to figure out what the firm is supposed to do and, therefore, impossible to figure out what the manager is supposed to do. By analyzing the main reasons why firms exist we can begin to think about what sorts of problems the manager is likely to face and the strategies that are likely to come into play.

Chapter 3 serves two purposes. First, to provide some basic tools that will be used in the book. Second, to serve as a brief review of introductory economics and re-acquaint readers with terms that will be used in the

book. The chapter is one of the few parts of the book that looks like a conventional managerial economics text. Here we analyze the two extreme competitive situations a firm can find itself in: a very large number of rivals (perfect competition) and no rivals (monopoly). These polar opposite cases are useful for introducing terminology about firms that will be used in the book. They are also useful because they represent cases where strategy plays a relatively minor role, meaning we can focus on the more mundane aspects of the firm's operation.

Chapter 4 continues with the analysis of a monopoly firm in order to introduce the notion of price discrimination. In particular, we look at various pricing methods that firms may use in order to squeeze more revenue from their customers. The many clever pricing practices that firms use are discussed here.

Chapter 5 introduces game theory. Here we define what is meant by a "game," what is meant by "strategy," and so on. We also introduce various types of games that will appear, in different contexts, throughout the book. This chapter is the core building block for much of the material that follows in the book.

Chapter 6 contains our first analysis of strategy in a business setting. We examine the relatively straightforward case of an industry that contains two firms. Here we begin to stretch our analysis beyond the two extremes of market structure by examining a special case where there are only two firms in an industry, which is called a duopoly. The chapter analyzes strategies of the firms in two cases: determining what price to charge, and determining how much output to produce. Thus, Chapter 6 presents the first concrete application of game theory.

Chapter 7 examines the issues surrounding product positioning. Suppose a firm is considering entering a market which is new to the firm. Should it design its new product to compete directly with existing products, or could profits be maximized by positioning the new product so that consumers view it as being distinct and different from those already available in the market? The strategic response from rival firms will be different in each case, but can be anticipated by a manager.

Chapter 8 discusses the role of advertising. With the large number of consumer goods available, and with new goods being introduced all the time, advertising plays an important role in informing consumers about the characteristics of a firm's products. But there is also a strategic role played by advertising. A manager may be able to increase demand for the firm's products by increasing advertising expenditures, thereby changing the perception of consumers. But increases in advertising expenditures are costly, so the positive effects of advertising on demand must balance the negative effects on cost. In Chapter 8, we consider the ways in which advertising can affect the structure of competition in a market and how advertising can be used to affect market demand and profits.

Chapter 9 looks at the role of information. Firms sometimes cannot be sure about the characteristics of their customers and this information might be extremely important. For example, a major problem faced by insurance companies is the possibility that too many of their customers end up to be bad risks. But there are ways insurance firms can design policies in order to minimize the risk of this happening. On the other side of the coin, consumers may not be certain about the characteristics of the firm they are thinking about buying from. Again, information on, say, the reliability of a firm's products,

might be very important to the prospective buyer. We will discuss ways firms can use to convince consumers that they are worth buying from.

At any point in time, a firm earning high profits must face the potential threat of entry by other firms seeking to capture some of these profits. In Chapter 10, we analyze how a firm might respond to the threat of entry by other firms. Might the firms want to deter entry, or would the firm be better off by accommodating entry by other firms and securing its market position? On the other hand, what market conditions might lead a firm to enter a market where there exists a well-defined structure of competition?

Most businesses resent government interference. But there are compelling reasons in favor of government regulation, which is discussed in Chapter 11. There, we look at the basic rationale for government regulation. We discuss issues of regulation that arise in monopolies, intellectual property, unfair business practices, and the environment.

Chapter 12 turns our attention away from the workings of firms in a single country and looks at the wider implications of increased global trade. We briefly examine the arguments for and against free trade. We then look at the recent formation of the World Trade Organization (WTO) and its implications for firms. There is a case study of a trade dispute between Australia and the United States over automobile parts.

The last part of the book focuses on strategic issues that arise within the firm itself. Chapter 13 looks at the multidivisional firm. Firms with divisions producing rival products and firms with divisions that produce goods or services used by other divisions within the firm must be careful that incentives are structured so that the goal of overall profit maximization at the firm is accomplished. One of the key issues in the area is that of transfer pricing. In order to maximize overall profits, it is crucial that the prices placed on transactions between divisions within the firm are priced correctly.

The last three chapters turn to a central problem within the firm: the management of human resources. Chapter 14 covers the basic model of a perfectly competitive labor market. This is useful for introducing things like the basic hiring rule that firms will follow and the way labor markets work to determine the wages firms have to pay.

But, just like the standard model was found inadequate in explaining most interactions in the product market, the standard model is not really an accurate description of hiring and compensation practices at modern corporations. The key issue is how to motivate employees to give the optimal amount of effort in their jobs when observing the employees actions might be difficult and costly. Chapter 15 looks at how firms structure human resource policies so as to get the right amount of work from their employees at minimum cost. We also discuss executive and management compensation schemes.[2]

Chapter 16 looks at the issues that arise when a firm's workers belong to a union. It contains a brief comparison of the three kinds of industrial relations system found in developed economies. The chapter goes on to discuss the theory of wage bargaining, union power, strikes, and the effects of unions on firms.

1.4 Partial equilibrium and general equilibrium

Before we get to our analysis of competition and monopoly we need to make a final point. A national economy is made up of thousands of firms and millions of consumers. In some

small way, the actions of each firm or consumer have an impact on all the other firms and consumers.

For example, when Northwest Airlines changes its fares, some consumers will change their travel plans. Obviously, Northwest is hoping that a lot of people who would not otherwise have flown with them will now decide to take a trip to visit family or friends. And this will certainly happen to some degree. The consumers who decide to take trips will change how they spend the rest of their income. Perhaps by taking a trip they will postpone buying a new car, or a new washing machine, or maybe they will just not go out to restaurants for a month or two. Each decision has repercussions for firms in the economy. Car sales might drop off, which has an impact on new-car dealers and on car producers. Sales of washing machines might fall, which affects department stores and producers of appliances. Restaurants will be less busy, and so on. As a result, restaurants, retailers, and goods-producing firms might cut back the hours of their employees. In turn, these workers will adjust their spending decisions, which has further implications for other firms and people in the economy.

What we have just described is the behavior of an economy in *general equilibrium*. A change in the behavior of one market in an economy will generally have impacts in markets throughout the whole economy. Sometimes these effects will be very small. Nevertheless it is important to acknowledge that these inter-market effects are present, and may be significant.

By and large, we will concentrate on the relation between firms and their immediate competitors. In the language of economics, we say that the analysis is *partial equilibrium* in nature. We will concentrate on the effects of a manager's strategic decision-making problem only on the market in which the manager operates. Northwest may drop its price on air travel, and this may cause such an increase in demand for air travel that local travel agents find they have to hire more people to handle the phones. The manager at Northwest is concerned only with the effect that the pricing strategy has on the firm's market, and does not take into account the effect on the market for travel agents. Partial equilibrium considers the determination of equilibrium in one single market at a time.

1.5 The role of the consumer

This book is about the behavior of managers running firms. Basically, firms produce goods or services to be sold to consumers. In the language of economics, firms *supply* goods or services that consumers *demand*. The exchange of goods or services takes place in a *market*. By and large, this book will completely ignore the role played by consumers in the market. We will simply summarize the behavior of consumers with a demand curve, which we will assume accurately represents the preferences of all consumers interested in buying a specific good or service. Mathematically, the demand curve is written:

$$q = D(p)$$

where q stands for the amount of the good or service that consumers demand and p stands for the price. Sometimes it is more convenient to express the demand equation with price on the left-hand side, in which case we have the inverse demand function, which is written:

$$p = P(q)$$

Often we will work with linear demand curves which have the basic form $q = a - bp$. Solving for p we have $p = (a/b) - (1/b)q$, which is the inverse demand curve.

An important concept related to a demand curve is the *price elasticity of demand*. The price elasticity, as it is often called for short, measures how responsive is quantity demanded to price changes. The price elasticity for a good or service is:

$$\varepsilon = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}} \qquad (1.1)$$

We shall use the symbol ε to stand for price elasticity throughout the book. In calculus, the price elasticity formula is:[3]

$$\varepsilon = -\frac{dq/q}{dp/p}$$

Why is there a minus sign here? Since the demand curve is downward sloping, an increase in price will result in a decrease in quantity demanded. In other words, if the denominator is positive, then the numerator will be negative, implying the ratio is negative. The convention is to report the price elasticity as a positive number, so the ratio is multiplied by minus one.

Another way of writing the price elasticity equation is:

$$\varepsilon = -\left(\frac{dq}{dp}\right)\frac{p}{q} = -\left(\frac{dp}{dq}\right)^{-1}\frac{p}{q}$$

The first equality shows that the price elasticity for a given value of p and q can be calculated as the derivative of the demand function times the ratio of p and q. The second equality shows that the elasticity can also be calculated as one over the slope of the inverse demand function times the ratio of p and q. If $\varepsilon < 1$, demand is *inelastic*, i.e. relatively unresponsive to price changes. If $\varepsilon > 1$, demand is *elastic*, i.e. relatively responsive to price changes.

Example

Suppose the demand function is $q = a - bp$, for $a > 0$ and $b > 0$. Then $dq/dp = -b$ and $\varepsilon = -(-bp/q) = bp/q$ for any point (q, p). Since $q = a - bp$, we could also write $\varepsilon = bp/(a - bp)$.

Summary

- A list of actions a firm may undertake to approach a market, or to react to actions by other firms in the same market is collectively referred to as the firm's strategy. Almost any business situation from output levels, to pricing, to marketing, to research, and so on, has a strategic element.
- Demand and supply analysis ignores strategy altogether, because in a competitive market prices and output decisions are made by the market and not by any individual firm.
- Traditional managerial economics largely ignores the role of strategy and the main tool economics has developed to deal with strategy, namely game theory. This book stresses strategic aspects of decision-making within the firm, using game theory as its primary tool of analysis.
- General equilibrium analysis considers the effect a change in one market has on every other market in the economy. Partial equilibrium analysis focuses on one market at a time, ignoring the spillover effects in other markets.