Preface: An Overview of the text and this Course

I. Organization of the Class

The class website is the main source of the class materials, which is for the most part a draft of a textbook in advanced microeconomics. The website also includes links to classic articles that created new strands of microeconomics during the twentieth century. The class website is a web-syllabus (and a pdf syllabus) that includes the approximate timing of all the chapters covered in the class and homework assignments. It also includes "due dates" for the 8 homework assignments that are each due roughly a week after a block of material is finished in class. They'll be graded and returned approximately a week after their due dates. No homeworks are accepted after their due dates without a note from a doctor or hospital. The assignments are all online and so can be done anywhere in the world that has internet access.

The website will also include links to prerecorded class lectures if Prof Congleton is out of town attending conferences. Your grades are based on the 8 homework assignments, 2 exams, and a final paper, plus a bit of extra credit for helpful class participation.

The course is based on the web notes, but the class lectures are not simply me reading my lecture notes. The class lectures are shorter somewhat more focused versions of the notes with more examples. The lectures are also an excellent time to ask questions. The optimal textbooks provide alternative ways to explain most of the material covered, and also extensions beyond the scope of the course. All questions in class are welcome—and usually benefit most students in the class! So, please ask questions.

II. Organization of the Textbook (an early draft this semester)

The primary aim of this book is to introduce students to some of the economic implications of purposeful decisionmaking. Part I of the book develops the core models of neoclassical economics: modesl of consumer choice, firm output decisions, firm production decisions, and neoclassical price theory. The choice settings that ground those models are all conventional economic ones. Part I also introduces the main mathematical methods used in the course. These include geometry, calculus-based characterizations of utility maximizing and profit maximizing decisions, and the use of the same mathematical methods to undertaken comparative statics. The calculus based models rely upon both concrete and abstract functional forms. The appendix at the end of Chapter 1 provides an overview of the mathematical terms and methods used throughout this text.

Part II of the book explores various extensions of the core model. It includes chapters on intertemporal decision making, decisionmaking in risky settings, decisions under uncertainty, entrepreneurship, firms as organizations, goods as clusters of attributes, multiproduct firms, and on the role of information (and expectations) in choice. Some of these topics are rarely discussed in microeconomic textbooks, but nonetheless are important ones for understanding the extent of the networks of exchange, production, and innovation that characterize contemporary markets. (Only a subset of these chapters are covered in this course.) Decision making procedures within firms and among sophisticated traders are quite complex. For example, managers and employees are each delegated non-trivial, but constrained, authority to make various kinds of decisions that affect each firm's costs, outputs, and profits. Each type of relationship inside the firm (owner, manager, employee etc.) can be analyzed using rational choice models. Only if we assume that a firm is well-organized and well-lead, can it be assumed that the "firm" maximizes its profits by producing particular things for sale in particular ways, and selling them at particular prices.

Part III of the book explores the effects of various institutions that are left out of mainstream texts, but that nonetheless have important effects on the extent and scope of market networks. The chapters include models that show how crime and law enforcement affect the extent of markets, how government policy decisions affect markets, and how internalized norms affect patterns of production and consumption in markets—and also the types of laws and regulations adopted by government decisionmakers. In addition, it reviews the primary normative theories used by economists to judge whether particular market outcomes, laws, and regulations are "good" or not, or "desirable" or not. A firm, for example, is a group of individuals who are members of an organization. All organizations have rules that attempt to induce the induvial members to engage in productive activities. And organizations normally operate in an environment in which various laws and regulations are adopted and enforced. To the extent that such rules are internalized, dutiful behavior by the employees of firms and citizenry at large have effects on both rates of return from alternative investment and also on the risks associated with economic activities. Through these and other effects, internalized norms can have significant effects on the extent and nature of market networks.

III. Similarities and Differences Between this Microeconomics Textbook and Others

Microeconomics is based on an approach to social phenomena referred to as methodological individualism. Methodological individualism is an approach to social science that regards all social outcomes to be consequences of individual decisions and thus the best way to understand social phenomena is to understand the individual choice that gave rise to those phenomena. From this perspective, a club, firm, community, market, or government is nothing more—nor less—than a collection of individuals whose choices jointly determine various outcomes. The circumstances of each individual and each decision matters. Thus, characterizing the essential features of relevant choice setting is central to microeconomic analysis. All the models attempt to determines the essential features of a choice setting and use those to develop mathematical models that allow one to explore their main implications for choices and markets.

Most mainstream microeconomic textbooks focus quite narrowly on the theory of price determination. That is to say, they focus on models that help to explain the prices observed in well-functioning commercial societies. The underpinnings of such societies such as relatively honest promise keeping individuals, effective law enforcement, and public policies that do not greatly inhibit market activities are generally neglected. However, such underpinnings cannot be taken for granted. Markets that lack some or all of these features will be less effective as a means of satisfying consumer wants than ones in which such features are ubiquitous. Normally, problems associated with illegal activities, market inhibiting regulation, and corruption are simply ignored—assumed away—in order to focus on how prices emerge in well-functioning commercial societies.

This textbook differs from most such textbooks by considering how such markets operate when these features are absent. This allows micro-economics to at least partly explain why some societies have more productive markets than others. Such differences are completely neglected in most micro-economic textbooks. Although price theory has been the "home territory" of contemporary economics since the marginal revolution of the late nineteenth century, it is not the only important part of that field of study. In the second half of the twentieth century, rational choice models have developed that provide new insights into a variety of economically relevant behaviors and outcomes in Law, Political Science, Sociology, Psychology, and Philosophy. The pioneers of these extensions in most cases were awarded Nobel prizes in economics.

Thus, although many such contributions are left outside of "normal" texts in advanced micro economics—they clearly deserve significant space in any text that claims to review the foundations and major implications of micro-economics.

The text also differs from most mainstream microeconomic textbooks in that it stresses the fact that economists use models—simplified characterizations of both individuals and circumstances—as their basis for making claims about how markets operate. Models are not reality, but highly simplified versions of it Thus, one should not be surprised that they do not fully explain all observed market phenomena. What they attempt to do is to capture as much of the systematic aspects of those phenomena as possible. The models are all subject to a variety of statistical tests, but in no case does one of the models explain everything about any individual or market. Instead, the models reveal tendencies in the choices of individuals and in market outcomes that emerge when individuals are forward looking, generally right about the anticipated consequences associated with their actions, and institutions are broadly supportive of market activities. When these assumptions are realistic, then much about what is predicted about individual behavior and markets will be evident in the data—as has been shown in many statistical and experimental analyses. When these assumptions are unrealistic, the implications of the models developed will be less useful and accurate than when they are.

The text as a whole is intended to be an introduction to microeconomics, rather than a complete in-depth overview of all aspects of that field of research. The optional texts and references at the end of each chapter provide useful supplemental material. Although most of the text is oriented towards models, the modeling is undertaken with relatively few mathematical tools. Most are calculus based. In most chapters the models and their implications are presented (i) geometrically, (2) using concrete functional forms, and (3) using abstract functional forms, with the latter being most general and most often seen in the academic literature. Practice problems are included (on the website) at the end of most chapters along with a few useful references.

IV. Aims of the Text

The entire field of micro-economics is enormous, and no single text can cover everything that might be usefully known by advanced students in economics. More could be said about every topic covered—but by providing a broader review than other books, students will have a broader understanding of the power and limits of microeconomics and be better prepared for further study.

This is not a difficult book for students that understand the geometry of intermediate micro-economics, have mastered the basics of calculus, and who have enough discipline to carefully read the text, think about it critically, and work homework problems on their own. Although the book presumes that students have such abilities, it provides short reviews of most of the "tools" from past training that are drawn on in the text. However, in spite of that review, it will be a challenging book for those who do not understand basic economic models, have never taken derivatives, and lack the discipline and free time to read and think about the subjects covered.

In the end, developing a clear coherent understanding of the choice settings covered in the book is up to the student— they have to take the material seriously and do more than memorize results. Instead, they should attempt understand their logic and limitations, and to incorporate them into their world views. The text, lectures, assignments, and exams can only help get those processes underway. I believe that the current text (and future revision of it) does so better than its alternatives.

Chapter 1: An Introduction to the Use and Usefulness of Models

I. On the Usefulness of Models

All scientific work attempts to determine what is general about the world. To do so, both individual scientists and teams of scientists use combinations of models, logic, and empirical evidence to determine what is (approximately) true. Because the real world is complex and interconnected in many ways, scientists normally abstract from many features of the world and focus on the subset of characteristics and relationships thought to be most important. In other words, they create models of the world that they believe help us to better understand various subsets of the properties of our universe.

Models are models, rather than the universe. They attempt to characterize the effects of the most important determinants of some phenomena of interest to the model builder or group of model builders. As such, they are always open to improvement. If a scientist or group of scientists has correctly determined the "most important" factors, then the model that he or she or they have developed will account for much about the phenomena of interest. It will explain why the phenomena occurs and allow its future (and often past) path to be predicted. A "good" model accounts for much—ideally most—of the phenomena of interest—even though it neglects many factors that may also play a role in determining the actual nature and course of the phenomena of interest.

It is rare for a model to account for everything of interest. For example, theories of gravity attempt to explain why and how objects fall. In many cases, this is fairly easy and models that ignore everything except gravity can explain quite accurately how an object such as a rock falls. However, there are cases in which other factors, such as wind, air resistance, and aerodynamics matter. It is much easier to predict how a rock falls than how a leaf falls. Although both do fall because of gravity, a leaf's path is often quite complex because of wind and its own aerodynamics. The "average" leaf may fall straight down, but leaves will be distributed widely around that spot because of the interactions of air and aerodynamics that basic theories of gravity ignore.

That does not make the simple theory of gravity worthless, it simply means that as a model it does not and cannot account for the path of every object. Fortunately, even models that only partially account for some phenomenon can be very useful. They may account for much of the phenomenon of interest (falling), and they may also provide a basis for developing new theories (ones that include the effects of air and aerodynamics).

Trying to explain the path of a volitional object such as a bird or person is even more challenging. Clearly, more than physics will be required to account for where a bird or person goes after it, he, or she leaves a tree. Birds may fly off to their nests or to continue looking for food. A person may go climb another tree or wander off to explore a mountain or city, or simply return home for lunch. Such paths are influenced by gravity, but gravity has only a trivial effect on those paths. It remains part of the causality behind such phenomena, but no longer accounts for most of them. More sophisticated or perhaps entirely different models are required. Volition itself may need to be modelled as well as biological necessities.

People are more complex and difficult to predict than rocks or birds, but in many cases average or typical actions can be modelled, and useful, if imperfect, predictions made. For example, economics, as a social science, deals with people in particular types of choice settings. Models of their decision making process and circumstances make significant factors more likely to be discovered and average or typical results more likely to be observed.

It turns out that people—at least on average—are influenced by the cost and benefits associated with their actions. Thus, we can predict they will do more of something when its benefits increase or costs decline, and do less of it when its benefits decrease or cost increase. Economic reasoning, thus, focuses a good deal of attention on the factors that determine the costs and benefits of particular types of activities—many of them, but not all, having to do with purchasing, producing, or selling goods and services.

II. The Modelling Methodology and Uncertainties of All Sciences

Active areas of science are "works in progress," although there are theories and facts that most experts believe to be true, scientific progress requires that every theory and every fact is open to challenge and subsequent revision. It is the process of theorizing, testing, and correcting theories that gradually generates scientific progress. Past theories are sometimes discarded as this process goes forth, but more often they are adjusted in various ways to take account of new ideas, data, and results. The latter tends to be true of micro-economics. Although the core results and models have not changed very much since the late nineteenth century, many extension and refinements were adopted throughout the twentieth century—and efforts to develop new extensions and refinements are likely to continue into the foreseeable future..

Theories that have stood the test of time are often taught in school as established facts rather than hypotheses that have withstood many challenges. An example of a theories that most educated persons accept is that all sun rises on Earth are caused by the Earth's daily rotation in combination with light generated by its nearest star—the sun. Since Copernicus in the sixteenth century and Newton and Galileo in the seventeenth century, this explanation for our daily cycle of light and darkness has been the explanation (model) accepted by all educated persons. None the less, our normal English expressions for the point at which the earth spins enough so that the sun becomes visible is called sun rise, rather than sun approach. Our language is still based on the earlier and in a sense more intuitive theory. The exact moment of sunrise or sunset is more difficult to determine. Is it when the sun disappears from view or is it when the transition to darkness is complete. If it is the former, does it matter whether one is on top of a mountain or in a deep valley?

Conversely, we all know that the purchasers of automobiles and houses take account of different characteristics of an automobile when they purchase a car or house, but also we know that all persons take account of "the price of a car." In most cases, it would be more accurate to say that purchasers take account of the price of the collection of attributes that a particular car includes, rather than the price of the average car. Nonetheless, it is often useful to think about the price of an average car, because that reduces the complexity of thinking about markets for automobiles and the average price is often of sufficient interest to be worthy of study. Abstraction often increases our understanding of complex events or activities.

Whether a consumer purchases a car or not, depends on a host of factors, not simply its price. For rational forward-looking consumers, that one's personal savings and ability to borrow may influence that decision. But such resources can also be used to purchase goods other than automobiles, which implies that the one will purchase a car only if its is expected to be more useful, more fun, or more valuable than other uses of his or her wealth. Nonetheless, it can be said that (in most cases) the higher the price of an automobile, the less likely an average consumer is to purchase cars, *other things being equal*.

Good models not only explain relationships and facts that people "know," but also tend to induce experts (scientists) to look for other relationships and facts implied by a theory, many of which have not previously been known, predicted, or imagined. A good theory should explain previously unknown or ignored facts in addition to well-known facts. However, no models can explain all the consequences of a particular action or all the relationships associated with a particular phenomenon.

For example, Newton's theory of gravity says that falling objects accelerate at the same rate on a given planet, and unless acted on by other forces tend to fall straight down. This is true for many objects, but not all, for reasons discussed above. Similarly, there are exceptions from the implications of downward sloping demand curves—even when that theory is correct or reasonably correct on average. For example, consumers who believe that markets are "perfectly efficient" may use price as a proxy for quality and, thus, tend to buy more expensive autos over less expensive autos, because they believe that the more expensive cars are of higher quality—even if they believe the automobiles to be nearly identical. This consumer's hypothesis tends to be true if many other consumers are well-informed and use similar gauges of quality—but not if they are not.

Quality differences matter, although they are often ignored in simple economic models. Demand curves for single goods may "slope downward," but many higher priced goods may be purchased more frequently than less expensive substitutes, because they are regarded to be of better quality (as true of Apple phones relative to many far cheaper Android phones in the US) or expected to last longer (as with Toyotas relative to most other automobiles according to *Consumer Reports*). Note that including the effects of quality on consumer choices can be explained, but doing so requires a more fine-grained and conditional theory than the simpler one taught in principles of economics classes and developed in most mathematical models of consumer choice—including those developed in Part I of this book.

This process of finding relationships or general rules that explain "how the world works" is a complex and time-consuming process. It can be described as a joint exercise in logic (model building), observation (empirical testing), and reflection about the results and implied limits of the model's assumptions. It is a nearly endless cycle of model building (hypothesizing), empirical testing, refinement, retesting, and so, forth (a process that I sometimes call boot strapping).

Through this process our understanding of the world gradually improves and is in a sense perfected. Even after several thousand years of efforts to understand the universe, some aspects of the world and universe are understood far better than others. Thus, some models are better than others—more precise, more encompassing, or more useful. Even somewhat imprecise models (mathematical representation of a principle or relationship) are often very useful. They allow one to discover and understand relationships among phenomena far better than human intuition alone can. And they serve as a source of hypotheses about the world that can be tested and refined.

III. The Presentation and Gradual Refinement of Microeconomic Models

"Model building" always starts with ideas about what is truly important and commonplace about the phenomena of interest. These factors are used in various ways (normally with diagrams or equations) to explain the phenomenon's existence and predict its future course or consequences associated with changes in the choice setting. Once a model has been deemed useful because it provides plausible explanations and has been affirmed by statistical or with other empirical tests, it may be considered to be "true" for most purposes and "standard" forms of the model tend to emerge. For the most part, this book focuses on such "standard" models—although as mentioned above, even "standard" or "mainstream" models may have failed some tests and most have been improved through time.

In most cases, intuition precedes theory. We all have the ability to postulate "if then" hypotheses about the world and to use and internalize them. However, models and their associated implications go beyond intuition by rigorously defining nature of a relationship or fact and their implications. Many of these relationships and implications initially are not intuitively obvious. Such results as one comes to understand them more deeply may in turn inform one's subsequent intuitions about economically relevant choice settings. For example, general equilibrium models were first presented in intuitive ways (by Walras in the late nineteenth century). His ideas were subsequently worked out mathematically using concrete functional forms. Subsequent generalizations of his results were generated using more abstract mathematical formulations. That all markets can clear simultaneously was not intuitively obvious to most persons—including those interested in economics. Real world markets appear to be in constant motion—much of which appears superficially chaotic. However, once that notion became accepted by most economists, the chaos seem less anarchic and more centered about such prices.

Models may also clarify weaknesses and errors in one's assumption about human activities. Does the assumption that markets "clear" really require perfect information or not to be approximately true? Is it really necessary to assume that an "Walrasian auctioneer" exists for market prices to converge toward their equilibrium values? To what extent doe the analysis ignore important institutions that at least partially determine the extent of realizable gains from exchange? And so on…

Both intuitive theories and theories grounded in mathematical models are often clearer in their mathematical expression than in their geometric ones—although that is not always true. Both the assumptions and their implications tend to be sharper and clearer in mathematical models. Nonetheless, our geometric intuition is usually stronger than our algebraic or calculus intuitions, and so we can often "squeeze" more insights from a geometric representation than from the equations that lie behind them. Graphs are thus often used in this book and in technical research papers to illustrate what is going on before developing the equivalent calculus-based models. Moreover, there are some economic ideas that are far easier to explain geometrically with a diagram than with other mathematical tools.

The standard geometric (graphical) models taught in principles of economics and intermediate micro-economics have mathematical foundations, because the math was often worked out before the geometry. This is partly because mathematical models require sharper assumption about goals (utility or profits) and opportunities (budget sets and cost functions) than geometric representations require. That abstractions and generalizations are required to construct mathematical models often induces scholars to focus on the essentials, which in turn often makes relationships clearer.

For example, utility functions are mathematical functions that represent a consumer's happiness or satisfaction as a function of goods purchased and consumed or activities undertaken. Production functions are mathematical functions that represent outputs as functions of the inputs used to produce intermediate and final goods. Both attempt to describe general linkages between choices (to consume or produce) and the objects of choice (useful or pleasant goods and services or inputs that can be used or combined to add value to materials processed or services provided).

Assumptions matter. Students should be alert for both the assumption explicitly made and others not mentioned but implicit in the models developed. The same alertness is useful for understanding the basis and limits of models developed in published research papers. Models that appear to be general are often narrower than they look, because implicit assumptions narrow the applicability of their results. Moreover, creating narrower models often turns out to be necessary or at least convenient when making one's assumptions more "realistic." For example, adding quality variation to goods and taking account of the manner in which quality generates value or utility often is analyzed in models that address only a small subset of goods and types of quality variation. Taking account of time or uncertainty often requires additional simplifying assumptions to make the mathematics tractable—e.g. able to generate reasonably clear implications about their effects.

It also bears noting that the empirical part of economics (econometrics) also has mathematical foundations. Statistical theory was developed using mathematics along with a few assumptions about probability distributions. Econometrics uses various statistical methods to "test" hypotheses generated from economic models. Moreover, nearly all statistical tests assume that you know the right functional form of the models that you estimate and also know the relevant error distributions (normal, etc.). One does no escape from model building when one shifts from theory to empirics. Moreover, most statistical methods assume that one already knows the functional form of the models being estimated.

Not all persons who use econometrics write down the economic models that generate the prediction being tested, but they all make implicit mathematical assumptions about the relationships of interest. They do so, for example, whenever they use linear or log-linear representations as the basis for their estimates (as in regression analysis and generalized least squares). Thus, econometric models and tests all have mathematical foundations—often quite narrow ones—although that is sometimes forgotten by applied econometricians.

IV. A Short History of the Use of Mathematical Models in Social Science

Economics has a long history, it is essentially as old as trade is, because trading always involves coming to terms about how much of this will be traded for how much of that—and theories about a "good deal" or "bad deal" must have emerged at basically the same time. The logic of supply and demand in their own markets would have been "intuitive" to many firm owners for thousands of years before the models were worked out in the nineteenth century.

The written record of theoretical explanations goes at least as far back as Aristotle, who proposed a theory of the origins and property of money that remains largely in place today (as an index and store of value, that can nonetheless decline in value through inflation). He also developed a theory of equilibrium prices that was worked out to illustrate his theory of proportional justice. The first truly encompassing work on economics is that by Adam Smith—the Wealth of Nations, written just before the time of the American Revolutionary War. Smith supported his theories with many illustrations and a significant amount of numerical data. He noted the advantages of specialization, the considerations that tended to determine various prices and exchange rates. He also described how and why prices tended to move toward long run equilibrium values and the factors that might induce them to depart from those values.

The use of mathematics for modelling human behavior arguably started in political science, rather than economics, just before the French Revolution when Condorcet and Borda used rational choice models to analyze the properties of different voting rules. Many of their results are still of interest today. Condorcet's analysis of majority rule identified the ideal of a dominant option (now referred to as a Condorcet winner) that is majority preferred to every other and Borda's suggested alternative for voting (the Borda count method) remains of interest to scholars of voting processes. The economic department has used the Borda count method to select among job candidate finalists for many years. However, very few political scientists adopted their approach until the post war period, and even then only relatively few political scientists did so.

Mathematical models of economic decisionmaking and consequences were developed in the late nineteenth century and extended throughout the twentieth century. Many of the first persons to do so were members of the philosophical school referred to as utilitarians. Their notion of "utility" turned out to be a very useful way of thinking about gains to trade and their insistence that all persons are utility-maximizers turned out to be a very useful basis for modeling economically relevant decision. Their normative perspective was also adopted as the normative strand of economics called welfare economics.

For several decades, this mathematical strand of economic research was a minor part of the overall research program of the group of scholars and practitioners who studied how markets operate, but it gradually became the main method used to understand prices and networks of exchange and production. Prose, geometric representations, and tables of numbers often dominated economic journals until around 1970. In this period, most of the geometry and mathematics covered in mainstream microeconomic text books were worked out.

By the 1970s, models that used calculus (and more advanced mathematics from real number theory) to analyze economic relationships had become the most common methodology for "theory" papers published in leading mainstream economic journals such as the *American Economic Review* (AER), *Quarterly Journal of Economics* (QJE), and *Journal of Political Economy* (JPE). Other more mathematically demanding approaches were often published in specialized journals such as *Econometrica* and the *Journal of Economic Theory* (JET). Very few prose or geometric based theory papers were published in leading economic journals after 1980.

Most mathematical and geometric models imply that results worked out for a particular product or market often generalize to essentially all markets. That is to say, there are commonplace relationships that exist in all markets, and these have commonplace implications about both existing prices, how they change through time, and their effects on behavior. This allows theory results to be applied to any phenomena that resemble a market and the core rational choice models can be applied elsewhere as well. It is for this reason that microeconomics provides a very broad understanding of social phenomena.

Of course, economics would not be a social science if such commonalities did not exist. Without those commonalities, the best that could be accomplished would be a catalog of special case results. This is not to say that such catalogs would not be useful, but it would imply that little about market and other social phenomena could be anticipated using models developed for other purposes.

The mathematization of economic research is one of many reasons for the mathematization of graduate economic programs. Some background in mathematical model building (and it limitations) is necessary if one is to be able to read contemporary research.

The book begins with an overview of some of the main results of neoclassical price theory then examines extensions and other applications of rational choice-based models to political economy, law and economics, and socio-economic topics. There will be a mix of ideas and mathematics in those chapters, rather than just a series of mathematical exercises.

V. Methodological Individualism

What distinguishes microeconomics from macroeconomics is both the widespread use of partial equilibrium models and an approach to social science referred to as **methodological individualism**. It also tends to be less directly public policy oriented than most macroeconomic research tend to be. Methodological individualism regards all social phenomena to be consequences of individual decision making . This includes such phenomena as markets, politics, norms, and social networks. Given this, it argues that must be analyzed in terms of the individuals in the networks, institutions, or societies of interest, and the choices they confront. The latter includes consumer choices, production choices, investment choices, choices of political candidates during elections, decisions to engage in criminal behavior or not, to marry or not, to have children or not, and so forth. This approach maintains that individuals are the prime movers, the choosing agents, through which all social phenomena emerge.

"Networks," "groups," and "societies" are all composed of individuals making independent decisions in particular choice settings. The properties of "networks," "groups," and "societies" emerge from the choices of the individuals in those networks, groups, and societies. In lean models, the decisions reached by individuals are determined jointly by each individual's particular circumstances (constraints) and partly by their aims in life (as summarized with a utility function). Most lean models assume that individuals make their choices without taking account of the effects of their actions on others. The choices are simple self-interested choices, ones that maximize their own utility. However, in more complex models, that assumption may be modified to take account of sympathy and hostility among individuals and groups that may exist. Such models may also explicitly take account of various rules and norms that an individual has internalized, some of which may have to be followed to maintain membership within a firm, group, or society.

Lean models of economic decision making also implicitly assume that the decisions made are either inhibited by a well-functioning system of laws or by personal inhibitions or by combinations of both that are sufficient to largely rule out non-market transactions. The individuals modeled do not steal or use threats of violence to gain what he or she wants—rather they engage in various forms of voluntary exchange. That is one of the fundamental "rules" or constraining principle of market networks.

VI. Rationality as Forward-Looking Internally Consistent Behavior

Microeconomic models use "rational choice" models to characterize the kinds of choices made by individuals in wide domain of possible circumstances. It is such models that allow methodological individualism to serve as the foundation for micro-economics. A wide variety of tastes and circumstances can be included in such analyses. In many economic settings, market level activities such as demand or supply are simply sums of individual consumer or firm decisions. In others, more complex, less linear effects emerge from the choices of individuals as with respect to externality and commons problems.

It bears keeping in mind that economists use the word "rational" in a manner that is quite different from its ordinary use in English. In normal usage, "rational" means "based on or in accordance with reason or logic." This in turn suggests that individuals who are rational are dispassionate, well-informed, analytically competent, and sane. Economists would regard such persons to be rational, but also many other types of individuals as long as their choices or ranking of alternatives are internally consistent. If A is preferred to B and C is preferred to B, than C must also be preferred to A for all possible A, B, and Cs. Individuals are locally rational is this is true for specific subsets of the possibilities confronted. Note that even insane or completely myopic persons may behave in a manner that is internally consistent and thus would be regarded to be rational in the economic sense, although their behavior would not be considered well-reasoned or reasonable.

For most purposes, local rationality is sufficient for the purposes of a model, insofar as models generally characterize only a subset of the choice settings that individuals confront Individuals that are rational in this sense tend to advance through aims their actions. The preferences of such persons with consistent preferences can be represented with numbers, with higher number representing choices like "C" above that are preferred to alternatives like "B" and "A" which are assigned lower numbers, with the number assigned to A lower than that assigned to "B." (One could not do so for preferences that are not consistent, because numbers are inherently transitive and hence consistent in this sense.)

It is, of course, the ability to characterize preferences with numbers that allows calculus to be used to characterize choices. Other aspects of choice settings determine the joint consequences of the choice made by groups of interdependent individuals.

The models used by economists, game theorists, and the rational choice strands of research in political science, sociology, and anthropology are all very similar to one another in spirit, in that they nearly all assume that people are basically rational—at least in the circumstances of interest. What differs is the choices to be made, the context of those decisions, whether expectations are accurate or not, and how individual choices determine the consequences of the choices made.

VII. Organization of this Book

The book is organized into three parts. Part I reviews the basic logic of neoclassical price theory. Part II reviews extensions to settings where time and uncertainties exist and to where firms are regarded to be organizations and goods as bundles of attributes. The roles of uncertainty and entrepreneurship are also analyzed using the same modelling methods used for the core models. Part III reviews extensions of the rational choice models to non-market settings that are relevant for economics. Law, Politics, and Ethics are all shown to have implications for the extent and nature of market networks. Part III concludes with a brief overview of the methods economists use to assess the relative merits of alternative market equilibria, laws, and public policies.

Although the book may appear to focus for the most part on mathematical representations using tools from calculus, its main aim is to expose students to broad subset of the most well-known ideas and results that emerged from rational-choice-based research in economics and related fields during the postwar period. The first and last lines of every model is where most of the economic insights can be found. The appendix of this chapter provides a useful list of rules for taking derivatives and definitions of mathematical terms used throughout the text.

References

Alchian, A. A., Allen, W. R., & Jordan, J. L. (2018). *University Economics*. Liberty Fund.

Buchanan, J. M., & Vanberg, V. J. (1991). The market as a creative process. *Economics & Philosophy*, 7(2), 167-186.

Knight, F. H. (1921). *Risk, Uncertainty and Profit*. (Vol. 31). Houghton Mifflin.

Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy*, 74(2), 132-157.

Nicholson, W., & Snyder, C. M. (2012). *Microeconomic theory: Basic principles and Extensions*. Cengage Learning.

Samuelson, P. A. (1948). Consumption theory in terms of revealed preference. *Economica*, 15(60), 243-253.

Varian, H. R., & Varian, H. R. (1992). *Microeconomic Analysis* (Vol. 3). New York: Norton.

Appendix I: Some Fundamental Rules, Concepts, and Definitions from Mathematics that Are Used throughout this Book

I. Some Useful Differentiation Rules from Calculus

i. Derivatives characterize the slopes of functions. They are generally of the form dy/dx, the change in y (the function's value) induced by a change in x (one of the variables that determines the values of y)

- If Y = a + bX, then dY/dX = b
- If $Y = aX^b$ then $dY/dX = abX^{b-1}$
- If Y = f(X) then dY/dX = df/dX
- The composite function rule
- If Y = f(g(X)) with g(X) = Z, then dY/dX = df/dZ * dg/dX
- The multiplicative rule

  If Y = f(X)*g(X) then dY/dX = df/dX * g(X) + f(X)*dg/dX

ii. Partial Derivatives. Many functions are determined by the values of more than one variable, such as X_1, X_2, X_3….. X_1, for example, might width, X_2 might be length, and X_3 might be height and Y might be the volume of a rectangular solid, $Y=X_1X_2X_3$. Similarly a Similarly a demand function might be a function of a goods own price, P_1, the prices of a complement, P_2, the price of a substitute, P_3, and personal income, Y, with the quantity of good 1 demand being $Q_1 = d(P_1, P_2, P_3, Y)$.

The partial derivative of Y with respect to X_1 is the slope of the function in the YxX_1 plane. To calculate a partial derivative, one takes an "ordinary" derivative with respect to the variable of interest (possibly X1) and treats the rest of the variables as "constants," e.g. as variables with a constant value and hence irrelevant for the derivative.

Below are some useful formula for functions of two variables.

- If Y = a + bX + cZ, then dY/dX = b , and dY/dZ = c
- If $Y = aX^bZ^c$ then $dY/dX = abX^{b-1}Z^c$ and $dY/dZ = acX^bZ^{c-1}$
- If Y = f(X, Z) then dY/dX = df/dX and dY/dZ = df/dZ
- If Y = f(g(X), R) with g(X) = Z,

  then dY/dX = df/dZ * dg/dX and dY/dR = df/dR. (Note that R's partial derivative is simpler, because it is part of function f rather than part of a composite function.

- If $Y = f(X)*g(X, R)$ then $dY/dX = df/dX * g(X) + f(X)*dg/dX$

  and $dY/dR=f(X)*dg/dR$ (Note that R's partial derivative is simpler because it is not used to multiply f(X).

- If $U = u([W-P_2Q_2]/P_1, Q_2)$ where $Q_1 = [W-P_2Q_2]/P_1$ then

  $dU/dQ_2 = (du/dQ_1)(-P_2/P_1) + du/dQ_2$

iii. The value of a variable that maximizes the value of a function is normally the one that sets the derivative of the function with respect that variable equal to zero—as long as the function being differentiated is strictly concave (e.g. has a negative second derivative).

- If $Y = f(g(X))$ with $g(X) = Z$, then function Y is maximized when X is such that

  $dY/dX = df/dZ * dg/dX = 0$

  (as long as $d^2Y/dX^2 = [d^2f/dZ^2 * (dg/dX)^2 + df/dZ * d^2g/dX^2 < 0$ at X*

- The value of X that maximizes Y is usually denoted as X* in this text and most others.

The equation that characterizes X* is normally a "first order condition" (a first derivative).

II. Definitions and Terminology

A. When the rules of logic are applied to numbers the result is mathematics.

i. Most of the mathematics we have been taught can be deduced from a few fundamental assumptions using the laws of logic.

- (See the postulates of Peano, an Italian mathematician (1850 - 1932).)

ii. Some mathematical economists are very attracted to the axiomatic approach (See Debreu's book for an early example), and we will spend a bit of time today seeing who that approach can be used to model human choices.

Some fundamental properties of logical and mathematical **relationships**:

i. DEF: Relationship R is **reflexive** in set X, if and only if aRa whenever a is an element of X.

ii. DEF: Relationship R is **symmetric** in set X if and only if aRb then bRa whenever a and b are elements of set X.

iii. DEF: Relationship R is **transitive** in set X if and only if aRb and bRc then aRc when a, b, and c are elements of set X.

iv. Recall that within the set of real numbers, there are relationships which are symmetric (equality),reflexive (equality) and transitive (equality, greater than, less than, greater than or equal than, less than or equal than).

v. In economics there are also several relationships which possess all three properties, and some that exhibit only transitivity.

vi. In general, economists assume that "rational" preference orderings satisfy all three of these properties. Strong and weak preference orderings are transitive, while indifference is transitive, symmetric and reflexive.

- Indeed, rationality in microeconomics is often defined as transitive preferences.

Note that the indifference relationship, I, can be defined in terms of the weak preference relationship R.

- The weak preference relationship R means "at least as good as."
- Note that if aRc and cRa, then aIc.

a. Similarly, the strong preference relationship, P, can be defined in terms of the weak preference relationship. The strong preference relationship means "better than."

- Note that if aRb but b~Ra then aPb.

DEF: A **function** from set X to (or into) set Y is a rule which assigns to each x in X a unique element, f(x), in Y. Set X is called the domain of function f and set Y its range.

- On most diagrams from math classes, the domain is the horizontal axis (X) and the range is the vertical axis (Y).
- However, most textbook diagram in economics have the domain of the function on the vertical axis (P) and the range of the function on the horizontal axis (Q). For example demand functions go from P (prices) into Q (quantities a consumer is prepared to purchase).
- This is evidently Marshall's fault, who decided that the diagrams were easier to draw this way—possibly because of the use of blackboards back in the 1890s.

DEF: A **utility function** is a function from set X into the real numbers such that iff aPb then U(a) > U(b) and if aIc then U(a)=U(c) for elements of the set X.

Note that a utility function defined in this way does not characterize satisfaction, but rather choices based on transitive weak preferences. However, if you think of utility as "satisfaction" or closeness to some "goal" you intuition will be correct. In diagrams, indifference curves are simply graphs (plots) of all combinations of two goods that generate the same utility.

Note that the assumption that a utility function exists, is equivalent to the assumption that individual preferences are transitive.

- Real numbers are transitive with respect to equality (indifference) and greater than (strict preference).
- The assumption that all combinations of the goods can be evaluated with the function implies that preferences are **complete**: each bundle (combination of goods and/or "bads") has a unique rank. a. Every bundle of goods generates either more or less or the same utility level as other goods.
- (Some theorists make a distinction between complete and incomplete utility mappings from X to R, but this distinction is not important for "routine" decisions.. Why?)

III. Some important definitions and concepts from Set Theory.

i. DEF: An infinite series, x_1, x_2, ... x_n is said to have a **limit** at x* whenever for any d >0, the interval x* d, x* + d contains an infinite number of points from the series. (That is to say, x* is a limit point of a series in any case where there are an infinite number of elements of the series arbitrarily close to x*.)

ii. DEF: A set is **closed** if it contains all of its limit points.

iii. Def: A set is **bounded** if every point in A is less than some finite distance, D, from other elements of A.

iv. Def: A set is **compact** if it is closed and bounded.

- Most opportunity sets in economics are assumed to be closed and bounded.
- Def: A set is **convex** if for any elements X_1 and X_2 contained in the set, the point described as $(1-d)X_1 + dX_2$ is also a member of the set, where $0<d<1$.

v. Essentially a convex set includes all the points directly between any two points in the set.

- That is to say, any convex (linear) combination of two points from the set will also be a point in the set.
- Thus, a solid circle, sphere, or square shaped set is a convex set but not a V-shaped or U-shaped set.
- To see this, draw one of these figures, pick serve representative pairs of points and connect them with a line interval (cord). The line interval will lie entirely in the set.
- What other common geometric forms are convex?
- (Why does a series of convex combinations trace out a cord? Because as d varies from 0 to 1, the “point” characterize moved along a line from one point (X_1) to the other (X_2.)

vi. Example from economics: "better sets" are usually assumed to be convex sets. That is to say, the set of all bundles which are deemed better than bundle a is generally assumed to be a convex set.

- Another example is the budget set, the set of all affordable commodities give a fixed wealth and fixed prices for all goods that might be purchased.

vii. **Convexity and compactness assumptions are widely used calculus and graphical models** of human decisionmaking, because they make smooth continuous functions (and lines) possible.

- Opportunity sets and production possibility sets are nearly always assumed to be convex and compact.